PRACTICAL ELECTRONICS

OCTOBER 1969

THREE SHILLINGS

FREE — INSIDE

★★★

SAMPLE CARD OF Cir-kit

★★★

use it with this project

P.E. WIDEBAND H.F. COMMUNICATIONS RECEIVER

AUDIO GENERATOR

ADCOLA PRODUCTS LIMITED (Regd Trade Mark)

THE RELIABLE SOLDERING INSTRUMENT!

SEND COUPON FOR LATEST LEAFLET

ADCOLA PRODUCTS LTD
ADCOLA HOUSE
GAUDEN ROAD
LONDON SW4
01-622 0291/3

NAME ....

ADDRESS ....

....

....

....

PE170

ORGAN TRANSISTORS

ZTX300	1/11	ZT1701	22/6	ZS170	1/11
ZTX302	3/-	ZT3055	20/6	OC28	19/-
ZT44	12/9	KR54	27/6	ACY21	5/4
ZT1613	7/9	KR56	24/9	ACY22	4/-
ZT1700	17/9	ZR12	16/9	OAZ203	12/-

Mullard LA2300 9/5

All above transistors direct from manufacturer.
Unmarked silicon planar transistors suitable for use in divider circuits:—**1/6** each or **£5** per 100.

LIGHT-SENSITIVE DEVICES

GIANT-SIZE SELENIUM SOLAR CELLS—PRODUCE UP TO 6MA FROM DAYLIGHT! 67mm diameter **10/-** each. 50mm × 37mm. 2 for **10/-**.

Transistors similar to OCP71 **2/-** each.

ORP12 CADMIUM SULPHIDE LIGHT-SENSITIVE RESISTORS **9/-** each. Light-sensitive diodes **10/-** per dozen.

WIRE-WOUND RESISTORS

Mains dropper type. Up to 30 watts. Some multi-tapped. Fraction of normal price! **10/-** per dozen.

MULLARD POLYESTER CAPACITORS FAR BELOW COST PRICE! 0·001μF 400V **3d.**, 0·0015μF 400V **3d.**, 0·0018μF 400V **3d.**, 0·0022μF 400V **3d.**, 0·01μF 400V **3d.**, 0·15μF 160V **6d.**, 0·22μF 160V **6d.**, 0·27μF 160V **6d.**, 1μF 125V **1/-**.

RECORD PLAYER CARTRIDGES. COMPLETE WITH NEEDLES GP67/2 Mono **15/-**, GP91/3 Compatible **£1**, GP93/1 Crystal Stereo **25/-**, GP94/1 Ceramic **30/-**.

TRANSISTORISED SIGNAL INJECTOR KIT 10/-.
SIGNAL TRACER KIT 10/-. CAR REV. COUNTER KIT 10/-.

VEROBOARD

2½ × 1"	0·15 matrix	**1/3**
3¾ × 2½"	0·15 matrix	**3/3**
3¾ × 3¾"	0·15 matrix	**3/11**
5 × 2½"	0·15 matrix	**3/11**
5 × 3¾"	0·15 matrix	**5/6**
17 × 2½"	0·15 matrix	**11/-**
17 × 3¾"	0·15 matrix	**14/8**
3¾ × 2½"	0·1 matrix	**4/2**
3¾ × 3¾"	0·1 matrix	**4/9**
5 × 2½"	0·1 matrix	**4/7**
5 × 3¾"	0·1 matrix	**5/6**

Spot Face Cutter **7/6**. Pin Insert Tool **9/6**. Terminal Pins **3/6** for 36.
Special Offer! Spot Face Cutter and 5 2½ × 1" boards......**9/9** only.

PAPER CONDENSERS. Mixed bags 0·001μF to ·5μF, **12/6** per 100.
SILVER-MICA, Ceramic, Polystyrene Condensers. Well assorted. Mixed types and values, **10/-** per 100.

RESISTORS. Mixed types and values, ¼ to 1 watt. **6/6** per 100. **55/-** per 1,000. Wire-wound resistors. 1 watt to 10 watts. Mixed values. 20 for **10/-**.

TRANSISTORS. Mixed, unmarked, mainly O.K. **7/6** for 50.

12 VOLT TRANSISTORISED FLUORESCENT LIGHTS. HALF NORMAL PRICE.
8 Watt 12" tube. Reflector type **£2.19.6.** 15 watt 18" Batten type **£3.19.6.**
IDEAL FOR CAMPING OR CARAVAN HOLIDAYS! A BRIGHT LIGHT FOR VERY LITTLE CURRENT!

ELECTROLYTIC CONDENSERS

0·25μF	3 volt	4μF	4 volt	10μF	25 volt	64μF	9 volt
1μF	6 volt	4μF	12 volt	20μF	6 volt	100μF	9 volt
1μF	20 volt	4μF	25 volt	25μF	6 volt	320μF	4 volt
1·25μF	16 volt	5μF	6 volt	25μF	12 volt	320μF	10 volt
2μF	3 volt	6μF	6 volt	25μF	25 volt	400μF	6·4 volt
2μF	350 volt	8μF	3 volt	30μF	6 volt	All at 1/- each.	
2·5μF	16 volt	8μF	12 volt	30μF	10 volt	20 assorted	
3μF	25 volt	8μF	50 volt	50μF	6 volt	(our selection)	
3·2μF	64 volt	10μF	6 volt	64μF	2·5 volt	10/-.	

Orders by post to:

G. F. MILWARD, DRAYTON BASSETT, NEAR TAMWORTH, STAFFS.

Please include suitable amount to cover post and packing. Minimum order 10/-. Stamped addressed envelope must accompany any enquiries.

For customers in Birmingham area goods may be obtained from Rock Exchanges, 231 Alum Rock Road, Birmingham 8.

prepare now for tomorrow's world

Today there is a huge demand for technologists such as electronics, nuclear and computer systems engineers, radio and television engineers, etc. In the future, there will be even more such important positions requiring just the up-to-date, advanced technical education which CREI, the Home Study Division of McGraw-Hill Book Co., can provide.

CREI Study Programmes are directly related to the problems of industry including the latest technological developments and advanced ideas. The individual tuition given by the CREI panel of experts in each specialised field is comparable in technological content with that of technical colleges.

Take the first step to a better job now—enrol with CREI, the specialists in Technical Home Study Education.

CREI Programmes are available in:
Electronic Engineering Technology ✱ Industrial Electronics for Automation ✱ Computer Systems Technology ✱ Nuclear Engineering ✱ Mathematics for Electronics Engineers ✱ Television Engineering ✱ Radar and Servo Engineering ✱ City and Guilds of London Institute: Subject No. 49 and Advanced Studies No. 300.

CREI

CREI (London), Walpole House,
173-176 Sloane Street, London S.W.1.
A Subsidiary of McGraw-Hill Inc.

Post this coupon today for a better future

To C.R.E.I. (London), Walpole House, 173-176 Sloane Street, London S.W.1.
Please send me (without obligation) details of your Educational Programmes
please tick
My interest is City and Guilds ☐ General ☐
Name ....
Address ....
....
Electronics experience ....
.... PE1 8

Lasky's

NEW SCOOP

THE ASTRAD ORION
THE WORLD'S SMALLEST 6 TRANSISTOR TWO WAVEBAND RADIO RECEIVER FROM RUSSIA

Made to the highest Russian space-age standard—this remarkable micro-size set measures only 1 11/16 x 1 3/10 x 5 5/16in. yet it contains 6 transistors and other components combined in a photo etched circuit, only ¾ x ½in; tuning capacitor, ferrite rod (or core) aerial, battery, wave band selection, switch, etc. Output to a high impedance, crystal earpiece, giving ample volume (automatically adjusted) and clear tone. Brief tech. spec. Waveband coverage—Medium wave 525 to 1605kc/s, Long wave 150kc/s to 408kc/s. Sensitivity: 35mV max. Selectivity—10dB (at 30kc/s de-tuning). Power source: 1 x 1·4V Mercury battery (Mallory type RM625 or equivalent).

The Orion is supplied fully built and tested complete with battery, left and right fitting earphone supports and attractive black and ivory plastic presentation/carrying case (matching the Orion). Never miss your favourite music, sport, news—the Orion is an ideal gift for all, providing a constant source of enjoyment without disturbing others. **Lasky's price 39/6 Post 2/6.** Extra battery (rechargeable type) 3/6.

*NOTE: The battery we supply with the Orion is a rechargeable type. Charger units are available enabling you to recharge the battery from AC Mains 220/240V supply. Price 19/6—post free if ordered now with radio—otherwise 2/-.

LASKY'S RADIO LTD., 3-15 Cavell St., London, E.1
See our other advert for list of London branches

CENTRAL HEATING
Complete systems at the LOWEST PRICES IN BRITAIN

As far as we know, no-one can possibly offer central heating prices like these—the lowest available in Britain today! Quality is assured too, for we only supply equipment and appliances by leading manufacturers. This is the really economical way to have central heating. The system of your choice, gas, oil or solid fuel to suit your home, your needs—and your pocket! You do the installation and that's easy with our step-by-step instructions and technical advice—and see what you save!

PARKRAY 99X
The latest room-heater and seven radiators, hot water cylinder, pump, pipes and all the fittings you need for a solid fuel central heating system and lashings of domestic hot water.
ONLY 165gns

GLOW-WORM MAJORCA
Roomheater and seven radiators, hot water cylinder, pump, pipes and all the fittings you need for a gas central heating system and a full domestic hot water supply.
ONLY 233gns

OIL-FIRED BOILER
Oil-fired boiler and nine radiators, hot water cylinder, pump, pipes, oil tank and all the fittings you need for an oil central heating system and domestic hot water
ONLY 299gns

and the latest microbore systems at even lower prices
All packs contain everything to complete your system and we offer free technical design and advice, free delivery, up to 5 years to pay on the N.C.B., Gas Board or Oil Companies. Finance Plans.

To:— Complete Heating Systems Ltd., 499 Bristol Road, Selly Oak, Birmingham 29.
Please send me full details of the lowest-priced central heating systems in Britain.
Name ....
Address ....
.... P.E.1

LIND·AIR OPTRONICS LTD

See our vast range of
Electronic Components
and Accessories
at our enlarged
Component Centre
25 Tottenham Court Road

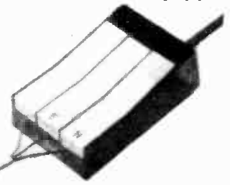
HI-TONE RECORDING TAPE

BRITISH MADE TOP QUALITY

J1001	3"	Long Play PVC	225ft	**5/6**	P. & P. 1/2
J1002	3"	Triple Play Poly	600ft	**10/6**	P. & P. 1/2
J1003	5"	Long Play PVC	900ft	**10/-**	P. & P. 1/8
J1004	5"	Double Play Poly	1200ft	**15/-**	P. & P. 1/8
J1005	5¾"	Long Play PVC	1200ft	**12/6**	P. & P. 2/-
J1006	5¾"	Double Play Poly	1800ft	**22/6**	P. & P. 2/-
J1007	7"	Standard Play PVC	1200ft	**12/6**	P. & P. 2/6
J1008	7"	Long Play PVC	1800ft	**17/6**	P. & P. 2/6
J1009	7"	Double Play Poly	2400ft	**25/-**	P. & P. 2/6
J1010	7"	Triple Play Poly	3600ft	**50/-**	P. & P. 2/6

Visit our Brand New
Hi-Fi Demonstration Room,
Tape, Record Bar and
Scientific Show of
Microscopes, Binoculars,
Telescopes and Watches at
18 Tottenham Court Road

MAINS KEYNECTOR
SAVES TIME—SAFELY!



One mains "Keynector" instantly and safely connects electrical appliances to mains supply without the use of a plug. A number of appliances may be used simultaneously up to the full 13 amp rating of this device. A red light glows when "live". The "Keynector" is fused and has its own robust switch which is interlocked to prevent connections when "live".
Invaluable to handymen, servicemen, demonstrators, etc.

39/6 P. & P. 3/-.

VHF AIRCRAFT BAND CONVERTOR.
When placed within 1in. of a MW band radio full coverage of VHF Aircraft Band 108-135Mc/s. can be obtained. All transistor, 9V battery operation. Fully tunable 18½in. × 7 section telescopic aerial. Size 4 × 2¾ × 1¼in. **79/6.** P. & P. 3/6.

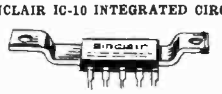
MODEL MAKER'S MOTOR No. 15RN. Voltage 1½-5V. Current 400mA. Torque 12g.cm. Body size 1⅛" × long × ⅞" dia. Shaft 3/16" long 1/16" dia. Ideal for small models and toys. **5/6** each. P. & P. 1/3. 3 for **15/-**. P. & P. 2/6.

DE-LUXE STEREO HEADPHONES

With soft rubber earpieces. Impedance 8-16 ohms. Frequency response 23-13,000cps. With lead and stereo plug.
Only **59/6.** P. & P. 3/6.

NEW STEREO/MONO HEADPHONES.
SDH-7. Soft rubber earpieces with slide switch for mono/stereo listening and ind. vol. controls. Impedance 8–16 ohm Freq. response 25–15,000cps. With lead and stereo plug.
£6.6.0. P. & P. 3/6.

SINCLAIR IC-10 INTEGRATED CIRCUIT



10 watt Amplifier. Size only 1 × 0·4 × 0·2in. A true hi-fi amplifier complete with manual giving details of a wide range of applications and instructions. Guaranteed 5 years. ONLY **59/6.** P. & P. 1/6.

TRANSFORMERS

AUTO WOUND TRANSFORMERS

All winding voltage ratings and tappings 0–115–200–220–240V, except MT113 0–115–210–240V

		Size	Weight	Price	
MT113	20W	2¾ × 1 11/16 × 1⅜in	11oz	**12/6**	(P. & P. 2/6)
MT64	75W	2⅝ × 2½ × 2⅜in	1lb 14oz	**21/9**	(P. & P. 4/6)
MT4	150W	3½ × 2⅞ × 3in	3lb	**33/-**	(P. & P. 6/-)
MT65	200W	3½ × 4½ × 4in	4lb	**39/6**	(P. & P. 6/-)
MT66	300W	4 × 4 × 3⅜in	6lb 7oz	**59/4**	(P. & P. 9/-)
MT110	400W	4⅜ × 4½ × 4in	11lb	**85/-**	(P. & P. 10/-)
MT67	500W	5½ × 4 × 4¾in	12lb 8oz	**89/-**	(P. & P. 10/6)
MT83	750W	4½ × 5½ × 5¾in	13lb 4oz	**95/7**	(P. & P. 10/6)
MT84	1000W	4½ × 5½ × 5½in	16lb	**142/2**	(Carr. extra)
MT93	1500W	5 5/16 × 5⅞ × 6½in	28lb 9oz	**170/6**	(Carr. extra)
MT94	1750W	5 5/16 × 6⅜ × 6¾in	31lb	**195/-**	(Carr. extra)
MT95	2000W	7 × 6½ × 8¼in	40lb	**211/2**	(Carr. extra)
MT73	3000W	6⅞ × 7⅛ × 8⅜in	45lb 8oz	**300/-**	(Carr. extra)

LOW VOLTAGE 12V RANGE

Primary 200–250V; secondary 12V

MT111	0·5A	3 × 2¼ × 1⅜in	12oz	**15/3**	(P. & P. 2/6)
MT71	2A	2⅜ × 2½ × 2¼in	1lb	**19/-**	(P. & P. 3/9)
MT69	4A	3½ × 2⅞ × 2⅞in	2lb 4oz	**28/-**	(P. & P. 6/-)
MT70	6A	4 × 3 × 3⅜in	3lb 12oz	**39/-**	(P. & P. 6/-)
MT72	10A	3½ × 4½ × 4in	6lb 3oz	**51/-**	(P. & P. 9/-)
MT115	20A	4⅜ × 4½ × 4in	11lb 13oz	**95/-**	(P. & P. 9/-)
MT187	30A	5¼ × 4⅞ × 4⅞in	16lb 12oz	**180/-**	(P. & P. 13/6)

LOW VOLTAGE 24V RANGE

Primary 200/250V; secondary 24V

MT58	1A	2⅝ × 2⅜ × 2¼	1lb 7oz	**23/9**	(P. & P. 4/6)
MT114	3A	2½ × 3 × 3in	3lb 6oz	**38/-**	(P. & P. 6/-)
MT72	5A	4 × 3⅜ × 3⅜in	5lb 12oz	**53/10**	(P. & P. 6/-)
MT17	8A	4⅜ × 3⅞ × 4in	7lb 8oz	**72/7**	(P. & P. 9/-)
MT115	10A	4⅜ × 4½ × 4in	11lb 13oz	**95/-**	(P. & P. 11/-)

LOW VOLTAGE 30V RANGE

Primary 200/250V; secondary tapped 12–15–20–24–30V

MT112	0·5A	3½ × 2 7/16 × 1 5/16in	1lb 4oz	**17/4**	(P. & P. 3/9)
MT79	1A	2⅜ × 2½ × 2⅜in	2lb	**23/-**	(P. & P. 6/-)
MT20	3A	4 × 3½ × 3⅜in	4lb 6oz	**46/2**	(P. & P. 6/-)
MT51	5A	4⅜ × 3½ × 4in	6lb 8oz	**60/9**	(P. & P. 9/-)
MT88	8A	5½ × 3⅜ × 4¼in	9lb 6oz	**92/4**	(P. & P. 11/-)
MT89	10A	5½ × 4 × 4½in	12lb 2oz	**103/6**	(P. & P. 11/-)

LOW VOLTAGE 50V RANGE

Primary 200–250V; secondary tapped 19–25–33–40–50V

MT102	0·5A	2⅞ × 2⅞ × 2¼in	1lb 11oz	**21/3**	(P. & P. 6/-)
MT104	2A	4 × 3½ × 3⅜in	5lb	**45/8**	(P. & P. 6/-)
MT106	4A	4⅞ × 4½ × 4	9lb 4oz	**77/-**	(P. & P. 9/-)
MT118	8A	5¼ × 5¼ × 4⅞in	18lb 9oz	**132/-**	(P. & P. 13/6)
MT119	10A	6½ × 4½ × 6¼in	19lb 12oz	**165/-**	(P. & P. 15/6)

LOW VOLTAGE 60V RANGE

Primary 200/250V; secondary tapped 24–30–40–48–60V

MT124	0·5A	3½ × 2⅞ × 2⅝in	2lb 4oz	**24/-**	(P. & P. 6/-)
MT127	2A	4 × 3½ × 3⅜in	5lb 6oz	**52/10**	(P. & P. 6/-)
MT123	4A	4½ × 3⅞ × 4½in	10lb 6oz	**99/-**	(P. & P. 11/-)
MT122	10A	6½ × 5 × 6¼in	23lb 2oz	**152/-**	(Carr. extra)

MAINS H.T. RANGE

				Size	Price	P&P
MT1AT	250–0–250V	80MA	6·3V 3·5A 5/6·3V 1A	3½ × 3 × 3in	**33/-**	6/-
MT6AT.	250–0–250V	100MA	6·3V 3·5A 5/6·3V 1A	4 × 3½ × 3¼in	**38/3**	6/-
MT110	250–0–250V	120MA	6·3V 3·5A 5/6·3V 1A	4 × 4 × 3¼in	**44/9**	6/-
MT11AT	300–0–300V	100MA	6·3V 3·5A 5/6·3V 1A	4 × 3½ × 3⅜in	**37/9**	6/-
MT12AT	300–0–300V	120MA	6·3V 4A 5/6·3V 1A	4 × 3⅞ × 3⅜in	**46/2**	9/-
MT33AT	300–0–300V	150	6·3V 4A 5/6·3V 1A	4 × 4 × 3¼in	**59/4**	9/-
MT2AT	350–0–350V	80	6·3V 3·5A 5/6V 1A	4 × 3½ × 3⅜in	**38/6**	6/-
MT7	350–0–350V	100	6·3V 3·5A 5/6·3V 1A	4 × 3½ × 3⅜in	**42/4**	6/-
MT8	350–0–350V	120	6·3V 3·5A 5/6·3V 1A	4 × 3⅞ × 3⅜in	**50/-**	6/-

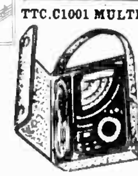
BATTERY CHARGER TYPES

Primary voltage 200–250V; secondary 6–12V

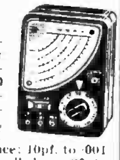
MT77	1A	2⅞ × 2¼ × 2⅜in	1lb 6oz	**15/-**	(P. & P. 4/6)
MT45	1·5A	2⅞ × 2⅜ × 2⅜in	1lb 9oz	**21/9**	(P. & P. 4/6)
MT46	2A	3½ × 2⅝ × 2⅜in	2lb 4oz	**25/4**	(P. & P. 6/-)
MT47	3A	4 × 3 × 3⅜in	3lb 8oz	**28/4**	(P. & P. 6/-)
MT5	4A	4 × 2⅞ × 3¼in	3lb 11oz	**33/-**	(P. & P. 6/-)
MT78	5A	4 × 3½ × 3⅜in	5lb 4oz	**42/-**	(P. & P. 6/-)
MT86	6A	4 × 3½ × 3⅞in	5lb 12oz	**48/-**	(P. & P. 6/-)
MT48	7A	4 × 4 × 3⅜in	6lb	**56/7**	(P. & P. 9/-)
MT146	8A	3½ × 4 × 4in	6lb 4oz	**75/-**	(P. & P. 9/-)
MT49	9A	4⅜ × 3⅞ × 4in	7lb 8oz	**99/-**	(P. & P. 9/-)
MT147	10A	4⅜ × 3½ × 4in	9lb 3oz	**105/-**	(P. & P. 9/-)
MT50	12·5A	5¼ × 4½ × 4⅜in	11lb 14oz	**125/-**	(P. & P. 11/-)

Amperages are d.c. with nominal selenium bridge rectifiers
MAINS ISOLATING RANGE also available

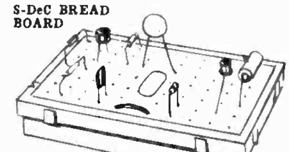
TTC.C1001 MULTITESTER in leather case. 20,000 opv. AC volts 10, 50, 250, 1,000V. DC volts 5 25, 125, 500, 2,500V. D.C. Current 0–50µA, 0–250mA Resistance 0–60K, 0–6 Megohm. Decibels −20 to +22dB. Size of meter 4¾ × 3⅞ × 1in. **85/-**. P. & P. 3/6.



SHIRA 62D MULTI-TESTER 20,000 o.p.v.
DC voltage: 5-25-50-250-500-2·5K (20,000 ohms per volt). AC Voltage: 10-50-100-500 1000 volts (10,000 ohms per volt). DC Current: 0-50µA, 0-2·5mA, 0-250mA. Resistance: 0-6K, 0-6Mg (300 ohm and 30K at centre scale). Capacitance: 10pf. to ·001 mfd, ·001µf to ·1µF. Decibels: −20 to +22dB. Size 4¾ × 3½ × 1in. Complete with case **77/-**. P. & P. 3/6.



S-DeC BREAD BOARD



British made

Solderless breadboard panels, for fast reliable component connections.
Single DeCs. One S-DeC with Control Panel, Jig and Accessories for solderless connections to controls, etc., with booklet "Projects on S-DeC" giving construction details for a variety of circuits. **29/6.** P. & P. 2/6.
4-DeC KIT. Four S-DeCs wth two Control Panels, Jigs and Accessories and, the booklet "Projects on S-DeC" all contained in a strong attractive plastic case. Ideal for the professional user. **£5.17.6.** P. & P. 3/6.

GARRARD DECKS

SRP22 less cartridge	**£5. 9.6**
1025 Stereo/Mono with cart.	**£6.19.6**
2025 Stereo/Mono with cart.	**£7.19.6**
3000S Stereo/Mono with cart.	**£9.19.6**
3000D Stereo/Mono with cart.	**£10.19.6**
SP25 less cartridge	**£11.19.6**
SP25 with Decca Deram cart.	**£17. 4.6**
SL55 less cartridge	**£11.19.6**
SL55 with Decca Deram cart.	**£17. 4.6**
SL65 less cartridge	**£14. 9.6**
Covers for above	**£2.19.6**
Bases for above	**£2.10.0**
AP75 less cartridge	**£18.18.0**
SL75 less cartridge	**£28. 7.0**
SL95 less cartridge	**£38.19.6**
Bases for above	**£4.19.6**
SPECIAL OFFER!	
SP25 less cart., with base	**£13.10.0**

P. & P. Decks 12/6, Cover 4/6, Base 4/6.
P. & P. Deck/Cover/Base 17/-.

MINIATURE SOLDERING IRON
British made and designed for use with transistor circuitry but ideal for many other uses. A.C. 240V. 18W. Length 7 5/16in. ⅛in slide on bit. Price **32/6.** P. & P. 2/-.

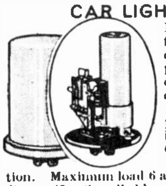
LAO

LIND·AIR OPTRONICS LTD

18, 25 & 53 TOTTENHAM COURT ROAD, LONDON W.1.
Telephone: 01-580 2255/4532/7679
Shops open 9-6 pm. Monday to Saturday. Thursday until 7 pm.

ALL MAIL ORDERS
To Dept. PE 1069
54a Tottenham Court Road,
London, W.1

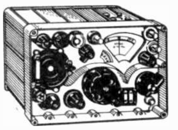
CAR LIGHT FLASHERS



Heavy duty light flasher employs a condenser discharge principle operating on electro mechanical relay. (As inset.) Housed in strong plastic case. Flashing rate between 60-120 per minute. 12 volt DC operation. Maximum load 6 amps. Size 2 11/16" dia. 4". Supplied brand new at a fraction of original cost **6/6** each. P. & P. 2/6. (3 for **17/6**. P. & P. 4/6.)

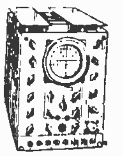
R209 MK II COMMUNICATION RECEIVER

11 valve high grade communication receiver suitable for tropical use. 1·20 Mc/s on 4 bands. AM/CW/FM operation. Incorporates precision vernier driver, BFO. Aerial trimmer, internal speaker and 12 V d.c. internal power supply. Supplied in excellent condition, fully tested and checked.



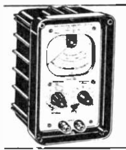
£15
Carr. 20/-.

TYPE 13A DOUBLE BEAM OSCILLOSCOPES



An excellent general purpose D/B oscilloscope. T.B. 2 c/s-750 kc/s. Bandwidth 5·5 Mc/s. Sensitivity 33 mV/CM. Operating voltage 0/110/200/250 V. a.c. Supplied in excellent working condition. **£22.10.0** or complete with all accessories, probe, leads, lid, etc. **£25**. Carriage 30/-.

MARCONI CT44/ TF956 AF ABSORPTION WATTMETER

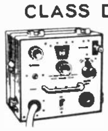


1 μ/watt to 6 watts.
£20. Carr. 20/-.

SOLARTRON CD. 1016 OSCILLOSCOPE

Double beam. d.c. To 5 Mc/s. Excellent condition. **£55** each. Carr. 20/-.

CLASS D WAVEMETERS



A crystal controlled heterodyne frequency meter covering 1·7-8 Mc/s. Operation on 6V d.c. Ideal for amateur use. Available in good used condition. **£5.19.6.** Carr. 7/6, or brand new with accessories. **£7.19.6.** Carr. 7/6.

CLASS D WAVEMETERS No. 2

Crystal controlled. 1·2-19 Mc/s. Mains or 12V d.c. operation. Complete with calibration charts. Excellent condition. **£12.10.0.** Carr. 30/-.

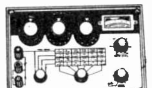
TO-3 PORTABLE OSCILLOSCOPE

3in. tube. Y amp. Sensitivity 0·1v p-p/CM. Bandwidth 1·5 cps-1·5 MHZ. Input imp. 2 meg Ω 25 PF. X amp. sensitivity 0·9v p-p/CM. Bandwidth 1·5 cps-800 KHZ. Input imp. 2 meg Ω 20 PF. Time base. 5 ranges 10 cps-300 KHZ. Synchronization. Internal/external. Illuminated scale 140 215 × 330 MM. Weight 15½lb. 220/240 V. A.C. Supplied brand new with handbook. **£35.0.0.** Carr. 10/-.

SOLARTRON CD. 711S.2 OSCILLOSCOPES

Double beam. D.C. to 9 Mc/s. Perfect order. **£65.** Carr. 50/-.

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

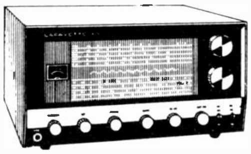


A new portable bridge offering excellent range and accuracy at low cost. Ranges: R. 1 Ω-11·1 meg Ω 6 Ranges ±1%. L.1 μH - 111 HENRYS 6 Ranges -2%. C. 10pF ±1110mFd. 6 Ranges ±2%. TURNS RATIO 1:1/1000-1:11100. 6 Ranges ±1%. Bridge voltage at 1,000 cps. Operated from 9 volts. 100μA. Meter indication. Attractive 2 tone metal case. Size 7¼ × 5 × 2in. **£20.** P. & P. 5/-.

UNR-30 4-BAND COMMUNICATION RECEIVER

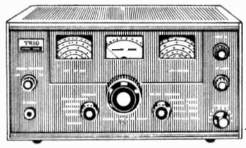
Covering 550 Kc/s-30 Mc/s. Incorporates BFO. Built-in speaker and phone jack. Metal cabinet. Operation 220/240V. a.c. Supplied brand new, guaranteed with instructions. Carr. 7/6 **13 gns.**

LAFAYETTE SOLID STATE HA600 RECEIVER



5 BAND AM/CW/SSB AMATEUR AND SHORT WAVE 150 kc/s-400 kc/s and 550 kc/s-30 Mc/s F E T front end ● 2 mechanical filters ● Huge dial ● Product detector ● Variable BFO ● Noise limiter ● S meter ● 24in Bandspread ● 230V a.c./12V d.c. neg. earth operation ● RF gain control. Size 15in 9⅞in 8¼in. Weight 18lb. EXCEPTIONAL VALUE. £45. Carr. 10/-. S.A.E. for full details.

TRIO COMMUNICATION RECEIVER MODEL 9R-59DE

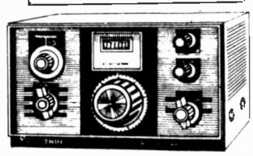


4 band receiver covering 550Kc/s to 30Mc/s. continuous and electrical bandspread on 10, 15, 20, 40 and 80 metres. 8 valve plus 7 diode circuit. 4/8 ohm output and phone jack. SSB-CW ● ANL ● Variable BFO ● S meter ● Sep. bandspread dial ● IF 455Kc/s ● Audio output 1·5W. ● Variable RF and AF gain controls. 115/250V A.C. Mains. Beautifully designed. Size: 7 × 15 10in. With instruction manual and service data. **£42.10.0.** Carriage paid.
TRIO COMMUNICATION TYPE HEADPHONES Normally **£5.19.6.**
OUR PRICE **£3.15.0** if purchased with above receiver.

TRIO JR-500SE 10-80 Metre AMATEUR RECEIVER

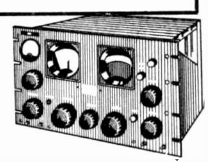
TRIO TS 510 AMATEUR TRANSCEIVER with speaker and mains P.S.U. £212. IN STOCK!

Covers all the amateur bands in 7 separate ranges between 3·5 and 29·7Mc/s, 7 valves, 2 transistors and 5 diodes plus 8 crystals: output 8 and 500 ohm and 5,000 ohm phone jack, Crystal controlled oscillator. Variable BFO, VFO. AVC, ANL. S meter. SSB-CW. Stand-by switch. Special double gear dial drive with direct reading down to 1kHz. Remote control socket for connection to a transmitter. Audio output 1W 115/250V a.c. mains. Superb modern styling. Size 7 × 13 × 10in. with instruction manual and service data. **£69.10.0.** Carr. paid.



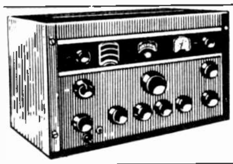
SPECIAL BONUS OFFER! TRIO SP5D Matching Speaker Mate and TRIO HS4 Communication Headphones. Normal Value £10.7.0. FREE OF CHARGE with every JR.500SE purchased.

HAMMARLUND SP600JX COMMUNICATION RECEIVER



High quality professional dual conversion communication receivers. Few available again in this country at a reasonable price. Frequency range 540 Kc/s-54 Mc/s in 6 bands, variable tuning or 6 channel crystal controlled. 2·5 watt output into 600 ohms. Input 110/230V a.c. 20 valve circuit incorporating: Xtal filter, B.F.O., A.N.L., Xtal calibrator, S meter etc. Size 19 × 12 × 22in. (List £520.) Offered in excellent condition fully tested and checked. **£100** each.

RCA COMMUNICATION RECEIVER AR88D

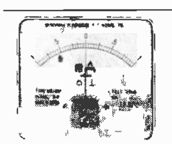


Latest release by ministry BRAND NEW in original cases. 110-250V a.c. operation. Frequency in 6 Bands. 535Kc/s-32Mc/s continuous. Output impedance 2·5-600 ohms. Incorporating crystal filter, noise limiter, variable BFO, variable selectivity, etc. Price **£87.10.0.** Carr. £2.

LAFAYETTE PF-60 SOLID STATE VHF FM RECEIVER

A completely new transistorised receiver covering 152-174 Mc/s. Fully tuneable or crystal controlled (not supplied) for fixed frequency operation. Incorporates 4 INTEGRATED CIRCUITS. Built in speaker and illuminated dial. Squelch and volume controls. Tape recorder output. 75 Ω aerial input. Headphone jack. Operation 230V. A.C./12V. D.C. Neg. earth. **£37.10.0.** Carr. 10/-.

CLEAR PLASTIC PANEL METERS



First grade quality Moving Coil panel meters. Type MR 38P. 1[21]/[32]in square fronts.

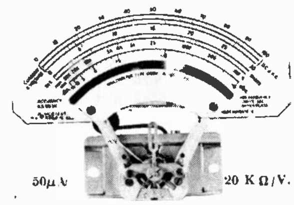
50μA	37/6	500-0-500μA	25/-	150V. D.C.	25/-
50-0-50μA	35/-	1mA	25/-	300V. D.C.	25/-
100μA	35/-	1-0-1mA	25/-	500V. D.C.	25/-
100-0-100μA	32/6	2mA	25/-	750V. D.C.	25/-
200μA	32/6	5mA	25/-	15V. A.C.	25/-
500μA	37/6	10mA	25/-	50V. A.C.	25/-
		50mA	25/-	150V. A.C.	25/-
		100mA	25/-	300V. A.C.	25/-
		150mA	25/-	500V. A.C.	25/-
		200mA	25/-	8 meter 1mA	29/6
		300mA	25/-	VU meter	39/6
		500mA	25/-		
		750mA	25/-		
		1 amp	25/-		
		2 amp	25/-		
		5 amp	25/-		
		20mA	25/-		
		3V. D.C.	25/-		
		10V. D.C.	25/-		
		20V. D.C.	25/-		
		100V. D.C.	25/-		

Full range of other sizes in stock. Send s.a.e. for leaflet.

POWER RHEOSTATS

High quality ceramic construction. Windings embedded in vitreous enamel. Heavy duty brush wiper. Continuous rating. Wide range ex-stock. Single hole fixing, ¼in. dia. shafts. Bulk quantities available.
25 WATT 10/25/50/100/250/500/1,000/1,500/2,500 or 5,000 ohms, **14/6.** P. & P. 1/6.
50 WATT. 10/25/50/100/250/500/1,000/2,500 or 5,000 ohms, **21/-.** P. & P. 1/6.
100 WATT. 1/5/10/25/50/100/250/500/1,000 or 2,500 ohms, **27/6.** P. & P. 1/6.

AVOMETER MOVEMENTS



50μA 20 KΩ/V.

Spare movements for Model 8 or 9. (Fitted with Model 9 scale) or basis for any multi-meter. Brand New and Boxed **69/6** P. & P. 3/6.

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

10 meg. input 10 ranges: ·01 / ·003 / ·1 / ·3 / 1 / 3 / 10 / 30 / 100 / 300V. R.M.S. 4c/s.-1·2Mc/s. Decibels —40 to +50dB. Supplied brand new complete with leads and instructions. Operation 230V a.c. **£17.10.0.** Carr. 5/-.

LELAND MODEL 27 BEAT FREQUENCY OSCILLATORS

Frequency 0·20 Kc/s on 2 ranges. Output 500 Ω or 5k Ω. Operation 200/250V. A.C. Supplied in perfect order. **£12.10.0.** Carr. 10/-.

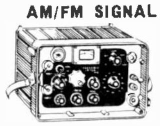
TE-65 VALVE VOLTMETER

High quality instrument with 28 ranges. D.c. volts 1·5-1,500V. A.c. volts 1·5-1,500V. Resistance up to 1,000 megohms. 220/240V a.c. operation. Complete with probe and instructions. **£17.10.0.** P. & P. 6/-. Additional Probes available: R.F. **35/-.** H.V. **42/6.**

COSSOR 1049 DOUBLE BEAM OSCILLOSCOPES

D.c. coupled. Band width 1kc/s. Perfect order. **£25.** Carr. 30/-.

AM/FM SIGNAL GENERATORS



Oscillator Test No. 2. A high quality precision instrument made for the ministry by Airmec. Frequency coverage 20-80Mc/s. AM C.W./FM. Incorporates precision dial, level meter, precision attenuator 1μV-100mV. Operation from 12V d.c. or 0/110/200/250V a.c. Size 12 × 8½ × 9in. Supplied in brand new condition complete with all connectors fully tested. **£45.** Carr. 20/-.

GEARED MAINS MOTORS

Paralux type SD19 230/250V a.c. Reversible. 30 RPM. 40 lb in. Complete with capacitor. Excellent condition. **99/6.** Carr. 10/-.

TE-16A Transistorised Signal Generator. 5 ranges 400 kHz-30 mHz. An inexpensive instrument for the handyman. Operates on 9v battery. Wide, easy to read scale. 800 kHz modulation. 5¼ × 5¼ × 3½. Complete with instructions and leads. **£7.19.6.** P.&P. 4/-.

FIELD TELEPHONES TYPE L

Generator ringing, metal cases. Operates from two 1·5v. batteries (not supplied). Excellent condition. **£4.10.0** per pair. Carr. 10/-.

AUTO TRANSFORMERS

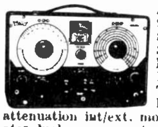
0/115/230v. Step up or step down. Fully shrouded.

150 W.	£1.12.6,	P. & P. 3/6
300 W.	£2.7.6,	P. & P. 4/6
500 W.	£3.10.0,	P. & P. 6/6
1,000 W.	£5.10.0,	P. & P. 7/6
1,500 W.	£7.19.6,	P. & P. 8/6
7,500 W.	£15.10.0,	P. & P. 20/-

G. W. SMITH & CO (RADIO) LTD.

Also see oppos. page

ARF-100 COMBINED AF-RF SIGNAL GENERATOR



A.F. SINE WAVE 20-200,000 c/s. Square wave 20-30,000 c/s. O/P. **HIGH IMP. 21V.** P/P600 Ω 3·8 V. P/P. TF 100 kc/s-300 Mc/s. Variable R.F. attenuation int/ext. modulation. Incorporates dual purpose meter to monitor AF output and % mod. on R.F 220/240 V a.c. **£30.0.0.** Carr. 7/6.

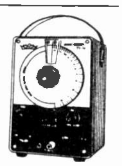
TE-20D RF SIGNAL GENERATOR

Accurate wide range signal generator covering 120kc/s to 500Mc/s on 6 bands. Directly calibrated. Variable RF attenuator, audio output. Xtal socket for calibration. 220/240V a.c. Size 140 × 215 × 170mm. Brand new with instructions. **£15.** Carr. 7/6.

PEAK SOUND PRODUCTS

Full range of Amplifiers, Kits, Speakers in stock.

TY75 AUDIO SIGNAL GENERATOR



Sine Wave 20c/s to 200kc/s. Square Wave 20c/s to 30kc/s. High and low impedance output. Output variable up to 6 volts. 220/240 volts a.c. Size 210 × 150 × 120mm. Brand new with instructions. **£16.** Carr. 7/6.

MARCONI TF142E DISTORTION FACTOR METERS

Excellent condition. Fully tested. **£20.** Carr. 15/-

LAFAYETTE TE46 RESISTANCE CAPACITY ANALYSER

2pF-2,000 mfd 2 ohms-200 megohms. Also checks impedance, turns ratio, insulation, 200/250V a.c. **Brand New £17.10.0.** Carr. 7/6.

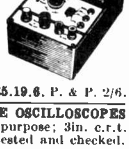
ADVANCE TEST EQUIPMENT

Brand new and boxed in original sealed cartons.

- **VM.76 VALVE VOLTMETER R.F. measurements in excess of 100Mc/s and d.c. measurements up to 100V with accuracy of ± 2% d.c. range 300 MV to 1kV a.c. range 300MV to 300V RMS. Resistance 0·02-500M Ω. Price £72.**
- **VM.78 A.C. MILLIVOLT METER. Transistorised 1 MV-300V. Frequency 1c/s to 1 Mc/s. Price £55.**
- **VM.79 UHF MILLIVOLT METER. Transistorised. A.c. range 10MV-3V. D.c. current range 0·01μ/A-0·3MA. Resistance 1 ohm-10 megohms. Price £125.**
- **H1B AUDIO SIGNAL GENERATOR. 15c/s-50kc/s. sine or square wave. Price £30.**
- **J1B AUDIO SIGNAL GENERATOR. 15c/s-50kc/s. Price £30.**
- **J2B AUDIO SIGNAL GENERATOR. As per J1B except fitted with output meter. Price £35.**
- **TT1S TRANSISTOR TESTER. £37.10.0.**

Carriage 10/- per item.

MODEL ZQM TRANSISTOR CHECKER



It has the fullest capacity for checking on A, B and Ico. Equally adaptable for checking diodes, etc. Spec.: A: 0·7-0·9967. B: 5-200. Ico: 0-50 microamps 0-5 mA Resistance for diode 200 Ω-1 MΩ. Supplied complete with instructions, battery and lead. **£5.19.6.** P. & P. 2/6.

SONOTRONIC PORTABLE OSCILLOSCOPES

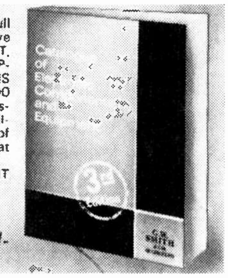
Ex-govt. scope, general purpose; 3in. c.r.t. Mains operated. Fully tested and checked. **£12.10.0.** Carr. 7/6.

SOLARTRON MONITOR OSCILLOSCOPE TYPE 101

An extremely high quality oscilloscope with time base of 10μ/sec to 20m/sec. Internal Y amplifier. Separate mains power supply 200/250V. Supplied in excellent condition with cables, probe, etc., as received from Ministry. **£8.19.6.** Carr. 30/-.

Latest Catalogue

The latest edition giving full details of a comprehensive range of HI FI EQUIPMENT, COMPONENTS, TEST EQUIPMENT and COMMUNICATIONS EQUIPMENT.... Nearly 200 pages, fully illustrated and detailing thousands of items—many at bargain prices. FREE DISCOUNT COUPONS VALUE 10/-.



SEND NOW—ONLY 7/6 P&P 1/-

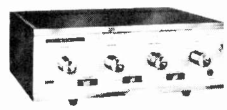
GARRARD

FULL CURRENT RANGE OFFERED. BRAND NEW AND GUARANTEED AT FANTASTIC SAVINGS

SRP22 Stereo	**£5.19.6**	*SL55	**£11.19.6**
*1025 Mono	**£7.10.0**	A70 MK II	**£12.10.0**
*1025 Stereo	**£7.15.0**	*AT60MK II	**£13. 5.0**
*2025 Stereo	**£7.19.6**	*SL65	**£14.14.0**
*2025T/C Mono/Stereo	**£8.17.6**	AP75	**£17.17.0**
		401	**£28. 7.6**
*3000 Stereo	**£9.19.6**	SL75	**£28.10.0**
SP25 MK II	**£11.19.6**	SL95	**£35. 0.0**

Carriage/insurance 7/6 extra any model. WB4 Bases **£3.19.6.** Perspex covers **£3.10.0.** *Special offer base and cover available for these models at **£4.15.0.** Carr. 5/-. Full range of Garrard accessories available.

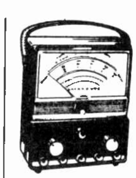
LAFAYETTE LA-224T TRANSISTOR STEREO AMPLIFIER



19 transistors, 8 diodes, IHF music power, 30W at 8 Ω. Response 30-20,000 ± 2dB at 1W. Distortion 1% or less. Inputs 3mV and 250mV. Output 3-16 Ω. Separate L and R volume controls. Treble and bass control. Stereo phone jack. Brushed aluminium, gold anodised extruded front panel with complementary metal case. Size 10¼ × 3 9/16 × 7 13/16in. Operation 115/230V. A.C. **£28.** Carriage 7/6.

MULTIMETERS *for EVERY purpose!*

TE-51. NEW 20,000 Ω/VOLT MULTIMETER with overload protection and mirror scale. 0/6/60/120/1,200V a.c. 0/3/30/60/300/600/3,000V d.c. 0-60μA/12/300mA d.c. 0/60K/6 meg. ohm. **92/6.** P. & P. 2/6.



TE-900 20,000 Ω VOLT GIANT MULTIMETER 6in. full view meter. 2 colour scale, overload protection. 0/2·5/10/250/1,000/5,000V a.c. 0/25/12·5/10/50/250/1,000/5,000V d.c. 0/50μA/110/100/500mA 10A d.c. 20K/200K/20 MΩ. **£15.** P. & P. 5/-.

MODEL AS-100D. 100K Ω/VOLT. 5in., mirror scale. Built-in meter protection. 0/3/12/60/120/300/600/1,200V d.c. 0/6/30/120/300/600V a.c. 0/10μA/6/60/300MA/12 Amp. 0/2K/200K/2M/200M Ω. —20 to +17dB. **£12.10.0.** P. & P. 3/6.

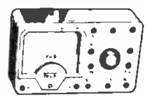
MODEL TE-10A. 20k Ω/Volt, 5/25/50/250/500/2,500 V, d.c. 10/50/100/500/1,000V. a.c. 0/50μA/2·5 mA./250mA. d.c. 0/6K/6 megohm. —20 to +22dB. 10-0, 100 mfd. t 0 0·100-0·1 mfd. **69/6.** P. & P. 2/6.

MODEL TE-90 50,000 O.P.V. MIRROR SCALE OVERLOAD PROTECTION 0/3/12/60/300/600/1,200V d.c. 0/6/30/120/300/1,200V a.c. 0·03/6/60/600MA d.c. 16k Ω/160k Ω/1·6/16M Ω. —20 to +63dB. **£7.10.0.** P. & P. 3/-.

MODEL TE 80. 20,000 O.P.V. 0/10/50/100/500/1,000V. a.c. 0/5/25/50/250/500/1,000V d.c. 0·5μA. 5/50/500mA/0/6K/60/K/600K/6 Meg. **£4.17.6.** P. & P. 3/-.

MODEL TE-70. 30,000 O.P.V. 0/3/15/60/300/600/1,200V. d.c. 0/6/30/120/600/1,200V. a.c. 0/30μA/3/30/300mA. 0/16K/160K/1·6M/16megohm **£5.10.0.** P. & P. 3/-.

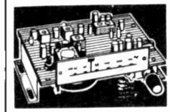
MODEL TE12. 20,000 O.P.V. 0/0·6/30/120/600/1,200/3,000/6,000V d.c. 1/6/30/120/600/1,200V a.c. 0/60μA/6/60/600MA. 0/6K/600K/6meg./60. Megohm 50PF. 2 MFD **£5.19.6.** P. & P. 3/6.



MODEL PT-34. 1,000 O.P.V. 0/10/50/250/500/1,000V a.c. and d.c. 0/1/100/500 mA d.c. 0/100 K Ω **39/6.** P. & P. 1/6.

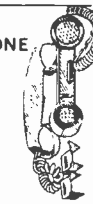
LAFAYETTE 57 Range Super 50,000 O.P.V. Multimeter. D.c. Volts 125V-1,000V A.c. Volts 1·5V-1,000V D.c. Current 25μA-10 Amp. **Ohms.** 0·15 Meg Ω dB.—20 to +81dB. Overload Protection. **£12.10.0.** Carr. 3/6.

★ TRANSISTORISED FM TUNER ★



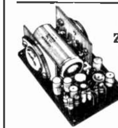
6 TRANSISTOR HIGH QUALITY TUNER, SIZE ONLY 6 × 4 × 2½in. 3 I.F. stages. Double tuned discriminator. Ample output to feed most **amplifiers.** Operates on 9V battery. Coverage 88-108 Mc/s. Ready built ready for use. Fantastic value for money. **£6.7.6.** P. & P. 2/6. Stereo multiplex adaptors **99/6.**

TRANSISTORISED TWO-WAY TELEPHONE INTERCOM



Operative over amazingly long distances. Separate call and press to talk buttons. 2-wire connection. 1000's of applications. Beautifully finished in ebony. Supplied complete with batteries and wall brackets. £6.9.6. P. & P. 3/6.

SINCLAIR EQUIPMENT



Z12 12 watt amplifier, **89/6**
PZ4 Power Supply Unit **89/6**
Stereo 25 Preamp., **£9.19.6**
Q14 Speakers. **£7.19.6**
Micromatic Radio Kit, **49/6.** Built **59/6**

NOW IN STOCK IC/10 **59/6** ALL POST PAID

SPECIAL OFFER

Two **Z12** Amps., **PZ4** Power Supply, **Stereo 25** Preamplifier, **£22,** or with two **Q14** speakers, **£37.**

NEW SINCLAIR 2000 SYSTEM

35 watt Integrated Amplifier **£29.** Carr. 5/-. Self powered F.M. Tuner. **£25.** Carr. 5/-.

HOSIDEN DH04S 2-WAY STEREO HEADSETS

Each headphone contains a 2½in woofer and a ⅞in tweeter. Built in individual level controls. 8 Ω imp. 25-18,000c/s. with cable and stereo plug. **£5.19.6.** P. & P. 2/6.

TE111. DECADE RESISTANCE ATTENUATOR

Variable range 0-111dB. Connections. Unbalanced T and Bridge T. Impedance 600 Ω range (0·1dB × 10) + (1dB × 10) + 10 + 20 + 30 + 40dB. Frequency: d.c. to 200kHz (—3dB). Accuracy: 0·05dB. +indication dB × 0·01. Maximum input less than 4W (50V). Built in 600 Ω load resistance with internal/external switch. Brand new **£27.10.0.** P. & P. 5/-.

RECORDING HEADS

Reuter ¼-track. As fitted to Collaro Mk. IV and Studio Decks. High imp. record play back, low imp. erase. Brand new. **19/6** pair. **COSMOCORD** ¼-track heads. High imp. record/playback **65/-.** Low imp. erase **20/-.** **MARRIOTT** ¼-track heads. High imp. record/playback **65/-.** Low imp. erase **20/-.** Post extra.

AMERICAN TAPE

First grade quality American tapes. Brand new. Discount on quantities.

3in. 225ft. L.P. acetate	**3/6**
3¼in. 600ft. T.P. mylar	**10/-**
5in. 600ft. std. plastic	**8/6**
5in. 900ft. L.P. acetate	**10/-**
5in. 1,200ft. D.P. mylar	**15/-**
5in. 1,800ft. T.P. mylar	**22/6**
5¾in. 1,200ft. L.P. acetate	**12/6**
5¾in. 1,200ft. L.P. mylar	**16/-**
5¾in. 1,800ft. D.P. mylar	**22/6**
5¾in. 2,400ft. L.P. mylar	**39/6**
7in. 1,200ft. std. acetate	**12/6**
7in. 1,800ft. L.P. acetate	**15/-**
7in. 1,800ft. L.P. mylar	**20/-**
7in. 2,400ft. D.P. mylar	**25/-**
7in. 3,600ft. T.P. mylar	**45/-**

Postage 2/-. Over £3 post paid.

MAXELL TAPE CASSETTES

C60. **10/3;** C90. **14/3;** C120. **19/6.** Post extra.

G.W. SMITH & CO (RADIO) LIMITED

3 and 34, LISLE STREET, LEICESTER SQ., LONDON, W.C.2 01-437 8204 01-437 9155

311, EDGWARE RD., LONDON, W.2 01-262 0387

(ALL MAIL ORDERS TO :- 3, LISLE STREET, LEICESTER SQUARE, LONDON, W.C.2)

9 a.m. to 6 p.m. Mon. to Sat. (Edgware Road ½ day Thurs.) Trade supplied.

Z.30

0·02% DISTORTION AT FULL POWER

■

OPERATES IDEALLY FROM 8 TO 35 VOLTS

■

SIZE $3\frac{1}{2} \times 2\frac{1}{4} \times \frac{1}{2}$ ins.

■

FREQUENCY RESPONSE FROM 20 Hz TO 30 kHz

■

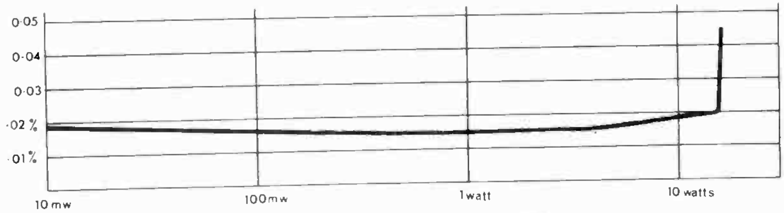
USE IT FOR HIGH FIDELITY MUSIC INSTRUMENTS, ECONOMY RECORD PLAYER, P.A., INTERCOM, ETC.

89/6

THE WORLD'S LOWEST DISTORTION HIGH FIDELITY AMPLIFIER.

For four years, the Sinclair Z.12 dominated the constructor world, being the best selling unit of its kind this side of the Atlantic. Excellent as it was, the new Sinclair Z.30 is still better. Half the size of the Z.12, it has more than twice the power, very much greater gain and a level of distortion 50 times lower. This incredible figure results from using over 60dB of negative feed back with a constant current load to the driver stage obtained by incorporating a two transistor circuit in place of the more usual boot-strapping. 9 silicon epitaxial planar transistors are used to provide enormous power (up to 25 watts RMS continuous sine wave (50 watts peak). The circuitry of this marvellous amplifier allows it to be operated from any voltage from 8 to 35 to perfection. At all output levels, distortion is only 0.02%. This puts true laboratory standards into the hands of every user of a Z.30. Two Z.30s and a new Stereo Sixty will make a stereo assembly of such perfection that it could not be bettered in its class no matter how much you spent. But the Z.30 has an enormous variety of applications, particularly where quality, precision and reliability are essential. Yet this brilliant new Sinclair design costs not a penny more than its famous predecessor.

- Input Sensitivity—250 mV into 100 Kohms
- Signal to noise ratio—better than 70dB unweighted
- Class AB output
- Power requirements 8-35 volts from batteries or PZ.5

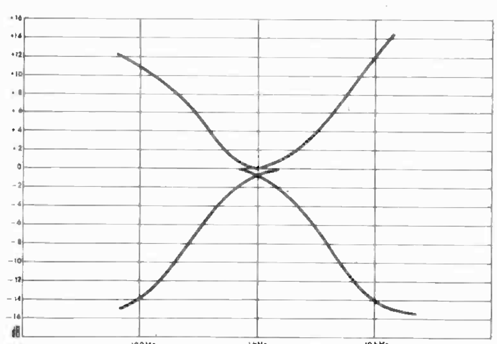


SINCLAIR RADIONICS LIMITED
22 NEWMARKET RD., CAMBRIDGE Tel: 0223 52731

sinclair

STEREO SIXTY

PRE-AMP & TONE CONTROL UNIT

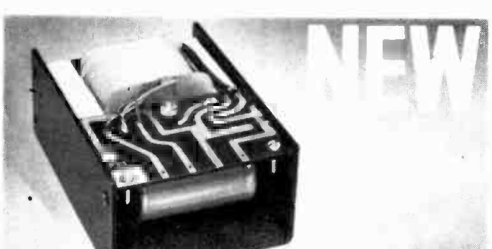


£9.19.6

This attractive and completely new unit is intended for use with two new Z.30 amplifiers to provide the finest possible standards of stereo reproduction. Four press buttons and four rotary controls are used to provide on-off, three input selectors and Volume, Bass cut/boost, Treble cut/boost and Stereo balance. The on-off button also switches the power amplifiers. The front panel in brushed aluminium is flush mounted to the cabinet front, it being necessary only to drill holes to accommodate the controls. Rear adjustable brackets hold the chassis tight to the cabinet. The very latest ganged rotary controls are used to afford compactness and extra long working life free from noise.

The Stereo-60 may also be used with 2 IC-10's or any other high performance amplifiers.

Frequency range:	Radio & Aux. 20-25,000 Hz ±1dB Pick-up corrected to within ±1dB for R.I.A.A. equalisation.
Inputs:	Radio, pick-up (magnetic, ceramic or crystal), Auxiliary.
Overload factor:	>20dB per channel on all inputs
Distortion:	0.03%
Signal to noise ratio:	Better than 70dB unweighted
Controls:	press buttons for on-off, P.U, radio and aux. Treble +15dB to —15dB at 10kHz. Bass +15dB to —15dB at 100Hz. Volume. Stereo Balance.
Size:	$8\frac{1}{4}$" x $1\frac{1}{2}$" x 4" from front to back, plus knobs.
Finish:	Brushed aluminium with black titling, knobs and press buttons.



PZ.5 POWER SUPPLY UNIT

A new heavy duty mains power supply unit designed specially to drive two Z.30s and a Stereo Sixty. New compact design.
For AC Mains, 200-240V/50Hz. £4.19.6

USE THIS COUPON FOR Z.30, STEREO 60 AND P.Z.5

To: SINCLAIR RADIONICS LTD., 22 NEWMARKET RD., CAMBRIDGE

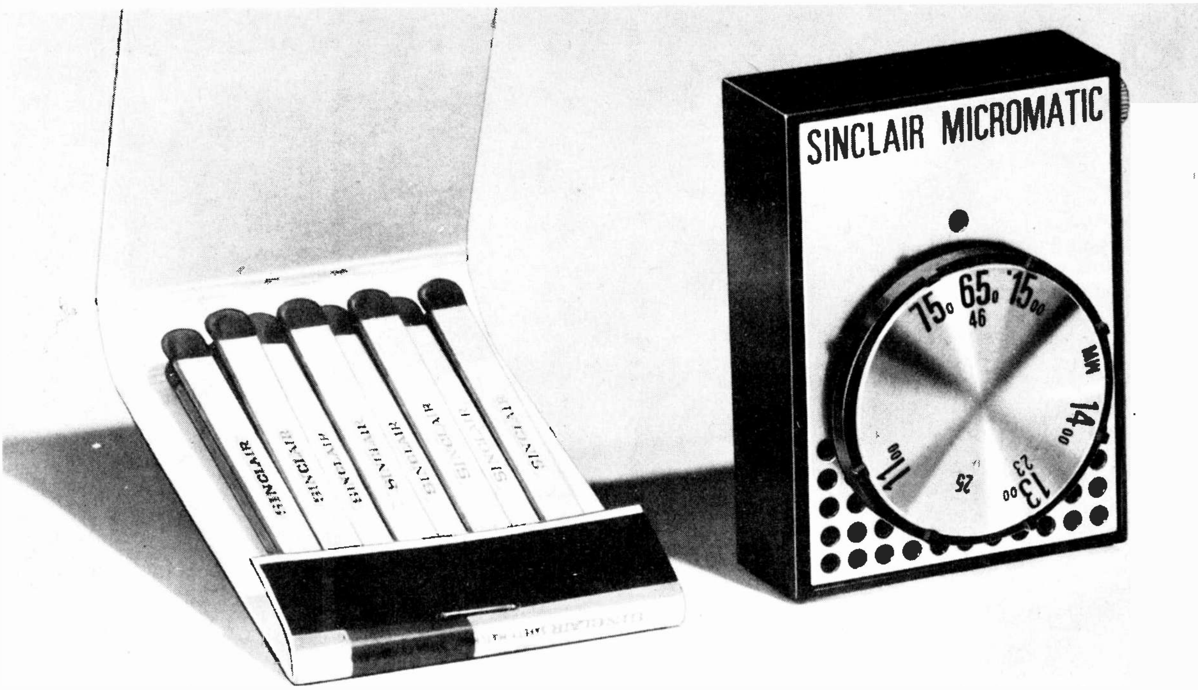
Please send ....

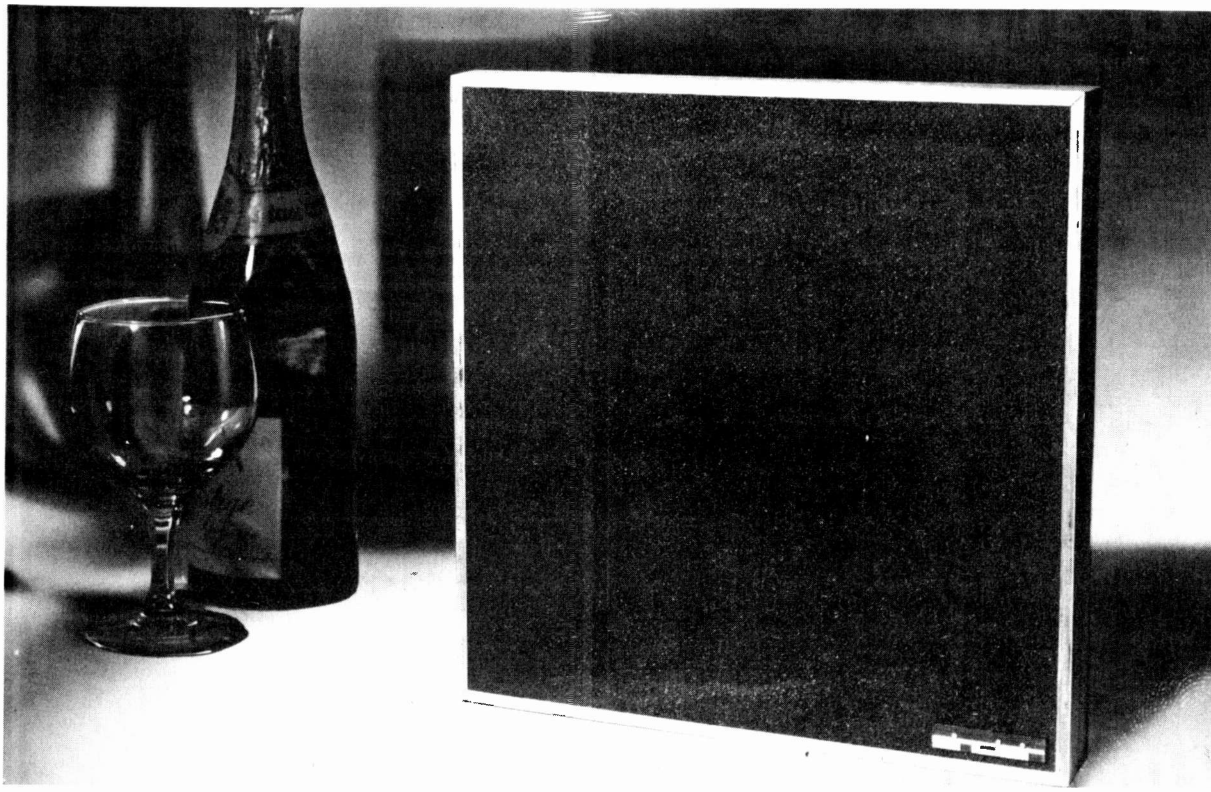
NAME ....

ADDRESS ....

For which I enclose cash/cheque money order

sinclair


SINCLAIR MICROMATIC



SINCLAIR

Q.16 new elegance in a loudspeaker of outstandingly fine performance

All the superb features which went to make the Sinclair Q.14 have been incorporated in the new Q.16 which gives an exciting new opportunity for you to match your Sinclair equipment with modern decor. Employing the same well proven acoustic system in which materials, processing and styling are used in such a radical and successful departure from conventional design, the new Q.16 presents an entirely new appearance with its attractive teak surround and all-over special cellular foam front chosen as much for its appearance as for its ability to pass all audio frequencies without loss. The Q.16 is compact and slim. Its new styling makes it eminently suitable for shelf mounting, but it is no less versatile than its famous predecessor. Listen to a pair of Q.16s in stereo and marvel at the standards of quality and clarity they give.

SINCLAIR GENERAL GUARANTEE

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

The Q.16 will handle loading up to 14 watts R.M.S. and presents an 8 ohm impedance to the amplifier output. Frequency response extends from 60 to 16,000 Hz. with exceptional smoothness. A specially designed driver system is used in a sealed and contoured pressure chamber to ensure good transient response at all frequencies. Size: 9¾″ square × 4¾″ deep from front to back.

£8.19.6

SINCLAIR RADIONICS LIMITED
22 NEWMARKET RD., CAMBRIDGE Tel: 0223 52731

sinclair

L.S.T. ELECTRONIC COMPONENTS LTD.

1N914	2/-	AC107	14/6	BF159	15/-	OAZ242	3/6
1S113	3/-	AC126	6/6	BF163	9/-	OAZ243	6/-
1S120	2/6	AC127	6/-	BF167	6/6	OAZ246	3/6
1S130	2/6	AC128	4/-	BF173	7/6	OAZ269	3/6
1S131	2/6	AC176	7/6	BF180	6/-	OAZ270	3/6
1S132	2/6	AC187	12/-	BF181	7/-	OAZ271	3/6
2G301	4/-	AC188	12/-	BF184	7/6	OC19	5/-
2G302	3/9	ACY17	5/8	BFW57	7/6	OC20	33/-
2G339A	5/-	ACY18	3/4	BFW58	7/6	OC22	13/-
2G374	5/-	ACY19	4/4	BFW59	6/6	OC23	15/-
2G381	5/-	ACY20	3/8	BFW60	6/6	OC24	10/-
2G371	3/-	ACY21	4/-	BFX13	4/8	OC25	6/8
2N385A / 2N388A	15/-	ACY22	2/4	BFX29	8/5	OC26	12/-
		AD140	15/-	BFY50	4/-	OC28	12/-
2N696	6/-	AD149	11/8	BFY51	6/-	OC29	15/-
2N697	6/-	AD161	6/-	BFY52	6/-	OC30	7/-
2N698	4/6	AD162	6/-	BFY53	6/-	OC35	9/6
2N706	3/-	ADT140	12/6	BSX20	3/3	OC36	13/-
2N706A	6/6	AF102	18/-	BSX21	8/-	OC41	3/6
2N708	4/-	AF114	4/4	BSY27	4/-	OC42	4/-
2N711	7/6	AF115	4/4	BSY95A	3/4	OC44	3/-
2N711A	7/6	AF116	4/4	BTX39/600	120/-	OC45	3/-
2N929	5/6	AF117	4/4	BUY11	15/-	OC71	3/-
2N930	6/6	AF118	16/6	BY100	5/-	OC72	4/6
2N1131	9/6	AF124	6/-	BYX10	4/9	OC73	3/-
2N1132	7/6	AF127	4/-	BYZ10	9/-	OC75	5/-
2N1302	4/6	AF139	15/-	BYZ12	6/-	OC76	2/6
2N1303	4/6	AF239	12/-	BYZ13	5/-	OC77	8/8
2N1304	5/-	AF186	11/-	GET102	6/-	OC81D	3/-
2N1305	5/-	AFZ12	11/9	GET103	4/6	OC82	4/6
2N1306	6/6	ASY26	5/8	GET113	5/-	OC82D	3/-
2N1307	6/6	ASY27	5/8	GET573	7/6	OC83	4/-
2N1308	8/-	ASY28	4/4	GMO378B	6/-	OC84	4/-
2N1309	8/-	ASY29	4/4	MAT100	5/-	OC123	7/-
2N1613	6/6	ASZ21	11/-	MAT101	5/6	OC139	8/-
2N2147	17/-	AUY10	39/6	MAT120	5/1	OC140	12/-
2N2148	12/6	BA115	2/8	MAT121	5/6	OC169	6/-
2N2160	14/-	BA130	3/-	MPF102	9/-	OC170	4/-
2N2368	6/6	BAY31	2/6	MPF103	9/-	OC171	6/-
2N2369	5/6	BAY38	3/-	MPF104	9/-	OC200	6/-
2N2369A	7/6	BC107	2/9	MPF105	9/-	OC201	10/-
2N2646	10/-	BC108	2/9	NKT216	10/5	OC202	16/6
2N2696	6/6	BC108A	2/9	NKT217	10/5	OC203	8/-
2N2924	5/-	BC109	2/9	NKT261	4/5	OC204	8/-
2N2925	5/6	BC113	5/-	NKT262	4/3	OC205	8/-
2N2926		BC114	10/-	NKT264	4/3	OC206	10/6
.. Green	2/-	BC115	13/6	NKT271	4/3	OC207	7/6
.. Yellow	2/-	BC116	9/-	NKT272	4/3	OCP71	18/3
.. Orange	2/-	BC118	5/-	NKT274	4/3	ORP60	8/-
.. Red	2/-	BC125	14/-	NKT275	3/6	ORP61	8/-
2N3053	8/-	BC126	14/-	NKT276	2/6	ORP63	9/-
2N3054	15/-	BC134	5/-	NKT281	5/6	SX631	7/4
2N3055	15/-	BC147	6/-	NKT403	15/-	SX636	16/8
2N3702	4/-	BC148	4/-	NKT405	15/-	SX638	12/-
2N3703	4/-	BC149	6/-	NKT713	5/6	SZ20C	15/-
2N3704	4/6	BC154	12/-	NKT773	5/4	SVC1	17/4
2N3705	4/-	BCY30	7/-	NKT774	5/4	C246	8/3
2N3706	3/-	BCY31	9/-	OA5	3/8	P346A	6/-
2N3707	4/6	BCY32	16/-	OA47	1/6	V405A	9/3
2N3708	3/-	BCY33	4/8	OA70	1/6	EC401	5/-
2N3709	3/-	BCY34	6/4	OA73	1/6	EC402	4/8
2N3710	4/-	BCY38	8/-	OA79	1/6	C111E	18/-
2N3711	4/-	BCY39	27/4	OA81	1/6	C400	9/-
2N3819	8/-	BCY40	13/4	OA85	1/6	2C111	45/9
2N3820	23/6	BCY54	15/3	OA90	1/6	2C425	32/-
2N4058	7/-	BCY70	4/4	OA91	1/6	EA403	3/6
2N4059	6/-	BCY71	8/8	OA95	1/6	EB383	3/6
2N4060	6/-	BCY72	6/6	OA200	2/-	MJ491	30/3
2N4061	6/-	BCY87	86/9	OA202	2/-	MJ481	27/-
2N4062	6/-	BCZ11	10/4	OA210	6/4	40361	13/3
2N4254	9/6	BD119	15/-	OAZ201	3/6	40362	16/3
2N4255	8/6	BD121	19/6	OAZ202	3/6	ST140	3/-
2S018	8/6	BD124	17/-	OAZ206	3/6	ST141	5/-
2S024	25/-	BF152	13/6	OAZ207	7/-		
2S034	15/-	BF154	9/-	OAZ241	3/6		

CHEAPEST EVER SOLID-STATE SALE

BEST VALUE IN BRITAIN

- 10 BFY50/1/2 Type NPN TO 5 Planar. Tested, uncoded 10/-
- 40 Silicon Planar Transistors. TO-18 case. NPN and PNP mixed. Similar V405A, P346A, etc. Not tested or coded. Guaranteed minimum 50% good 10/-
- 10 Silicon Planar PNP 3 watt similar BSX40 2N2904/A, etc. TESTED. Not coded 10/-
- 30 Silicon Planar Transistors. TO-18 case. NPN type similar BC107/8/9 range. Not tested or coded. Guaranteed minimum 50% good 10/-
- 3 Silicon Power Transistors similar to BUY11. TO-3 case. Not tested or coded. Gold plated cases 10/-
- 20 Germanium Transistors 2G371B. Case SO-2. Fully tested to makers' specifications PNP. Equal to OC71 range. Not coded 10/-
- 25 Silicon NPN VHF Transistors. TO-18 case. Similar to BSY27, etc. Not tested or coded 10/-
- 20 Silicon Planar Transistors. Plastic type. NPN. Similar to 2N3705/7 range. Not tested or coded. Guaranteed minimum 50% good 10/-
- 20 Silicon Planar Transistors. Plastic type. PNP. Similar to 2N3702. Not tested or coded. Guaranteed minimum 50% good 10/-
- 16 Silicon Rectifiers. Top-Hat case. 750mA " 100 1,000 piv. Guaranteed minimum 80% good 10/-
- 12 Silicon Avalanche Rectifiers. Top-Hat case 1½ amp " up to 1,200 piv. Guaranteed minimum 80% good 10/-
- 15 Silicon Epitaxial Planar Diodes—Sub-miniature. Type SD19 Plessey. Exact substitute for 1N914, etc. 100% perfect. Not coded 10/-
- 30 Part made Top-Hat Rectifiers (top connection broken, but plenty room to solder) 750mA up to 800 piv. Guaranteed minimum 80% good 10/-

2G371B and SD19 are Manufacturers' tested devices.
Other un-coded stock are given type numbers as a guide only.
Money refunded if not satisfied.
All above packs post free in UK.

S-DeCs

Single "DeC" with accessories and project manual 29/6
"2-DeC" kit contains two "DeCs", component tray, accessories, instructive book, all packed in attractive plastic box 69/6
"4-DeC" kit contains four "DeCs", accessories, manual, etc. 117/6

BOOKS FROM STOCK
"General Electric Transistor Manual", 660 pages of data and circuits 29/6
"RCA Transistor Manual", 554 pages includes SCR circuits 28/-
"Designers Guide to British Transistors". Excellent data book lists over 1,000 common types plus computer selected substitution chart 25/-
(ADD 2/6 POST & PACKING FOR ALL BOOKS)

NEONS
Signal neons for many types of circuit type "N"
Price 1/6 each or 16/- dozen

HEATSINKS. Suitable for 2 × OC35, etc. As used in commercial equipment. Type 10D 6/-

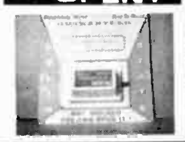
ALUMINIUM CHASSIS
6 × 4 × 2½in with reinforced corners 6/9 each (P. & P. 1/6). Ally panel to fit, 1/6. Paxolin panel to fit, 2/-. Many other sizes in stock up to 12 × 8 × 2½in (see catalogue)

X-LINE

X—161	2 Watt Amplifier	35/-
X—461	Siren	35/-
X—471	Burglar Alarm	35/-
X—661	Metronome	30/-
X—761	Morse Oscillator	20/-
X—691	Lamp Flasher (Double)	30/-

Generous discounts to Retailers given on all "X"-line products. Send for details now.

MODULES YOU CAN OPEN!



SILICON RECTIFIERS

PIV	200mA	750mA	2 Amp	10 Amp
50	6d	1/-	2/3	—
100	9d	1/6	2/3	4/6
200	1/3	2/-	2/9	5/-
400	—	2/6	4/-	8/-
600	—	3/-	4/6	9/6
800	3/-	3/9	5/-	11/3
1000	—	6/-	6/6	14/-

THYRISTORS - SCRs

PIV	1A	3A	10A	30A	100A
50	7/6	9/-	—	25/-	20/-
100	—	10/-	10/-	30/-	22/-
200	8/6	—	12/6	42/-	35/-
300	—	11/-	—	51/-	—
400	9/6	12/6	15/-	60/-	45/-
600	—	—	20/-	84/-	120/-
800	—	—	—	—	—

ZENER DIODES

¼ Watt 10% Tolerance—Voltages:

3·0	4·7	7·5	12 ALL
3·3	5·1	8·2	13 ONE
3·6	5·6	9·1	15 PRICE.
3·9	6·2	10	16
4·3	6·8	11	3/6 ea.

See IR Panel for 1 watt types. Full range 5 watt also in stock

BC107/8/9 NPN 2/9

2N3819 TEXAS FET 8/-

2N2646 UNI-JUNCTION 10/-

CRS3/40AF
STC SILICON AVALANCHE THYRISTOR 400PIV 3A 12/6
25+ 11/- 100+ 10/3

SC41D GE TRIAC 400PIV 6AMP 37/-

TD716 TUNNEL DIODE 12/-

BF180 MULLARD UHF AMPLIFIER 6/-

2N3055 115 WATT POWER SILICON NPN 15/-
25+ 13/- 100+ 11/-

2N2926 POPULAR PLANAR NPN 2/-

2N4871 MOTOROLA UNIJUNCTION 6/9
EQUIV. TIS43 2N2646, ETC.

FAIRCHILD μ LOGIC

	1-6	7-11	12+
uL900	11/-	9/6	8/4
uL914	11/-	9/6	8/4
uL923	14/-	12/6	11/9

5 page Data and Circuits article 2/6
Larger quantity prices (100+ and 1,000+ on application)

LINEAR AMP. IC'S

CA3020 ½ watt output 9 volt supply 30/6
(price includes free circuit for Guitar/PA Amplifier!!)

TAA263 Tiny Mullard linear only 17/6—data on request

CA3012 Wide band with built in regulation 27/6

CA3014 3 stage amp. with Darlington output 32/6

SL701 Plessey lin. amp. for PE circuits 18/-

ULTRASONIC TRANSDUCERS

Operate at 40kc/s. Can be used for remote control systems without cables or electronic links. Type 1404 transducers can transmit and receive.
FREE: With each pair our complete transmitter and receiver circuit.
PRICE £5.18.0 Pair (sold only in pairs)

IR

SOLAR CELLS
B2M 0·2-0·4 volts @ 2mA Selenium type 12/6
B3M 0·2-0·4 volts @ 1½-2½mA Selenium type 15/-
S1M 0·3-0·4 volts @ 10-16mA Silicon 19/-
S4M 0·3-0·4 volts @ 25-40mA Silicon 33/6

SOLAR DRIVE MOTOR
EP50A Runs from sunlight activity on S4M cells (above) 39/6

PHOTOCONDUCTIVE CELL
CS120 20V 0·4 watt dark Res 110kohms Min. R @ 10FC = 7·2k R @ 100FC = 800 ohms 19/8

SOLAR CELL KITS
DD190 Contains 4 Selenium photocells and free 24 page handbook 9/11
K-421 Super assortment of 7 cells, 3 Selenium, 2 Silicon and 2 Cadmium Sulphide plus 24 page manual 58/6

TRANSISTOR KITS
DD180 Contains 2 audio and 1 RF transistor plus free manual 11/4
DD184 Contains audio, RF, and power transistors, Silicon solar cell and germanium diode. With FREE manual 33/6

SILICON RECTIFIER KITS
DD175 Contains 4 100 piv ½ amp diodes 9/11
DD176 Contains 2 200 piv ½ amp diodes 5/11
DD177 Contains 2 400 piv ½ amp diodes 9/11
ALL INCLUDE FREE 24 PAGE MANUAL

ZENER DIODES
Available in the following voltages with a dissipation of 1 Watt and tolerance on 10%. All supplied with free manual describing many interesting projects.
3·9V, 4·7V, 5·6V, 6·8V, 8·2V, 10V, 12V, 15V, 18V, 22V, 27V.
ALL ONE PRICE: 7/11

ZENER KIT
DD170 Bargain pack—contains 5 popular 1 watt diodes plus free project manual 19/6

TRANSISTOR SUBSTITUTION
Our TR01-C to TR10-C range are universal replacements for over 700 JEDEC (2N———) types. Prices in our FREE Catalogue.
FULL SEMICONDUCTOR CENTRE LISTINGS, DOZENS OF INTERESTING DEVICES IN OUR CATALOGUE.

COMPONENTS

RESISTORS ¼ OR ½ WATT 5% LOW NOISE CARBON FILM
10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82 ohms and decades (×10, ×100, ×1,000, ×10,000) 1 Meg etc. to 8·2 Megohms (10% tolerance). PRICES 1-25, 4d, 26-99, 3d, 100+, 2d (your selection ¼ and/or ½ watt mixed)

SKELETON PRESET POTS. 20% Tol. Linear. Low noise. Available in sub-miniature or standard size, horizontal or vertical. 100, 250, 500, 1k, 2·5k, 5k, 10k, 25k, 50k, 100k, 250k, 500k, 1 Meg, 2·5 Meg, 5 Meg. NEW PRICE: 1/- each or any selection of 12 pieces 10/-

ELECTROLYTIC CAPACITORS (Mullard). —10% to +50% Tol.

Subminiature (all values in μF)

4V	8	32	64	125	250	400
6·4V	6·4	25	50	100	200	320
10V	4	16	32	64	125	200
16V	2·5	10	20	40	80	125
25V	1·6	6·4	12·5	25	50	80
40V	1	4	8	16	32	50
64V	0·64	2·5	5	10	20	32
Price	1/6	1/3	1/2	1/-	1/1	1/2

MIN. POLYESTER CAPACITORS. Printed circuit type 250V d.c. working, 0·01, 0·015, 0·022, 7d each, 0·033, 0·047, 8d each, 0·068, 0·10, 9d.

VEROBOARD 0·15in Matrix FLUX COATED
2½in × 3¾in, 3/3, 2½ × 5in, 3¾ × 3¾in, 3/11, 3¾ × 5in, 5/6, 3¾ × 18in, 18/-.
BARGAIN PACK of 36 square inches all good size pieces only 10/- pack
VEROBOARD 0·1in Matrix, 3¾in × 2½in, 3/9
VEROPINS for 0·15in, 36 pieces 3/-
VERO-CUTTER, 9/- each plus Free sample pieces

LST. 7 COPTFOLD ROAD BRENTWOOD ESSEX

Prices quoted are current at time of going to press and may be subject to variation. Semi-conductors offered bear Manufacturers' original markings and are subject to our full replacement guarantee if not to published specifications. We DO NOT offer "Re-marked" semi-conductors. New catalogue free on request. Post and Packing (First class) 1/- per order. Retail and Trade supplied. Export enquiries particularly welcome.

GIRO No. 388-3159

SENSATIONAL STEREO OFFERS!

SAVE UP TO 33⅓% OFF OUR STEREO SYSTEMS

As Britain's Largest Specialists our tremendous purchasing power enables us to offer you the famous makes — Garrard, Golding, Rogers, Decca, Wharfedale, Arena, Philips, etc. — at unbelievably low prices. We offer 30 Hi-Fi Stereo Systems utilising these famous makes all showing substantial savings off our normal list prices.

Every Nusound Stereo System is complete with all leads, plugs, etc., fully guaranteed and backed by 100% Nusound after-sales service.

Illustrated literature and technical data sent by return of post (Dept. PE/OT).

NuSound
BRITAIN'S LARGEST SPECIALISTS

24 OXFORD ST., LONDON, W.1
Tel. 01-580 4638, 4639, 5755
50 yards Tottenham Court Road Tube
Open 6 days a week

ERSIN **Multicore** 5 CORE SOLDER

for fast, easy, reliable soldering

Contains 5 cores of non-corrosive flux, instantly cleaning heavily oxidised surfaces. No extra flux required.

SAVBIT ALLOY ALSO REDUCES COPPER BIT WEAR.
Ecomically packed for general electrical and electronic soldering. 90 ft. 18 gauge on plastic reel. Recommended retail price **15/-**

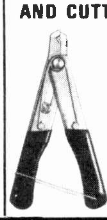
THIN GAUGE SOLDER, ESSENTIAL FOR
soldering small components and thin wires. High tin content, low melting point, 60/40 alloy, 202 ft. 22 gauge on plastic reel. Recommended retail price **15/-**

A RANGE OF SOLDERS IN HANDY DISPENSERS.

REF.	ALLOY	SWG	
4A	60/40	18	2/6*
Size 5 (illustrated)	Savbit	18	2/6*
15	60/40	22	3/-*

*Recommended Price

INVALUABLE FOR STRIPPING FLEX, THE NEW AUTOMATIC OPENING BIB WIRE STRIPPER AND CUTTER, easily adjustable for all standard diameters. Plastic covered handles can also be used as wire cutter. Recommended retail price **8/6**



From Electrical and Hardware shops. If unobtainable, write to: Multicore Solders Ltd., Hemel Hempstead, Herts.

OMICRON ELECTRONICS

Peak Sound Products:
Cir-Kit 5ft × 1/8in or 1/16in. 1/11 per card. N.B. The 1/8in Cir-Kit can easily be cut in half with scissors to form 1/16in. This way you have double the amount.
Matrix Boards 0·1in: 5in × 3¾in **3/9**, 2½in × 3¾in, **2/3**.
No. 3 Cir-Kit Pack, containing 4in × 6in sheet Cir-Kit, 6in × 12in laminate board: 15ft × 1/8in Cir-Kit Strip. **12/-**.
PA 12–15 Amplifier Modules, built and tested **£5.9.6.** PS 45 Power Supply Modules, built and tested **£4.10.0.**
All other Peak Sound Products available. Baker Group 25 Speakers, 12in 25 watt 15 ohm, **£5.19.9.** R.C.A. Integrated Circuits: CA3020 500mW amp, **26/-**, CA3018 Trans Array, **22/-**, CA3014 FM/IF amp/Discrim. **25/-**, CA 3012 FM IF amp, **20/-**.
International Rectifier Semiconductor Centre. Unijunction Transistors 2N2160, **13/6.**
Professional quality Tudor Tape at fantastic low prices.

	Std.		L.P.		D.P.	
5in	600ft	9/6	900ft	13/-	1,200ft	16/3
5¾in	—		1,200ft	15/9	1,800ft	20/-
7in	—		1,800ft	16/9	2,400ft	25/-

Send S.A.E. for stock list. Send 5/6 for our 80-page 1969 Hi-Fi Catalogue. C.W.O. Please. Add 1/6 P. & P.

OMICRON ELECTRONICS
172 Baslow Road, Totley, Sheffield S17 4DR

---

the 1969 INTERNATIONAL audio festival & Photo-Cine FAIRS

OCTOBER 16-22

Hear and compare the world's finest sound producing equipment for the home. The top loudspeakers, amplifiers, tape-recorders, pick-ups, tapes and accessories have been brought together under one roof to give you a superb Festival of Sound and Sight. Both newcomer and expert . . . everyone who takes pleasure in using and listening to Hi-Fi equipment of the Highest Standard must visit this International Audio Fair.

Lovers of music of all types, if they are true to their enthusiasm, can hear for themselves, how exactly and faithfully their favourite passage can be played back to them.

Admission 4/-

OLYMPIA

10 a.m.—9 p.m.
Not Sunday

London W14

Quality Transistor Radios to build yourself

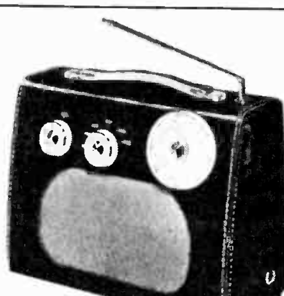
backed by our after sales service

NEW! roamer eight mk 1

7 Tunable Wavebands: Medium Wave 1, Medium Wave 2, Long Wave Trawler Band, S.W.1, S.W.2, S.W.3 Trawler Band. Built in ferrite rod aerial for Medium and Long Waves. 5 section 22in chrome plated telescopic aerial for Short Waves can be angled and rotated for maximum performance. Push-pull output using 600Mw type transistors. Socket for car aerial. Tape record socket. Selectivity switch. Switched earpiece socket complete with earpiece for private listening. 8 transistors plus 3 diodes. Famous make 7 × 4in speaker. Air spaced ganged tuning condenser. On/off switch volume control. Wave change switch and tuning control. Attractive case in rich chestnut shade with gold blocking. Size 9 × 7 × 4in approx. First grade components. Easy to follow instructions and diagrams make the Roamer Eight a pleasure to build. Parts price list and easy build plans 5/-. (FREE with parts).

Total building costs
£6.19.6 P. & P. 7/6

roamer seven mk IV

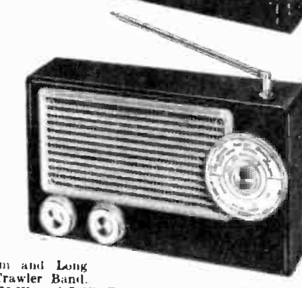


7 FULLY TUNABLE WAVE BANDS—M.W.1, M.W.2, L.W., S.W.1, S.W.2, S.W.3 and Trawler Band. Extra Medium waveband provides easier tuning of Radio Luxembourg, etc. Built in ferrite rod aerial for Medium and Long Waves. 5 Section 22in chrome plated telescopic aerial for Short Waves—can be angled and rotated for peak S.W. listening. Socket for Car Aerial. Powerful push-pull output. 7 transistors and two diodes including Micro-Alloy R.F. Transistors. Famous make 7 × 4in P.M. speaker. Air spaced ganged tuning condenser. Volume/on/off control, wave change switches and tuning control. Attractive case with carrying handle. Size 9 × 7 × 4in approx. First grade components. Easy to follow instructions and diagrams make the Roamer 7 a pleasure to build. Parts price list and easy build plans 3/- (FREE with parts).

Total building costs
£5.19.6 P. & P. 7/6

Personal Earpiece with switched socket for private listening, 5/- extra.

NEW! transeight



SIX WAVEBAND PORTABLE WITH 3in. SPEAKER

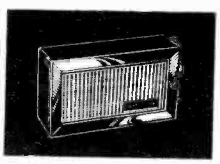
Attractive case in black with red grille and cream knobs and dial with polished brass inserts. Size 9 × 5½ × 2½in. approx. Tunable on Medium and Long Waves, 3 Short Waves and Trawler Band. Sensitive ferrite rod aerial for M.W. and L.W. Telescopic aerial for Short Waves. 8 improved type transistors plus 3 diodes. All top grade components. Push-pull output. Ample power to drive a larger speaker. Parts price list and easy build plans 5/- (FREE with parts).

Total building costs
89/6 P. & P. 5/6

Earpiece with switched socket for private listening 5/- extra.

pocket five

MEDIUM WAVE, LONG WAVE AND TRAWLER BAND (to 50 metres approx.) PORTABLE WITH SPEAKER AND EARPIECE

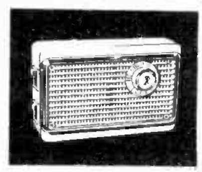


Attractive black and gold case. Size 5½ × 1½ × 5½in. Tunable over both Medium and Long Waves with extended M.W. band for easier tuning of Luxembourg, etc. All first grade components—7 stages—5 transistors and 2 diodes, supersensitive ferrite rod aerial, fine tone moving coil speaker, also Personal Earpiece with switched socket for private listening. Easy build plans and parts price list 1/6 (FREE with parts).

Total building costs
44/6 P. & P. 3/6

transona five

MEDIUM WAVE, LONG WAVE AND TRAWLER BAND (to 50 metres approx.) PORTABLE WITH SPEAKER AND EARPIECE

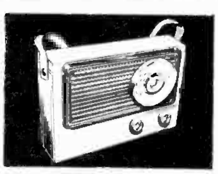


Attractive case with red speaker grille. Size 6¼ × 4½in × 1½in. 7 stages—5 transistors and 2 diodes, ferrite rod aerial, tuning condenser, volume control, fine tone moving coil speaker also Personal Earpiece with switched socket for private listening. All first grade components. Easy build plans and parts price list 1/6 (FREE with parts.)

Total building costs
47/6 P. & P. 3/9

roamer six

SIX WAVEBAND PORTABLE WITH 3in. SPEAKER



Attractive case with gilt fittings. Size 7½ × 5½ × 1½in. Tunable on Medium and Long Waves, two Short Waves, Trawler Band plus an extra M.W. band for easier tuning of Luxembourg, etc. Sensitive ferrite rod aerial and telescopic aerial for Short Waves. All top grade components. 8 stages—6 transistors and 2 diodes including Micro-Alloy R.F. Transistors, etc. (Carrying strap 1/6 extra). Easy build plans and parts price list 2/-.

Total building costs
79/6 P. & P. 4/6

* *Callers side entrance Stylo Shoe Shop*
* *Open 10-1, 2.30-4.30 Mon.-Fri. 9-12 Sat.*

RADIO EXCHANGE LTD

61a, HIGH STREET, BEDFORD. Tel. 0234 52367

I enclose £ .... please send items marked

ROAMER EIGHT	☐	ROAMER SEVEN	☐
TRANSEIGHT	☐	POCKET FIVE	☐
TRANSONA FIVE	☐	ROAMER SIX	☐

Parts price list and plans for

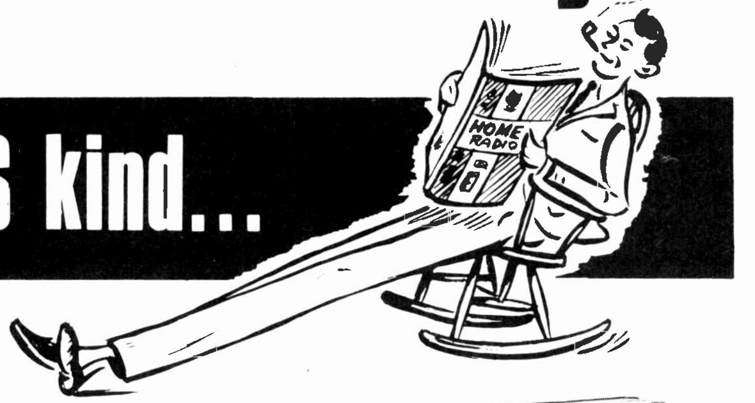
Name ....

Address ....

PE 10

There are Catalogues AND Catalogues!

Ours is THIS kind...



. . . the kind that's

INDEXED THOROUGHLY. F'rinstance "Aerials Telescopic" under "A" and "Telescopic Aerials" under "T".

PLANNED LOGICALLY. Having over 8,000 items it *needs* to be! Components are listed alphabetically in logical sections.

ILLUSTRATED PROFUSELY. Over 1,800 pictures. Some are photos, some are drawings, but all clearly show the features you look for.

PRINTED CLEARLY. No eyestrain here. Large easy-to-read type, on 330 sensible-size pages—$9\frac{3}{4}'' \times 7\frac{1}{4}''$ (ignore our artist's enthusiastic exaggeration !)

BOUND SECURELY. This catalogue is bound to receive long and frequent use. Glossy laminated covers don't show fingerprints, don't tear easily.

PRICED REASONABLY. Just 8/6d plus 3/6d for post, packing and insurance. Folk tell us it's worth twice the price. We quite agree.

WINGS APPEAL SEPT. 15th-20th
GIVE FOR THOSE WHO GAVE

Yes—the Home Radio Catalogue is a pleasure to buy and to use

By the way, every Catalogue contains six Vouchers, each worth 1/- when used as directed, and we supply free a 30-page Price Supplement, a Bookmark giving electronic abbreviations and, of course, an Order Form.

POST THIS COUPON NOW with cheque or P.O. for 12/-

Please write your Name and Address in block capitals

Name ____________________

Address ____________________

____

____

HOME RADIO (Components) LTD., Dept. PE,
234-240 London Road, Mitcham, Surrey CR4 3HD

The price of 12/- applies only to catalogues purchased by customers residing in U.K.

VOL. 5 No. 10
October 1969
PRACTICAL
ELECTRONICS

AUTUMNAL AWAKENING

TAKE a peep into a typical amateur constructor's den or workshop, around mid-summer, and what will you discover as likely or not?

On a workbench, now collecting a film of dust, a half-finished circuit board or two, or some other partially built equipment bearing a sad air of neglect.

Clear evidence of a sudden departure some months ago. Yet the explanation is all too obvious and innocent.

The summer always makes special demands upon the active handyman. His spare time and energies are then directed outdoors. Nature in her most bounteous and prolific mood insists upon regular attention to the garden, and other outdoor maintenance jobs have to be fitted in while the weather is clement. And, of course, the annual holiday provides its welcome and long awaited, if disruptive, interlude in the year's pattern of events in most homes.

Now autumn is upon us. Both the autumn and winter seasons bring their own compensations. Soon a host of constructors will be ensconced once more in their respective dens or workshops, each one (no matter how humble or how frugally equipped) a refuge and solace from the many irritations of the outside world. If only for a few hours in the evening or at the weekend.

In his private retreat, the electronics enthusiast can read and think about circuit ideas—and their possible application to his own or the family's needs. And he can usefully employ himself and practise various skills in building and testing chosen projects.

This kind of recreational activity is, we reckon, as beneficial as a winter's cruise (!) No excuse now for further absenteeism from one's favourite hobby, or for any more accumulation of dust during the next six months or so.

The time has come to return to those half-built projects, also to consider making a start on other designs read about during the close season and mentally recorded as likely subjects for attention when time permitted. And there will be additional new ideas coming along regularly each month. A sample of stick-on-wiring is included in this month's issue. This should arouse the interest of novices and old hands alike and provide added incentive to start or resume building activities straightaway.

So make it a productive and rewarding season.

F. E. Bennett—*Editor*

THIS MONTH

CONSTRUCTIONAL PROJECTS

AUDIO SIGNAL GENERATOR 722
P.E. COMMUNICATIONS RECEIVER—1 734
P.E. ORGAN—6 746
PHOTO-ELECTRIC PARKING LIGHT 762

SPECIAL SERIES

MODEL RAILWAY LOGIC SYSTEMS—2 756
COLD CATHODE TUBES—5 766

GENERAL FEATURES

STICK-ON WIRING 728
I.C. AUDIO AMPLIFIERS 741

NEWS AND COMMENT

EDITORIAL 721
SPACEWATCH 729
ROYAL RADAR ESTABLISHMENT 730
NEWS BRIEFS 745, 753
ELECTRONORAMA 754
MARKET PLACE 777
READOUT 778

Our November issue will be published on Thursday, October 16

Subscription Rates including postage for one year, to any part of the world, 42s.
All correspondence intended for the Editor should be addressed to Tower House, Southampton St., London, W.C.2. Phone: 01-836 4363.
Address correspondence regarding advertisements to Advertisement Manager, Fleetway House, Farringdon St., London, E.C.4. Phone 01-236 8080.

SPECIFICATION

SINE OR SQUARE WAVE OUTPUT

FREQUENCY RANGES (Switch S1a and S1b)
1. f × 1   15Hz to 200Hz
2. f × 10   150Hz to 2kHz
3. f × 100   1·5kHz to 20kHz
4. f × 1,000   15kHz to 200kHz
Where f is the frequency indicated on the fine control

DISTORTION ON SINE WAVE OUTPUT
0·17% at 20Hz   0·04% at 10kHz
0·04% at 100Hz   0·07% at 20kHz
0·04% at 1kHz

ATTENUATOR RANGES (Switch S3) showing r.m.s. output up to:
1. 1mV   3. 100mV
2. 10mV   4. 1V
Fine control VR3 gives intermediate r.m.s. voltages

POWER SUPPLY REQUIRED 18V ± 1V d.c.

LOW DISTORTION AUDIO

In the light of controversy over specifications for audio amplifying equipment, it is becoming increasingly important to be sure that what is labelled "hi fi" really does live up to the conventionally accepted standards of true high fidelity reproduction.

This article is a useful practical prelude to getting started in hi fi. It shows how simple it is to construct an audio oscillator which can be used to carry out performance tests on a wide range of audio amplifiers. It is suitably styled to blend in with the domestic scene without being an eye-sore, as so often test equipment is designed for workshop decoration.

The circuit is based on the well-known Wien bridge configuration with extended ranges to provide high frequency response tests with a square wave output (Fig. 1). The unit can be arranged to provide sine or square waves, whilst a calibrated attenuator facilitates accurate signal levels. Of course, it is necessary to have an a.c. millivoltmeter with very high input impedance for measuring the resulting output from the equipment under test. Although not essential, a wide band oscilloscope also adds to the interpretation of resulting measurements by giving a direct visual image of the test waveform.

WIEN BRIDGE OSCILLATOR

Three transistors are used to provide the sine wave, TR1 and TR2 being a compounded Darlington pair to give high gain, TR3 acting as the phase inversion stage to provide regenerative positive feedback.

Because of the necessity in this circuit for additive reactionary build-up of oscillations, the feedback path must provide in-phase currents from output to input. The frequency of oscillation is determined by the feedback components and, in order to provide a wide frequency range, it is essential to employ transistors of high cut-off frequency, with switched selection of capacitance values.

Any change or mismatch in component values in the series or parallel circuits of the bridge will cause the feedback signal to TR1 base to become out of phase with the bridge input, preventing oscillation.

To achieve perfect oscillation the total phase shift through the amplifier and back through the bridge must be zero or an integral multiple of 2π radians.

FREQUENCY SELECTION

Frequency selection is by means of S1a and S1b (coarse) and the twin-ganged potentiometers VR1 and VR2. VR1 and S1a determine the series feedback characteristic and VR2 with S1b selects the parallel feedback. So to ensure correct match, VR1 and VR2 must be ganged (a "stereo" type of control is ideal) and the capacitors selected by S1a must be the same values as those selected by S1b. It is worthwhile, if at all possible, to measure the capacitance of selected samples to achieve a good match; these should be ideally within one per cent of each other for each nominal value quoted.

The resistance-capacitance network must not load the amplifier output too much, so it should be made a high impedance network compared with the output impedance of TR3. Similarly, the input impedance of the amplifier must be high so that it does not load the bridge feedback path.

The input impedance of the first stage TR1 is approximately equal to R_5 times the current gain squared. Hence, the ideal application of a Darlington pair at the front end to provide a high input impedance to the first stage.

The thermistor RT is used to provide d.c. stabilisation of the transistors because of the direct coupling configuration, necessary to avoid minor phase shift. Consequently, amplitude control is achieved and stabilised to a better degree than if a fixed resistor was used.

For most purposes a sine wave oscillator is adequate to test an audio amplifier for frequency response, power output (undistorted), and amplifier sensitivity, when used in conjunction with an oscilloscope. Tape head alignment can also be made. Bias and erase frequencies are usually greater than about 50kHz and may be as high as 120kHz; this is the reason why the range of this instrument is high to cover these applications.

SIGNAL GENERATOR

SQUARE WAVE CONVERTER

Many people prefer to use a square wave for quick frequency response checks. In this case a wide frequency range oscilloscope, extending to about 50kHz or or more with level response, is a must. With experience and practice it is a simple matter to determine the limitations of frequency response by studying the resulting wave shape at the amplifier output.

One other great advantage of this method is that high frequency oscillation (ringing) inherent in the amplifier will show up. Although this "ringing" is seldom audible on its own, it can have a serious effect on the coloration of complex waveforms, such as from violins or reed instruments. This is often the cause of disturbing "edginess" in music reproduction.

The sine to square wave converter is shown in Fig. 2 and is basically a modified form of Schmitt trigger with very rapid switching.

It is not expected that square waves above about 50kHz will be needed for audio equipment, so any deterioration of wave shape at higher frequencies is no serious handicap.

For frequencies above approximately 20kHz, C14 was added to assist TR5 during its switch-on period, and also keeps the mark/space ratio constant at these

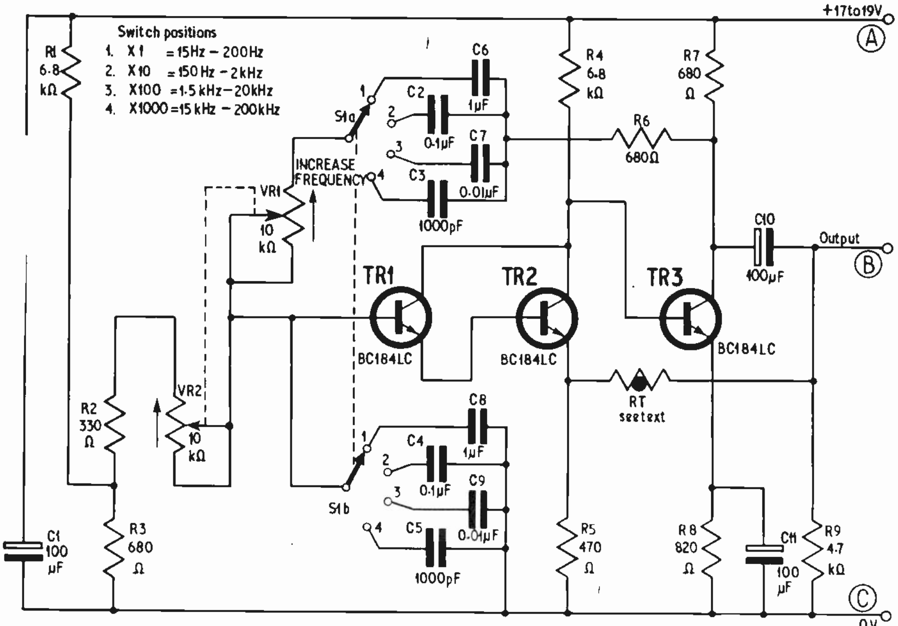


Fig. 1. Circuit diagram of the Wien bridge sine wave generator. Output B is connected to the input of the circuit in Fig. 2 or to the attenuator input F

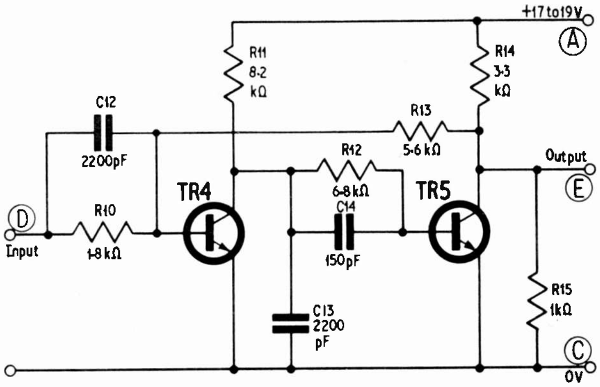


Fig. 2. Circuit diagram of the sine to square wave converter. Output E is connected to the attenuator input F; D to Wien bridge output B

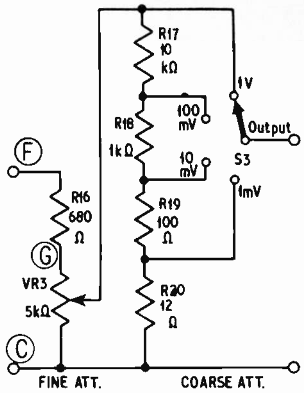


Fig. 3. Stepped and continuously variable attenuator. Input F is connected to Wien bridge output B or converter output E. The output from S3 wiper is fed to the apparatus under test

COMPONENTS . . .

Resistors

R1	6·8kΩ 5%	R11	8·2kΩ 10%
R2	330Ω 5%	R12	6·8kΩ 5%
R3	680Ω 5%	R13	5·6kΩ 10%
R4	6·8kΩ 5%	R14	3·3kΩ 10%
R5	470Ω 5%	R15	1kΩ 10%
R6	680Ω 5%	R16	680Ω 10%
R7	680Ω 5%	R17	10kΩ 5%
R8	820Ω 5%	R18	1kΩ 5%
R9	4·7kΩ 10%	R19	100Ω 5%
R10	1·8kΩ 10%	R20	12Ω 5%

All resistors ¼W carbon

Potentiometers

VR1 10kΩ } twin ganged anti-log carbon miniature
VR2 10kΩ }
VR3 5kΩ linear carbon

Transistors

TR1, 2, 3, 4, 5 BC184LC *or* BC107 *or* BC108 (5 off)

Thermistor

RT 5kΩ at 20°C, 100Ω at 5·5mA. Type R53

Switches

S1 2-pole 6-way (only 4 ways used) rotary wafer
S2 2-pole changeover slide switch
S3 2-pole 6-way (only 1 pole 4 ways used) rotary wafer
S4 2-pole changeover slide switch

Capacitors

C1 100μF elect. 25V
*C2 0·1μF 10%
*C3 1,000pF 5%
*C4 0·1μF 10%
*C5 1,000pF 5%
*C6 1μF 10%
*C7 0·01μF 10%
*C8 1μF 10%
*C9 0·01μF 10%
C10 100μF elect. 25V
C11 100μF elect. 25V
*C12 2,200pF silver mica 5%
*C13 2,200pF silver mica 5%
*C14 150pF silver mica 5%

Note: C2 and C4 to be matched
C3 and C5 to be matched
C6 and C8 to be matched
C7 and C9 to be matched

* These capacitors can also be 1% polystyrene (Wima), 1% silver mica, or 2½% polystyrene according to availability (see text)

Miscellaneous

Perforated s.r.b.p. 0·1in matrix 3¾in × 2¾in (2 off)
Sample of "Cir-Kit" and extra wiring (see text)
Batteries 9V type PP9 (4 off) *or* see text
Coaxial output cable, knobs, battery connectors
Aluminium sub-chassis
Metal case to choice (prototype uses Peak Sound case, 12in × 9in × 3in, type SA8–8 with wood ends)

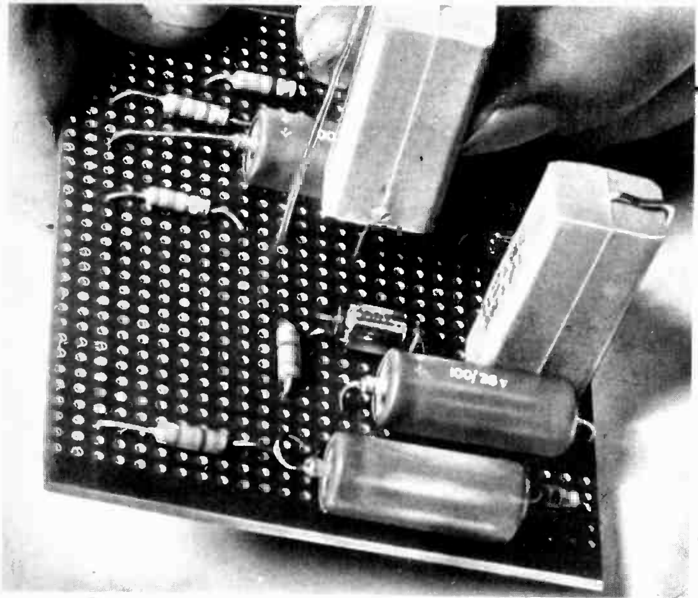
high frequencies. For frequencies below about 100Hz the converter output is directly coupled to the attenuator (Fig. 3). This overcomes the charging and discharging problems of an output coupling capacitor which would otherwise prevent rapid switching at these low frequencies.

ATTENUATOR

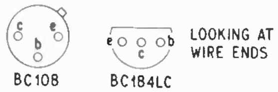
The output attenuator is a simple potential divider arrangement with fine control at VR3 and coarse control by switched resistors (Fig. 3). All values of resistors should have five per cent tolerance, but it is well worth calibrating the output on each switch range, with VR3 wiper set at the R16 end of the track, against a known standard a.c. voltage source.

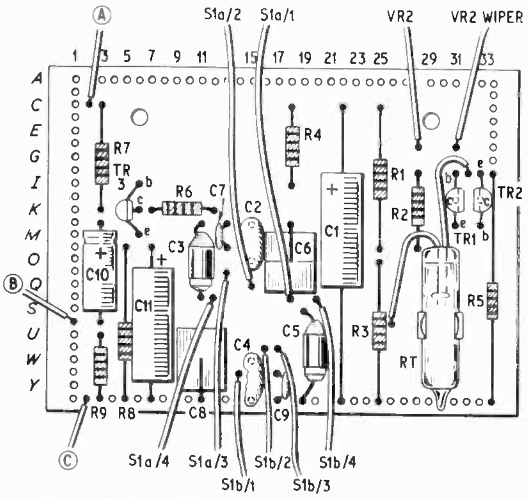
STICK-ON WIRING

The form of construction suggested for this project uses plain perforated s.r.b.p. board (0·1 in matrix) with "Cir-Kit" adhesive copper strip (see accompanying article on how to use this form of "stick-on" wiring). The free sample, given with this issue of PRACTICAL ELECTRONICS, is sufficient to wire up the Wien bridge oscillator only, but there is no reason why the constructor should not combine this with the sine to square wave converter on one board; additional wiring material will, of course, be needed to do this.



The capacitors are positioned. Note the lead-out wire from the centre of the lower end of the large "stand-up" capacitor





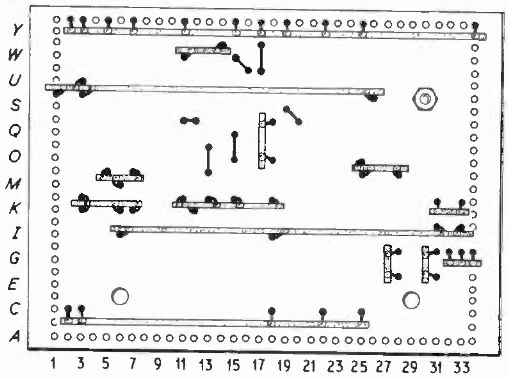
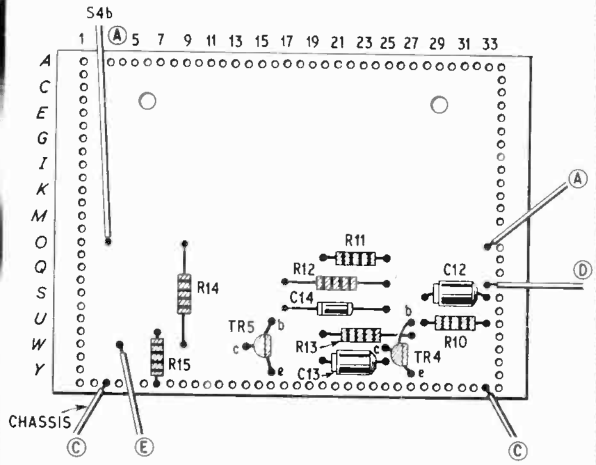


Fig. 4. Component positions and wiring layout of the Wien bridge oscillator board. To aid clarity only the relevant holes are shown for reference of positions



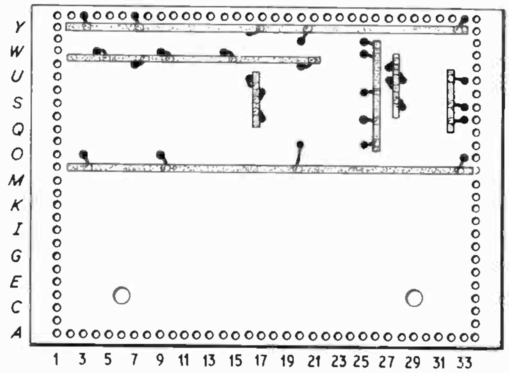
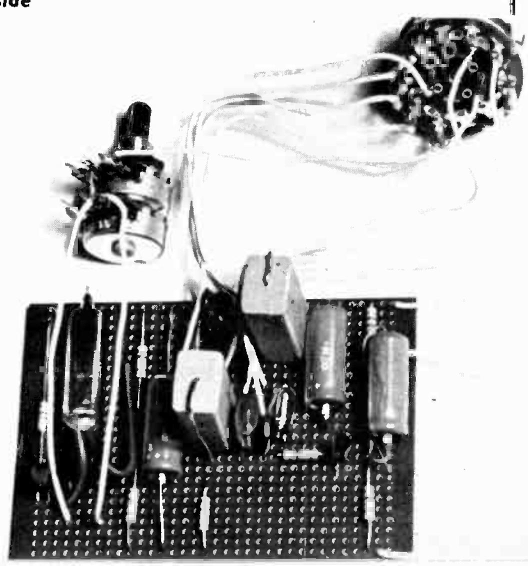


Fig. 5. Component positions and wiring layout of the sine to square wave converter. Only the outermost holes and wire fed holes are shown for reference. These drawings are shown half scale; the instructions on the free sample card apply only to full size drawings

The finished sine wave generator board with switch S1 and ganged potentiometers VR1 and VR2. Resistor R8 is hidden from view by C11 on the right-hand side



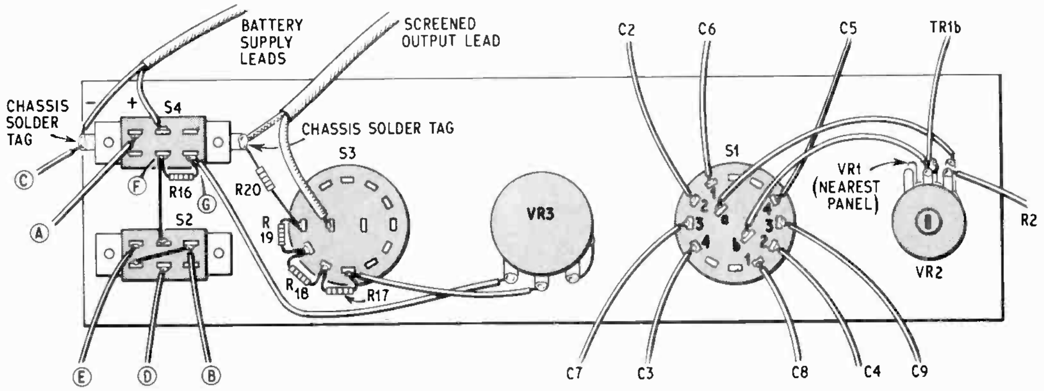


Fig. 6. Rear view of the front panel with inter-board wiring connections and attenuator (on S3). Ringed letters indicate connections shown in all previous diagrams and in Fig. 7 below

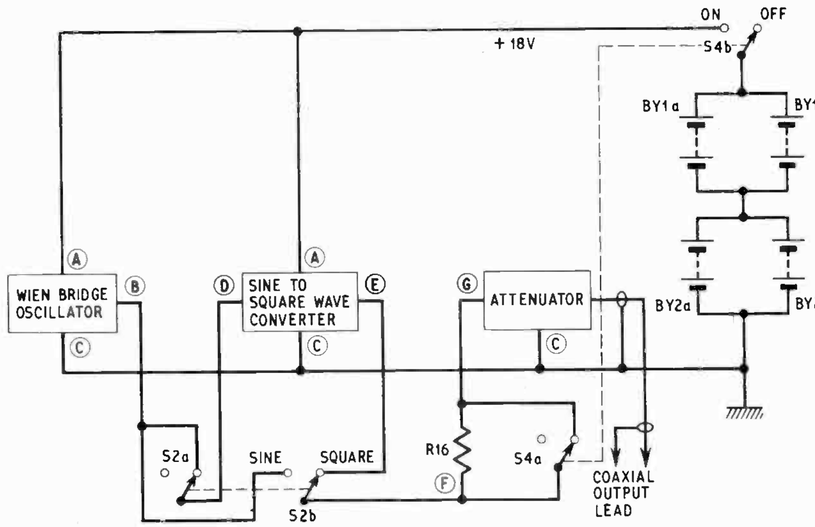
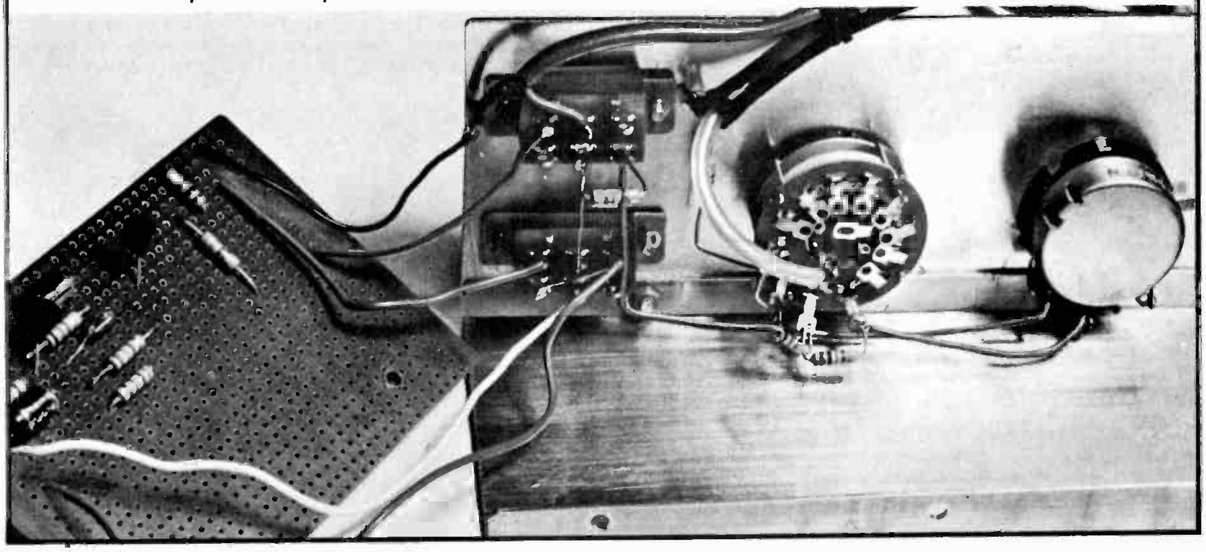


Fig. 7. Block diagram showing how the boards and attenuator are inter-connected and wired to the d.c. supply

The sine to square wave converter (below left) and the wiring of the attenuator switch S3 with control VR3. The two slide switches are S4 (upper) and S2 (lower). Resistor R16 is mounted on S4a for convenience and does not interfere with the function of the circuit



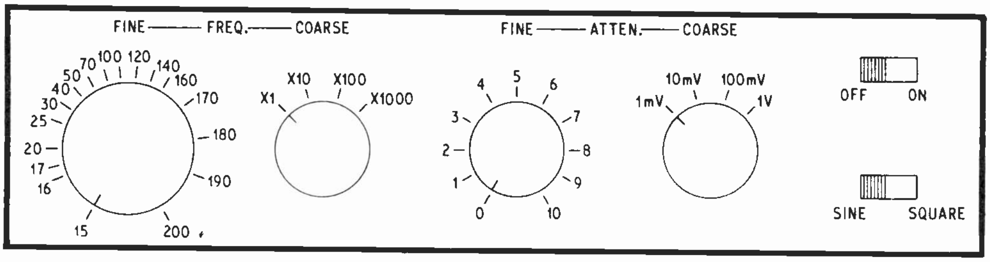


Fig. 8. Approximate positions of frequency and attenuator scale markings. The two slide switches are shown on the right

Wiring instructions are given in the drawings and photographs. The circled letters on the circuit diagrams correspond to those on the wiring diagrams.

Although the prototype version used "Cir-kit", there is no reason why the instructions given in the diagrams should not be applied to plain tinned copper wire. This can be anchored by threading into vacant holes and securing by the soldered joints. These must be sound in any case to avoid faults.

Rearrangement of the wiring layout can be done for other proprietary wiring boards without adversely affecting the circuit operation.

Because the circuit wiring is so simple the component boards can be easily mounted vertically on an aluminium sub-chassis, which would also take the front panel controls (see photographs).

ASSEMBLY

The diagrams in Figs. 4 and 5 show the inter-board connections and cross-reference is given in the schematic diagram in Fig. 6, to show more clearly the switching arrangement. It will be noted that S4a is used only as an anchor point for R16. The battery connections are also shown.

The front panel will need to be labelled as shown in Fig. 7, but the exact positions of fine frequency values will probably vary slightly between one potentiometer and another. It is desirable if at all possible to calibrate this scale using a reliable frequency source for comparison on an oscilloscope display. This would be more important for work with tuned filters than with a straightforward amplifier.

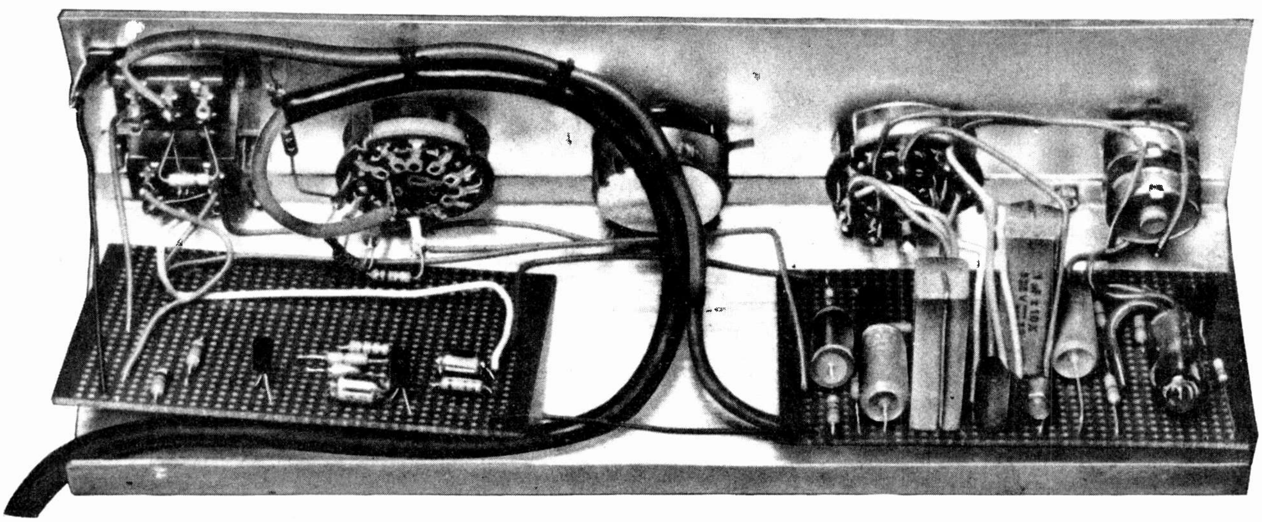
The attenuator scale should also be compared with an accurate known a.c. voltage source using a calibrated high impedance meter.

POWER SUPPLIES

It is recommended that the whole circuit is driven by four PP9 (or equivalent) batteries; two parallel pairs are wired in series to give a high capacity 18 volt supply. If the supply voltage is allowed to drop below about 17V the oscillator will cease to operate. In this respect, some constructors may prefer to incorporate a stabilised low voltage (18V) supply, details of which can often be found in text books and magazines.

One other advantage of a constant voltage source is that it overcomes problems of frequency variation and distortion which could otherwise result from too low a supply voltage. ★

The finished interior of the complete signal generator



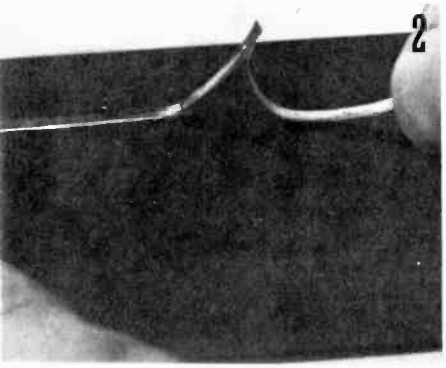
CIR-KIT STICK-ON WIRING

GIVEN FREE with this issue is a sample card of "Cir-kit", a versatile form of circuit wiring using self-adhesive copper strip (1). The strip has a protective paper backing which is peeled off when the copper strip is required to be stuck down on a plastics sheet (such as s.r.b.p.), cardboard, or wood.

It is a simple matter to arrange a circuit wiring lay-out with this strip cut to the required lengths and positioned anywhere on the board. It is also possible to arrange crossed over-lapping strips without short circuit risks, not easily achieved with conventional printed circuit board without using connecting link wires.

One example of a circuit that can be made up using this technique is shown in the previous article—*Audio Signal Generator*. There is sufficient "Cir-kit" on the card to build *one* of the modules for this project; further supplies are only obtainable through the normal retail channels, many of which advertise in this magazine. It should be noted that further supplies cannot be obtained direct from the magazine publishers.

1



2

CIRCUIT BUILDING

The series of photographs shown on this page illustrate how to use "Cir-kit" with s.r.b.p. sheet. The technique can be applied to almost any circuit construction using transistors and a typical stage by stage procedure is shown.

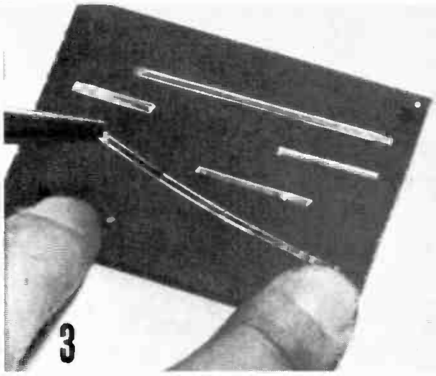
Cut the strip to the required length for the first piece and stick down before going on to the next (2). Do not remove the paper backing until after cutting. Maximum protection should be given to the adhesive until ready for sticking down. Do not allow the fingers to touch the adhesive unnecessarily or the sticking power will be impaired. Do not moisten the adhesive.

If a mistake is made the strip can be lifted and repositioned as required (3). When satisfied that each piece is correctly laid, smooth down all the strips firmly (4), then mark the positions of the holes on the s.r.b.p. with a scriber (5).

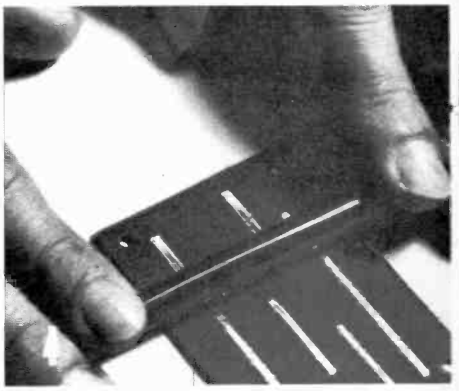
It is not necessary to drill through the copper (which might produce rough burrs); if holes are drilled beside the strips the component wires can be passed through the board, bent over on to the copper and then soldered (6). Use a small drill just big enough to accept the wires through the holes.

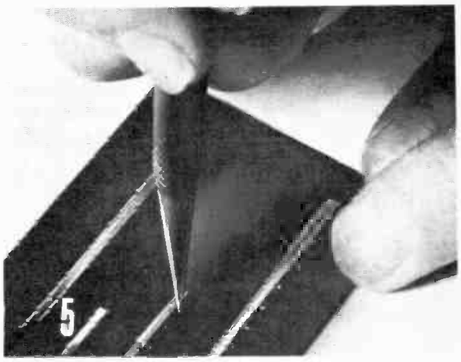
If the adhesive becomes softened by the heat from the soldering iron the copper may lift slightly; wait for it to cool and press down again firmly into position.

Crossovers can be made by building up the circuit on both sides of the board, or by placing one strip over another with thick paper insulation between them (7). ★

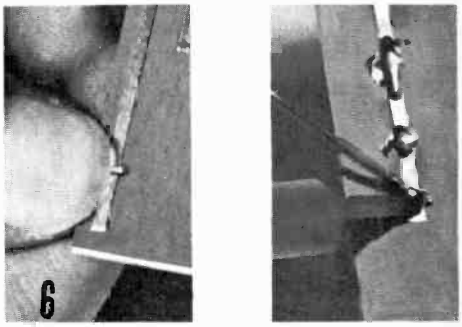


3

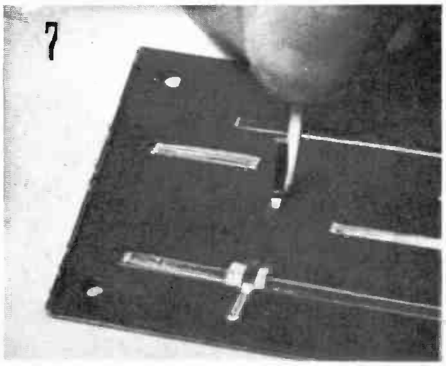




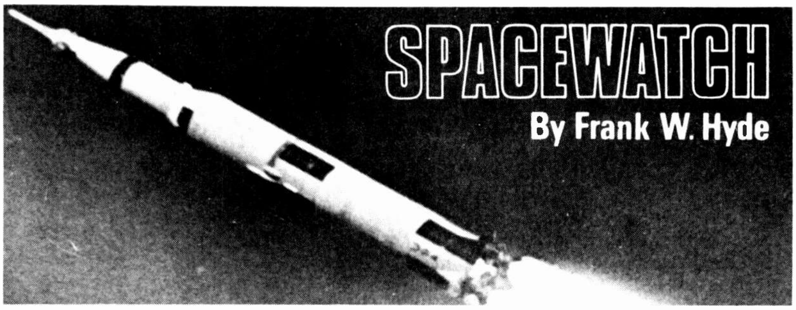
5



6



7



THE RADIO ASTRONOMY SATELLITE

Explorer 38, now in orbit, has confirmed that the earth radiates in the decametre band. In the part of the spectrum below 10MHz the radiation shows similar characteristics to that of the radiation from Jupiter. The sharp bursts narrowly beamed indicates a similar mechanism operating in the magnetosphere.

There is still much to be investigated in the decametre band, for some radiation is affected by the satellites of Jupiter particularly 10, Amalthea and the newly discovered satellite.

The fact that the earth's magnetic field is very considerably less than that of Jupiter will almost certainly show a diminishing level of intensity from the lower frequency end of the decametre band to the higher frequency end. The effects of the solar wind are thought to be greater at the earth, and no doubt this will have to be taken into account.

There is evidence to suggest that there is a continuous background of radiation from Jupiter, its detection dependent upon the size of the aerial arrays used. There are also indications of pulses of radiation of a very rapid nature. The manner in which rapid changes in level, up to more than 100 times that of the normal background, arise has not been satisfactorily explained so far.

The fact that the solar radiation, as indicated by *Explorer 38*, is very much higher than was previously thought at these low frequencies, may have a considerable bearing on future observations. From the point of view of earth based observatories, the ionosphere has a significant effect below 10MHz, though in some places like Tasmania satisfactory observations down to 2MHz have been made. The purpose of the large aerials (four of them each 230 metres long) was to monitor the region of the spectrum below 10MHz from its orbit well above the ionosphere.

RADIO SOURCES STUDIED BY BRITAIN AND USSR

Two major surveys have been completed by Jodrell Bank and the Ukranian Academy of Science at Grakovo. The Jodrell Bank survey is a very complete one covering 387 sources at frequencies of 2·695 and 4·996GHz. The Russian survey covered 80 sources at 12·6, 14·7, 16·7, 20·0 and 25·0MHz. This low frequency survey is an important one and may help to answer some of the questions relating to the grouping of the sources.

Some spectra show a characteristic shape particularly at low frequencies. Many of the sources have a relatively flat spectra at high frequencies and then show a wide change below about 50MHz. Making due allowance for the various effects of the ionosphere, some sources such as 3C48, a quasar, has a spectra which bends down sharply. On the other hand 3C295 shows a turn down for a few megahertz and then a rise. Others yet again show a sudden steep rise at low frequencies.

The value of the work done by Jodrell Bank and Ukranian Academy of Science lies in the wide range of frequencies covered. It is now possible with these two surveys added to the Cambridge surveys to plot the spectra of a significant number of known sources.

Three of the sources examined in the Russian survey had a variation pattern of emmission over a period of several months. In particular 3C461, which is a supernova remnant, and 3C48, a quasar, have doubled their intensity in the low frequency part of the spectrum. This fact had not previously been noted in the literature.

As it is not related to the season of the year, it is not an ionospheric effect and must be a characteristic of the source. Some of the variations in the shape of the spectra must be due to differences in emmission mechanism.

In the synchrotron process, radiations are developed in a weak magnetic field by fast electrons. The bending downwards of the spectra (lower intensity) could be due to the absence of slow moving electrons or to the absorption of the radiation by the source.

A sudden increase in intensity is more difficult to account for and there may be a more complicated method of production of low frequencies. One possible way this could take place is the acceleration of electrons by a shock wave condition operating in the source itself or between it and the earth.

It is clear that further work in this frequency range may add a great deal to our understanding of the physics of cosmic sources.

CANADA SHAPES HER SATELLITE BEAM

Canada has departed from normal in the coverage of territory by the aerial pattern of her satellite for synchronous orbit. If the normal type of aerial were used it would be necessary to provide ground stations with much larger aerials at the edge of the beam.

The new aerial that has been developed will have a basically parabolic beam but so shaped that a kidney pattern will result. The difference in level overall is reduced to less than 1·0dB and all the ground stations can therefore be of one standard type. The aerial measures 1·3 metres by 1·5 metres and there is an offset horn-fed driver to a nominally parabolic reflector.

Allowances have been made in the design for satellite positioning and altitude variations and for the northern latitude path length which adds attenuation losses. The aerial will be arranged on the satellite so that its beam points always to the earth.

COLOUR TELEVISION FROM SPACE

The normal colour television equipment is physically too large to have aboard a spacecraft and a last minute decision to transmit live colour from *Apollo 10* was the result of a successful demonstration of a new system small enough to be accommodated in the module. The *Apollo 11* spacecraft also carried the same system.

In essence the system is little more than a black and white camera with a three colour disc spinning between the lens and the tube. A series of pictures are taken through the red, green and blue filters on the disc, which spins at 60 revolutions per second, and amplified and recorded on a six track disc recorder. After a series of each colour has been received, the three colours are read out simultaneously.

INTERNAL REFLECTION

The camera shots from the fixed camera on *Eagle* showed many internal surface reflections within the lens system and on several of the shots, where Aldrin walked diagonally away from the camera, the reflection revealed a figure moving divergently; when the astronauts stepped into shadow they disappeared from sight. These are some of the facts known and spoken of by many people before the moon landing, often they were at best half believed. Once more the proof appeared.

It is worthwhile contemplating on the amount of right thinking that has gone to make space a success.

ROYAL RADAR ESTABLISHMENT

A BRIEF LOOK AT BRITAIN'S LARGEST ELECTRONICS RESEARCH CENTRE

In an idyllic setting in peaceful Worcestershire countryside with the Malvern Hills rising steeply just a mile away in the west, is the Royal Radar Establishment, Britain's largest centre for electronics research. (The Ministry of Technology suggest it may well be the largest in Europe.) The Royal Radar Establishment evolved from two famous war-time establishments, T.R.E. and R.R.D.E. which were concerned with methods of locating aircraft by radar reflections. R.R.E. is still responsible for the development of radar systems for all three Services, but its activities are now much wider and cover an extensive range from basic physics research to advanced equipment development.

There are apparently no recruitment problems at R.R.E. Despite attractive offers from certain overseas countries, the brain drain has little effect at Malvern; quite the reverse in fact, since many British engineers and scientists earlier wooed away to North America have eagerly seized opportunities to return to the United Kingdom and to work at the R.R.E.

It is not the wonderful pastoral location which provides the magnet—although this must surely add to the attraction of working at Malvern. The incentive to join the Establishment is the nature and scope of the research and development being undertaken there. Some idea of the extent and importance of this work was revealed during the Open Days in June last.

There are two major departments in R.R.E. The Physics and Electronics Department specialising in the development of new electronic materials and devices, and the Military and Civil Systems Department which is concerned with electronic systems for particular applications.

SOLID STATE MICROWAVE DEVICES

It is difficult for an outsider to attempt to evaluate, and place in any order of importance, the great variety of activities the Establishment is currently engaged upon.

This battery-operated radar transmitter and receiver uses a pin-head size crystal of gallium arsenide as the generating source of microwaves. It can be used for detecting moving objects and indicating their speeds on the meter shown. The equipment is potentially suitable for use in checking the speeds of road vehicles, as a railway warning device, and for school demonstration equipment. This radar was developed at the Royal Radar Establishment

In terms of emerging technology, however, the value and future significance of the present work in the field of semiconductor microwave oscillators is clear to see.

The first gallium arsenide X band oscillators were made at the R.R.E. in 1965. Since then, they have been manufactured commercially, and have found application in hand-held radar speed-meters, train approach warning systems, burglar alarms, signal generators, microwave communication links, and as local oscillators in radar equipments.

Particularly interesting as an example of recent work is the portable c.w. radar, with solid state generator, which can measure the velocity at which a ship is approaching its berth. This system was designed by R.R.E. in conjunction with Esso Petroleum Co. Ltd., specially to facilitate the docking of super tankers.

INFRA-RED DETECTORS

One of the activities of the Physics Group is the development of infra-red detectors and the study of the fundamental properties of the semi-conductor and other materials from which detectors are made.

There are two main types of infra-red detectors. Thermal detectors such as the thermopile, bolometer and the Golay cell. A newer one, which R.R.E. is working on at present is the pyroelectric detector. This makes use of the temperature coefficient of the internal electrical polarization of materials such as triglycine sulphate or lithium niobate.

Then there are photoconductive detectors, now becoming commercially available, due to a mixed compound material discovered at R.R.E.

MATERIALS DIVISION

The reference to new electronic materials brings into the picture a very important part of the Physics Group.

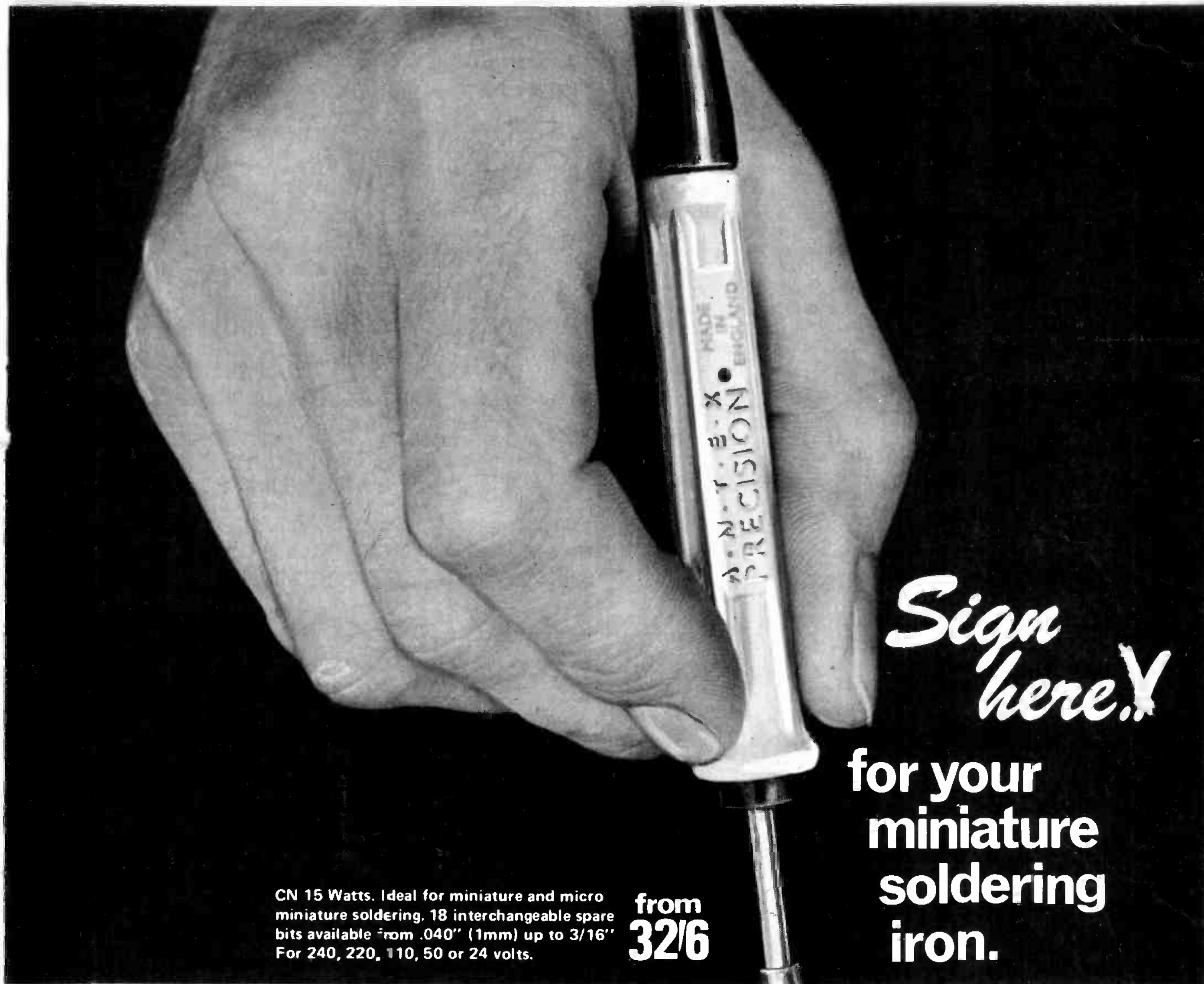
The Materials Division has grown up over the past decade to meet the need for new materials among teams working within the Establishment on new solid state devices. As the number and variety of such devices has increased so the Division has grown until it is now one of the largest teams in Europe dedicated solely to the preparation of single crystals.

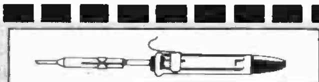
The successful development of the many solid state devices on which scientists have been and are still working depends on the constant availability of well-characterised high-quality single crystals of the essential materials. The newest materials are not usually available from commercial sources and of necessity must be specially developed.

In its early days the Division was concerned with growing the elements silicon and germanium for use in semiconductor devices. After this came an interest in compound semiconductors beginning with the pioneer work on indium antimonide for use in far infra-red detectors. Another very important semiconducting compound is gallium arsenide, which has come into prominence for the fabrication of Gunn effect oscillators. Recently the work has been extended to include a number of ternary semiconducting materials with device potential.

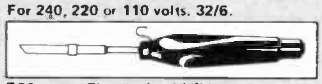
LASER AND ELECTRO-OPTIC MATERIALS

With the invention of the laser the research broadened to include work on the production of suitable host-lattice materials such as ruby, calcium fluoride, calcium tungstate and yttrium aluminium garnet. Electro-optic devices have necessitated the growth and investigation of a variety of materials including lithium niobate, thio-acid salts such as proustite (silver ortho-thioarsenite) and pyrargyrite (silver thioantimonite) and various water-soluble com-





G 18 watts. Fitted 3/32" bit for miniature work on production lines. Interchangeable spare bits, 1/8", 3/16" and 1/4" available. For 240, 220 or 110 volts. 32/6.



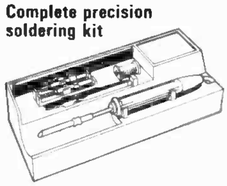
E 20 watts. Fitted with 1/4" bit. Interchangeable spare bits 3/32", 1/8", 3/16" available. For 240, 220, 110 volts. From 35/-

ES 25 watts. Fitted with 1/8" bit. Interchangeable bits 3/32", 3/16" and 1/4" available. Ideal for high speed production lines. For 240, 220, 110, 24 or 12 volts. From 35/-

F 40 watts. Fitted 5/16" bit. Interchangeable bits 1/4", 3/16", 1/8", 3/32" available. Very high temperature iron. For 240, 220, 110, 24 or 20 volts. From 42/6

Spare bits and elements for all models and voltages immediately available from stock.

Complete precision soldering kit



This kit—in a rigid plastic "tool-box" — contains

- Model CN 15 watts miniature iron, fitted 3/32" bit. Interchangeable spare bits 1/32", 3/32".
- Reel of resin-cored solder
- Felt cleaning pad
- Stand for soldering iron

PLUS 36-page booklet on "How-to-Solder"—a mine of information for amateur and professional.

From Electrical and Radio Shops or send cash to Antex. **49/6**

Model CN 240/2
15 watts - 240 volts

Fitted with nickel plated bit (3/32") and in handy transparent pack. From Electrical and Radio Shops or send cash to Antex. **31/-**

ANTEX

PRECISION MINIATURE SOLDERING IRONS

Antex, Mayflower House, Plymouth, Devon.
Telephone: Plymouth 67377/8.
Telex: 45296. Giro No. 2581000.

☐ Please send me the Antex colour catalogue

☐ Please send me the following irons

Quantity	Model	Bit Size	Volts	Price
....	....	....	....	....
....	....	....	....	....
....	....	....	....	....

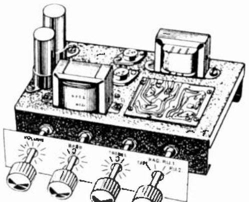
I enclose cheque/P.O./cash value ....

NAME ....

ADDRESS ....

.... P.E.10

NEW! HSL.700 MONO TRANSISTOR AMPLIFIER



A really high fidelity monaural amplifier with performance characteristics to suit the most discriminating listener. 6 transistor circuit with integrated preamplifier assembled on special printed sub panel. AD161-AD162 operating in symmetrical complementary pair. Output transformer coupled to 3 ohm and 15 ohm speaker sockets. Standard phono input sockets. Full wave bridge rectifier power supply for a.c. mains 200–240v. Controls: bass, treble, volume/on/off. Function selector for PU1, PU2, tape, radio. The HSL.700 is strongly constructed on rigid steel chassis bronze hammer enamel finish, size 9½ × 5 × 4½in. high.

Performance figures:
Sensitivity—PU1—50m/v, 56K input impedance.
PU2—110m/v, 1 meg input impedance.
Tape—110m/v, 1 meg input impedance.
Radio—110m/v, 1 meg input impedance.

Output power measured at 1Kc—6·2 watts RMS into 3 ohms, 5·8 watts RMS into 15 ohm. Overall frequency response 30c/s–18Kc/s: Continuously variable tone controls; Bass, +8db to −12db at 100c/s. Treble, +10db to −10db at 10Kc/s.

The HSL.700 has been designed for true high fidelity reproduction from radio tuner, gramophone deck and tape recorder preamp but is also capable of being used in conjunction with a guitar by connecting to PU1 socket and the peak output power will then be in the region of 15 watts.

Supplied ready built and tested, complete with knobs, attractive anodised aluminium front escutcheon panel, long spindles (can be cut to suit your housing requirements) full circuit diagram and operating instructions.

OUR SPECIAL PRICE £7.19.6. P. & P. 7/6.

LOUDSPEAKER BARGAINS

5in 3 ohm **16/-**, P. & P. 3/-. 7 × 4in 3 ohm **21/-**, P. & P. 4/-. 10 × 6in 3 ohm **27/6**, P. & P. **6/-**. E.M.I. 8 × 5in 3 ohm with high flux magnet **21/-**, P. & P. 4/-. E.M.I. 13½ × 8in 3 ohm with high flux ceramic magnet **42/-**, (15 ohm **45/-**), P. & P. 6/-. E.M.I. 13 × 8in, 3 or 15 ohm with two inbuilt tweeters and crossover network **4 gns**, P. & P. 6/-.

BRAND NEW. 12in 15w H/D Speakers, 3 or 15 ohm. Current production by well-known British maker. Now with Hiflux ceramic ferrobar magnet assembly **£5.10.0**, P. & P. 7/6. Guitar models: 25w **£6.0.0.** 35w **£8.0.0.**

E.M.I. 3½in HEAVY DUTY TWEETERS. Powerful ceramic magnet. Available in 3 or 8 ohm **15/-** each; 15 ohm **18/6** each. P. & P. 2/6.

12in "RA" TWIN CONE LOUDSPEAKER. 10 watts peak handling. 3 or 15 ohm, **37/6**, P. & P. 6/-.

35 OHM SPEAKERS

3½in **14/-**, P. & P. 2/6; 7 × 4in **21/-**, P. & P. 4/-.

SPECIAL OFFER
Hi-Fi Celestion Speaker Unit. Size 6 x 4in. Powerful 11,000 line magnet with specially treated cone surround. 10–12 ohm impedance. Few only at 20/-. P. & P. 3/6.

QUALITY PORTABLE TAPE RECORDER CASE. Brand new. Beautifully made. Only **49/6**. P. & P. 8/6.

DUAL PURPOSE BULK TAPE ERASER AND TAPE HEAD DEMAGNETISER 35/-. P. & P. 3/-.

CRYSTAL MIKES. High imp. for desk or hand use. High sensitivity, **18/6**. P. & P. 1/6.

HIGH IMPEDANCE CRYSTAL STICK MIKES. OUR PRICE **21/-**. P. & P. 1/6.

S.T.C. TYPE 25 MINIATURE RELAYS—48 volt. 4 s/p, c/o contacts. 1 amp rating. Coil resistance 5,800 ohms. Size approx. ¾ × 1¼ × 1¼in. high. **8/6** each. P. & P. 1/6.

SPECIAL OFFER! PLESSEY TYPE 29 TWIN TUNING GANG. 400pF + 146pF. Fitted with trimmers and 5:1 integral slow motion. Suitable for nominal 470 kc/s I.F. Size approx. 2 × 1 × 1½in. Only **8/6**. P. & P. 2/6.

BRAND NEW MULTI-RATIO MAINS TRANSFORMERS. Giving 13 alternatives. Primary: 0-210-240V. Secondary combinations: 0-5-10-15-20-25-30-35-40-60V half wave at 1 amp or 10-0-10, 20-0-20, 30-0-30V. at 2 amps full wave. Size 3inL × 3½inW × 3inD. Price **32/6**. P. & P. 6/-.

MAINS TRANSFORMER. For transistor power supplies. Pri. 200/240V. Sec. 9-0-9 at 500mA. **11/-**. P. & P. 2/6. Pri. 200/240V. Sec. 12-0-12 at 1 amp. **14/6**. P. & P. 2/6. Pri. 200/240V. Sec. 10-0-10 at 2 amp. **27/6**. P. & P. 3/6.

BRAND NEW MAINS TRANSFORMERS for Bridge Rectifier. Pri. 240v. AC Sec. 240v. at 50mA and 6·3v. at 1·5 amp. Stack size 2½ × ¾ × 2½in. **10/6**. P. & P. 3/6. (Special quotations for quantities.)

HIGH GRADE COPPER LAMINATE BOARDS
8 × 6 × $\frac{1}{16}$in. FIVE for 10/-. P. & P. 2/-.

TRANSISTOR STEREO 8 + 8 MK II

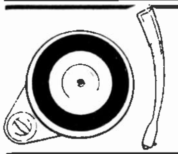
Now using Silicon Transistors in first five stages on each channel resulting in even lower noise level with improved sensitivity. A really first-class Hi-Fi Stereo Amplifier Kit. Uses 14 transistors giving 8 watts push pull output per channel (16W mono). Integrated pre-amp. with Bass, Treble and Volume controls. Suitable for use with Ceramic or Crystal cartridges. Output stage for any speakers from 3 to 15 ohms. Compact design, all parts supplied including drilled metal work. Cir-Kit board, attractive front panel, 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: Freq. response ±3dB. 20–20,000c/s. Bass boost approx. to +12dB. Treble cut approx. to −16dB. Negative feedback 18dB over main amp. Power requirements 25V at 0·6 amp.

PRICES: AMPLIFIER KIT **£10.10.0;** POWER PACK KIT **£3.0.0;** CABINET **£3.0.0.** All Post Free.

Also available STEREO 10 + 10. As above but 10 watts per channel. **PRICES:** AMPLIFIER KIT **£12**. POWER PACK KIT £3.10.0.

Circuit diagram, construction details and parts list (free with kit) 1/6. (S.A.E.).

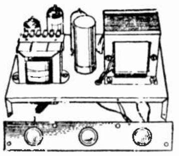
Official stockists of all PEAK SOUND HI-FI EQUIPMENT including the **P.W. DOUBLE 12 STEREO AMPLIFIER** as featured in Practical Wireless April, May and June issues. Component pack as specified. Total cost **£23.5.6** plus P. & P. 11/-. (Excluding metalwork, knobs, plugs and sockets and fuses.)



SPECIAL PURCHASE! E.M.I. 4-SPEED PLAYER
Heavy 8¼in. metal turntable. Low flutter performance 200/250 V shaded motor (90 V tap). Complete with latest type lightweight pick-up arm and mono cartridge with t/o stylii for LP/78. ONLY **63/-**. P. & P. 6/6.

QUALITY RECORD PLAYER AMPLIFIER MK II
A top-quality record player amplifier employing heavy duty double wound mains transformer, ECC83, EL84, EZ80 valves. Separate Bass, Treble and Volume controls. Complete with output transformer matched for 3 ohm speaker. Size 7in. w. × 3 d. × 6 h. Ready built and tested. PRICE **75/-**. P. & P. 6/-. ALSO AVAILABLE mounted on board with output transformer and speaker ready to fit into cabinet below. PRICE **97/6**, P. & P. 7/6.

DE LUXE QUALITY PORTABLE R/P CABINET MK II
Uncut motor board size 14½ × 12in., clearance 2in. below, 5½in. above. Will take above amplifier and any B.S.R. or GARRARD changer or Single Player (except AT60 and SP25). Size 18 × 15 × 8in. PRICE **79/6**. P. & P. 9/6.



3-VALVE AUDIO AMPLIFIER HA34 MK II
Designed for Hi-Fi reproduction of records. A.C. Mains operation. Ready built on plated heavy gauge metal chassis, size 7½in w. × 4in. d. × 4½in. h. Incorporates ECC83, EL84, EZ80 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker. Separate volume control and now with improved wide range tone controls giving bass and treble lift and cut. Negative feedback line. Output 4½ watts. Front panel can be detached and leads extended for remote mounting of controls. Complete with knobs, valves, etc., wired and tested for only **£4.15.0**. P. & P. 6/-.

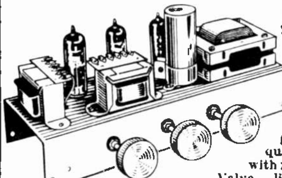
HSL "FOUR" AMPLIFIER KIT. Similar in appearance to HA34 above but employs entirely different and advanced circuitry. Complete set of parts, etc. **79/6**. P. & P. 6/-.

BRAND NEW TRANSISTOR BARGAINS. GET 15 (Matched Pair) **15/-**; V15/10p, **10/-**; OC71 **5/-**; OC76 **6/-**; AF117 **3/6**; 2G339 (NPN) **3/-**.
Set of Mullard 6 transistors OC44, 2—OC45, AC128D, matched pair AC128 **25/-**; ORP12 Cadmium Sulphide Cell **10/6**. All post free.

VYNAIR AND REXINE SPEAKERS AND CABINET FABRICS app. 54in. wide. Usually 35/- yd., our price **13/6** yd. length. P. & P. 2/6 (min. 1 yd.). S.A.E. for samples.

BRAND NEW! PARMEKO MAINS TRANSFORMERS. Primary 110v-250v. Secondary 330–0–330v. 100mA and 6·3v. at 2 amps, 6·3v. at 2 amps and 6·3v. at 1 amp. Conservatively rated. Fully impregnated Electrostatic screen. Suitable for vertical or drop through mounting. Overall size 4¼ × 3¾ × 3½in. Weight 8 lb. Limited number only at **37/6**. P. & P. 8/-.

DE LUXE STEREO AMPLIFIER



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 full wave rectifier. Two dual potentiometers are provided for bass and treble control, giving bass and treble boost and cut. A dual volume control is used. Balance of the left and right hand channels can be adjusted by means of a separate "balance" control fitted at the rear of the chassis. Input sensitivity is approximately 300m/v for full peak output of 4 watts per channel (8 watts mono), into 3 ohm speakers. Full negative feedback in a carefully calculated circuit, allows high volume levels to be used with negligible distortion. Supplied complete with knobs, chassis size 11in. w × 4in. x. Overall height including valves 5in. Ready built and tested to a high standard. **Price 8 gns.** P. & P. 8/-.

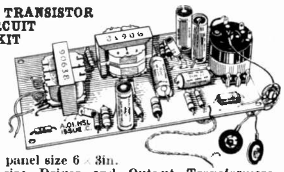
4-SPEED RECORD PLAYER BARGAINS
Mains models. All brand new in maker's packing.
B.S.R. UA25 with latest mono compatible cart... £6.19.6
All plus Carriage and Packing 6/6.

LATEST GARRARD MODELS. All types available 1025, 2025, SP25, 3000, AT60 etc. Send S.A.E. for Latest Prices!

PLINTH UNITS cut out for Garrard Models 1025, 2025, 2000, 3000, AT60, SP25. With transparent plastic cover. OUR PRICE **5 gns.** complete. P. & P. 8/6.

SONOTONE 9TAHC compatible Stereo Cartridge with diamond stylus **50/-**. P. & P. 2/-.
LATEST RONETTE T/O Stereo Compatible Cartridge for EP/LP/Stereo/78. **32/6**. P. & P. 2/-.
LATEST RONETTE T/O Mono Compatible Cartridge for EP/LP/78 mono or stereo records on mono equipment. **30/-**. P. & P. 2/-.
FEW ONLY! ACOS HIGH-G Mono Cartridge for EP and LP. Only **10/-**. P. & P. 2/-.

HIGH GAIN 4 TRANSISTOR PRINTED CIRCUIT AMPLIFIER KIT Type TA1



- Peak output in excess of 1½ watts.
- All standard British components.
- Built on printed circuit panel size 6 × 3in.
- Generous size Driver and Output Transformers.
- Output transformer tapped for 3 ohm and 15 ohm speakers.
- Transistors (GET114 or 81 Mullard AC 128D and matched pair of AC128 o/p).
- 9 volt operation.
- Everything supplied, wire, battery clips, solder, etc.
- Comprehensive easy to follow instructions and circuit diagram **2/6** (Free with Kit). All parts sold separately.

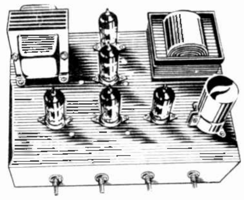
SPECIAL PRICE 45/-, P. & P. 3/-. Also ready built and tested, **52/6**. P. & P. 3/-.

HARVERSON'S SUPER MONO AMPLIFIER

A super quality gram amplifier using a double wound mains transformer. EZ80 rectifier and ECL82 triode pentode valve as audio amplifier and power output stage. Impedance 3 ohms. Output approx. 3·5 watts. Volume and tone controls. Chassis size only 7in. wide × 3in. deep × 6in. high overall. AC mains 200/240V. Supplied absolutely Brand New completely wired and tested with valves and good quality output transformer. FEW ONLY.

OUR ROCK BOTTOM BARGAIN PRICE 49/6 P. & P. 6/-

10/14 WATT HI-FI AMPLIFIER KIT

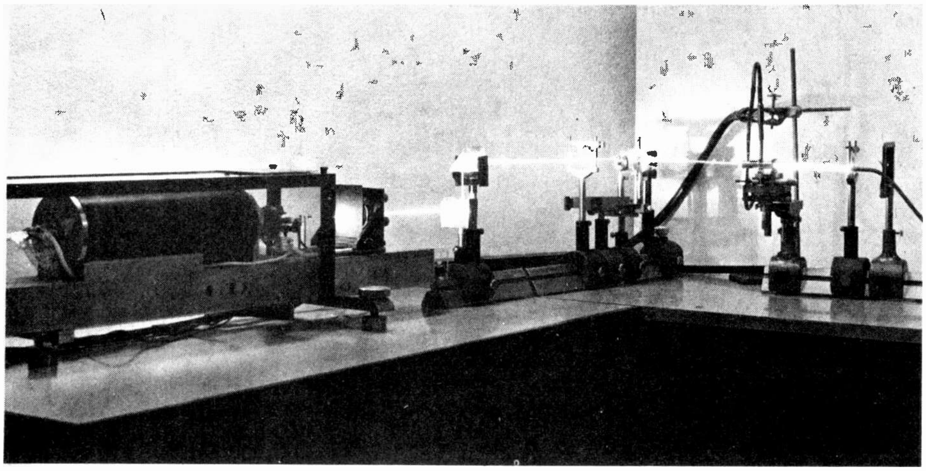


A stylishly finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other. Fully shrouded section wound output transformer to match 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 **2/6** (Free with parts). **All parts sold separately.** ONLY **£7.9.6**, P. & P. 8/6. Also available ready built and tested complete with std. input sockets, **£9.5.0**, P. & P. 8/6.

Open all day Saturday
Early closing Wed. 1 p.m.
A few minutes from South Wimbledon Tube Station

HARVERSON SURPLUS CO. LTD.
170 HIGH ST., MERTON, LONDON, S.W.19 Tel. 01-540 3985
SEND STAMPED ADDRESSED ENVELOPE WITH ALL ENQUIRIES

(Please write clearly)
PLEASE NOTE: P. & P. CHARGES QUOTED APPLY TO U.K. ONLY. P. & P. ON OVERSEAS ORDERS CHARGED EXTRA.



Turbulence studies by laser doppler spectroscopy. This technique, developed at R.R.E., in collaboration with A.E.R.E. and University of Kent, offers several advantages over previous methods, e.g. high spatial resolution, absolute velocity measurement, and no disturbance of the flow. The argon-ion laser in the foreground was developed by the British Admiralty and is the most powerful sealed-off laser of its type in the world

pounds such as potassium dihydrogen phosphate. Among the most recent developments are pyroelectric and electro-acoustic materials, for example, triglycine sulphate and zinc oxide.

A new class of materials is that of the semiconductor eutectics consisting of two sets of single crystals grown simultaneously from the melt. An interesting example is the cadmium arsenide/nickel arsenide eutectic whose rod morphology affords useful magnetoresistive properties.

Examples of non-crystalline materials also developed in the Division are a series of chalcogenide glasses transmitting in the infra-red.

NEW GROWING TECHNIQUES

Concurrently with growing crystals there has been much work on the development of techniques and equipment for the growth of crystals together with research on a variety of related topics. The technique most frequently employed in the Division for the production of crystals has been growth from the melt by vertical pulling (usually referred to as the Czochralski process). Other melt-growth techniques such as zone-melting and the Stockbarger, Bridgeman and Kyropoulos processes have also been used.

The simple puller originally designed by the Division to produce its first germanium crystals has been developed over the years into a refined and highly versatile apparatus which can produce a whole range of single crystals of refractory materials with melting points up to that of spinel (2,135°C). Spinel crystals with masses up to 150gm and sapphires up to 250gm have been grown. To extend the range of temperatures still further, a new crystal growth technique has been developed using gas laser power as the source of heat. By this means oxide crystals have been grown with melting points up to 2,500°C; for example, yttrium oxide.

The applications of vertical pulling have been further extended by the development of the liquid encapsulation technique to prevent the loss of volatile constituents from the melt. Gallium arsenide and indium arsenide have been produced using this technique. The latest addition to the R.R.E. puller is a work-chamber capable of withstanding a pressure of 200 atmospheres. This is used, in conjunction with liquid encapsulation to pull crystals of substances that have a high vapour pressure at the melting point, for example gallium phosphide and indium phosphide.

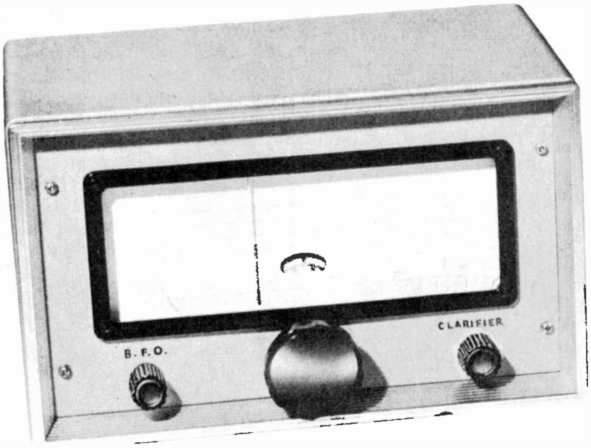
MILITARY AND CIVIL SYSTEMS

Advanced electronic equipment for particular applications is the concern of the Military and Civil Systems Department. Research is now being carried out in respect of the combined use of radars and computers to assist Air Traffic Controllers to handle air traffic. The computer assisted approach sequencing system (C.A.A.S.) aims to increase the landing capacity of a busy airport by assisting controllers to attain consistent intervals between landing aircraft.

The Touch-Display is a novel input/output device for computers which has been developed at R.R.E. to provide an efficient method of communication between man and machine. The device has a number of wires placed on the face of the ray tube. These wires are made, by electronic means, sensitive to the touch of a finger and information is written by the computer as characters, words or even complete sentences against them. The "controller" indicates his reaction to the information shown by touching the appropriate wire. The Touch-Display is thus an integration of the electronic data display and a keyboard whose engravings can be varied to suit the needs of the moment. Its possible commercial application include air traffic control, car ferry bookings, etc.

Much of the Establishment's work in the field of military radar is necessarily of a restricted nature, and details are not generally revealed. But one example on display was The Rapier guided weapon system. This permits a supersonic direct-hitting missile to be automatically commanded to follow an optically established sightline to the target. A surveillance radar is used for target detection and provides information from which the optical sight can be laid on the target. Flares are mounted in the tail of the missile to provide a light source for detection by a television camera in the tracking head of the control unit.

The R.R.E. Small Portable Radar Torch (SPRAT) is an experimental hand-held radar which weighs less than 5½ pounds. It is completely self contained and will operate for several hours from a rechargeable battery housed in the handle. It is intended for use at night or when visual observation is impossible and under such conditions a trained operator can detect, locate and classify moving targets at ranges up to 1100 metres



P.E. WIDEBAND H.F. COMMUNICATIONS RECEIVER

By R. HIRST S.T.C. LTD.

THIS series of articles describe a modern high frequency receiver working on the principle of single sideband (s.s.b.) transmission and reception. The main features of the design lie in the introduction of a wideband front end r.f. amplifier and a simple modular constructional approach. *This does not mean to imply that the receiver is necessarily a simple unit to construct or to electrically "set up"* but indicates that the mechanical design is broken down into a number of easily recognisable sub-units.

Before the specific design is described in detail it is desirable, for the sake of newcomers to this field, that some of the more fundamental aspects of single sideband transmission, and the resultant reception, are presented in a simple form.

PRINCIPLES OF S.S.B.

Fig. 1.1 shows two single sidebands displaced about a 10MHz carrier, one above the carrier frequency, this is called the upper sideband, and one below the carrier, this being the lower sideband. For normal speech transmission and reception a 3kHz bandwidth is quite adequate, therefore the upper sideband will be between 10MHz and 10·003MHz and the lower sideband between 9·007MHz and 10MHz. A receiver is called a single sideband receiver when it is capable of receiving information in one sideband or the other and an independent sideband receiver when it is capable of receiving and presenting information in both sidebands simultaneously.

The receiver described in this series is a single sideband receiver but it is relatively simple to convert it to an independent sideband receiver, that is, from s.s.b. to i.s.b.

In single sideband operation two distinct pieces of information are transmitted; these are, the carrier—to operate automatic gain control and automatic frequency control—and the sideband information—to convey the required information to the receiver. Usually only a small portion of the transmitted power is used to provide the carrier and the much larger proportion contains the intelligence. It is common to find that the carrier level is 16dB or 26dB below the sideband information and for the sake of simplicity during this initial examination it is proposed to consider that the carrier is 26dB below the sideband.

After the last i.f. amplifier the received signals are split into two paths, the carrier path and the signal path. The carrier path is used to provide automatic gain and frequency control, the latter for more complex receivers, and the signal path converts the sideband information into audio. It is therefore necessary to adequately filter out the frequencies required for both paths and the diagram of Fig. 1.2 indicates how these two filters fit into the back end of a receiver chain.

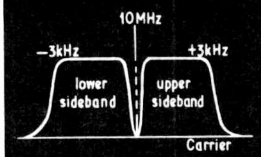


Fig. 1.1. Two single sidebands displaced about a 10MHz carrier

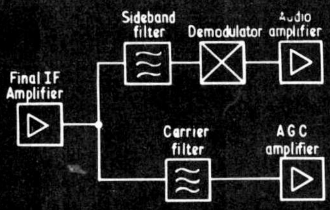


Fig. 1.2. Showing how the sideband and carrier filters fit into the receiver chain

NOISE EXCLUSION

Due to the fact that the carrier signal is so much lower than the sideband signal, it is essential to reduce the bandwidth of the carrier acceptance filter to exclude noise from the circuit. If a sideband signal of approximately 1 microvolt is considered with a signal to noise ratio of 12dB in a 3kHz bandwidth, then the carrier signal in the same bandwidth would have a *noise to signal ratio* of 14dB if this signal was 26dB below the sideband signal. Under these circumstances the noise would operate the a.g.c. and the sensitivity of the receiver would be considerably reduced.

In order to have a workable signal in the carrier path it is desirable that the signal to noise ratio is better than 10dB, therefore the signal to noise ratio in the carrier path has to be improved by 14 + 10dB, i.e. 24dB or *eight times*. The method of working out the bandwidth of the carrier filter is very simple once the relative levels have been determined and from the formula in expression 1:

$$\text{Carrier filter bandwidth} = \frac{\text{sideband width (Hz)}}{X} \quad (1)$$

$$= \frac{3{,}000}{8} = 375\text{Hz}$$

(Where X has been computed as described in the preceding paragraph.) The carrier filter is equally displaced about the fundamental signal of 10MHz, accepting signals 187·5Hz either side of 10MHz. In order to avoid accepting sideband information in the carrier filter, it is usual to make the carrier filter between 40Hz and 100Hz wide. Fig. 1.3 shows (a) the effect of the sideband filter and (b) the effect of the carrier filter.

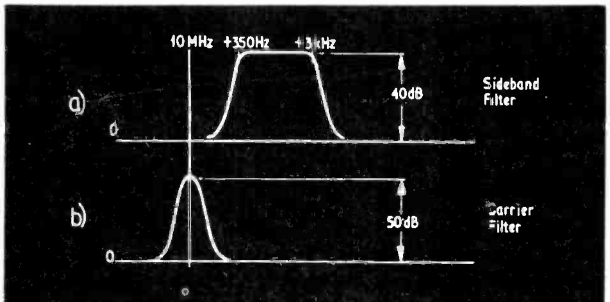


Fig. 1.3. (a) The effect of the sideband filter (b) The effect of the carrier filter

AUTOMATIC GAIN CONTROL

The information derived from the carrier path is converted into a d.c. voltage and fed back to the preceding amplifiers to promote automatic gain control holding the gain of the receiver relatively constant over a considerable range of input signals. The a.g.c. is fast in its attack but when the carrier signal is removed, some considerable time may elapse before the receiver is returned to its fully sensitive state. This is to stop the receiver gain moving up and down by large amounts when the carrier signal is affected by a fast fade. The a.g.c. has not been fed back to the r.f. amplifier in the following receiver as this level may be stabilised by the introduction of an aerial attenuator when the aerial signal reaches large proportions.

SPECIFICATION

Sensitivity	2 microvolts in the sideband for S.S.B. operation to produce full output.
Signal to Noise ratio	Better than 10dB at 2 microvolts sensitivity.
Audio bandwidth	750Hz to 1·75kHz or 350Hz to 3kHz.
Frequency range	2MHz to 30MHz.
Stability	With crystal operation better than four parts in ten to the sixth.
A.G.C.	For a change in level from 2 microvolts to 65dB above 2 microvolts, the audio output will not vary by more than 4dB.
Intermodulation products	With the r.f. gain control set for maximum sensitivity, two unwanted signals, with an amplitude of 100 millivolts will not produce in band interference of more than an equivalent aerial signal of 8 microvolts.
Emissions (Receptive modes)	A3h (compatible d.s.b.), A3a (s.s.b.), A1 with suitable attachment (see text).
Power supply	0–220–240 volts 50Hz.
Controls	1. R.F. gain. 2. Audio gain. 3. Function switch. 4. Tuning control (optional).
Metering	1. Signal strength. 2. Audio level.

DOUBLE SIDEBAND OPERATION

For double sideband operation (d.s.b.), the transmission is treated as a single sideband piece of informa-

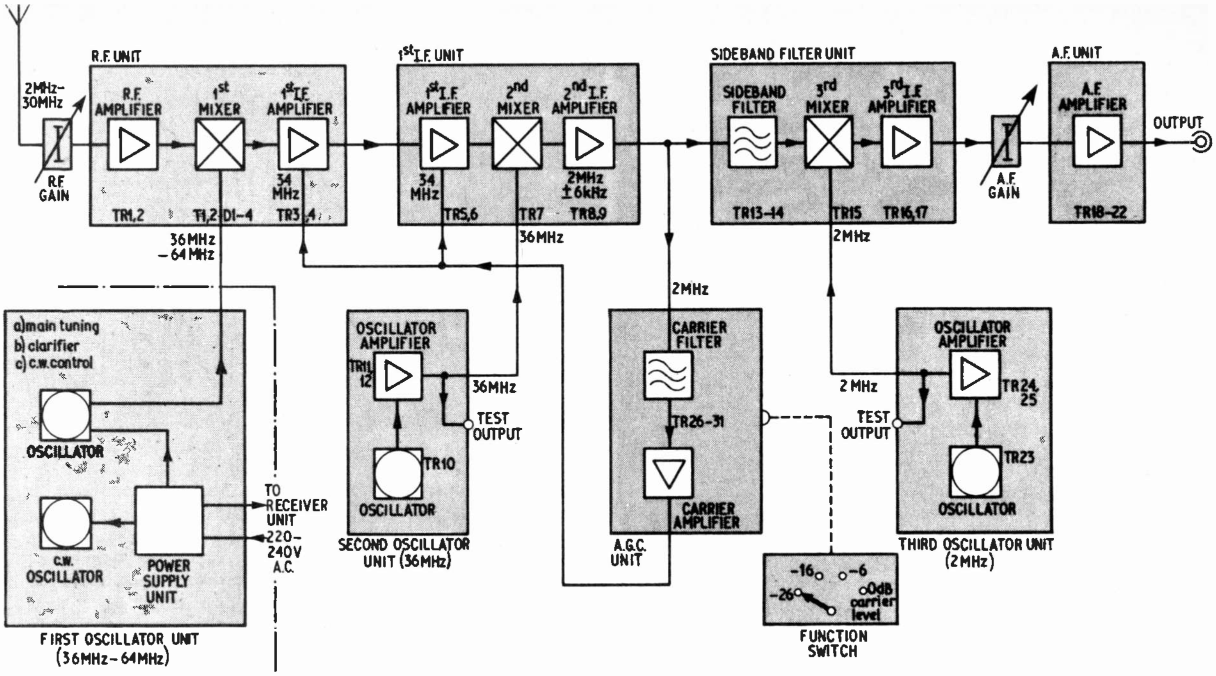


Fig. 1.4. The block schematic diagram of the complete P.E. wideband h.f. communications receiver

tion but the carrier amplifier has its gain adjusted by the function switch to take into account the increased level of the carrier. This type of d.s.b. operation is classed as "A3h" where the signal to noise ratio will be somewhat reduced upon the standard form of transmission due to the acceptance of only one of the sidebands.

While the introductory paragraphs have only skirted the workings of a modern sideband receiver, it is hoped that some of the elementary points have been made in such a manner as to clear certain relevant principles.

RECEIVER CIRCUIT

Moving into the receiver proper it is intended to present the equipment as a series of modules for ease in construction. This part describes the basic operation of the receiver and gives a block diagram showing the functions of its various parts. Following articles will detail the circuitry and give full constructional details of the modules and the final assembly.

As indicated earlier, this is not a project to be lightly undertaken as *it does require some reasonable knowledge of soldering and previous experience of laying out circuits dealing with relatively high frequencies.*

The majority of the filters have been designed around coils even though high frequency crystal filters have been available for quite a few years. This is mainly to keep the cost of the overall receiver within a reasonable budget. For the more affluent, crystal filters may be used and full directions will be given to incorporate a number of alternatives. A circuit of a b.f.o. is included to enable the operator to deal with the more simple "on/off" keyed transmissions (c.w.).

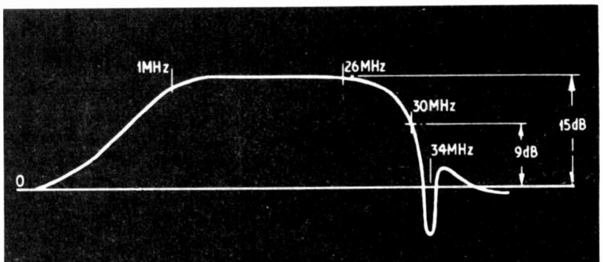


Fig. 1.5. This diagram shows the overall gain of the r.f. amplifier

R.F. UNIT

This module is described fully here and constructional details and a circuit diagram will be published next month. In the block schematic shown in Fig. 1.4 the aerial signal is fed into an attenuator which may be manually operated by the user. The r.f. amplifier contains a wideband two stage amplifier which is not affected by a.g.c., and amplifies aerial signals in the range 2 to 30MHz. The gain of this amplifier is shown in Fig. 1.5 over the frequency range and the fall off at the upper end is due to the introduction of the 34MHz i.f. rejection filters. However there is sufficient gain in the range 26MHz to 30MHz to make the receiver perfectly usable in the top 4MHz.

The first two stages comprising the r.f. amplifier have an overall gain in the order of 5 times and the output of this amplifier is fed into the first mixer. The amplifier has a considerable dynamic range and is quite capable of handling signals from 1 microvolt to half a volt without the introduction of detrimental intermodulation and crossmodulation. This is a dynamic range of 54dB and accounts for the use of a high supply voltage and power devices in the front end stages.

The 2N3866 transistors used in this r.f. amplifier can in fact handle up to 5 watts of power over the complete frequency range. It is in this area that the whole performance of a receiver can be determined, therefore the introduction of relatively expensive components in the early stages may be excused. Due to the considerable amount of current passed through the first two devices, the signal to noise ratio of the receiver is not necessarily as good as professional receivers covering the same range but it must be appreciated that the very high grade communication receiver complexes may cost anything up to five or six thousand pounds.

UP-CONVERSION TECHNIQUE

Coils L1 and L2 are rejection filters set accurately at 34MHz to ensure that the i.f. amplifier is not loaded by a direct aerial signal of 34MHz. T1, T2, and D1 to D4 form the first mixer in the well-known "ring modulator" configuration where the aerial frequency is subtracted from the first oscillator frequency giving an output at 34MHz. This "up-conversion technique" is well proven and ensures that the image response, that is to say, the aerial signal plus the oscillator frequency, is well above the response of the following amplifier. It is this up-conversion that enables the normal front end coil system to be dispensed with.

It is often mistakenly assumed that the introduction of a number of selective tuned circuits prior to the first mixer removes intermodulation and cross-modulation distortion. However, while it may be that some hundreds of kilohertz away from the fundamental frequency, assistance is given by the inclusion of such circuits, they have virtually no effect when the receiver is measured in accordance with C.C.I.R. as these measurements are made only 10kHz removed from the required frequency.

The first i.f. of 34MHz has now been established and it would be desirable to pass these signals through a narrow band crystal filter, however, this type of filter is expensive and could cost in the order of £30, therefore a three stage coil filter has been introduced, two of which appear in the r.f. unit. The first filter has been introduced before the first stage of the i.f. amplifier to get some discrimination as soon as possible, this is immediately followed, after some amplification, by another tuned circuit which is in the collector of the first stage of the i.f. amplifier. This is also the first amplifier to be controlled by the a.g.c. system and due to the forward a.g.c. action the i.f. discrimination improves as the aerial signal increases due to the lowering of the input impedance of TR3, therefore effectively increasing the Q of the first tuned circuit in series with TR3 base.

A.G.C. OPERATION

The a.g.c. works on the forward characteristic where a reduction in the collector to emitter voltage, due to an increase in base and collector current, reduces the gain of the stage by as much as 35dB. Part of this reduction in gain is due to the reducing input impedance of TR3, this acting as an attenuator in conjunction with the series element L3 and C.

This curve is shown in Fig. 1.6 and is more commonly referred to as the V_{CEsat} condition. This is one of the many forms of applying automatic gain control to a transistor and where signals of a relatively small amplitude are being dealt with, little or no distortion is introduced. The gain of these latter two stages are in the order of six times giving an overall gain in the r.f. unit of approximately thirty times. Some loss occurs in the mixer, therefore the full overall gain available is reduced by the amount of this loss. The two inputs and the one output of the r.f. unit are terminated in 50 ohm coaxial sockets which are readily available.

FIRST I.F. UNIT

Transistor TR5 is the last stage of the first i.f. filter, tuned to 34MHz. The stage gain is variable due to the a.g.c. voltage applied to the base of the transistor and the stage gain is reduced in an identical manner to that indicated in Fig. 1.6. The overall change in gain of TR5 is approximately 30dB, giving a total of 65dB for the whole of the first i.f. amplifier. TR6 presents a high

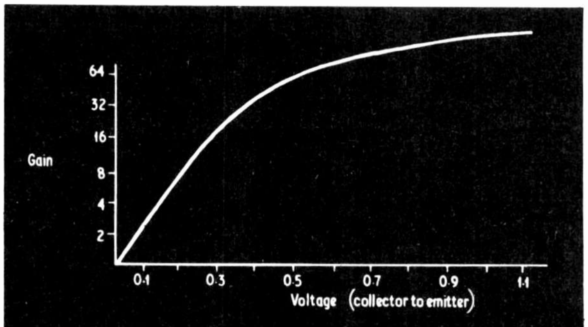


Fig. 1.6. Showing how the gain is altered with the changing collector to emitter voltage on TR3

impedance to the tuned circuit in the collector of TR5 thus avoiding undesirable damping with a consequent reduction in selectivity. TR6 converts an approximate input impedance of 5 kilohms into an output impedance of 200 ohms which feeds the following mixer.

The second frequency changer TR7 is a combined converter and amplifier where the signal is fed into the base at 34MHz and the oscillator frequency of 36MHz is applied to the emitter of TR7 at sufficient level to promote good switching. The collector circuit is tuned to 2MHz thus accepting the wanted frequency of 2MHz and rejecting to some degree the 34MHz input signal and the switching frequency of 36MHz. This time, to avoid damping the tuned circuit, the impedance change to the following circuit is effected by a capacitor divider where the impedance change is a function of the square of the capacitor ratio.

Transistors TR8 and TR9 form the second i.f. amplifier at 2MHz and considerable voltage gain is effected by the common base stage, TR8. The voltage gain of this stage is approximately equal to collector load divided by the source resistance. In order to take advantage of the voltage gain available, TR9 has been introduced as an emitter follower with an input impedance in the order of 30 kilohms, the output of which feeds into the next module, the sideband filter and third converter.

It is possible to directly couple this particular amplifier as a.g.c. has not been applied, therefore the d.c. conditions remain the same irrespective of signal input level at the aerial. For an aerial input of 5 microvolts in the sideband the output at 2MHz is approximately 500 microvolts. Therefore the nine stages employed up to this point have an overall gain of 100 times, i.e. 40dB.

This amount of gain may appear to be paltry for such a considerable amount of circuitry but each of the mixers have a loss in terms of efficiency of about 6dB therefore the overall gain of the amplifying stages is something in the order of 52dB.

SIDEBAND FILTER UNIT

This module commences with a five stage crystal filter which separates the upper sideband of the transmission from the carrier and the lower sideband. This filter has a relatively flat passband from 2·000750MHz to 2·001750MHz which determines the final audio bandwidth of 750Hz to 1·75kHz. An eight stage crystal filter is described later for the constructor who requires a passband in the order of 3kHz.

The five stage filter however is relatively economical and just about suffices the requirements of speech transmission and reception. Having separated the required upper sideband, the resultant signal is fed into the demodulator where it is converted to audio and the high unwanted frequencies are filtered out by a simple *LC* filter. The level is now amplified sufficiently to drive the audio amplifier.

A.F. UNIT

As there is considerable work involved in constructing this receiver, there seemed little point in building an audio output amplifier when a pre-built unit is available which adequately meets the required specification at a reasonable cost. This is the Newmarket packaged circuit module Type PC2 which may be purchased from Newmarket Transistors Ltd., or their accredited agents. It uses five transistors, TR18–22.

This unit can deliver 100 milliwatts into a speaker or up to 5 milliwatts into headphones and the level of the output may be controlled from the front panel of the receiver.

SECOND OSCILLATOR UNIT (36MHz)

This is a crystal high stability oscillator of the emitter coupled variety where the high impedance in the collector circuit is transferred into the required low impedance drive for the emitter, by a capacitive divider network. The crystal used is of the overtone variety and it is therefore necessary to tune the collector of the transistor circuit to obtain the required frequency.

The single stage oscillator TR10 is followed by a d.c. coupled pair TR11 and TR12 which provides up to a volt of output at low impedance to act as the switching voltage in the second mixer thus converting the intermediate frequency of 34MHz into the required 2MHz.

A.G.C. UNIT

In this unit the 2MHz carrier signal is sampled and selected from the upper and lower sideband by a narrow band crystal filter. As previously explained in the introduction, this filter is necessarily narrow in order to improve the signal to noise ratio of the carrier signal. The carrier signal is now amplified and converted into d.c. by the voltage doubler circuit D5 and D6.

Even though the following capacitor is very large the attack time of the system is less than 50 milliseconds due to the low impedance of the source. Once the a.c. signal is removed the capacitor cannot discharge through the source as the diodes are now almost open circuit, therefore the following series resistor acts as the discharge path taking approximately 20 seconds to discharge fully when an aerial signal in the order of 10 millivolts is removed. This avoids the gain of the receiver changing rapidly as a result of rapid carrier fading.

Having converted the carrier signal to d.c. by D5 and D6, the d.c. voltage is amplified and fed to the bases of TR3 and TR5 in the r.f. unit and the i.f. amplifier. With a signal in the order of 5 microvolts in the sideband at the aerial, with the carrier 26dB below this level the d.c. voltage is approximately 2·5 volts. However, when the aerial signal has increased to about 5 millivolts with the r.f. gain set for maximum sensitivity, the d.c. output of the a.g.c. unit is 11 to 12 volts thus promoting full a.g.c. over the receiver chain. Once the aerial input has exceeded 5 millivolts it is necessary to reduce the sensitivity of the receiver with the r.f. gain control which is mounted on the front panel.

The level of the a.g.c. voltage is monitored on the front panel by amoving coil meter and when this indicates that the full a.g.c. condition has been reached the r.f. gain control should be used to introduce some attenuation so that there is always some a.g.c. in hand. For different carrier levels of the transmitted information, a calibrated potentiometer is located on the front panel so that the carrier level may be adjusted to give zeroreading on the v.u. meter.

THIRD OSCILLATOR UNIT (2MHz)

This unit is almost identical to the 36MHz oscillator but the frequency of operation is 2MHz to provide the switching voltage for the final converter. The crystal used is of the fundamental type, therefore it would not normally be necessary to include a tuned circuit in the collector of the oscillator. However, to reduce the effects of the second harmonic that may be generated in the oscillator stage, a simple tuned circuit has been included. The output from the single stage oscillator is fed into a d.c. coupled pair which gives up to one volt of signal at low impedance. The frequency may be adjusted to within 1Hz and once set there should be no need to make any further adjustment for some months.

MAIN CHASSIS ASSEMBLY

The main chassis contains all the inter-module wiring and the external controls which would be used during normal day to day operating. The *r.f. gain* control may be adjusted to reduce the input level received by the first amplifying stage in the r.f. unit. This control would only be brought into operation when the aerial signal has reached something between 1 and 5 millivolts. However, if considerable interference is present on the frequency required the r.f. gain control can be used to see whether the level of the interfering signal is sufficiently high to generate intermodulation products within the receiver itself.

The *audio gain* control is to enable the operator to adjust the output level at the speaker or the headphones and does not have any affect upon the working characteristics of the receiver. The *function switch* adjusts the level at which the automatic gain control comes in and can cater for carrier levels of —26dB, —16dB, —6dB and 0dB. If the constructor so desires this switch may be replaced by a potentiometer that will give a constantly variable adjustment of carrier level but it will be necessary to calibrate the control so that the required condition may be located to suit the service being received.

FIRST OSCILLATOR UNIT

This unit has been presented in a separate container of similar dimensions to that of the receiver cabinet. This has been arranged so that the constructor may choose one of a few different methods of obtaining the tuning mechanism for the receiver. In one instance the unit comprises an *LC* oscillator and a mixer system so that fully variable coverage over the range 2MHz to 30MHz may be obtained. Another unit is a simple crystal oscillator with a high degree of stability for spot frequency working.

Included in this cabinet is a b.f.o. for c.w. reception. The first oscillator unit also contains the power supply for the entire system and is connected to the receiver unit by a multicore cable. The whole of this cabinet will be described in more detail in later articles when the constructional and operational details are presented.

Next month: circuit diagram, components list, and constructional details for the r.f. unit module.

The D51 is a new, low cost, dual-beam oscilloscope incorporating all current requirements for a modern easy to use general purpose oscilloscope. Of strong construction and equipped with simple controls, the D51 can be readily operated by non-technical personnel and is an ideal oscilloscope to satisfy the requirements of A-level syllabuses and the needs of Technical Colleges.

See us at the
Ist Electronics Instruments Exhibition

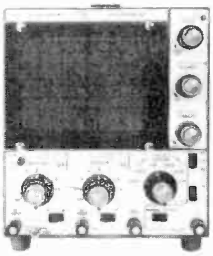
Hotel Leofric, Coventry
September 16th, 17th & 18th

Hotel Piccadilly, Manchester
September 23rd, 24th & 25th

Look at the features:

✳ True Dual-Beam
✳ Large display area 6 x 10 cm
✳ Wide Bandwidth (DC-6MHz channel 1, DC-3MHz channel 2)
✳ 10mV/cm Sensitivity (DC-2MHz)
✳ Exceptionally Bright Trace
✳ Small Size — Lightweight

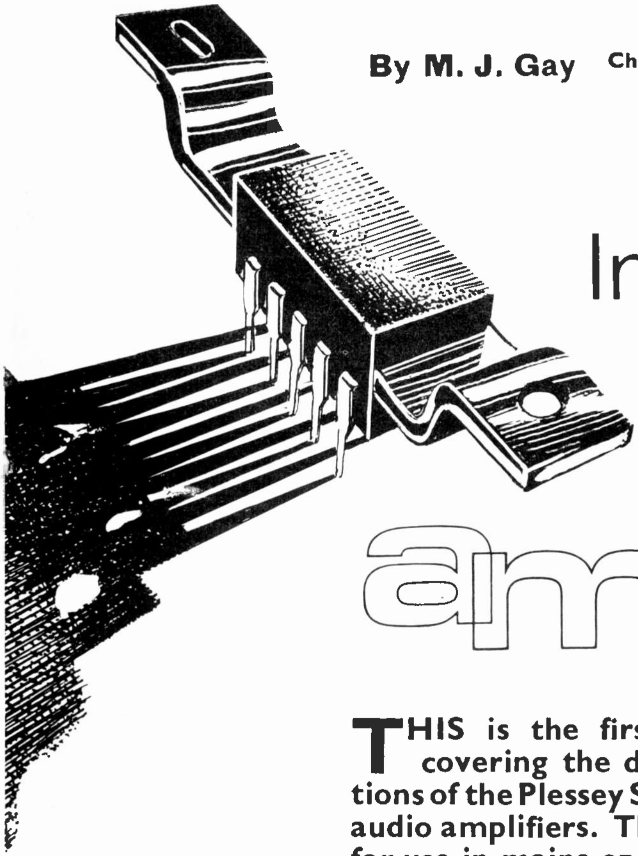
At only £93.0.0. this oscilloscope must be seen to be believed.
Send for full details NOW!!!



TELEQUIPMENT

Telequipment Ltd., 313 Chase Road, Southgate, London, N.14. Tel: 01-882 1166 Telex 262004
For Overseas enquiries write to: Tektronix Limited, P.O. Box 48, Guernsey, C.I. A member of the Tektronix Group

By M. J. Gay Chief Circuit Engineer (Linear)
Plessey Microelectronics



Integrated Circuit audio amplifiers

THIS is the first in a series of three articles covering the design, performance and applications of the Plessey SL402 and SL403 integrated circuit audio amplifiers. These have been specially designed for use in mains operated record players, etc. They deliver up to 3 watts r.m.s. continuous sine wave output and can operate directly from crystal or ceramic pickups. They also contain an integral preamplifier providing sufficient gain to allow tone control networks to be driven.

This article will cover the design and basic performance of the amplifier, the essential features of its use and the design of a suitable power supply. The subsequent constructional articles will cover its use in different amplifier designs.

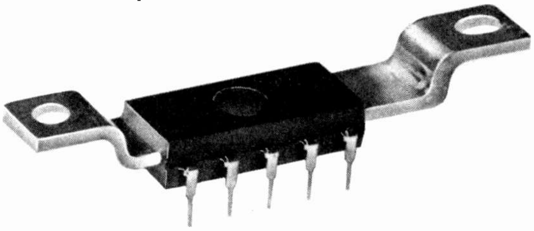
A PHOTOGRAPH of the amplifier, which is fabricated on a silicon chip measuring 0·05in × 0·05in (by 0·008in thick), is shown on this page. To allow removal of the heat dissipated, the chip is mounted on a steel bar in a special package to which a heat sink can be attached (see photograph). The circuit is available for operation at 2 watts output on a 14 volt nominal supply (SL402) or for operation at 3 watts output on an 18 volt nominal supply (SL403). The specifications allow adequate margin for normal supply voltage variations.

CIRCUIT DESIGN

The complete circuit is shown in Fig. 1. The ensuing description is included so that those interested in the circuit's operation may be satisfied. It is not necessary that the reader should be able to follow the detailed points of design in order to use the devices satisfactorily and indeed, since the description has been kept fairly brief, only those with appreciable experience of transistor circuit design could expect to understand the operation at first reading.

The circuit (Fig. 1) will be seen to consist of a simple preamplifier (TR1 to TR3) followed by the main amplifier (TR4 to TR13). The basis of the design is of course the output stage whose operation we will now consider. An all *npn* design is used since the integrated circuit process is not suited to the manufacture of high current *pnp* transistors.

The integrated circuit package used to house the SL402 and 403 silicon chip—shown full size



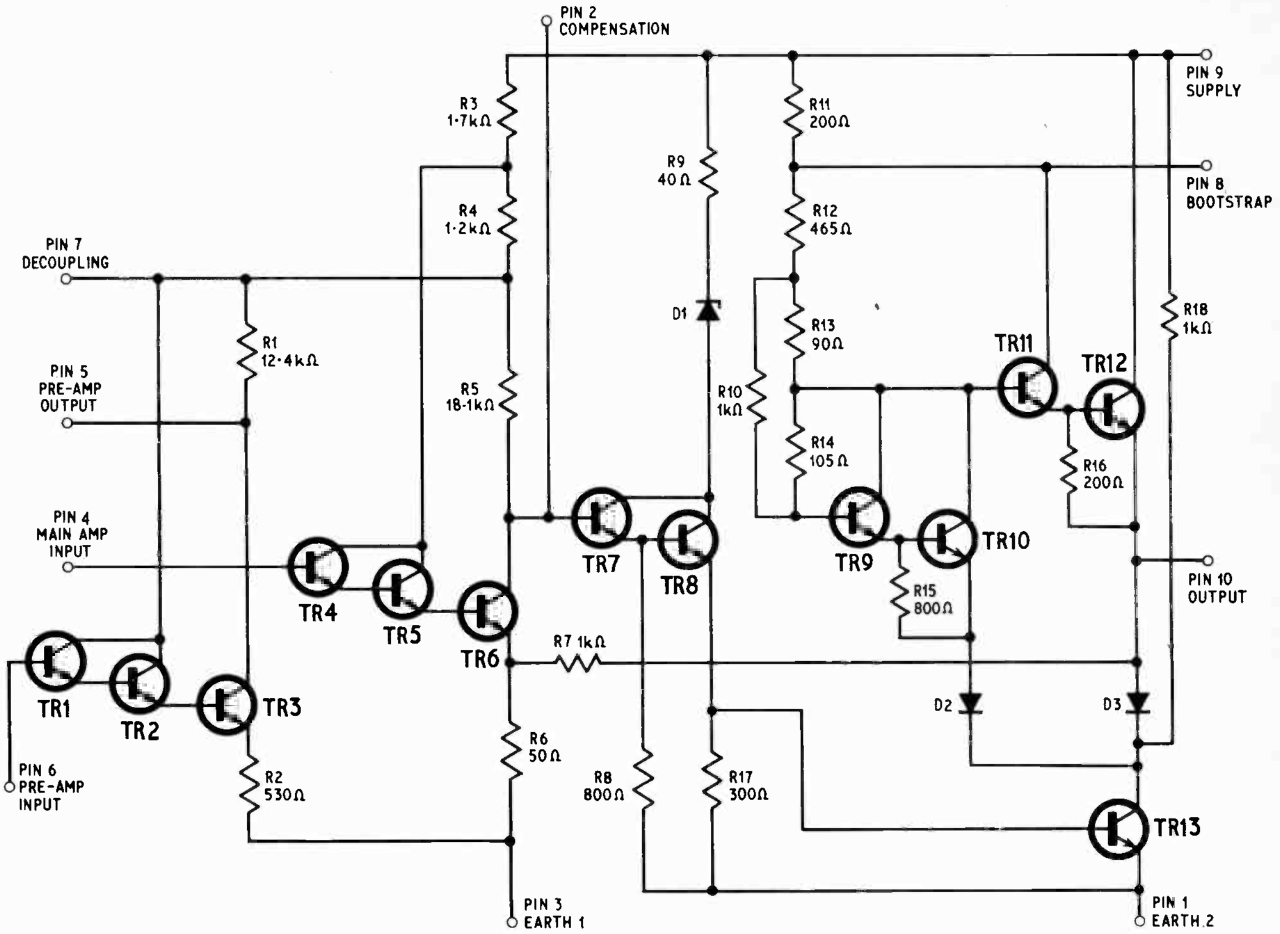


Fig. 1. Complete circuit diagram of the SL402 and SL403 integrated circuit audio amplifier

OUTPUT STAGE

The basic output stage is shown in Fig. 2. The three diodes serve to define the quiescent current and to steer the dynamic output current through one or other output transistor. It can readily be shown, from exponential characteristics of the transistors and diodes, that

$$i_2 . i_3 = \text{Constant} \times i_1^2 \qquad (1)$$

Under quiescent conditions, neglecting any d.c. flowing in the feedback network, i_2 and i_3 are equal and thus controlled by i_1, which is in turn controlled by R_a.

When signals are present the overall feedback assures the correct voltage and the biasing arrangements ensure that the output current is steered via one or other output transistor, since from equation (1) i_2 and i_3 cannot be simultaneously large. Thus during positive half cycles when i_2 is large, i_3 must be small, i.e. D_a is virtually out of conduction, R_a acts as the load of TR_b and TR_a acts as an emitter follower. During negative half cycles when i_3 is large, i_2 must be small, i.e. TR_a is virtually out of conduction and TR_b feeds directly into the load resistor R_L.

Naturally the open loop gain is very different between positive and negative half cycles, and considerable negative feedback is required to linearise the operation. Fortunately the integrated circuit process automatically gives us transistors with very high cut-off frequencies (approximately 1GHz) which, by keeping spurious phase shifts low, allow this feedback to be applied.

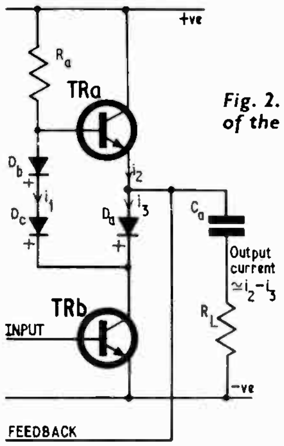


Fig. 2. The basic output stage of the SL402 and 403

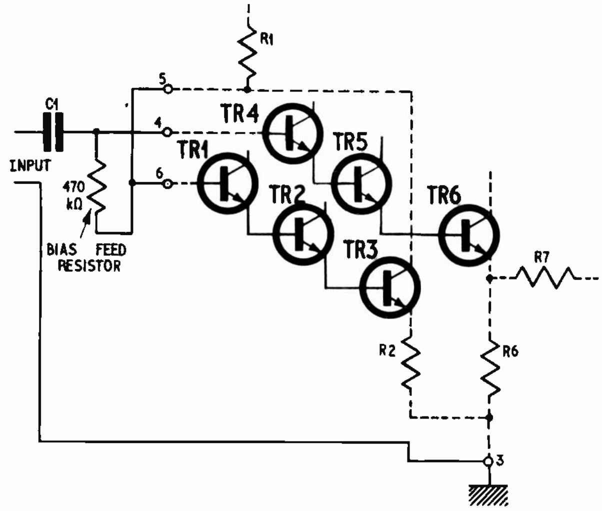


Fig. 3. Connections for using the preamplifier to bias the main amplifier

In the complete circuit, Fig. 1, it will be seen that TR_a of Fig. 2 has been replaced by a Darlington pair (TR11 and 12) and D_b by another Darlington pair (TR9 and 10); the bias resistor has been provided with a bootstrap connection and an offset voltage has been generated in series with the bias "diodes" by means of R10, R13 and R14 (this voltage could be generated by a single low value resistor but the three resistor arrangement takes up less area on the integrated circuit). This offset voltage adjusts the constant in equation (1) and thus allows us to control the relationship between bias current through R12 and quiescent current in the output stage.

An external bootstrap capacitor (50μF is normally used) is connected between the output and bootstrap connections. This causes the voltage at pin 8 (bootstrap) to follow that at the output, so that the bias current through R12 is maintained at a constant level during positive half cycles; this is essential to guarantee sufficient base current for the Darlington output pair TR11 and TR12.

Incidentally D2 and D3 will not be readily seen in the chip photograph; they have combined with TR13 to form the lower of the two power transistors on the right hand side.

AMPLIFIER SECTION

The remainder of the main amplifier section is essentially straightforward. TR13 is fed via two emitter followers TR7 and TR8 from an input stage TR4, TR5 and TR6. This cascade provides very high input impedance and very low input current. Overall series voltage feedback is used and the collector of TR6 is brought out so that an external compensation capacitor can be connected to ensure stability of the negative feedback loop (the required capacitor—0·01μF—is too large to be integrated economically).

Various precautions are taken to protect the amplifier against excess supply voltage: these include bypassing the emitter-base junctions with resistors, the inclusion of D1 and most important, the tapping of the collectors of TR4 and TR5 into the input stage load resistor. This is designed to achieve a situation in which, if the supply rises too high, TR5 protected by R3 breaks down before any other device in the circuit and in so doing switches the rest of the circuit into a non-operating state in which it can sustain much higher voltages than when operating normally. Thus the circuit is protected against overvoltages well in excess of the nominal operating value.

PREAMPLIFIER SECTION

The preamplifier (TR1, TR2 and TR3) serves also to provide a temperature compensated bias voltage for the main amplifier. It will be seen from Fig. 1 that the input bias required consists of the voltage across the feedback resistor R6 plus the base-emitter voltages of TR4, TR5 and TR6. Now base-emitter voltage varies with temperature at a rate of −2mV per degree C and it is therefore essential that the bias voltage be derived from a source with corresponding temperature variation. The preamplifier provides this source. Fig. 3 shows how it may be connected simply as a biasing network for the main amplifier.

Due to the very small input current of the amplifier, the voltage drop along the external bias feed resistor will be small and can be neglected. The sum of the base-emitter voltages of TR4, TR5 and TR6 are matched by those of TR1, TR2 and TR3, so that the resultant voltage which must be developed across R6 is equal to that derived from the supply line across R2. Later we will see how the preamplifier may be used as such whilst still providing the bias required.

To allow the use of a simple power supply with high ripple content, the supply to the pre-amplifier and main amplifier input stage is provided with a decoupling point (pin 7) to which an external capacitor (25μF suffices) is to be connected.

AMPLIFIER CHARACTERISTICS

The amplifier is available in two versions, distinguished by different operating supply voltage ranges. The ratings of the two versions are as follows:

Operating Range	SL402	SL403
Nominal operating supply voltage	14	18 volts
Maximum operating supply voltage	16	21 volts
Absolute maximum supply voltage	20	24 volts
Maximum output current (peak)	1	1 amp
Minimum load impedence	5·5	7·5 ohms

The "absolute maximum supply voltage" is the maximum transient voltage the amplifier will withstand without damage; it may, however, switch into a non-operating state as detailed earlier while the transient is present. The amplifier is guaranteed to operate at up to the rated "maximum operating supply voltage" which is 15 per cent above the "nominal operating supply voltage". This 15 per cent is intended to cover mains voltage variations. The power supply should be designed to give 14V nominal for the SL402 or 18V nominal for the SL403.

The amplifiers are rated to handle 1A peak (sine wave or square wave). The minimum load impedances specified ensure that this level is not exceeded at the nominal operating supply voltage. The small increase in current which may occur when the supply voltage is high, but within the limits specified, is allowable. If the load impedance used is significantly reduced however, the peak current rating will be

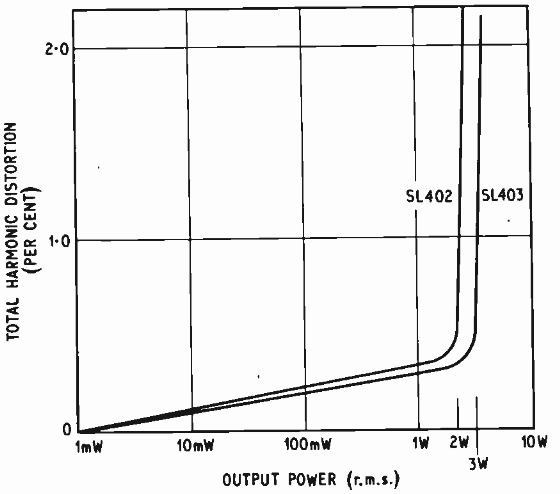
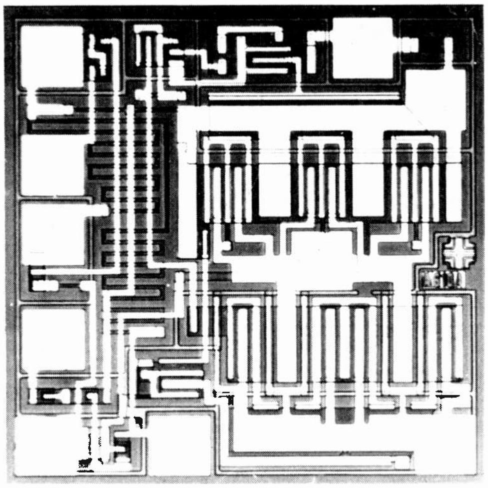


Fig. 4. Graphs showing total harmonic distortion of the two main amplifiers



Photograph of the silicon chip as used in the SL402 and SL403

considerably exceeded at full output, and prolonged operation under these conditions may cause failure of the circuit.

The amplifier characteristics are listed below for the two versions:

Test Conditions: SL402: 14V supply, 7·5 ohm load
SL403: 18V supply, 7·5 ohm load

Characteristic	SL402	SL403
Maximum output power typical	2 watts	3 watts
Maximum output power minimum	1·5 watts	2·5 watts
Distortion: main amplifier	See Fig. 4	
pre-amplifier	0·1 per cent at 1V r.m.s. output	
Voltage gain: main amplifier	20	20
pre-amplifier	20	20
Input impedance: main amplifier	$>10M\,\Omega$	$>10M\,\Omega$
pre-amplifier	$>10M\,\Omega$	$>10M\,\Omega$
Maximum input current: main amplifier	$0·25\mu A$	$0·25\mu A$
pre-amplifier	$0·25\mu A$	$0·25\mu A$

Hum, noise and frequency response have not been listed here; they depend on how the device is used and will be covered in the later articles.

HEAT SINK REQUIREMENTS

The amplifiers dissipate up to 3W at full output and must be provided with a heat sink, or more accurately a heat radiator, to keep their temperature within reasonable limits. A total radiating surface of 10 square inches is required. This can be conveniently obtained from a channel section radiator, bolted to the package as shown in Fig. 5. The material may be aluminium, copper, brass or steel and should be 18 s.w.g. or thicker. The fixing bolts should be firmly tightened and fitted with plain washers both sides, but it is not necessary to use silicon grease between the surfaces, though it will do no harm.

As an alternative to using a separate radiator the amplifier may be bolted to the chassis of a complete equipment. It must be remembered, however, that the metal bar through the package will be connected to the negative side of the supply, via the chip. It cannot therefore be directly affixed to the chassis if this is connected to the positive side of the supply (as in car radios if the vehicle has a positive earth for example).

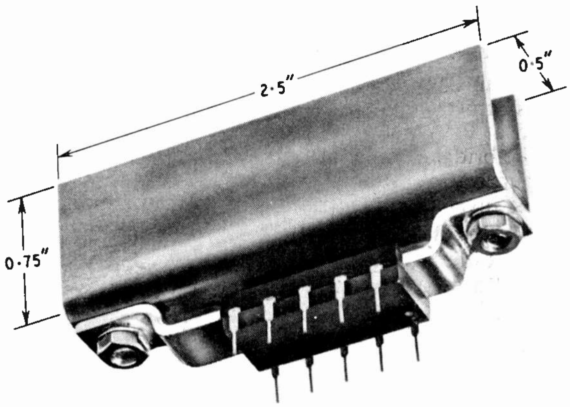


Fig. 5. Heat sink attached to the amplifier package

ESSENTIAL PRECAUTIONS

The following precautions should be observed when building and commissioning equipment using the SL402 and 403:

(a) Do not short circuit the output; this is not invariably fatal but can be, and certainly will be, if the short circuit is maintained for more than a few seconds.

(b) Never use the device without the prescribed heat radiator attached.

(c) Do not short pin 4 (the main amplifier input) directly to ground; this upsets the output stage biasing and can cause failure.

(d) Ensure that the supply potential is correct before switching on for the first time.

(e) Do not exceed the rated voltage and currents.

POWER SUPPLY

The SL402 and 403 are specifically designed to run on the simplest of power supplies. They may be operated from an unregulated car supply for instance or from a basic mains power supply consisting simply of transformer, bridge rectifier and reservoir capacitor, Fig. 6. The SL402 operating on a nominal 14V supply is particularly suited to operation from a car battery, in a radio or tape player for instance. The higher power, higher voltage, SL403 is more suited to operation on mains supplies.

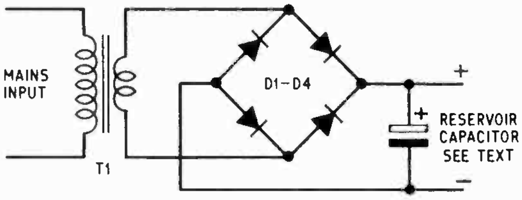


Fig. 6. Basic power supply circuit

The mains transformer for an SL403 power supply should give, ideally, 14V r.m.s. output and should be rated at 0·5A or higher per amplifier to be supplied. The voltage specified is the unloaded value and can be obtained from heater transformers. The following types are suitable and readily available:

(a) Radiospares hygrade filament transformer
Rated output: 2 × 6·3V at 1·8A (connect secondaries in series).

(b) Radiospares standard filament transformer 13V
Rated output: 13V at 0·5A
Suitable for supplying a single amplifier only.

A mains power supply for the SL402 would require a transformer giving 11V r.m.s. unloaded output and rated at 0·5A per amplifier to be supplied.

The bridge rectifier again should be rated at 0·5A per amplifier to be supplied. It should also have a p.i.v. (peak inverse voltage rating) of 50V minimum. The following types are suitable and readily available:

(a) Radiospares REC 41
Rated output: 1·5A

(b) STC selenium rectifier bridge type P66E/1B
Rated output: 1A
Supplier: Electroniques.

(c) Slater Electric potted rectifier bridge type SLA—50—LCD
Rated output: 2A
Supplier: Electroniques.

The reservoir capacitor value required depends on the application. A value of 5,000μF will be sufficient for almost all requirements and in many cases 2,000μF or even 1,000μF will be found satisfactory. The voltage rating should be 25V.

The transformers listed are not fully enclosed types; it is worthwhile enclosing the whole power supply in a separate metal box to ease problems of hum pick-up.

The Plessey integrated circuits SL402 and SL403 are available from various retail suppliers.

Following articles will describe a simple mono record player amplifier without tone controls, a more elaborate stereo record player amplifier with full tone controls, and a stereo hi fi system. Full constructional information will be provided for all three systems.

NEWS BRIEFS

Equipment Confiscated

A RADIO communications expedition to North, East and South Africa, led by 25-year-old Mr David Dunn, of Cardiff, has run into difficulty with the Moroccan police.

The main objective of the four-man expedition is to study the reliability of low power short wave radio communications. Mr Dunn—a senior draughtsman with the Powell Duffryn Group company Hydraulic Machinery (Great Britain) Limited, did not have a transmitting licence for Morocco and, in accordance with Moroccan law, the radio equipment was confiscated.

Mr F. J. Seller, secretary of the Amateur Radio Society at the University College, Cardiff, said the party were told the equipment would be returned when the expedition left the country, but this promise was not fulfilled.

Mr Seller said in a recent letter from Addis Ababa, Mr Dunn told him that he was beginning to despair of ever seeing the equipment again.

"If this is so it will, of course, mean the end of any short wave communication aspect of the expedition," said Mr Seller. "This is most unfortunate since I understand Mr Dunn has transmitting licences for almost all the countries he has yet to visit."

New TV Equipment

A COMPLETELY new range of rugged, reliable and extremely compact television equipment, tested to stringent international military specifications, has been introduced by the Electro-Optical Systems Division of The Marconi Company. The new range, comprising a number of units which can be built up as required, caters for a wide variety of military applications, and sensor tubes are available to cover light levels from the brightest sunlight to the darkest night. A working demonstration of the new equipment was recently given in London before representatives of the governments, armed forces and industrial concerns from more than 25 countries.

MP's to Get New Telephones

A MASSIVE reorganisation of Whitehall's telephone network to meet the greatly increased demands of the next 20 years is being launched by the GPO and the first orders have now been placed with Plessey Telecommunications Group.

The project will be split into two stages. The first, covering about 30,000 telephone extensions, will modernise and extend existing facilities to bring them into line with the forecast requirements of the 1970's. The second, covering a further 30,000 extensions, will concentrate on the advanced facilities envisaged for the 1980's—including push-button access by phone to a central computer for all MP's.

The first stage, costing over £2 millions for telecommunications equipment alone, is due for completion in 1972/3. This will replace a large number of manually operated switchboards at present in use.

Export Success

A TARGET export growth of 70 per cent for the current year is already virtually assured by orders now in hand, report Electrosil Ltd. Electrosil confidently expect this success to continue and to cope with the demand on their export department, an assistant export manager has been appointed. The bulk of the exports are of resistors.

PE ORGAN PART 6

By Alan Douglas, Sen. Mem. I.E.E.E.

Last month we looked at the more theoretical aspects of the various kinds of basic subtractive filter used for tone forming. In essence, these consisted of the low pass filter which attenuated high notes, the inversion of this circuit, the high pass filter which removes the low notes, and the resonant band pass or band stop filter which accentuates some frequencies at the expense of others.

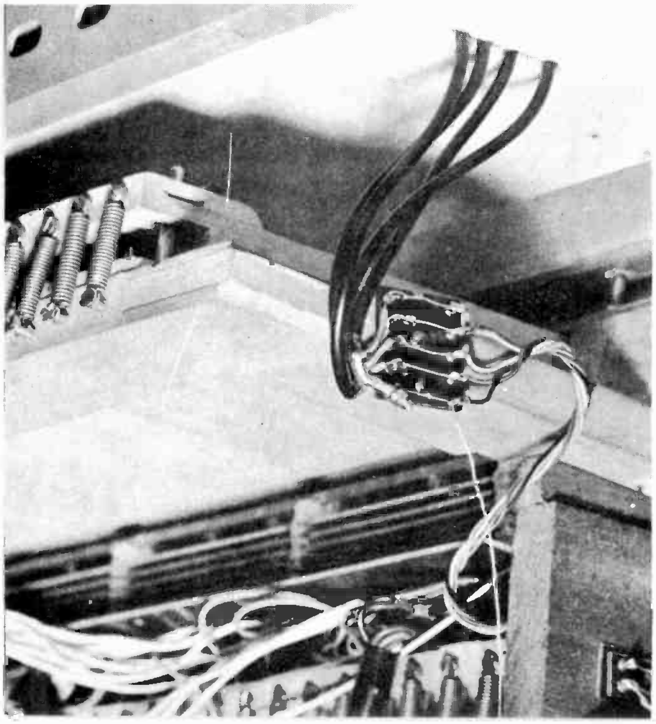
All of these filters can be extended or combined as will be seen in the practical voicing circuits presented in this article.

VOICE GROUPING

An organ is a blend of voices and this means that there must be no gaps in the sound spectrum when stops are combined and that the recognised groupings of such stops will produce a melodious effect.

In Fig. 6.1 is given a detailed block diagram of the voice groupings of our organ in relation to both manuals and pedalboard. When we key these we route a signal very rich in overtones from the pitch busbars, shown marked in Fig. 6.1, to the stop selecting voice networks. The tonal quality of this waveform is subsequently modified by partial removal of harmonics by the subtractive filters to produce the distinctive sound of the organ voices.

Solo tagstrip attached to edge of Goddard keyframe. Here five busbar wires connect to four screened inputs to emitter followers



EMITTER FOLLOWERS AND PRE-AMPLIFIERS

In producing a note at either of the two keyboards, the square wave output from the dividers must pass via the 100 kilohm anti-robbing resistors which are integral to the manual contact assembly.

In combining several notes in a chord the net value might be 25 kilohms when lumping these resistors in parallel. To offset this and keep the loading substantially constant, each busbar feeds directly into an emitter follower and pre-amplifier as shown in Fig. 6.2.

The output level from TR1 can be conveniently adjusted by the slider of VR1, this being a.c. coupled to the pre-amplifier via C2.

The frequency pass band is to some extent controlled by this capacitor and the input capacitor C1, so it is necessary to alter these capacity values with different pitch inputs. A table showing these changes is given under the circuit of Fig. 6.2.

From Fig. 6.1 it can be seen that each pitch busbar on each keyboard has its own emitter follower and pre-amplifier. The pedal busbars have only pre-amplifiers to feed its filters.

The supply for these amplification units is derived from P.S.U. 1, the power supply unit which feeds the generator and divider units.

SOLO PRE-AMPLIFIER CONSTRUCTION

The four emitter followers and pre-amplifiers, fed from the solo 2ft, 4ft, 8ft and 16ft busbars, are constructed on a single piece of Veroboard as shown in Fig. 6.3.

Since the component complement is almost identical for each pitch assembly, a balanced layout is possible, and each assembly is easily identifiable in the figure, it being contained by dotted lines.

The wiring and cutouts for the Veroboard underside are given in Fig. 6.4.

After soldering wires or cutting the copper, make sure that no solder or swarf is bridging adjacent copper strips or there may be trouble with inter-modulation faults.

BUSBAR TAGSTRIPS

In Fig. 6.3 the inputs to the emitter followers are given colour identification. These colours refer to the wires from the solo manual busbar outlets which are yellow for 4ft, red for 2ft, grey for 8ft, and blue for 16ft. There is also a black earth wire.

This bunch of five wires is shown coiled on the left hand side of Fig. 2.1. First, uncoil these, bringing them out parallel to the edge of the upper keyframe. To fix their position a five way miniature tag strip should be screwed to the rear edge of the keyframe as shown in the photograph. The busbar wires can now be bared, connected and soldered.

TONE CIRCUITS

This organ will be demonstrated at The International Audio Festival and Fair, Olympia, London, October 16 to 22

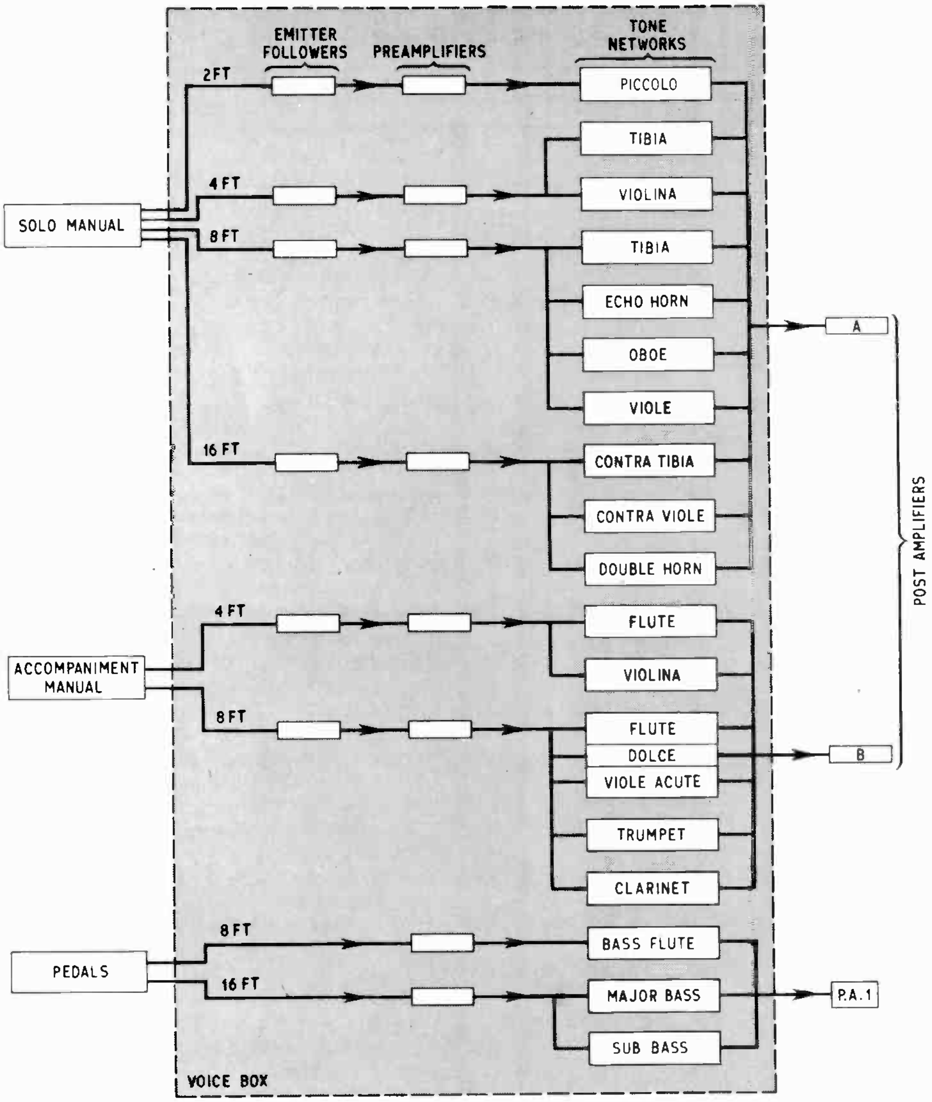


***Fig. 6.1.** Block diagram of the organ's manual and pedal voicing circuits. Note the inclusion of the Dolce stop which is additional to the specification given in Part One. This voice derives from the flute family but has a quieter sound achieved by additional low pass filtering*

At this stage the wires from the lower manual busbars can be similarly connected. Here, of course, only three wires are involved coloured yellow, grey and black, so a three way tag strip is required.

When this is completed a link wire is made to join the busbar black, or earth, wires at their tags.

For connection from the upper tagstrip to the emitter follower input, four, one yard lengths of single miniature microphone cable are needed. This cable is screened and to prevent hum and crosstalk arising it is necessary to connect the screens with the busbar black wires at their common tag.

The cable inners are now connected at the tags at one end and the Veroboard at the other as shown in Fig. 6.3.

SUPPLY CONNECTIONS

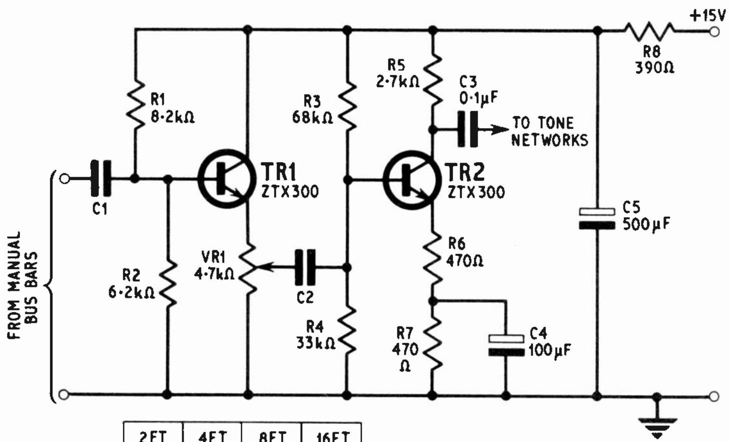
Since we need to tap a 15V supply to test the pre-amplifier board, the wiring from P.S.U.1 to the oscillator and dividers can now be completed. This is a simple task since the oscillators are in position as are the divider boards.

To mount the power unit, a wooden shelf 6½in × 8in should be made up and fixed to the console side using angle brackets. To establish the positioning of this, refer to the rear view photograph given in Part Two.

If wood quadrant is added to the edge of the shelf, this will prevent any movement of this unit.

A 2½ft length of twin cable will suffice to connect from the power supply output terminal block to the oscillator shelf.

SOLO PRE-AMPLIFIERS



	2FT	4FT	8FT	16FT
C1/C2	0·01µF	0·1µF	0·22µF	0·33µF

Fig. 6.2. Circuit diagram of the solo emitter followers and pre-amplifiers which are fed from the solo manual busbars. Changes in capacitance of C1 and C2 necessary to accommodate pitch variation are shown in the table

COMPONENTS . . .

SOLO EMITTER FOLLOWERS AND PRE-AMPLIFIERS

Resistors

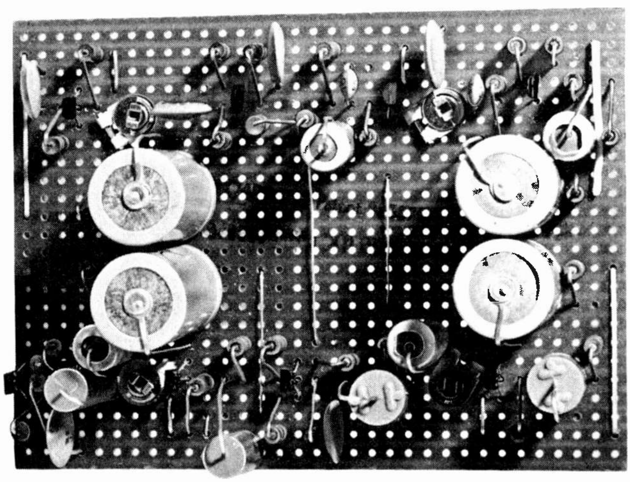
R1 8·2kΩ 4 off
R2 6·2kΩ 4 off
R3 68kΩ 4 off
R4 33kΩ 4 off
R5 2·7kΩ 4 off
R6 470Ω 4 off
R7 470Ω 4 off
R8 390Ω 4 off
All 10% ½ watt carbon

Capacitors

C1, C2 } Values according to pitch. See Fig. 6
C3 0·1µF disc ceramic 4 off
C4 100µF elect 6V 4 off
C5 500µF elect 25V 4 off

Transistors

TR1 ZTX300 (Ferranti) 4 off
TR2 ZTX300 (Ferranti) 4 off



Topside view of solo emitter follower and pre-amplifier board

Potentiometers

VR1 4·7kΩ miniature horizontal presets 4 off

Miscellaneous

Veroboard 3¾in × 5in

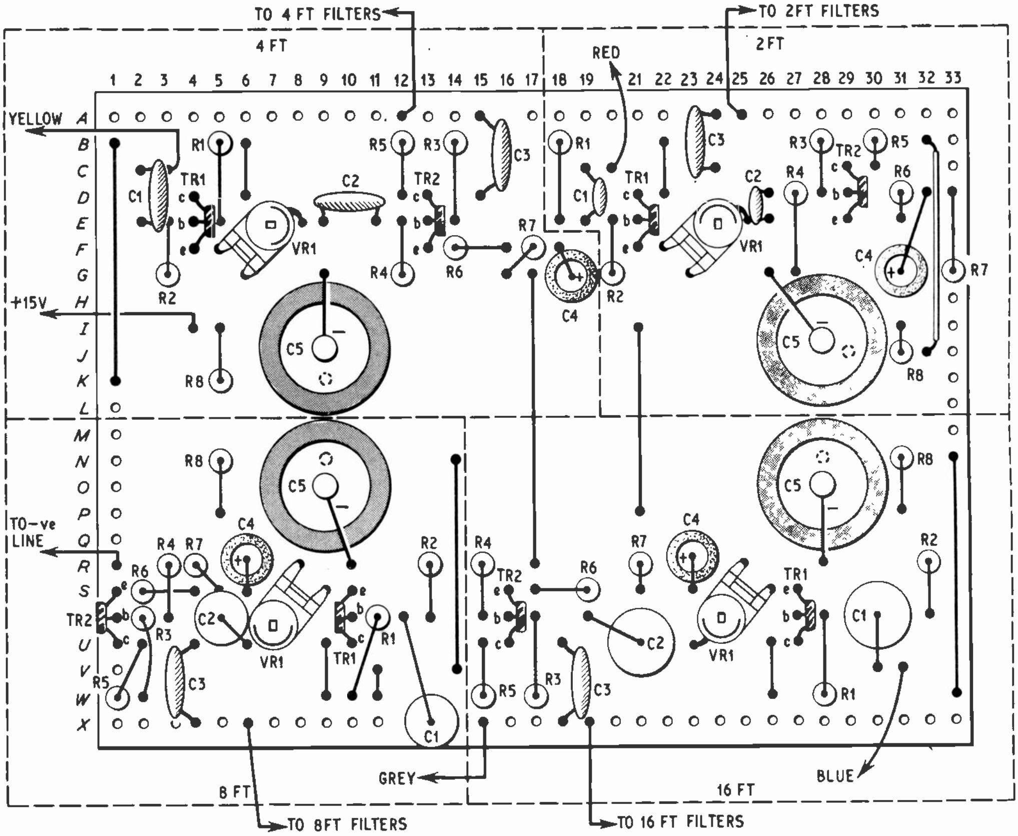


Fig. 6.3. Component layout of the four solo emitter followers and pre-amplifier circuits

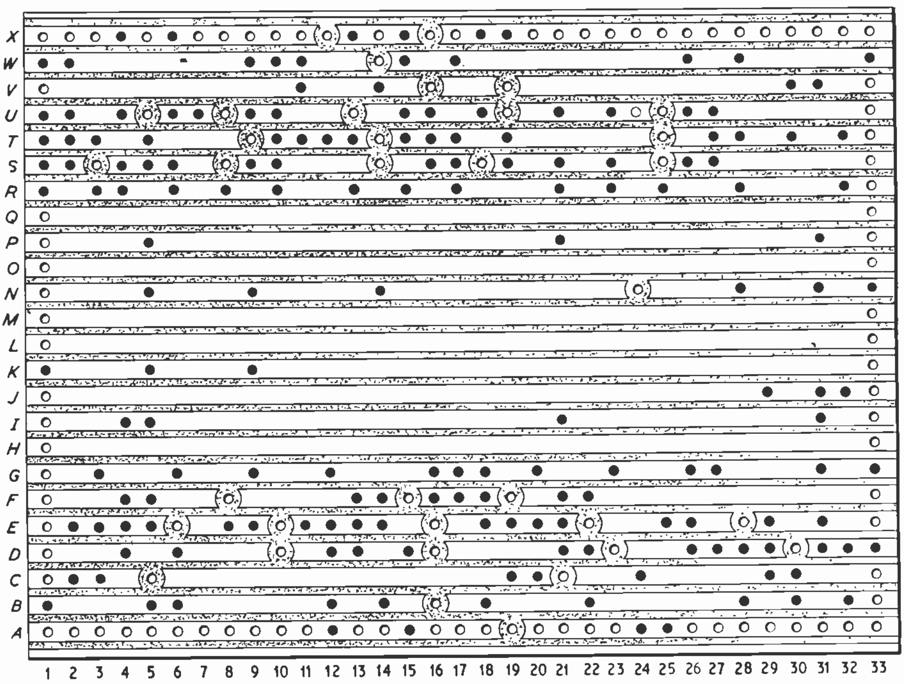
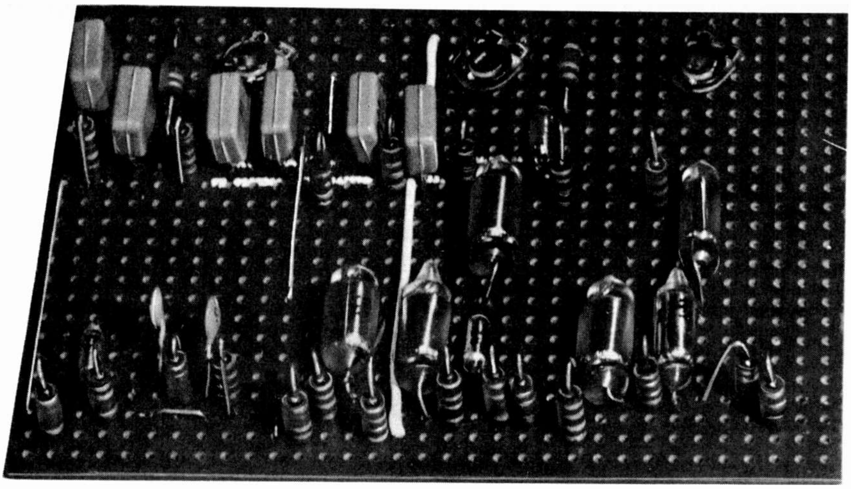


Fig. 6.4. Wiring and copper cut out for Veroboard underside



Topside view of solo filter networks mounted on board. The inductors are not shown as these are mounted in the screening box

Since all the oscillators and dividers require 15 volts they are all wired in parallel across this supply which is a simple operation provided the diagrams given in Parts Two and Three are referred to.

When this wiring is completed a 1,000μF 25V electrolytic capacitor should be connected across the supply line as an additional aid to smoothing.

TESTING THE VEROBOARD ASSEMBLY

We can now take supply leads from any one of the oscillators to the pre-amplifier board, these connections being given in Fig. 6.3.

To generate a test signal a 30,000pF capacitor should be connected across one of the oscillator coils, at the same time taking particular notice of the note sign of the divider which it feeds as a busbar signal will only be apparent when the corresponding key on the solo manual is depressed.

To complete the test circuit, join the black leads at the busbar tagstrip to the negative side of the 15V supply.

First switch on the supply, then with a pair of high impedance headphones connected between the negative supply line and the 4ft pitch output capacitor C3, depress the appropriate manual key and a clear note should be heard. If the note is fuzzed or not apparent then the cause is almost certainly a faulty transistor.

Variations in amplitude can be made by adjusting VR1.

To check the other pitch pre-amplifiers, the headphones should be connected to the other output capacitors in turn, these all being annotated C3 in Fig. 6.3.

If the same key is depressed and four sections are functioning correctly, you will immediately be aware of octave changes upwards when moving from the 4ft output to the 2ft, and downwards when moving from the 4ft to the 8ft then to the 16ft.

This board should now be disconnected and put to one side.

SOLO FILTERS

The filters for the solo or upper keyboard are given in Fig. 6.5. As can be seen, the tone nets are fed from the four pitch pre-amplifiers.

In the solo keyboard four pitches are required as more kinds of sounds are needed for melodic effects. In these circuits we have all three types of filter discussed in Part Five.

The three tibia are low pass circuits with somewhat differing characteristics, dependent on the pitch and degree of filtering.

The string stops, violes and violina, are high pass circuits and again the component values are chosen to produce a difference in character.

The oboe is a parallel tuned circuit using a Mullard Ferroxcube coil type LA2 which has no external fields.

STOP SWITCHES

The considerable resistance that precedes any one of the stop switches S1 to S10 means that there is little, if any, change in volume when adding stops and one network does not influence another so that the character of the tones is unimpaired and we get the effect of adding quite distinct sounds instead of one compound sound.

Although the inputs come from separate pre-amplifiers, the outputs are combined and fed into a common post amplifier. It will be noted that there is an adjustment for volume on some of the voices, this being provided by small preset potentiometers.

SOLO VOICE DETAILS

Three stops follow the 16ft pre-amplifier, these being the contra tibia, contra viole, and double horn.

One must be very careful with this pitch, because the lower notes run down to 32Hz and chords formed in the bottom octave are unusable. Even on the best pipe organ there would be very few 16ft stops per manual, often none at all. We use such stops because solo voices are excellent down to tenor C and the bottom octave is useful for special effects—one can form a good bass here.

The 16ft tibia is an essential part of the theatre chorus, therefore we keep it round in character with virtually no harmonics. It is a strict foundation tone derived from a low pass filter.

The contra viole is a string voice devoid of fundamentals which is kept low in amplitude so that it can be used in chords down to tenor C.

The double horn is a series resonant circuit, designed to give useful results over the whole keyboard. It is really a solo voice and if made too loud, would overload the post amplifier when played in chords.

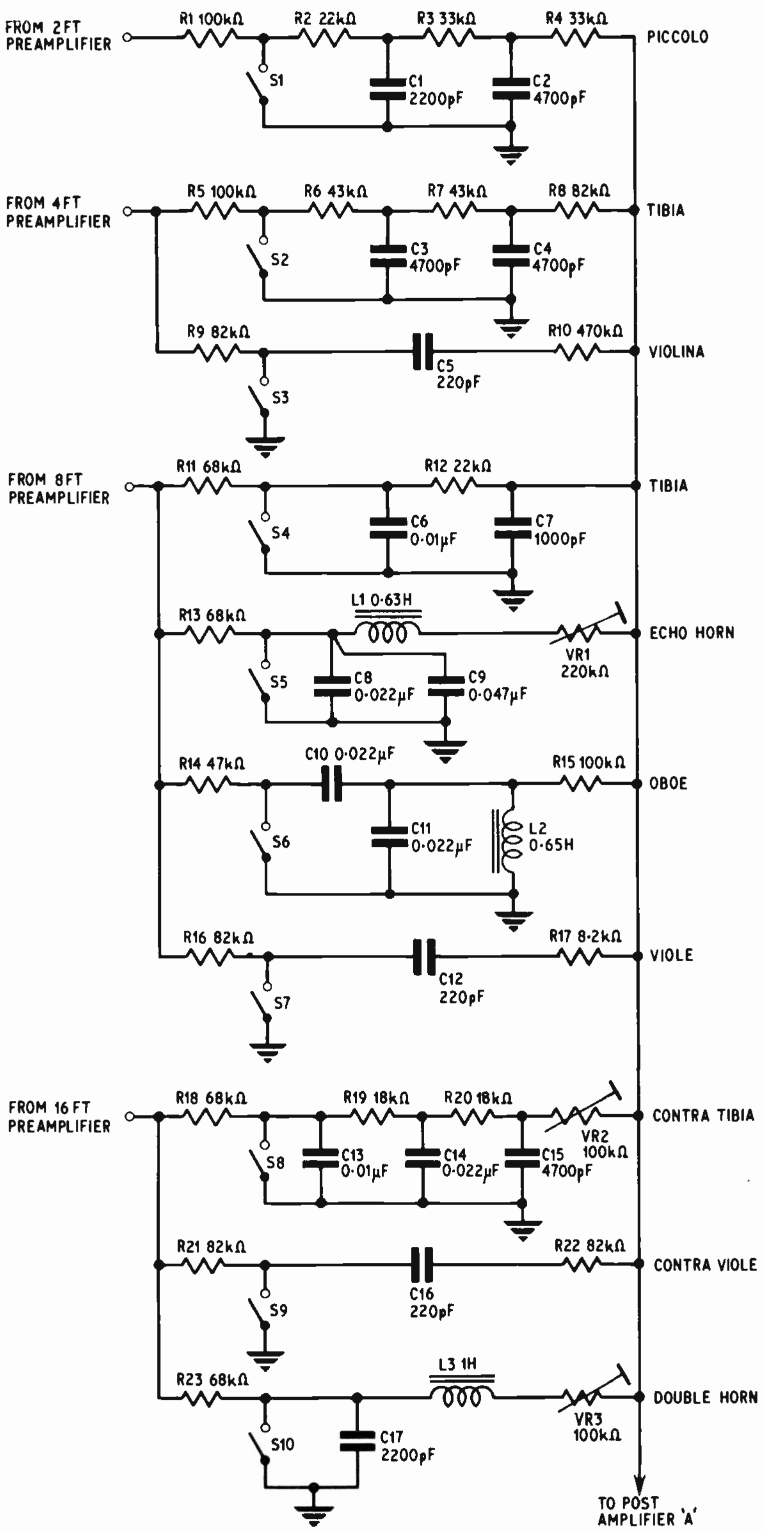
8ft STOPS

The 8ft pre-amplifier supplies a tibia tone, a string tone and two 8ft reeds.

The tibia is similar to the 16ft one, voiced to give more harmonics than a flute. Then we have the echo horn, a smooth sound of value for quiet work.

The oboe, which is quite characteristic of the pipe organ stop, is not nearly so plaintive as the orchestral

SOLO TONE NETWORKS



COMPONENTS . . .

SOLO TONE NETWORKS

Resistors

R1	100kΩ	R13	68kΩ
R2	22kΩ	R14	47kΩ
R3	33kΩ	R15	100kΩ
R4	33kΩ	R16	82kΩ
R5	100kΩ	R17	8·2kΩ
R6	43kΩ	R18	68kΩ
R7	82kΩ	R19	18kΩ
R8	82kΩ	R20	18kΩ
R9	82kΩ	R21	82kΩ
R10	470kΩ	R22	82kΩ
R11	68kΩ	R23	68kΩ
R12	22kΩ		

All 10% ½ watt carbon

Capacitors

C1	2,200pF	C10	0·022µF
C2	4,700pF	C11	0·022µF
C3	4,700pF	C12	220pF
C4	4,700pF	C13	0·01µF
C5	220pF	C14	0·022µF
C6	0·01µF	C15	4,700pF
C7	1,000pF	C16	220pF
C8	0·022µF	C17	2,200pF
C9	0·047µF		

Potentiometers

VR1 220kΩ, VR2 100kΩ, VR3 100kΩ } miniature horizontal preset

Inductors

L1 0·63H, L2 0·65H, L3 1H } All Mullard ferrite pot cores type LA2. For winding details see text.

Miscellaneous

Veroboard 3¾in × 5in

Fig. 6.5. Circuit diagram of the solo tone networks with the piccolo and tibias made up from low pass RC filters and the strings—violes and violina—made up from high pass filters. Resonant circuits are used for the other wind family members.

Note the inclusion of a preset potentiometer in series with the outputs of the more strident voices. This permits volume adjustment

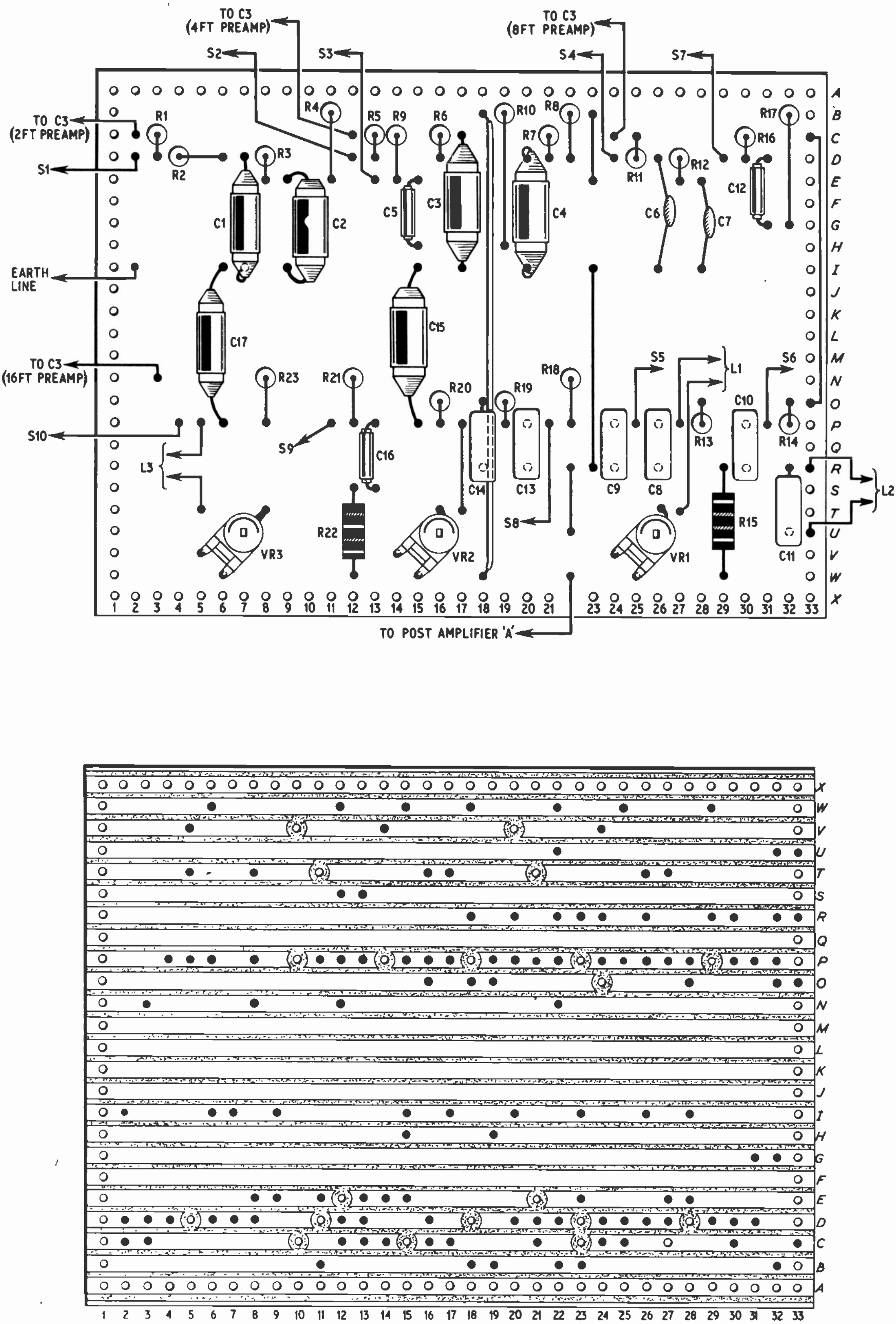


Fig. 6.6. Component layout and underside wiring of solo filter board

oboe, as a square wave will not produce a perfect oboe sound.

Finally, the viole, which is not quite so strong as its counterpart in the lower keyboard because it is meant to mix with the 16ft and 4ft strings.

4ft AND 2ft STOPS

The two voices feeding from the 4ft pre-amplifier are the tibia, an important register only slightly louder than the 8ft, but sounding very similar, and the violina which may be regarded as an extension of the 8ft viole.

We are left with the 2ft piccolo, a most useful sound for brightening everything else, and a vital component of the tibia chorus.

There is no adjustment for this low pass filter which covers the keyboard range right up to B, 7902Hz. This is at least an octave higher than one would find in any but the largest electronic organs.

As many high harmonics are retained, an unusual brilliance is imparted to the sound and lets us dispense with the twelfth, 2⅔ft, which is very difficult to regulate with a square wave generator, and is only of real value with sine wave systems.

The 2ft stop can be used as a solo voice on its own.

SOLO FILTER CONSTRUCTION

All of the solo filter components, with the exception of the coils, are mounted on a single Veroboard as shown in the component layout and wiring of Fig. 6.6.

Eventually, all of the voicing sub-assemblies will be contained in a metal screening box, so no inter-board wiring will be done at this stage, only board assemblies.

Since these circuits are passive, testing is not really necessary so this board can be laid aside after component mounting, first making sure that the wipers of the preset potentiometers are set at mid travel.

COIL WINDING

To calculate the number of turns to be wound on the LA2 coil former we use the formula:

$$n = 65\sqrt{L} \times 10^3$$

where n is the number of terms to produce L the coil inductance. The factor 65 is the number of turns required for 1 millihenry with this particular coil.

Using 44 s.w.g. enamelled copper wire, the approximate number of turns required for each coil are:

L1—1,600 turns
L2—1,650 turns
L3—2,000 turns

When these are wound and the Ferroxcubes re-assembled, these should be placed to one side as they will eventually be mounted in the voice screening box.

KIMBER-ALLEN KEYBOARDS

Upon investigation it has been discovered that the Kimber-Allen keyboard and the Harmonics contact assembly are dimensionally incompatible. The author apologises for any inconvenience to readers, but the original recommendation was based on his own personal measurement of a sample Kimber-Allen keyboard. Constructors intending to purchase keyboards and contact assemblies are now advised to purchase Goddard keyboards and Harmonics contact assemblies.

Readers who have already purchased the Kimber-Allen keyboards may be able to negotiate their return for credit. In this connection it should be noted that the Kimber-Allen stop switches (specially engraved) and pedalboard will be specified as standard items for the P.E. Organ in forthcoming articles.

To be continued

NEWS BRIEFS

Ultrasonics Conference and Exhibition

IMPORTANT advances in ultrasonics techniques for industry and medicine will be discussed in sixteen 30-minute lectures at the Sixth Ultrasonics for Industry Conference, to be held at St. Ermin's Hotel, London, on October 7 and 8.

An exhibition, run in conjunction with the conference, will display a range of ultrasonic equipment for cleaning, degreasing, flaw detection, thickness measurement, level sensing and control, medical diagnosis, welding, drilling and cutting, homogenising and depth sounding. Senior engineers will attend the stands to provide information and discuss application possibilities.

The conference is divided into four half-day sessions: Materials Evaluation; Medical and Biophysical; Electronics Applications; Non-destructive Testing.

Registration fee for the conference is £8 for the whole conference or £6 for a single day. Admission to the exhibition is free. Full details and registration forms can be obtained from the Organiser, Ultrasonics Conference and Exhibition, Dorset House, Stamford Street, London, S.E.1.

Miniature Battery in Moon Experiment

A MINIATURE mercury battery, smaller than a thimble, is serving as the power source for the seismic experiment package that Apollo 11 astronauts "planted" on the moon.

Designed to last two years or more, the battery controls the timing mechanism of instrumentation that gathers and transmits scientific data from the lunar surface.

The tiny Mallory battery is similar to those used to power a heart pacemaker. It is encapsulated in a special casing as protection against severe environmental strains.

Radio Buses

WITHIN the next few months, 37 Corporation buses in Coventry will be fitted with GEC mobile radio communications systems which will provide crews with a permanent and instant radio contact with their new traffic control centre in the centre of Coventry.

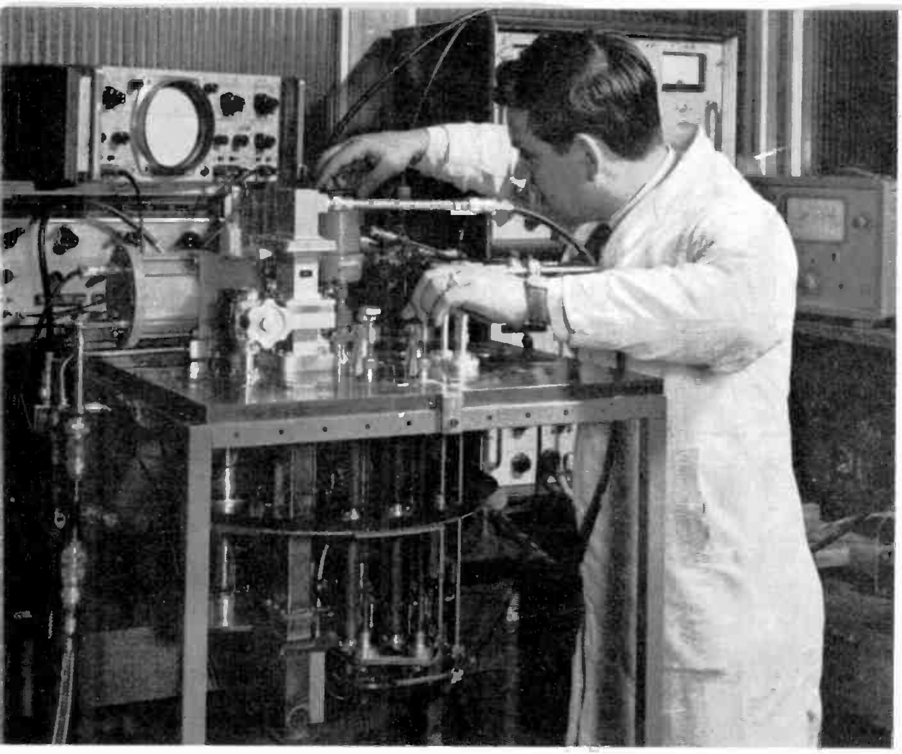
This system is designed to provide the crews with a measure of protection against hooliganism and vandalism, and is particularly important on the newer types of "pay-as-you-enter" bus, where the driver is completely on his own.

Two of these units have been in trial operation for some six months, and their success has decided the Transportation and Highways Committee to order an additional 35 systems, in addition to the 11 GEC Courier v.h.f. pocket transceivers which are already being used by inspectors patrolling the routes, and also by the management. Two of the mobile systems are now installed in vehicles used by traffic inspectors.

New Structure for GEC-Marconi Electronics

A NEW management structure was announced recently for the GEC-Marconi Electronics group, with the formation of the following four new management companies responsible to Mr R. Telford, Managing Director of The Marconi Company Ltd.

Marconi Communication Systems Ltd.
Marconi Radar Systems Ltd.
Marconi-Elliott Avionic Systems Ltd.
GEC-Elliott Space and Weapons Systems Ltd.



Goonhilly 1 Refurbished

THE Goonhilly 1 installation recently reopened, after being re-equipped, receives and transmits signals via satellite to the Americas. One of the main improvements resulting from this updating is the conversion from narrow band to wide band operation, thus making possible the simultaneous reception and transmission of television programmes and hundreds of telephone channels. Goonhilly 1 was used to receive Apollo 11 television pictures bounced off satellites above the Indian and Pacific oceans.

Parametric amplifiers, supplied by Mullard Ltd., boost the very weak television and telephone signals received via satellite from Japan and Australia at Goonhilly Down.

Two Mullard parametric amplifiers have been installed at Goonhilly: one for operational use; the other on standby. Designed and built by scientists at the Mullard Research Laboratories and the Mullard Mitcham plant, they operate over a bandwidth of 3·7–4·2GHz. One of the amplifiers is shown (left) being checked before installation.

ELECTRONORAMA

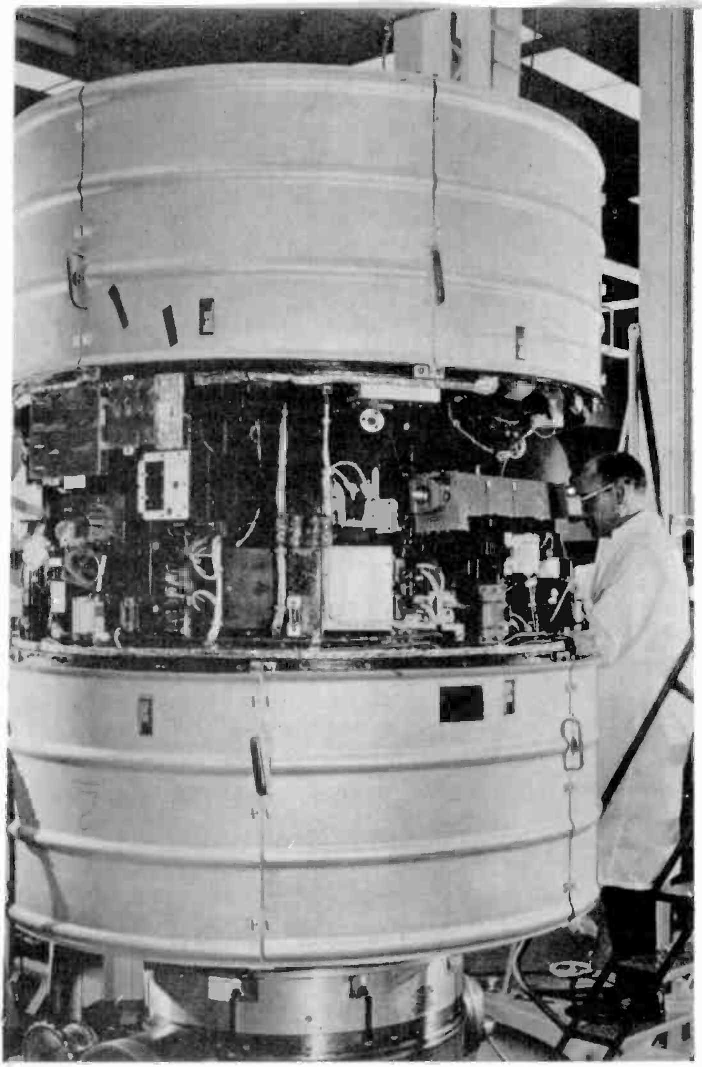
Optical Mark Reading System

IN many modern organisations there is a need to collate and analyse a large amount of statistical data. Prior to the introduction of the computer, however, such data was prepared in a conventional words-and-figures form, which cannot be "read" by computers. It has therefore now become necessary to convert the conventional data into a coded form which is acceptable as a direct input to an automatic data-processing system.

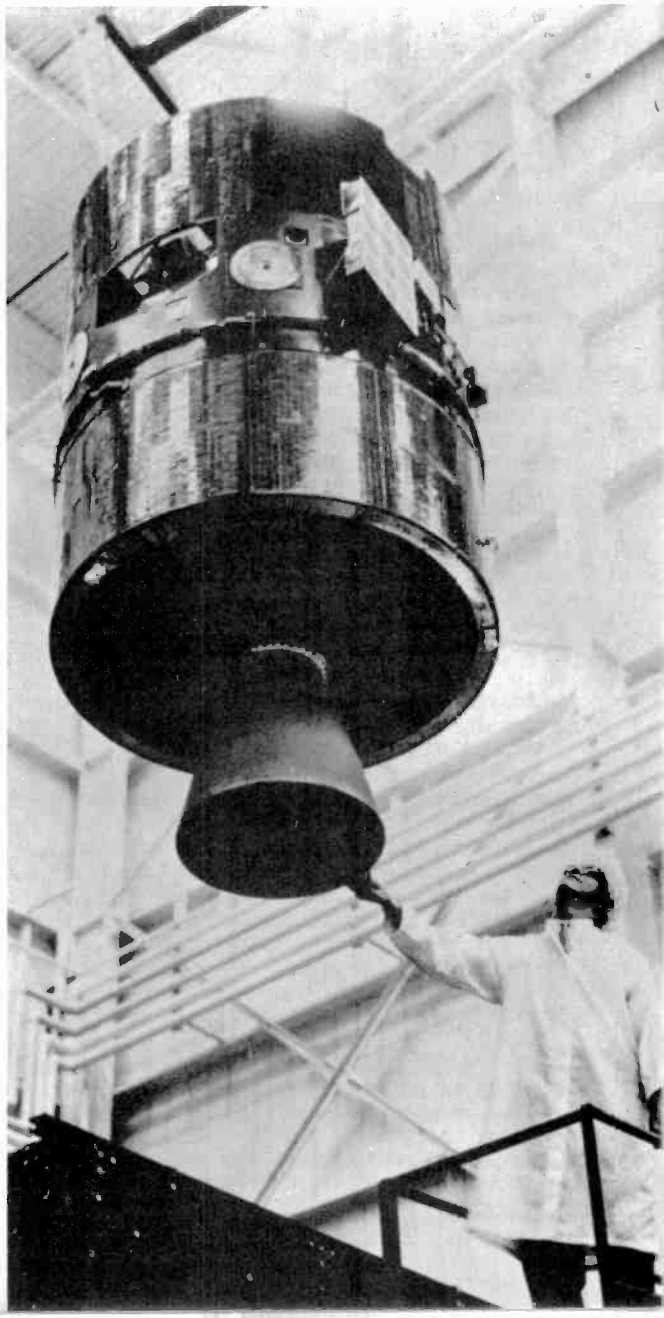
One technique, which has been applied manually for many years, is to use a "grid" system. In this, a grid of columns and lines is printed on a document, and the location of each box in the grid thus formed is assigned a particular value or represents a unique item of information. It is then a simple matter to make a mark in the predetermined positions on the grid.

Data Recognition have now automated this principle and have produced a versatile reading machine. This has been designed to read marks entered on documents, and provide a punched paper tape version of the document.

The DR 500 will read a wide range of sizes and thicknesses of documents.



ATS-E shown during final tests (left and below) at Hughes Aircraft Company, El Segundo, California, where the spacecraft were built for NASA. The rectangle with a dozen small circles at upper right section of the spacecraft (below) is the antenna portion of an L-Band communications system.



Another Satellite

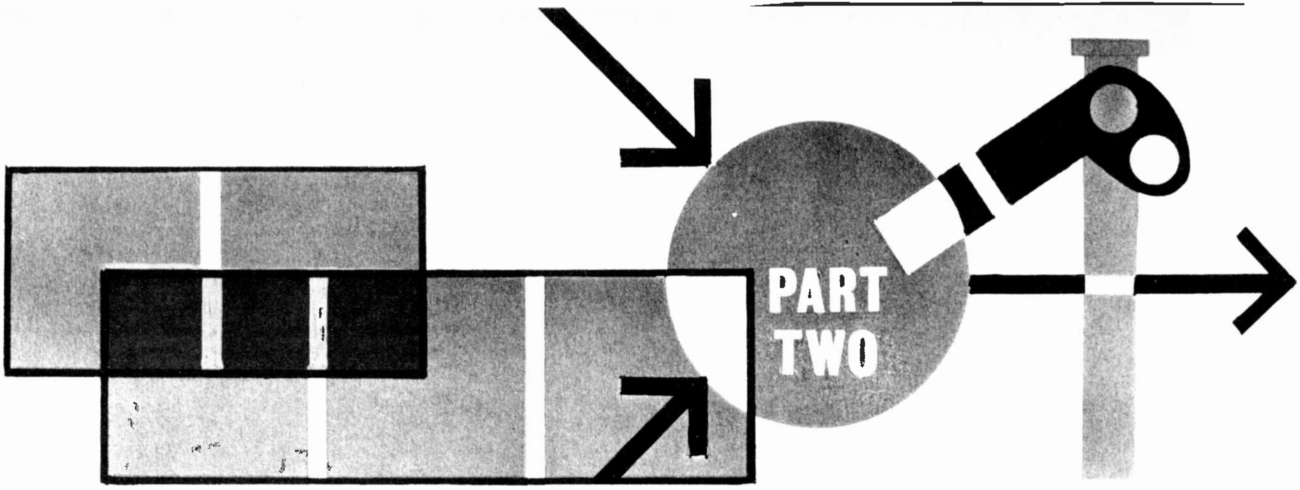
THE fifth Applications Technology Satellite built for NASA by Hughes Aircraft Company of California which was launched from Cape Kennedy on August 12, carried 13 experiments into space—more than any of its predecessors.

The ATS-E, renamed ATS-5 after launch, joins ATS-1 and ATS-3 in synchronous orbit 22,300 miles above the earth. It is 5ft in diameter, 11ft from the bottom of the apogee motor to the tip of the omni-directional antenna and weighs 1,901lb at separation from the booster.

The satellite extends arm-like booms into a giant X nearly the length of a football field, in a "gravity gradient" experiment designed to use the earth's gravity to stabilise the spacecraft in orbit.

The satellite carries an L-band repeater, recently developed by Hughes, that may pave the way for development of an improved system of using satellites for aircraft communications and navigation.

The objectives of the experiment are: to determine the reliability of an L-band system for aircraft-to-ground voice communications; to study its use in voice communications between aircraft, and to study its accuracy in locating the positions of many aircraft and tracking their progress.



MODEL RAILWAY LOGIC SYSTEMS

By P. GOODES

In this second article of the present series, logic circuits are employed to make up interlocking signalling systems.

SIGNALLING SYSTEMS

The purpose of an interlocking signalling system on a model railway is to enable two or more trains to be run on the same track without the possibility of an accident.

Three circuits have been designed and constructed by the author, the first being very basic and the other two somewhat more complex. Although it is quite possible to have the whole of the layout on an interlock system, this type of signalling was used in one main line with suburban line loop only.

SIMPLE TRACK SIGNALS

Referring to Fig. 2.1 it will be seen that the track is split up into isolated sections. The longer sections are all joined electrically to the controller of the train and the smaller sections are connected via relay contacts to the controller.

Consider now the mode of operation. A train may not enter a section unless that section is clear of all other trains. When a train enters a section it must inform the previous section that it has done so. At no time must there be two trains in one section.

Two-coloured light signals are used and these are controlled as shown in Fig. 2.2 by bistables feeding relay buffers. (These circuits were described in Part 1.)

Assume a train is going past signal X2 which is at green. It then trips switch S2, which feeds a 1 pulse into bistables BS2A and BS3B. BS2B now has a 1 output which operates relay RLB, changing X2 signal to red and cutting off the supply to the short section immediately before signal X2. The operation of bistable BS3 causes RLC to drop out, changing X3 to green and applying engine power to the short section in front of X3. Thus another train may progress beyond X3 and will stop at X2, until X2 is cleared from red to green by the previous train tripping switch S1.

This process is repeated at each signal giving a complete loop, which may be quite simply expanded according to size of railway layout, the number of trains to be run on the one track, and introduction of points hazards.

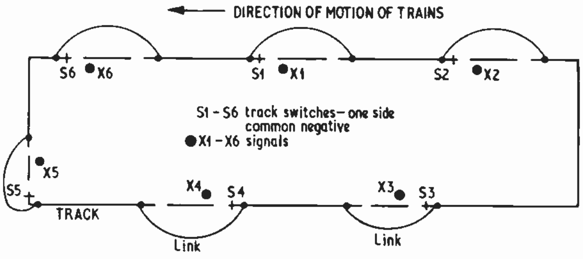


Fig. 2.1. Track layout for simple signalling

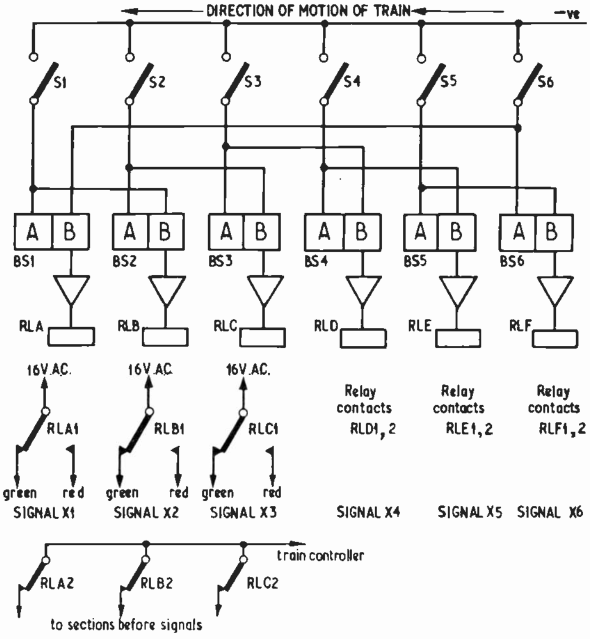


Fig. 2.2. Block diagram of the signalling logic system

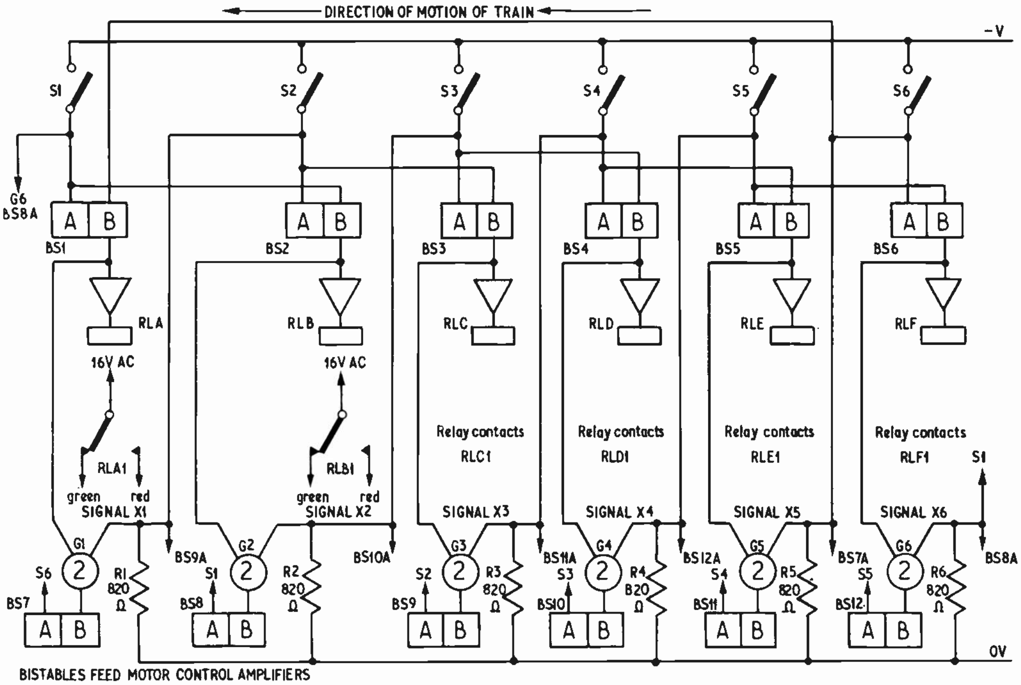


Fig. 2.3 (above). Stop and start control is achieved by using AND gates. When feeding a bistable from an AND gate, replace the bistable input resistor by a diode, input to cathode

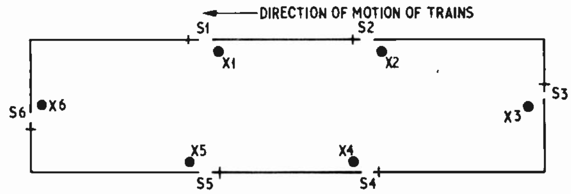
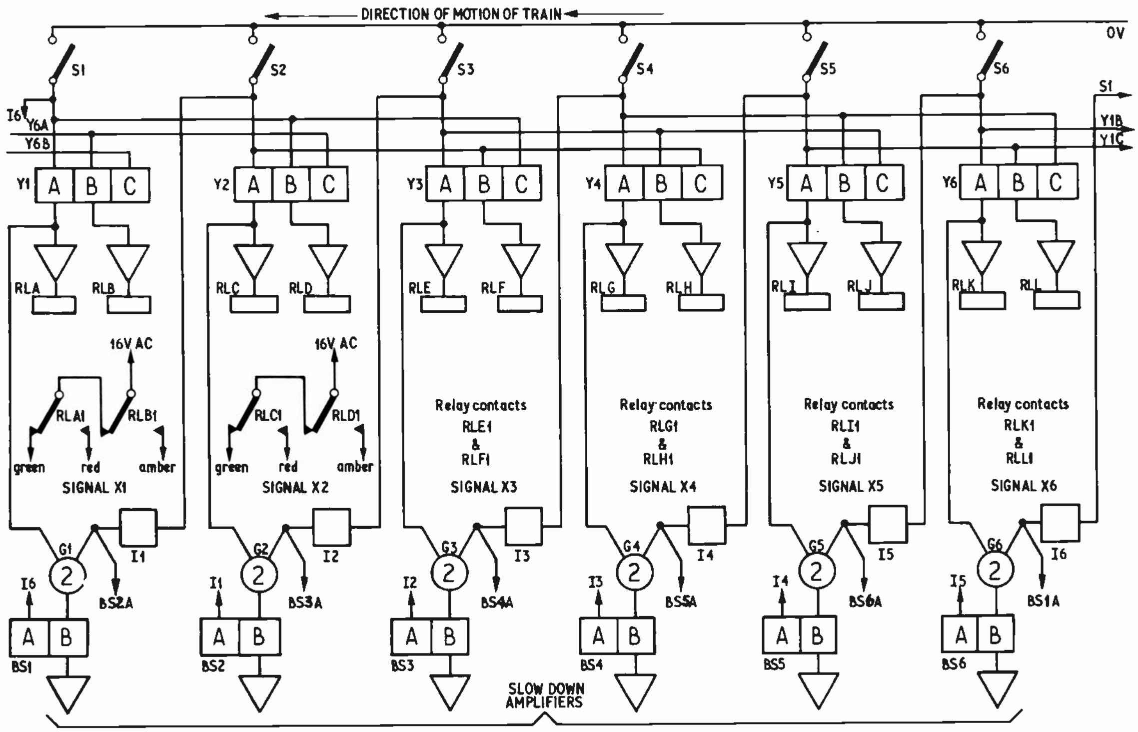


Fig. 2.4 (left). Track layout for circuit shown in Fig. 2.3. Signals are indicated by X numbers

Fig. 2.5 (below). Logic diagram for home and distant signals with slow down amplifiers using the track layout shown in Fig. 2.4



STOP AND START CONTROL

Another more superior system is shown in Fig. 2.3. The splitting up of the track loop into sections is slightly different as will be seen in Fig. 2.4. All the short isolated sections have been disposed of and each long one now has its own engine control amplifier.

It is possible to have one control amplifier per train, but a very complicated switching network would result. To ensure individual control, a control amplifier was required for each section. This would enable the system to be expanded quite simply for use with three or four trains.

The operation of the signal bistables is as explained in the previous section but, using an engine control amplifier, a more realistic stopping and starting of the train with gradual acceleration and deceleration is effected.

Assume signal X1 is at red and a train is approaching passing signal X2. As S2 switch is tripped, signal X2 changes to red. Gate G1 is primed by the condition that signal X1 is red, i.e. a 1 on BS1B output. Thus as S2 is tripped, this gate gives a 1 pulse output which triggers bistable BS7 and causes the control amplifier for that section to slow the train down and bring it to a halt.

This train will then remain stationary until signal X1 changes to green. This occurs when the previous going train passes signal X6 and trips S6.

The pulse from switch S6 also resets the bistable BS7 and allows the train to start off. As it strips S1 switch, it sets X1 signal to red and, if X6 signal is at red also, it starts slowing the train down again via BS12 bistable. If however gate G6 is unprimed (i.e. signal X6 is green) no output pulse occurs and the train continues without slowing.

All bistables on signalling should have their input resistors replaced by diodes—input to cathode, anode to base of transistor. Although the circuit does work using the input resistor, analysis shows that under adverse conditions, misfiring may occur.

HOME AND DISTANT SIGNALS

The most realistic signalling system is the home and distant where three-colour lights are used. These signals are obtainable commercially although an avid modeller will have no difficulty in constructing his own. Again the loop or track length is divided up into sections (Fig. 2.4) and, considering any one signal, the following colour codes are used.

RED: The section immediately after the signal is occupied by a train. Any further train coming will stop at the signal.

AMBER: The section immediately after the signal is unoccupied but the next section along is occupied by a train. Trains may pass an amber signal.

GREEN: There are two or more clear sections after the signal and a train is allowed through.

Thus the signal colour sequence is red-amber-green, when considering a single train going round the track.

In Fig. 2.5 on the shift register, A represents red, B represents amber, C represents green.

Suppose a train has just passed X2 signal. When S2 switch is tripped, Y2A gives a 1 output operating relay RLC through its buffer, applying red to X2. S2 also sets Y3B which changes X3 to amber, and also Y4C which sets signal SX4 to green. If signal X1 is red when S2 is tripped, then gate G1 gives a 1 output into BS1 bistable. This bistable feeds its control amplifier and causes the train to slow down before the signal X1. When this signal has been cleared by a previous going train the engine speeds up and on tripping, switch S1 changes X1 to red, X2 to amber and X3 to green.

Once again this is a loop system and may be extended quite easily to cater for more signals. The engine control section is exactly the same as that used in the previous system, but in this case the common side of the trip switches S1 to S6 is connected to 0V. Thus, when a switch operates it cuts off the associated transistor in the shift register.

Next month: An automatic marshalling yard

APOLOGY

We regret that the title of the first part of this article last month was omitted due to a printing error.

ELECTRONIC BROKERS

TEST EQUIPMENT

HIGH VALUE RESISTANCE BOX TYPE R.7003

Specification. Range: 0·01-111 Megohm in 0·01 Megohm divisions. Accuracy: 0·05%. Maximum power rating: 0·1W per step. Case: Hammer finished stove enamel.
List price £60. Our price **£22.10.** P. & P. £1

MUTUAL INDUCTANCE BOX TYPE R.7005

Specification. Range: 0–11·110mH in 0·002mH divisions. Accuracy: $\pm\left(0\cdot3 + \frac{0\cdot012}{M}\right)\%$
where M = value of mutual inductance in mH set on the box. Frequency range: 0-2·5K/cs for all decades except X1 = 0·15K/cs. Maximum current: 0·5A for decades 1A for variometer (both primary and secondary windings). Case: Polished teak. List price £65. Our price **£26.10.** P. & P. £1

PORTABLE WHEATSTONE BRIDGE

Specification. Type: Moving Coil Galvanometer. Ranges: 1. 0·05 to 5 ohms. 2. 0·5 to 50 ohms. 3. 5 to 500 ohms. 4. 50 to 5,000 ohms. 5. 500 to 50,000 ohms. Scales: Switched. Slidewire: 0·5 to 50. Galvanometer Scale: 10–0–10. Case: Moulded plastic. Internal Source: 4V. Dry battery. Operating Temperature: +10 to +35 deg. C. Operating Humidity: up to 80% R.H. Dimensions: 200 × 110 × 65mm. Weight: 0·9kg.
List price £25. Our price **£9.19.6.** P. 10/–

MUTUAL INDUCTANCE COIL TYPE R.7006

Specification. Value: 0·001H. Accuracy: ±0·3%. Operating Frequency: 5Kc/s. 10Kc/s. Maximum current: 1A, 3A. Resistance of coils 4 ohm, 1 ohm. Case: Moulded plastic.
List price 8 gns. Our price **50/–**. P. 7/6

PORTABLE MULTIRANGE METER

Specification. Ranges: 0-60 and 0-300uA. D.C. 0-3, 0-30 and 0-12mA, D.C. 1·2 and 12 amps D.C. 0·6-3, and 6-30mA, A.C. 24-120mA, A.C. 0·24-12A, A.C. 3-12-30-300-600-1,200 and 6,000V, D.C. 0·6-3, 2·4-12. 6-30, 60-300, 120-600, 240-1,200 and 1,200-6,000V A.C. 3-333 ohms, 0·3-30 Kohms, 0·03-3 megohms D.C. Resistance −12 to +78 Decibels. Frequency: 50cps. Input Resistance D.C.: 20,000 ohms/volt. Input Resistance A.C.: 2,000 ohms/volt. Temperature Range: −10 to +50 deg.C. Dimensions: 255 × 215 × 170mm. Weight: 8kg. Supplied with 2 voltage dividers. H.V. leads, spare rectifiers, 1·5 and 22·5V battery.
List price £25. Our price **£12.19.6.**

MARCONI VALVE VOLTMETER TF 428B/1

Frequency response on probe 10Kc/s/3-100Mc/s. Five separate Voltage Ranges. Overload Protection 100-250 A.C.I.P. Input 1MΩ Acc. ±2% or 00·2V. Size: 10 × 16½ × 9in–15lb. **£5.19.6.**

E.M.I. BRT.1 TAPE RECORDER

Identical to those as used by the BBC. Excellent condition. Completely overhauled. A must for the enthusiast at **£135.**

LOW COST ELECTRONIC & SCIENTIFIC EQUIPMENT AND COMPONENTS

MOTORS

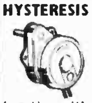
HYSTERESIS REVERSIBLE MOTOR

Incorporating two coils. Each coil when energised will produce opposite rotation of the output shaft. 240 volt 50 cycle, ½ r.p.m., ¼ r.p.m., 1/6 r.p.m., 1/10 r.p.m., 120 volt 60 cycles 1/10 r.p.m. 80/– reduced to 30/–. P. & P. 3/–.

LOW TORQUE HYSTERESIS MOTOR MA23

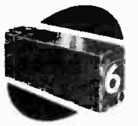
Ideal for instrument chart drives, extremely quiet; useful in areas where ambient noise levels are low. Having a high starting torque a relatively high inertia load can be driven. ·6 oz/in at 1 r.p.m. 240 volts 50 cycles. 10 r.p.m. R, 1 r.p.m. R and L, ½ r.p.m. L, ¼ r.p.m. R, 1/5 r.p.m. R, 1/10 r.p.m. R, 1/12 r.p.m., 1/20 r.p.m., 1/40 r.p.m., 1/60 r.p.m., 1/80 r.p.m., 1/360 r.p.m.; 1/6 r.p. hour, 1/12 r.p.h.; 1 r.p.m., 1½ r.p.m. **25/–**. P. & P. 3/–.

HYSTERESIS CLUTCH MOTOR



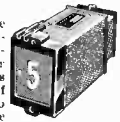
With integral clutch allowing the motor to drop out of engagement with the gear train, thereby facilitating easy resetting when used in timers or in conjunction with a light spring. 6 oz torque at 1 r.p.m. 240V, 50c/s. L = left, R = right. 15 r.p.m. L. 8 r.p.m. R and L, 6 r.p.m. L. 4 r.p.m., ½, ⅓, ¼ r.p.m. L, 1/5 r.p.m., 1/6 r.p.m., R and L. 1/10 r.p.m., 1/12, 1/15 r.p.m. L. Also 120V 50c/s 2, 1/6, 1/12, 5/12, 4/11, 1/10 r.p.m. **25/–**. P. 3/–.

MINIATURE DIGITAL DISPLAY



Operates on a rear projection 6·3 pilot lamp. The lamp projects the corresponding digit on the condensing lens through a projector lens, on to the viewing screen at the front of the unit. 1in width. 3¾in deep. 1⅛in high. Weight 3½oz. Character size ⅝in high, 0·9 with 8 right hand decimal point and degree. Available to special order, words and other characters or colour, at cost of artwork or plates. List price 6 gns.
Our price **49/6**. P. & P. 5/–.

EAC DIGIVISOR Mk. II DIGITAL READ-OUT DISPLAY

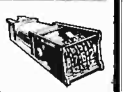


Ideally suitable for use in conjunction with transistorised decade counting devices. No need for amplifiers or relays as only a few milliwatts of power are required to charge the digits. The DIGIVISOR incorporates a moving coil movement which moves a translucent scale through an optical system and the resultant single plane image is projected on a screen. The translucent scale is made to represent digits 0–9. Specifications: 6·3V 250 microamp. Image height ⅝in. Size 4 9/16 × 2 39/64 1⅝in.
Our price 3½ gns. List price 8½ gns.

MINIATURE MOVING COIL RELAY S115

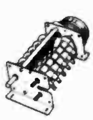
By Sangamo Weston, suitable for D.C. circuit. A high sensitivity relay more sensitive than the electromagnetic type. Single Coil Resistance 310 micro amps. 315Ω.
List price £4.10. Our price **20/–**.

ELECTRO MAGNETIC COUNTER



Slow impulse counter of 10 impulses per second. **6/6**. P. & P. 3/–.

REPEAT CYCLE TIMERS



These timers repeat a set cycle of switching operations via a cam and micro switch, for as long as the motor is energised. Single Cam RB 21in 2 min, 3 min, 4 min, 5 min, 6 min, cycles at **45/–**. Twin Cam RD 22 in 1 min, 2 min. 3 min, 4 min, 5 min cycles at **55/–**. 4 Cam RD 24 in 4 min. and 5 min cycles at **75/–**. 3 Cam RD 26 in 1 min, 2 min, 3 min, 4 min, 5 min cycles at **95/–**. 8 Cam RD 28in 1 min, 2 min, 3 min, 4 min, 5 min, cycles at **115/–**. All plus P. & P. 5/–.

ADVANCE TRANSISTORISED DC STABILISED POWER UNITS

	Input Volts	Output Volts	Amps	Price
DC 4	200–245 ± 15%	12	4	**£17.10**
DC 3	200–245 ± 15%	12	1·25	**£10.10**

SOLA CONSTANT VOLTAGE TRANSFORMERS

210 – 250 – 600 watts. **£25.** P. & P. 25/–.

★ HIGH PRECISION ★ FULLY STABILISED TRANSISTORISED LOW VOLTAGE POWER SUPPLIES

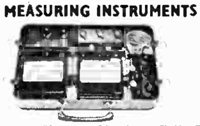
incorporating
* S.C.R. Panel for overload projection.
* OVERLOAD & CIRCUIT BREAKER WITH MANUALS RESET button.
* RIPPLE better, better than 3000: 1.
* CHOKE OR CAPACITOR transistorised 120/130V A.C. INPUT.

Available in the following types:

6V 9 amp	**£12.10.0**
6V 12 amp	**£17.10.0**
6V 16 amp	**£22.10.0**
12V 8 amp	**£22.10.0**
12V 16 amp	**£25. 0.0**
12V 22 amp	**£25. 0.0**
20V 16 amp	**£25. 0.0**
24V 4 amp	**£22.10.0**
30V 8 amp	**£18.10.0**
56V 7 amp	**£25. 0.0**

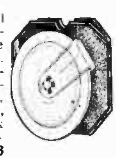
Ex-equipment but fully tested in our laboratory Carr. 30/–

SET OF MEASURING INSTRUMENTS



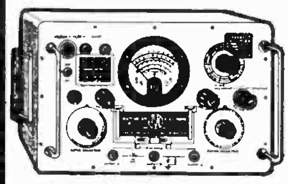
Specification Type: Moving Coil D.C. Ranges: 0–75mV, 0–3V, 3–15–150V, 3–150–450V, 0·3–0·75A, 1·5–7·5A, 15–30A. Scale Length: 82mm. Accuracy: 1·0%. Shunts: 1.0·3–0·75 amps. 2. 1·5–7·5 amps. 3. 15–30 amps. Case: Moulded plastic. Carrying Case: Stove enamelled metal.
List price £30. Our price **£12.19.6.**

POCKET CALCULATOR



Save time and solve all your multiplication, division, percentage, cube and square root problems. Easy to use pocket calculator with no errors. Invaluable daily aid, should last a lifetime, offered complete in black wallet with full instructions, 3¼in diam. **12/6** each, P. & P. 1/6.

NEW—AVO ELECTRONIC METER



A quality instrument capable of measuring A.C. and D.C. voltage and current, resistance plus power output.
Ranges: D.C. voltage 250mV-10,000V. D.C. current 100uA-25A. A.C. voltage 100mV-250V, A.C. current 10u-A-25A, Resistance 0-100MΩ. Power output 50μW-5W. Supply voltage 110/200/25 50Hz.
Complete with lead and probe for RF measurement up to 250 M Hz **£25.** P. & P. £1

METERS

Milliammeter. A.C./D.C. 100MA and 200MA FSD Cambridge 47526/4 Electro-dynamic **£25**	
Precision Voltmeter. A.C./D.C. 0–75V: 0–150V: 0–300V Sangamo Weston S.92.1–6 **£35**	
Precision Multimeter. V.I.R.W. E.I.L. Model 44	**£15. 0.0**
Watt Absorption Meter. Marconi CT44 200 UW–6W	**£35. 0.0**
A.F Micro Voltmeter. Dymar 703, as new	**£45. 0.0**
V.H.F. "Q" Meter—Marconi TF886B	**£45. 0.0**
Wide Band Millivoltmeter—Marconi TR1371	**£35.10.0**

POTENTIOMETERS

Precision—Tinsley 5205C	**£55. 0.0**
Precision Vernier Pot.—Cambridge	**£65. 0.0**
Wheatstone Bridge—Tinsley	**£35. 0.0**

COMPUTER EQUIPMENT

Arithmetic unit	**£70. 0.0**
Memory Store	**£8.10.0** and **£49.10.0**
Holerith Punch Card Machines	**£190. 0.0**
Ferrite Core Memory Planes 40 × 20 × 4	**£8.10.0 each**
Diode Function Generator	**£89.10.0**
Commutator	**£75. 0.0**

OSCILLOSCOPES

Cossor 1035	**£25. 0.0**
Cossor 1035 Mk. III	**£35. 0.0**
Cossor 1049 Mk. III	**£40. 0.0**
Solartron CD513.2, CD523S.2—LF and Servos, Long Persistent tube	**£49.10.0**
Solartron AD557—Pulse and Radar Field	**£55. 0.0**
Solartron CD711S.2—Double Beam DC.7 Meg.	**£85. 0.0**
Mullard L101/3 Double Beam	**£99.10.0**
Furzehill 0·100	**£25. 0.0**
Airmec 723	**£15. 0.0**
Airmec 249	**£25. 0.0**

PEN RECORDERS

Ammeter D.C. 0–2mA Single Pen—Elliott	**£37.10.0**
Portable Single Pen—Record Electrical New	**£49. 0.0**

OSCILLATORS

Audio Sweep Oscillator and Controller Dawe 443B New	**£99.10.0**
Automic L.F. Sweep Oscillator Dawe 444C New	**£89.10.0**
Wide Band Oscillator Dawe 400C	**£35.10.0**

STOP PRESS

New items not yet catalogued

Stepping Motor. 24 steps. 6 banks 18V D.C.	**£4.10.0**
Infra-red Quartz Lamp 70,000 A and 20,000 A 1440 Watts 240V	**£1. 5.0**
Capstan Motor ¼ h.p. continuous 3,000 r.p.m. 230V 50Hz. P. & P. 15/–	**£4.19.0**
2 Vehicle Ignition Testers. English Electric	**£19.10.0**
Variac O/P 35/0–35V 7A 0Hz 15/P. P. & P. 10/–	**£4.10.0**
Sampling Switches 24 segment in 6 bank 8,000 samples/sec.	**£25. 0.0**

ELECTRONIC BROKERS LTD., 49-53 PANCRAS RD., LONDON, N.W.1 Tel. 01-837 7781/2 Cables: SELELECTRO

VALUE ALL THE WAY

INTEGRATED CIRCUITS

BI-PAK MONOLITHIC DIGITAL CIRCUITS (10 lead TO-5)

BP305A, 6-Input AND gate, **9/6** each.
BP314A, 7 Input NOR gate, **9/6** each
BP315A, Dual 3-Input NOR gate, **9/6** each.
BP316A, Dual 2-Input NOR gate (expandable), **9/6** each.
BP320A, J-K-Binary element, **11/6** each.
BP332A, Dual 3-Input OR gate, **9/6** each.

BI-PAK MONOLITHIC AMPLIFIERS (TO-5 8 lead)

BP709C, Operational amplifier, **15/-** each.
BP701C, Operational amplifier (with Zener output), **12/6** each.
BP702C, Operational amplifier (with direct output), **12/6** each.
BP501, Wide band amplifier, **18/-** each.
BP521, Logarithmic wide band amp., **14/-** each.
BP20/C, General purpose amplifier (TO-5 8 lead), (voltage or current amp.), **12/6** each.
I.C. Operational Amplifier with Zener output. **Type 701C.** Ideal for P.E. Projects. 8 Lead TO-5 case. Full data.

Our price 12/6 each

5 off 11/- each. Large Qty. Prices quoted for.

OTHER MONOLITHIC DEVICES

BP424, Zero voltage switch, **8/6** each.
This device is a monolithic I.C. that acts as combined threshold detector and trigger circuit for controlling a triac. It is designed to pulse the gate of a thyristor at the point of zero supply voltage, and therefore eliminate radio frequency interference when used with resistive loads.
D13D1 Silicon Unilateral switch **10/-** each.
A Silicon Planar, monolithic integrated circuit having thyristor electrical characteristics, but with an anode gate and a built-in "Zener" diode between gate and cathode. Full data and application circuits available on request.

FAIRCHILD (U.S.A.) RTUL MICROLOGIC INTEGRATED CIRCUITS

Epoxy case T8-5 lead temp. range 15°C. to 55°C.
UL900, Buffer, **10/6** each.
UL914, Dual two-input gate, **10/6** each.
UL923 J-K-flip-flop, **14/-** each.
Complete data and circuits for the Fairchild I.C.'s available in booklet form priced **1/6**.

MULLARD I.C. AMPLIFIERS

TAA243, Operational amplifier, **70/-** each.
TAA263, Linear AF amplifier, **18/6** each.
TAA293, General purpose amplifier, **21/-** each.

CA3020 RCA (U.S.A.) LINEAR INTEGRATED CIRCUITS

Audio Power Amplifier, **30/-** each.
Owing to the mass of I.C. printed matter often required by customers in connection with the I.C.'s themselves we ask you to help us in the cost of reproducing this literature by adding 2s. towards same. This is only necessary when a number of different sheets are required.

Sil. trans. suitable for P.E. Organ. Metal TO-18 Eqvt. ZTX300 1/- each. Any Qty.

AD161 *NPN*
AD162 *PNP*

MATCHED COMPLEMENTARY PAIRS OF GERM. POWER TRANSISTORS.

For mains driven output stages of Amplifiers and Radio receivers.

OUR LOWEST PRICE OF **12/6** *PER PAIR*

HIGH POWER SILICON PLANAR TRANSISTORS
TEXAS 2S034 NPN TO-3.

VCB100	Ic 4A	
	fT. 15M/cs	
VCE100	Ptot. 40W	
VEB8	hFE(min.)	
	60	Price **15/-** each

FREE

One 10/- Pack of your own choice free with orders valued £4 or over.

SEMICONDUCTOR HANDBOOK (VOLUME 2)

with introduction to basic circuits, registered transistor and diode types, full specifications. Eleven languages including English, Dutch, French, German, Swedish, Spanish and Italian.
240 pages of semiconductor information.
Price **28/6.** Money refunded if not fully satisfied.

NPN DIFFUSED SILICON PHOTO-DUO-DIODE TYPE IS701 (2N2175) for Tape Readout, high switching and measurement indicators, 50V, 250mW. OUR PRICE 10/- EACH, 50 OR OVER 8/6 EACH, FULL DETAILS.

KING OF THE PAKS Unequalled Value and Quality

SUPER PAKS — NEW BI-PAK UNTESTED SEMICONDUCTORS

Satisfaction GUARANTEED in Every Pak, or money back.

Pak No.		
U1	120 Glass Sub-min. General-Purpose Germanium Diodes	10/-
U2	60 Mixed Germanium Transistors AF/RF	10/-
U3	75 Germanium Gold Bonded Diodes sim. OA5, OA47	10/-
U4	40 Germanium Transistors like OC81, AC128	10/-
U5	60 200mA Sub-min. Sil. Diodes	10/-
U6	40 Silicon Planar Transistors NPN sim. BSY95A, 2N706	10/-
U7	16 Silicon Rectifiers Top-Hat 750mA up to 1,000V	10/-
U8	50 Sil. Planar Diodes 250mA OA/200/202	10/-
U9	20 Mixed Volts 1 watt Zener Diodes	10/-
U11	30 PNP Silicon Planar Transistors TO-5 sim. 2N1132	10/-
U13	30 PNP-NPN Sil. Transistors OC200 & 2S104	10/-
U14	150 Mixed Silicon and Germanium Diodes	10/-
U15	30 NPN Silicon Planar Transistors TO-5 sim. 2N697	10/-
U16	10 3-Amp Silicon Rectifiers Stud Type up to 1000 PIV	10/-
U17	30 Germanium PNP AF Transistors TO-5 like ACY 17-22	10/-
U18	8 6-Amp Silicon Rectifiers BYZ13 Type up to 600 PIV	10/-
U19	30 Silicon NPN Transistors like BC108	10/-
U20	12 1·5-amp Silicon Rectifiers Top-Hat up to 1,000 PIV	10/-
U21	30 A.F. Germanium alloy Transistors 2G300 Series & OC71	10/-
U22	10 1-amp Glass Min. Silicon Rectifiers High Volts	10/-
U23	30 Madt's like MAT Series PNP Transistors	10/-
U24	20 Germanium 1-amp Rectifiers GJM up to 300 PIV	10/-
U25	25 300Mc/s NPN Silicon Transistors 2N708, BSY27	10/-
U26	30 Fast Switching Silicon Diodes like 1N914 Micro-min	10/-
U28	Experimenters' Assortment of Integrated Circuits, untested. Gates, Flip-Flops, Registers, etc., 8 Assorted Pieces	20/-
U29	10 1 amp SCR's TO-5 can up to 600 PIV CRS1/25-600	20/-
U30	15 Plastic Silicon Planar trans. NPN 2N2924-2N2926	10/-
U31	20 Sil. Planar NPN trans. low noise Amp 2N3707	10/-
U32	25 Zener diodes 400mW D07 case mixed Volts, 3–18	10/-
U33	15 Plastic case 1 amp Silicon rectifiers 1N4000 series	10/-
U34	30 Sil. PNP alloy trans. TO-5 BCY26, 2S302/4	10/-
U35	25 Sil. Planar trans. PNP TO-18 2N2906	10/-
U36	25 Sil. Planar NPN trans. TO-5 BFY50/51/52	10/-
U37	30 Sil. alloy trans. SO-2 PNP, OC200 2S322	10/-
U38	20 Fast Switching Sil. trans. NPN, 400Mc/s 2N3011	10/-
U39	30 RF Germ. PNP trans. 2N1303/5 TO-5	10/-
U40	10 Dual trans. 6 lead TO-5 2N2060	10/-
U41	30 RF Germ. trans. TO-1 OC45 NKT72	10/-
U42	10 VHF Germ. PNP trans. TO 1 NKT667 AF117	10/-

Code Nos. mentioned above are given as a guide to the type of device in the Pak. The devices themselves are normally unmarked

QUALITY-TESTED PAKS

6	Matched Trans. OC44/45/81/81D	10/-
20	Red Spot AF Trans. PNP	10/-
16	White Spot RF Trans. PNP	10/-
5	Silicon Rects. 3 A 100-400 PIV	10/-
2	10 A Silicon Rects. 100 PIV	10/-
2	OC1 140 Trans. NPN Switching	10/-
1	12 A SCR 100 PIV	10/-
3	Sil. Trans. 2S303 PNP	10/-
4	Zener Diodes 240mW 3-12V	10/-
3	200 Mc/s Sil. Trans. NPN BSY26/27	10/-
3	Zener Diodes 1W 33V 5% Tol.	10/-
4	High Current Trans. OC42 Eqvt.	10/-
2	Power Transistors 1 OC26 1 OC35	10/-
5	Silicon Rects. 400 PIV 250mA	10/-
4	OC75 Transistors	10/-
1	Power Trans. OC20 100V	10/-
10	OA202 Sil. Diodes Sub-min.	10/-
2	Low Noise Trans. NPN 2N929/30	10/-
1	Sil. Trans. NPN VCB 100 ZT86	10/-
8	OA81 Diodes	10/-
4	OC72 Transistors	10/-
4	OC77 Transistors	10/-
4	Sil. Rects. 400 PIV 500mA	10/-
5	GET884 Trans. Eqvt. OC44	10/-
5	GET883 Trans. Eqvt. OC45	10/-
2	2N708 Sil. Trans. 300Mc/s NPN	10/-
3	GT31 LF Low Noise Germ Trans.	10/-
6	1N914 Sil. Diodes 75 PIV 75mA	10/-
8	OA95 Germ. Diodes Sub-min. 1N69	10/-
3	NPN Germ. Trans. NKT773 Eqvt.	10/-
2	OC22 Power Trans. Germ.	10/-
2	OC25 Power Trans. Germ.	10/-
4	AC128 Trans. PNP High Gain	10/-
4	AC127/128 Comp. pair PNP/NPN	10/-
3	2N1307 PNP Switching Trans.	10/-
7	CG62H Germ. Diodes Eqvt. OA71	10/-
3	AF116 Type Trans.	10/-
12	Assorted Germ. Diodes Marked	10/-
4	AC126 Germ. PNP Trans.	10/-
4	Silicon Rects. 100 PIV 750mA	10/-
3	AF117 Trans.	10/-
7	OC81 Type Trans.	10/-
3	OC171 Trans.	10/-
5	2N2926 Sil. Epoxy Trans.	10/-
7	OC71 Type Trans.	10/-
2	2S701 Sil. Trans. Texas	10/-
3	12 Volt Zener 400mW	10/-
2	10 A 600 PIV Sil. Rects. 1S45R	10/-
3	BC108 Sil. NPN High Gain Trans.	10/-
1	2N910 NPN Sil. Trans. VCB 100	10/-
2	1000 PIV Sil. Rect. 1·5 A R53310 AF	10/-
3	BSY95A Sil. Trans. NPN 200Mc/s	10/-
3	OC200 Sil. Trans.	10/-
2	GET880 Low Noise Germ. Trans.	10/-
1	AF139 PNP High Freq. Trans.	10/-
3	NPN Trans. 1 ST141 & 2ST140	10/-
4	Madt's 2 MAT100 & 2MAT120	10/-
3	Madt's 2 MAT101 & 1 MAT121	10/-
4	OC44 Germ. Trans. AF	10/-
3	AC127 NPN Germ. Trans.	10/-
1	2N3906 Sil. PNP Trans. Motorola	10/-
2	Sil. Power Rects. BYZ13	15/-
1	Sil. Power Trans. NPN 100Mc/s. TK201A	15/-
6	Zener Diodes 3-15V Sub-min.	15/-
1	2N1132 PNP Epitaxial Planar Sil.	15/-
3	2N697 Epitaxial Planar Trans. Sil.	15/-
4	Germ. Power Trans. Eqvt. OC16	15/-
1	Unijunction Trans. 2N2646	15/-
2	Sil. Trans. 200Mc/s 60Vcb ZT83/84	15/-
1	Tunnel Diode AEY11 1050 Mc/s	15/-
2	2N2712 Sil. Epoxy Planar HFE225	15/-
8	BY100 Type Sil. Rects.	20/-
25	Sil. and Germ. Trans. Mixed, all marked, New	30/-

SIL. G.P. DIODES

300mW	30	10/-
25PIV (Min.)	100	25/-
Sub-Min.	500	£5
Fully Tested	1,000	£9

Ideal for Organ Builders.

CADMIUM CELLS

ORP60 ORP61 **8/-** each ORP12 **8/6**

FULL RANGE OF ZENER DIODES VOLTAGE RANGE 2-16V.
400mW (DO-7 Case) ....**2/6** each
1·5W (Top-Hat) ....**3/6** each
10W (SO-10 Stud) ......**5/-** each
All fully tested 5% tol. and marked state voltage required.

SILICON HIGH VOLTAGE RECTIFIERS

10 Amp 3 kV (3000 PIV). Stud type with flying leads **13/-** each

BRAND NEW TEXAS GERM. TRANSISTORS
Coded and Guaranteed

Pak No.			EQVT.	
T1	8	2G3710	OC71	10/-
T2	8	2G374	OC75	10/-
T3	8	2G3744A	OC81D	10/-
T4	8	2G381A	OC81	10/-
T5	8	2G382T	CC82	10/-
T6	8	2G344A	OC44	10/-
T7	8	2G345A	OC45	10/-
T8	8	2G378	OC78	10/-
T9	8	2G399A	2N1302	10/-
T10	8	2G417	AF117	10/-

PRINTED CIRCUITS
EX-COMPUTER

Packed with semiconductors and components, 10 boards give a guaranteed 30 trans. and 30 diodes. Our price 10 boards **10/-**. Plus 2/- P. & P.

GERM. RECTIFIER SINGLE-PHASE BRIDGE. Mullard type. GEX541-B.P. Output Vlts. 48V. Output I.C. 5A. List Price 58/-. OUR PRICE **12/6** EACH.

2N2060 NPN SIL. DUAL TRANS. CODE D1699 TEXAS. OUR PRICE **5/-** each.

120 VCB NIXIE DRIVER TRANSISTOR Sim. BSX21 & C407. 2N1893 FULLY TESTED AND CODED ND120. 1-24 **3/6** each. TO-5 NPN 25 up **3/-** each.

PLEASE NOTE. To avoid any further Increased Postal Charges to our Customers and enable us to keep our "By Return Postal Service" which is second to none, we have re-organized and streamlined our Despatch Order Department and we now request you to send all your orders together with your remittance, direct to our Warehouse and Despatch Department, postal address: **BI-PAK SEMICONDUCTORS, Despatch Dept., P.O. BOX 6, WARE, HERTS.** Postage and packing still 1/- per order. Minimum order 10/-.

FET'S

2N 3819 .... **10/-**
2N 3820 .... **25/-**
MPF105 .... **8/-**
OCP71 Type ... **8/6**

UNIJUNCTION

UT46, Eqvt. 2N2646, Eqvt. TIS43. BEN3000

7/6 EACH

25–99 **5/-** 100 UP **4/-**

TESTED SCR'S

PIV	1A	7A	16A	30A
25	—	7/6	—	30/-
50	7/6	8/6	10/6	35/-
100	8/6	10/-	15/-	45/-
200	12/6	15/-	20/-	55/-
300	15/-	20/-	25/-	—
400	17/6	25/-	35/-	80/-
500	30/-	40/-	45/-	95/-
600	—	40/-	50/-	—

SIL. RECTS. TESTED

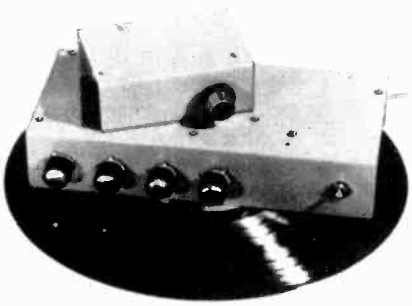
PIV	750mA	3A	10A	30A
50	1/-	2/9	4/3	9/6
100	1/3	3/3	4/6	15/-
200	1/9	4/-	4/9	20/-
300	2/3	4/6	6/6	22/-
400	2/6	5/6	7/6	25/-
500	3/-	6/-	8/6	30/-
600	3/3	6/9	9/-	37/-
800	3/6	7/6	11/-	40/-
1000	5/-	9/3	12/6	50/-
1200	6/6	11/6	15/-	—

BI-PAK

500 CHESHAM HOUSE
150 REGENT STREET
LONDON, W.1

KING OF THE PAKS BI-PAK GUARANTEE SATISFACTION OR MONEY BACK

THREE OF OUR IMPORTANT FEATURES IN NEXT MONTH'S ISSUE

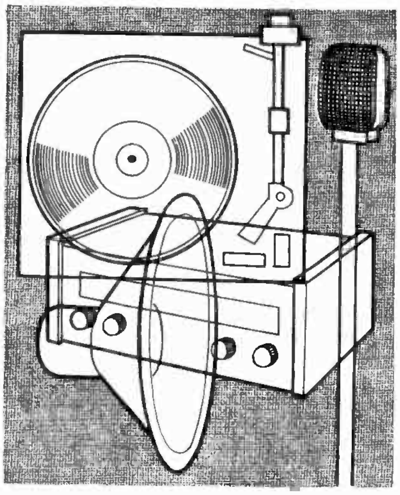


SPACE PROBLEM SOLVED

Build a miniature high quality audio system with integrated circuits. Select your system from :
Simple mono audio amplifier.
Stereo amplifier with tone controls.
High Fidelity Stereo amplifier for twin three channel speaker systems.
The first designs will appear next month. All three projects have been specially designed for Practical Electronics readers, and are based on the Plessey SL402 and SL403 integrated circuits described in this current issue.

SPECIAL AUDIO SUPPLEMENT

A practical guide to Hi Fi outlines the technical requirements for a good domestic sound reproducing system and clarifies the meaning of terms encountered in equipment specifications.



TIME LAPSE PHOTOGRAPHY

Build this inexpensive addition to your ciné equipment and speed up any sequence from 20 to 7,000 times. This unit fits most ciné cameras with provision for single frame operation.
Professional film sequences such as opening flowers and high-speed journeys can easily be captured using this device.

PRACTICAL ELECTRONICS

NOVEMBER ISSUE ON SALE THURSDAY OCTOBER 16 **ORDER YOUR COPY NOW! 3/-**

MOTORISTS often have to leave their cars in daylight and return to them after dark. If they park in an area where lights are required they must switch on a parking light when leaving the car. The light then stays on right through the hours of daylight, resulting in battery drain; especially undesirable in wintry conditions. The remedy is a parking light that will remain off in daylight and switch itself on automatically at dusk.

CIRCUIT DESCRIPTION

Light falling on the light dependent resistor (X1) reduces its resistance and switches on TR1 (Fig. 1). Practically all the voltage drop is then across the 680 ohm resistor (R2). The base of TR2 is thus well positive and TR2 is cut off. In very bright sunlight the resistance of the l.d.r. (X1) may fall to a very low value, thus R1 is inserted in series with the cell to limit the current.

When darkness falls the resistance of the cell increases and TR1 switches off, most of the voltage drop is then across TR1 and TR2 base becomes negative causing TR2 and LP1 to switch on.

The diode protects the circuit against damage from accidental reversal of supply polarity. This circuit can be used with positive or negative earth cars.

CONSTRUCTIONAL DETAILS

Drill a $\frac{1}{2}$in hole in the underside of the parking light and attach the photo cell using epoxy resin (see photograph). Leave the leads to the cell about $\frac{3}{8}$in long. The rest of the circuit is assembled as a five terminal encapsulated module on the back of a power transistor (TR2). The power transistor has two holes in its case (collector), drill a third hole in the case large enough for two leads to pass through (see Fig. 2).

Start the assembly by soldering R2 and the collector terminal of TR1 (the terminal with the spot) to the base pin of TR2. To the other end of R2 solder the negative end of D1 and a short lead and pass this lead through the new hole in TR2. The positive lead

The completed photo electric parking light ; position of X1 can be clearly seen

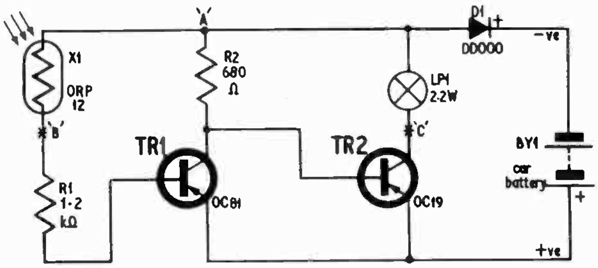
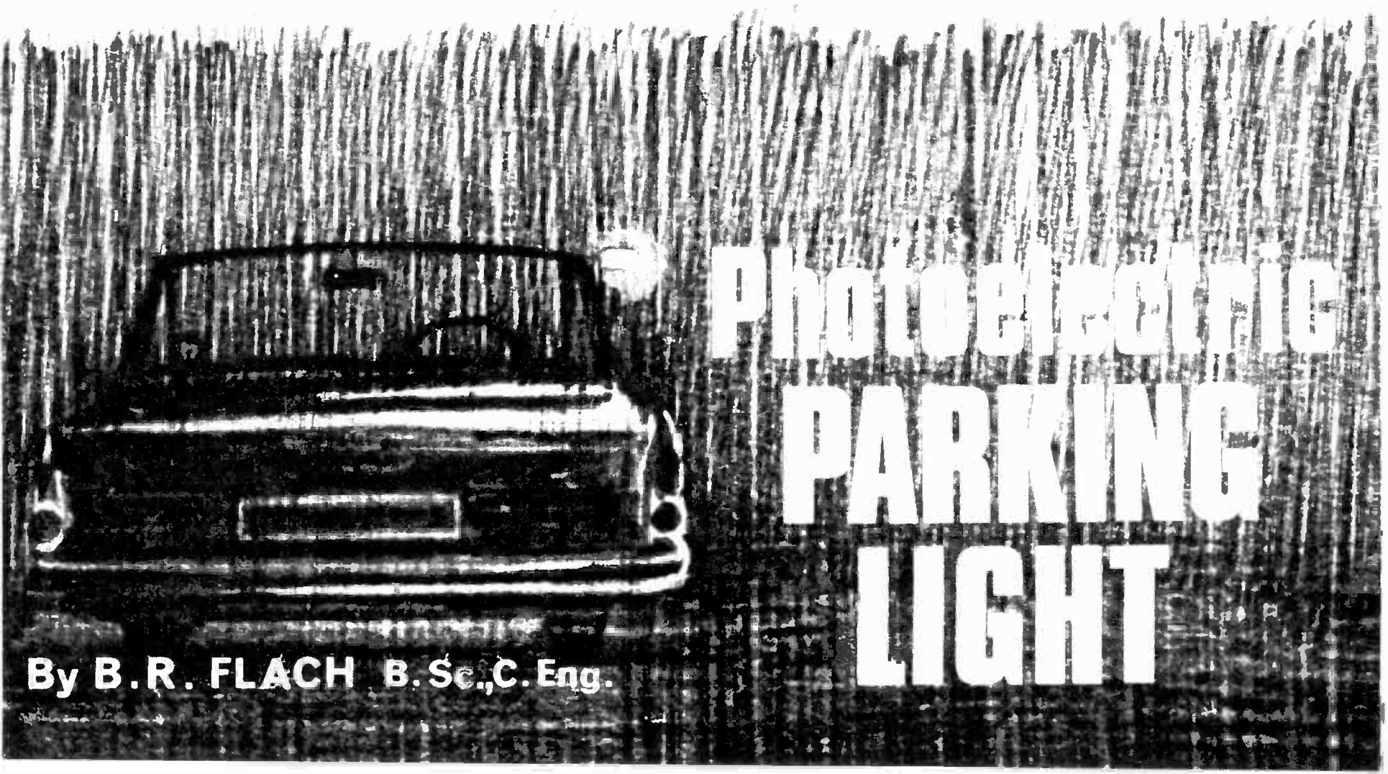


Fig. 1. The complete circuit diagram of the photo electric parking light

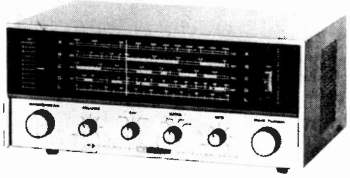


NEVER BUILT A KIT BEFORE?

Why not build one of these?

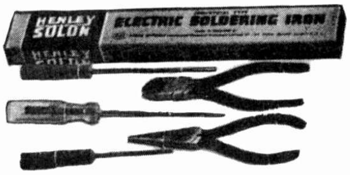
Solid-State Stereo FM Tuner/ Amplifier, AR-17. 7 watts music power-per-channel. 28 transistor, 7 diode circuitry. 6 position source switch. Wonderful value and styling.
Kit K/AR-17 **£36.10.0.** Carr. 11/-. Walnut or teak cabinet **£3.10.0.** extra.

High performance Car Radio, CR-1. 4 watts output will drive two speakers. 12V pos. or 12V neg. supply. Tastefully styled.
Kit K/CR-1 (less Spkr.) **£12.12.0.** Carr 5/-.
8 × 5in. speaker **£1.2.0.** extra.

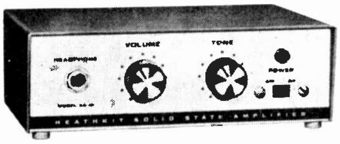


Low-cost 4 Band Receiver, GR-64. Covers 1MHz–30MHz in 3 SW Bands. Plus 550kHz–1620kHz AM band. Features bandspread tuning. 5in. Speaker.
Kit K/GR-64 **£24.16.0.** Carr. 9/-.

Solid-State VVM, IM-17. For the hobbyist. Tests home or car electrics, etc. 4 AC, 4 DC, 4 Res. ranges. Battery powered. Portable.
Kit K/IM-17 **£12.18.0.** Carr. 6/-.



Hobby Tool Kit, TK-1. Excellent low cost set comprising:—Solon Soldering Iron, 1 pair diagonal cutters, 1 pair needle nosed pliers, 3 sizes of screw-driver.
Only **£2.4.0.** Carr. paid.



Low Cost Solid-State Mono Amplifier, AA-18. The ideal basic audio amplifier. 4 watts music power output. Gram, Tape or Radio inputs. Modern clean styling.
Kit K/AA-18 **£11.10.0.** Carr. 5/-.

Practical electronics the easy way!

Leisure time takes on a new sparkle, a new interest when you add the creative fun you get from building a Heathkit model. Get the thrill of personal achievement when you switch on and realise that you've done something you doubted you could ever do. Your first step is FREE! just simply send for the latest Heathkit catalogue and see what a wide choice of models we offer. What ever your requirement, be it Hi-Fi, Audio, a Portable Radio, a Record Player, Amateur Radio, a SW Receiver, a Test Instrument or Educational Equipment . . . There is something for everyone. And we are adding to our wide range continuously. Get your Free catalogue today.

TO DAYSTROM LTD., GLOUCESTER
I want to save some money. Please send me your fully-detailed catalogue immediately
NAME ....
ADDRESS ....
PE10
☐ Include me on your mailing list

HEATHKIT

DAYSTROM LIMITED
Gloucester GL2 6EE England
Tel.: Glos. 29451 Telex 43216

DE LUXE PLAYERS

PORTABLE CABINET As illustrated. To fit standard player or autochanger. **75/-**

RCS AMPLIFIER 3 WATT. Ready made and tested. This is a 2-stage unit using a triode pentode condenser coupled valve, giving 3 watts output into a 3 ohm loudspeaker. Tone and volume controls mounted on panel. Supplied with knobs, loudspeaker and valves UCL82, UY85. Frequency response 50-12,000 cps. Sensitivity 200mV. **59/6** Post 5/6 each item

SINGLE PLAYERS MONO		AUTOCHANGERS MONO	
EMI Junior Mains	£2.19.6	Balfour Princess	£5.19.6
Garrard SRP22 ...	£6.19.6	BSR Superslim UA25	£6.19.6
Garrard SP25 MkII	£14.19.6	MA70 Transcription	£13.19.6
		Garrard 3000 with Sonotone 9TA diamond.	£12.19.6

All fitted LP/78 stylii and pickup cartridge complete. Stereo/mono pick-ups 20/- extra except 3000.

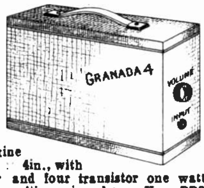
GARRARD TEAKWOOD BASE WB.1. Ready cut out for mounting 1025, 3000, SP25, AT60, etc. **65/-**
GARRARD PLASTIC COVER SPC.1 for WB.1 BASE. Durable tinted attractive appearance. **65/-**

E.M.I. PICK-UP ARM. Complete with mono cartridge 29/6; XTAL GP67 17/6; Stereo Ceramic 35/-. ACOS LP only 10/6

CRYSTAL MIKE INSERTS

1½" dia. 6/6: ACOS 1½" dia. 9/6. BM3, 1" dia. 9/6
QUALITY RIBBON MIKE WITH GOOSENECK £11.11.0

PORTABLE TRANSISTOR AMPLIFIER PLUS DYNAMIC MICROPHONE



A self-contained fully portable mini p.a. system. Many uses — ideal for Parties, or as a Baby Alarm, Intercom, Telephone or Record Player Amplifier, etc. Attractive rexine covered cabinet, size 12 9 4in., with powerful 7 4in. speaker and four transistor one watt power amplifier plus ultra sensitive microphone. Uses PP9 battery. Brand new in Makers' carton with full makers' guarantee. World famous make. Only **90/-** Post Free

WEYRAD P50 — TRANSISTOR COILS

RA2W 6 in. Ferrite Aerial with car aerial coil	12/6	Spare Cores	6d.
Osc. P50/1AC	5/4	Driver Trans. LFDT4	9/6
I.F. P50/2CC 470 kc/s	5/7	Printed Circuit, PCA1	9/6
3rd I.F. P50/3CC	6/-	J.B. Tuning Gang	10/6
		Weyrad Booklet	2/-

Telescopic Chrome Aerials 6in. extends to 23in. 5/-.
Ferrite Rods Only 8 × ⅜in. 4/-. 6 × ¼in. 5/-.

VOLUME CONTROLS

Long spindles. Midget Size 5 K. ohms to 2 Meg. LOG or LIN. L/S 3/-. D.P. 5/-
STEREO L/S 10/6, D.P. 14/6
Edge 5K. S.P. Transistor, 5/-.

80ohm Coax 8d. yd.
BRITISH AERIALITE AERAXIAL-AIR SPACED 40 yd. 20/-; 60 yd. 30/-.
FRINGE LOW LOSS Ideal 625 lines **1/6yd.**

WIRE-WOUND 3-WATT POTS. T.V. Type. Knurled Knob. Values 10Ω to 30 K., Carbon 30 K to 2 meg. **4/6**

WIRE-WOUND 3-WATT STANDARD SIZE POTS. LONG SPINDLE 10 OHMS to 100 K. **7/6**

VEROBOARD 0·15 MATRIX
2½ 5in. 3/8. 2½ × 3¾in. 3/2. 3¾ × 3¾in. 3/8. 3¾ × 5in. 5/2.
EDGE CONNECTORS 16 way 5/-; 24 way 7/6.
PINS 36 per packet 3/4. FACE CUTTERS 7/6.
S.R.B.P. Board 0·15 MATRIX 2½in. wide 6d. per 1in., 3¾in. wide 9d. per 1in.; 5in. wide 1/- per 1in. (up to 17in.).
S.R.B.P. undrilled 1/16 in. Board 10 8in. 3/-.

BLANK ALUMINIUM CHASSIS. 18 s.w.g. 2½in. sides, 7 × 4in., 5/6; 9 × 7in., 6/6; 11 × 3in., 6/6; 11 × 7in. 7/6; 13 × 9in., 9/6; 14 × 11in., 12/6; 15 × 14in., 15/-.
ALUMINIUM PANELS 18 s.w.g. 12 × 12in. 6/6; 14 × 9in. 5/6; 12 × 8in. 4/6; 10 × 7in. 3/6; 8 × 6in. 2/6; 6 × 4in., 1/6.

Q MAX CHASSIS CUTTER

Complete: a die, a punch, an Allen screw and key

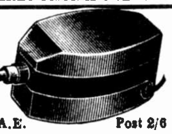
½in.	16/-	⅝in.	17/6	1⅛in.	19/6	1½in.	24/-	2 3/32in.	44/3
⅝in.	16/-	1in.	19/6	1¼in.	20/6	1¾in.	29/-	2½in.	57/3
¾in.	16/9	1 1/16 in.	19/6	1⅜in.	21/6	2in.	39/-	1in. sq.	36/6

WAVE-CHANGE SWITCHES WITH LONG SPINDLES.
2 p. 2-way, or 2 p. 6-way, or 3 p. 4-way 4/6 each.
1 p. 12-way, or 4 p. 2-way, or 4 p. 3-way, 4/6 each.
Wavechange "MAKITS" 1 p. 12-way, 2 p. 6-way, 3 p. 4-way, 4 p. 3-way, 6 p. 2-way. 1 wafer 12/-, 2 wafer 18/-. 3 wafer 24/-, 4 wafer 30/-, 5 wafer 36/-.
TOGGLE SWITCHES, sp. 2/6; sp. dt. 3/6; dp. 3/6; dp. dt. 4/6

ALL PURPOSE HEADPHONES

H.R. HEADPHONES 2000 ohms Super Sensitive ..	35/-
LOW RESISTANCE HEADPHONES 3-5 ohms	39/6
DE LUXE PADDED STEREO PHONES 8 ohms ..	79/6

"THE INSTANT" BULK TAPE ERASER AND RECORDING HEAD DEMAGNETISER



200/250 v. A.C. Leaflet S.A.E. Post 2/6 **42/6**

BARGAIN STEREO/MONO SYSTEM

Attractive Slim PLAYER CABINET with B.S.R. Stereo Autochanger 4 + 4 AMPLIFIER and TWO matched 6½ in. LOUDSPEAKERS. Carr. 10/6 (Only 4 pairs of wires to join). **£19.19.6**

NEW TUBULAR ELECTROLYTICS				CAN TYPES	
2/350V ..	2/3	100/25V ..	2/-	8/600V ..	9/6
4/350V ..	2/3	250/25V ..	2/6	16/600V ..	12/6
8/450V ..	2/3	500/25V ..	4/-	16+16/500V	7/6
16/450V ..	3/-	8+8/450V	3/6	50+50/350V	7/-
32/450V ..	3/9	8+16/450V	3/9	60+100/350V	11/6
25/25V ..	1/9	16+16/450V	4/3	32+32+32/350v.	8/6
50/50V ..	2/-	32+32/350V	4/6	100+50+50/350V	10/6

SUB-MIN. ELECTROLYTICS. 1, 2, 4, 5, 8, 16, 25, 30, 50, 100, 250mF 15V 2/-; 500, 1000mF 12V 3/6; 2000mF 25V 7/-.
CERAMIC. 500V 1pF to 0.01mF, 9d.
PAPER 350V-0·1 9d, 0·5 2/6; 1mF 3/-; 2mF 150V 3/-. 500V-0·001 to 0·05 9d; 0·1 1/-; 0·25 1/6; 0·5 3/-. 1,000V-0·001, 0·0022, 0·0047, 0·01, 0·02, 1/6; 0·047, 0·1, 2/6.
SILVER MICA. Close tolerance 1%. 5-500pF 1/-; 560-2,200pF 2/-; 2,700-5,600pF 3/6; 6,800pF-0·01, mfd 6/-; each
TWIN GANG. "0-0" 208pF+176pF, 10/6; 365pF, miniature 10/-; 500pF standard with trimmers, 12/6; 500pF midget less trimmers, 7/6; 500pF slow motion, standard 9/-; small 3-gang 500pF 19/6. Single "0" 365pF 7/6.
SHORT WAVE. Single 10pF, 25pF, 50pF, 75pF, 100pF, 160pF, 200pF, 10/6 each.
TUNING. Solid dielectric. 100pF, 300pF, 500pF, 7/- each.
TRIMMERS. Compression 30, 50, 70pF, 1/-; 100pF 150pF, 1/3; 250pF, 1/6; 600pF, 750pF, 1/9; 1000pF, 2/6.
RECTIFIERS CONTACT COOLED ½wave 60mA 7/6; 85mA 9/6. BY 100 10/-.
Full wave Bridge 75mA 10/-; 150mA 19/6; TV rects. 10/-.
NEON PANEL INDICATORS 250v. AC/DC 3/6.
RESISTORS. Preferred values, 10 ohms to 10 meg. ¼ w., ½ w., 1 w., 20% 3d.; 1½ w. 8d.; 2 w. 1/-; ⅓ w. 10% 6d.
HIGH STABILITY. ½ w. 1% 10 ohms to 10 meg., 2/-. Ditto 5%. Preferred values 10 ohms to 22 meg., 9d.
WIRE-WOUND RESISTORS 5 watt, 10 watt, 15 watt, 10 ohms to 100K. 2/- each; 3 watt, 0·5 ohm to 8·2 ohms, 2/-.
FULL WAVE BRIDGE CHARGER RECTIFIERS: 6 or 12v. outputs. 1½ amp. 8/9; 2 amp. 11/3; 4 amp. 17/6.
CHARGER TRANSFORMERS. P. & P. 5/-. Input 200/250v. for 6 or 12v., 1½ amp., 17/6; 2 amp., 21/-; 4 amp., 30/-
BRAND NEW TRANSISTORS OC71, OC72, OC81, OC44, OC45, AF117. 6/- each.
MAT 100 7/9; MAT 101 8/6; MAT 120 7/9; MAT 121 8/6.

REPANCO TRANSISTOR TRANSFORMERS.
TT45. Push Pull Drive, 9:1 CT, 6/-. TT46 Output, CT8:1 6/-.
TT49. Interstage, 4·5:1, 6/-; TT52 Output 3 ohms, 20:1, 6/-.
TT23/4 PAIR 10 watt Amp. Transformers and circuit 35/-.

TRANSISTOR MAINS POWER PACKS. FULL WAVE 9 volt 500mA. Size 4½ × 2½ × 2in. Metal case. Crackle finish. Output terminals. On/off switch. **49/6**
Half Wave 9 volt 50mA. Size 2½ × 1¼in. Snap terminals 32/6
9 volt 500mA. TRANSFORMER ONLY. 2¼ × 1¾ × 1¾in. 10/6
BENCH POWER PACK 230-250v. A.C. Mains with Meter. Supplies 6-9-12v. 1 amp D.C. **£7**

MAINS TRANSFORMERS

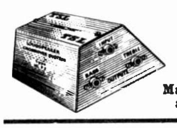
Post 5/- each

250-0-250 50 mA. 6.3 v. 2 amps, centre tapped	19/6
250-0-250 80 mA. 6.3 v. 3.5 a. 6.3 v. 1 a, or 5 v. 2 a.	30/-
350-0-350 80 mA. 6.3 v. 3.5 a. 6.3 v. 1 a, or 5 v. 2 a.	35/-
300-0-300 v. 120 mA., 6.3 v. 4 a. C.T.; 6.3 v. 2 a.	45/-
MINIATURE 200 v. 20 mA., 6.3 v. 1 a. 2½ × 2 × 1⅝in.	12/6
MIDGET 220 v. 45 mA., 6.3 v. 2 a. 2½ × 2½ × 2in. ..	17/6
HEATER TRANS. 6.3 v. 1½ a., 8/6; 6.3 v. 4 a.	12/6
Ditto tapped sec. 1.4 v., 2, 3, 4, 5, 6.3 v. 1½ amp. ..	12/6
GENERAL PURPOSE LOW VOLTAGE. Outputs 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30 v. at 2 a.	30/-
1 amp., 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60,	35/-

AUTO TRANSFORMERS 0-115-230 v. Input/Output, 60w. 18/6; 150w. 30/-; 500w. 92/6; 1000w. 195/-.

COAXIAL PLUG 1/3. **PANEL SOCKETS** 1/3. **LINE** 2/-. **OUTLET BOXES. SURFACE OR FLUSH** 4/6. **BALANCED TWIN FEEDERS** 1/- yd. 80 ohms or 300 ohms. **JACK SOCKET** Std. open-circuit 2/6, closed circuit 4/6; Chrome Lead Socket 7/6. Phono Plugs 1/-. Phono Socket 1/-. **JACK PLUGS** Std. Chrome 3/-; 3·5mm Chrome 2/6. **DIN SOCKETS** Chassis 3-pin 1/6; 5-pin 2/-. **DIN SOCKETS** Lead 3-pin 3/6; 5-pin 5/-. **DIN PLUGS** 3-pin 3/6; 5-pin 5/-.

T.S.L. LOUDSPEAKER CROSSOVER HLP2.



2-way crossover for 8 or 15 ohm speakers and tweeters. 3 phono input/output sockets.
Made to sell at 42/-. OUR PRICE Post 2/6. **22/6**

Tape Spools 2/6. Tape Splicer 5/-. Leader Tape 4/6.
Reuter Tape Heads for Collaro models 2 track 21/- pair.

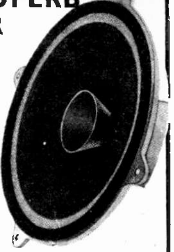
MINI-MODULE LOUDSPEAKER KIT

10 WATT **55/-** CARRIAGE 5/-

Triple speaker system combining on ready cut baffle. ½ in. chipboard 15 in. × 8½ in. Separate Bass, Middle and Treble loudspeakers and crossover condenser. The heavy duty 5 in. Bass Woofer unit has a low resonance cone. The Mid-Range unit is specially designed to add drive to the middle register and the tweeter recreates the top end of the musical spectrum. Total response 20-15,000 cps. Full instructions for 3 or 8 ohm.

TEAK VENEERED BOOKSHELF ENCLOSURE. 16 × 10 × 9 in. Specially designed for Mini-Module above. **£4.15.0** Post 5/-

BAKER 12in. "SUPERB" LOUDSPEAKER



Suitable for all Hi-Fi Systems. Provides rich clear reproduction of the deepest bass and remarkable efficiency in the upper register. Response 20-17,000 cps. "Baker" double cone with special "Ferroba" ceramic magnet. Flux density 16,500 gauss. Bass resonance 22-26 cps. 20 watts rating. Voice coil 8 ohms or 15 ohms.

£15 Post Free

48-page Enclosure Manual 5/9 post paid.

LOUDSPEAKER CABINET WADDING 18in wide, 2/6ft

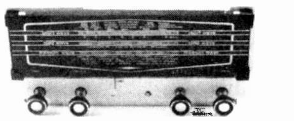
BAKER "GROUP SOUND" SPEAKERS—POST FREE

'Group 25'	'Group 35'	'Group 50'
12in 25 watt **6gns.**	12in 35 watt **8½gns.**	15in 50 watt **18gns.**

ALL MODELS "BAKER SPEAKERS" IN STOCK

Goodmans Tweeter 3½in 3 ohm 35/-, EMI 2½in 8 ohm 17/6. Horn Tweeters 2-18kc/s, 10W 15 ohm 29/6. Crossover 16/6.
LOUDSPEAKERS P.M. 3 OHMS. 2¾in, 3in, 4in, 5in, 7 × 4in. 17/6 each; 6½in 22/6; 8 × 5in, 21/-; 8 × 2½in 21/-; 10 × 6in. 30/-; 10in. or 12in. Double cone 3 or 15 ohm 39/6.
E.M.I. Double Cone 13½ × 8in, 3 or 15 ohm models, 45/-. DITTO with twin tweeters and X/over 3 or 8 or 15 ohm 79/6.
SPECIAL OFFER! 8 ohm, 2½in; 6 × 4in; 80 ohm, 2½in, 2½in **15/6** EACH TYPE 25 ohm, 6 × 4in; 35 ohm, 3in; 15 ohm, 7 × 4in., 8 5in.
8in **LOUDSPEAKER UNITS** 3 ohm 27/6; 15 ohm 30/-; 8 in. De Luxe Ceramic 3 ohm 45/-; 15 ohm 50/-.
8in **LOUDSPEAKER. TWIN CONE** 3 ohm 35/-.
5 in. WOOFER. 8 watts max. 20-10,000 cps. 8 or 15 ohm. 39/6.
OUTPUT TRANS. EL84 etc. 4/6; **MIKE TRANS.** 50:1 3/9.
SPEAKER COVERING MATERIALS. Samples Large S.A.E.

1969 GRAM CHASSIS



Post 7/6
Three Wavebands: Long, Med., Short, Gram. Five Valves: ECH81, EF89, EBC81, EL84, EZ80, 12-month guarantee. A.C. 200-250v. Ferrite Aerial 5 watts 3 ohm. Chassis 13½in. × 7in. × 5in. dial size 13in. × 4in. Two pilot Lamps. Four Knots. Aligned calibrated. Chassis isolated from mains **£11.18**
DE LUXE STEREO GRAM CHASSIS V.H.F., MW, SW 19-50m. SW 60-180m. Magic eye, push buttons, 6 valve plus rect. Size 15 × 7½ × 6in. high. **£22.10**

VALVE HOLDERS, 9d.; **CERAMIC** 1/-; **CANS** 1/-

ALL EAGLE PRODUCTS

SUPPLIED AT LOWEST PRICES.
45-PAGE EAGLE CATALOGUE 5/-. Post free.

BARGAIN AM TUNER. Medium Wave. Transistor Superhet. Ferrite aerial. 9 volt. **79/6**

BARGAIN DE LUXE TAPE SPLICER Cuts, trims, joins for editing and repairs. With 3 blades. **17/6**

BARGAIN 4 CHANNEL TRANSISTOR MIXER. Add musical highlights and sound effects to recordings. Will mix Microphone, records, tape and tuner with separate controls into single output. 9 volt. **59/6**

BARGAIN FM TUNER 88-108 Mc/s Six Transistor. Ready built. Printed Circuit. Calibrated slide dial tuning. Size 6 × 4 × 2½in. 9 volt. **£6.19.6**

BARGAIN 3 WATT AMPLIFIER. 4 Transistor Push-Pull Ready built, with volume control. 9v. **69/6**

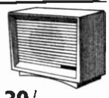
★ RADIO BOOKS ★ (Postage 9d.)

Practical Transistor Receivers	5/-
Practical Stereo Handbook	3/6
Supersensitive Transistor Pocket Radio	3/6
High Fidelity Speaker Enclosures and Plans	5/-
Radio Valve Guide, Books 1, 2, 3, or 4 ea. 5/- No. 5 ea.	6/-
T.V. Fault Finding 405/625 lines	8/6
Shortwave Transistor Receivers	5/-
Transistor Communication Sets	6/-
Modern Transistor Circuits for Beginners	7/6
Sub-Miniature Transistor Receivers	5/-
Wireless World Radio Valve Data	9/6
At a glance valve equivalents	6/-
PAL Colour T.V. by Mullard	12/6
Receive foreign T.V. programmes by simple modifications	5/-
Transistor Circuits Radio-Controlled Models	7/6

MANUFACTURERS' SURPLUS! 25/-
TAPE RECORDER CABINET. Grey/Red or Grey 2-tone. Rexine covered. Size 15 × 12 5½in. POST FREE

POCKET MOVING COIL MULTIMETER. 0-1,000 A.C./D.C. , ohms 0 to 100k, etc. **49/6**
SUPERIOR MOVING COIL MULTIMETER 0-2-500v. D.C. 20,000 ohms per volt, 0-1,000v. A.C. Ohms 0 to 6 meg. 50 Microamps (Full list Meters S.A.E.) **99/6**

BRAND NEW QUALITY EXTENSION LOUDSPEAKER



Handsome plastic cabinet, 20ft. lead and adaptors. For any radio, intercom, tape recorder, etc. 3 to 15 ohm.
Size: 7½" × 5½" × 3". Post 2/6 **30/-**

Minimum Post and Packing 2/6. **RETURN OF POST DESPATCH. HI-FI STOCKISTS. CUSTOMERS FREE CAR PARK. CALLERS WELCOME**

RADIO COMPONENT SPECIALISTS 337 WHITEHORSE ROAD, WEST CROYDON

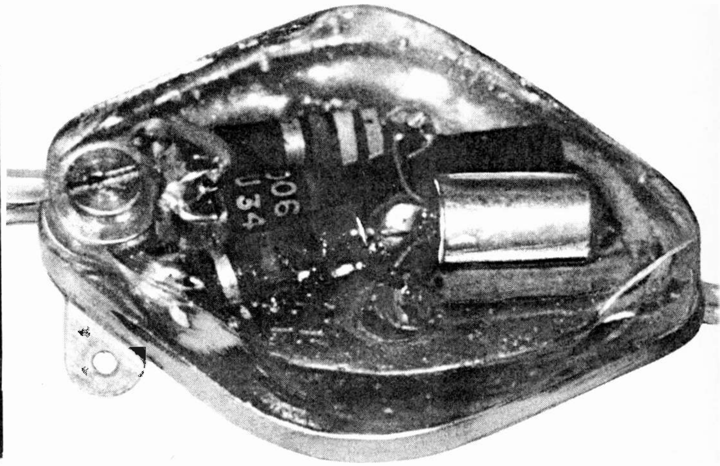
List 1/-. **Written guarantee with every purchase.** *(Export: Remit cash and extra postage.) Buses 133, 68 pass door. S.R. Stn. Selhurst.* **Tel. 01-684-1665**

COMPONENTS . . .

Resistors
R1 1·2kΩ
R2 680Ω
±10%, ¼W carbon

Semiconductors
TR1 OC81
TR2 OC19
D1 DD000 silicon rectifier

Miscellaneous
X1 ORP12 light dependent resistor
Parking light (large enough to hold unit)
4B.A. screw and solder tag
Insulated wire
Epoxy resin (Araldite, Bondaglass or Cataloy)



Photograph of the completed electronic assembly encapsulated in epoxy resin

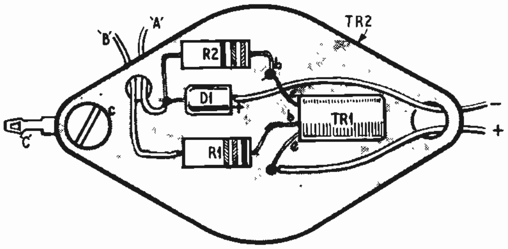


Fig. 2. Layout and wiring of all components except LP1 and X1

from D1 is sleeved, soldered to the negative battery supply and passed through the original hole in the power transistor. The positive supply lead is passed through the same hole and soldered to the emitter terminal of TR2 together with the emitter of TR1. Next connect R1 to the base of TR1 and the other end of R1 to a thin lead (connection "B") and pass it out through the new hole. Bolt a tag (connection "C") to the collector of TR2 by means of a 4B.A. screw.

With this assembly all the circuit components are on one side of TR2 and the five connections are on the other side; the rim of TR2 is free from any obstructions. Test the circuit at this stage and see that there are no shorts.

Stop up the holes in TR2 case with plasticine or candle wax, and put insulating tape all around the rim of TR2 forming a vessel containing the components. Place the assembly on a level surface, mix some epoxy resin with its hardener and pour it into the vessel to cover the components. On the following day remove the tape and finish the module by painting the other side of the transistor with epoxy resin to provide complete insulation.

The module can then be carefully inserted into the parking light and attached with epoxy resin. There is no need to modify the wiring of the light as only the two supply leads leave it, the other three leads are connected to the cell and lamp—connection "A" to the cell and lamp—connection "B" to the cell only—connection "C" to the lamp only.

OPERATION

The switching of this unit is entirely electronic and, with the components chosen, quite fast. The author has made several units and all switch on at the correct ambient light. However, the light may be made to switch on earlier by partially obstructing the photo cell.

The current drawn by the unit is about 10mA in its quiescent state and 200mA when the light is on. The circuit is suitable for 12V or 6V operation although with a 6V supply R2 could be reduced to 470 ohm.

The external appearance of the light does not betray its electronic contents and it is therefore no more liable to pilfering than an ordinary parking light. ★

COLD CATHODE TUBES

By J. B. Dance M.Sc.

DECADE COUNTING TUBES

Cold cathode decade counting tubes (also known as "stepping tubes") were first produced about 1950 mainly for counting the electrical pulses from nucleonic detecting devices. They have since been used for many other medium speed counting applications and have also been used for other purposes not directly involving counting.

Most decade tubes can count up to a few kilohertz, some up to approximately 20kHz, whilst two high-speed tubes have been developed for counting up to 1MHz. The first important tube of this type was developed by Ericsson Telephones and was marketed under their trade name "Dekatron".

A cold cathode decade counting tube usually consists of a ring of electrodes (normally cathodes) surrounding a single electrode (usually the common anode). These electrodes are all situated in the domed end of the tube so that they can easily be seen.

VISIBLE GLOW INDICATION

When a suitable h.t. potential is applied to the tube via a current limiting resistor, a visible glow will be formed in the gas between one cathode and the nearest point on the anode to that particular cathode. If appropriately shaped pulses (which are the units to be counted) are applied to the tube in a suitable way, the glow can be made to rotate around the ring of cathodes in the dome of the tube in a series of ten steps per revolution. Each step represents a single count.

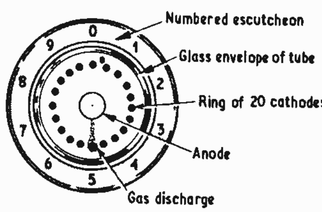


Fig. 5.1. End view of an asymmetrical tube indicating digit 5. A ring of 20 cathodes is used

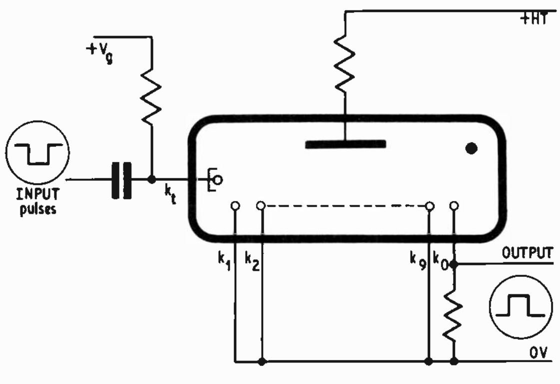


Fig. 5.2. Typical circuitry used to operate an asymmetrical tube

The dome of each tube is mounted in an escutcheon which is numbered as in Fig. 5.1. The number of counts is indicated by the figure on the escutcheon which is nearest the glow in the gas.

A single decade tube can indicate any number of counts up to nine. However, at the tenth count (when the glow returns to the zero position), an output pulse can be obtained from the zero cathode and, after amplification, this pulse can be used to feed another decade tube which indicates the number of tens counted. Output pulses from the zero cathode of this latter tube may be fed to a third tube which indicates the number of hundreds and so on.

ASYMMETRICAL TUBES

One type of tube (shown in Fig. 5.1) employs 20 cathodes surrounding a common anode. Ten of these cathodes are placed opposite numbers on the escutcheon and are known as main cathodes.

The other ten cathodes are placed in between the main cathodes and are known as auxiliary, guide or transfer cathodes. These transfer cathodes receive a positive bias; the glow does not therefore remain at a transfer cathode for more than a very short time, since the anode to main cathode potential is greater than the anode to transfer cathode potential.

In tubes which employ 20 cathodes in the ring, all of the transfer cathodes are connected together. The basic circuit in which they would be used is shown in Fig. 5.2; the circular structure of the tube is usually represented as shown for convenience.

A suitable bias potential V_g is applied to the common connection for all of the transfer cathodes k_t by the method shown. The square bracket on k_t indicates that there is more than one transfer cathode in each tube, although only one is shown for simplicity. The main cathodes are numbered k_0 to k_9.

OPERATION

When h.t. is first applied, the anode voltage will rise until it reaches the striking voltage of the anode to main cathode gap. A discharge will then be initiated to one of the main cathodes and the anode potential will fall to the maintaining voltage of the tube, the remainder of the applied potential appearing across the anode resistor.

The anode voltage is now inadequate to cause any other gap to strike. Once conduction has been initiated in any gap, no other main gap will strike.

If a suitable negative going input pulse is now applied to all of the transfer cathodes via the capacitor shown in Fig. 5.2, their potential can be made to fall below that of the main cathodes for a short time.

In tubes of this type the cathodes are shaped so that the glowing cathode directs ions onto the next succeeding cathode to anode gap, but causes few ions to be formed in the preceding gap. The glow therefore moves to the transfer cathode which follows the glowing cathode, since this is the only cathode which is strongly primed by the ions.

At the end of the input pulse, the transfer cathodes return to their quiescent bias potential (positive) and the glow now tends to move to a main cathode, since the main cathode to anode potential is now greater than the transfer cathode to anode potential.

The only main cathode which is sufficiently primed by the ions is the one following the glowing transfer cathode and the discharge accordingly moves to this main cathode. A single count is thus registered.

Tubes which employ this principle are known as asymmetrical tubes, since they are not symmetrical in the two possible directions of rotation. The direction of rotation of the glow is determined by the shape of the cathodes used.

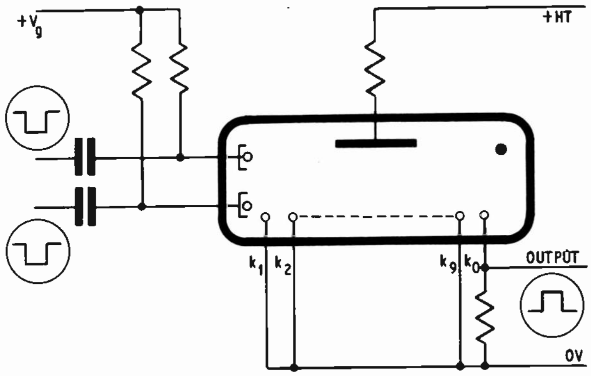


Fig. 5.3. Double pulse tube with two sets of guide cathodes

DEKATRONS

The Ericsson "Dekatrons" and similar double pulse tubes are symmetrical tubes, the direction of rotation of the glow being determined by the order in which two successive pulses are applied to groups of transfer cathodes. Tubes of this type have a structure rather similar to that of the tube illustrated in Fig. 5.1, but there are two transfer cathodes in between each main cathode. Thus there are 30 cathodes in the ring surrounding the anode.

In this type of tube all of the transfer cathodes on the clockwise side of the adjacent main cathode are connected together and are known as the first guides. Similarly all of the transfer cathodes on the counter-clockwise side of the adjacent main cathode are joined together and are known as the second guides. A positive bias is applied to both sets of guides, the basic circuit being shown in Fig. 5.3.

When the discharge is resting at a main cathode and a negative going pulse of a suitable amplitude is applied to all of the first guides, the glow will move to the first guide which is one place in a clockwise direction from the previously glowing main cathode. There is no tendency for the glow to move to any other transfer cathode, since only the transfer cathode adjacent to the previously glowing main cathode has been appreciably primed by the ions from the discharge.

The glow remains at the first guide during the time this guide is receiving a negative going pulse but, before this pulse terminates, a second similar negative pulse is applied to the second guides. At the end of the first guide pulse, the discharge therefore moves to the second guide succeeding the previously glowing first guide. No other second guide is sufficiently primed for the discharge to move to it.

At the end of the second guide pulse, the discharge moves to the succeeding main cathode. Thus each time a count is registered, the glow moves in three successive steps. As in the case of asymmetrical tubes, an output pulse can be obtained from the zero cathode for the operation of a succeeding tube if a resistor of a suitable value is included in the cathode circuit as shown in Fig. 5.3.

In actual practice only a single input pulse is available for the operation of a double pulse tube. This input pulse is normally applied directly to the first guides, the pulse for the second guides being obtained by means of a resistor capacitor integrating circuit which effectively delays the pulse. Although the integrating circuit also alters the shape of the pulse, this is not usually too important unless it is vital to obtain the maximum possible operating speed. Practical circuits employing the integration method will be discussed later in this article.

PRACTICAL CIRCUITS

A simple circuit for the S.T.C. G10/241E "Nomotron" asymmetrical tube is shown in Fig. 5.4. This tube contains a shield electrode to promote rapid deionisation; this electrode is shown on the right-hand side of the circuit symbol. The circuit is suitable for use up to 5kHz, but another circuit has been recommended for use at counting speeds up to 20kHz.

The input pulses required are negative going pulses of about 120 volts in amplitude, rectangular in shape, and of about 16 microseconds in duration. (Suitable circuits for the generation of these input pulses have been published by the manufacturers of the counting tube.) For simplicity, only two of the cathode circuits are shown in Fig. 5.4, but the other cathodes are connected in the same way as those shown.

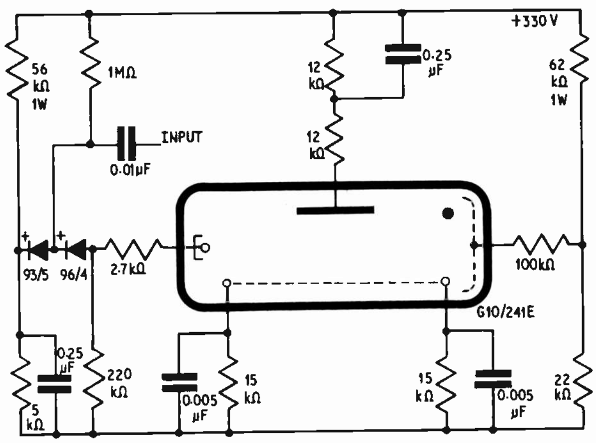
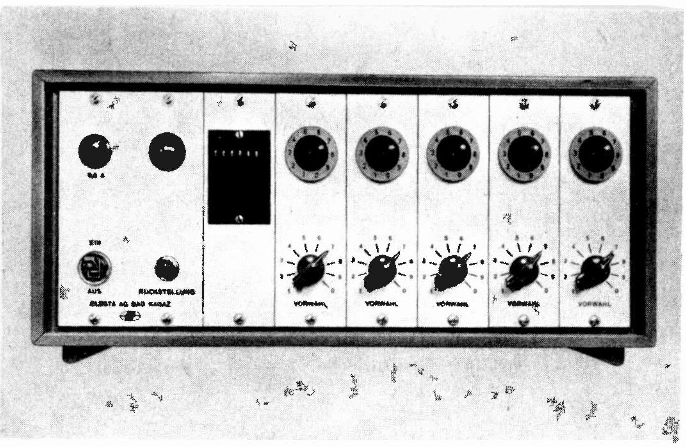


Fig. 5.4. Low speed counting circuit for the S.T.C. "Nomotron" tube



Elesta EZ10B with electromagnetic counter in this scaler

FAST COUNTING

A circuit published by the Elesta Company of Switzerland for their high speed EZ10B tube is shown in Fig. 5.5. This tube can count at speeds up to at least 1MHz, but the circuit shown is designed for frequencies of up to 100kHz. The tube is an asymmetrical type, the indication being given as a blue glow instead of the red glow emitted by most decade tubes. The gas filling controls the colour of the glow; in the case of the EZ10B it is hydrogen.

The input circuit consists of a transistor blocking oscillator, all of the coils L1, L2 and L3 being wound on a common Philips pot core type S14/8. The coil L1 consists of 400 turns of 46 s.w.g. enamelled copper wire, L2 of 60 turns of 42 s.w.g. enamelled wire, and L3 of 15 turns of 42 s.w.g. enamelled wire.

The input pulses used to trigger this blocking oscillator circuit should have an amplitude of about 10 volts and a duration of at least 3μs; they should be fairly rectangular, the rise time being less than 1μs. The blocking oscillator converts the input pulses into pulses of an amplitude great enough to operate the EZ10B tube. Diodes are used to protect the transistor against transient peak voltages and to prevent excessive free oscillations at the end of each input pulse.

DOUBLE PULSE TUBE CIRCUITS

A circuit designed by Ericsson Telephones for the operation of their 4kHz double pulse tubes is shown in Fig. 5.6a. The output pulses from this circuit may be fed into the circuit shown in Fig. 5.6b, which contains another decade tube for counting the number of tens. Any number of circuits of the type shown in Fig. 5.6b may be cascaded so that the whole circuit will count up to any desired number.

The circuit of Fig. 5.6a requires a positive pulse of not less than 20V in amplitude to drive it. This pulse causes the monostable circuit of V1a and b to switch, V1a conducting instead of V1b. A negative pulse is taken from the anode of V1a. The duration of this pulse is determined by the component values used and is independent of the input pulse duration. It is passed through the cathode follower stage V2a, from which it emerges as a negative going pulse suitable for driving the decade counting tube V3.

The pulse from V2a cathode is passed through a coupling capacitor C3 to the first guides in V3. It is also passed through R16 to the second guides; R16 and C4 serve as an integrating circuit to delay the pulse at the second guides. Diode D3 in the guide circuit prevents the guide potential from becoming too positive when the current passed by the tube flows to the guides.

The reset line is connected to earth through a resistor which is normally shorted by a switch. When the switch is opened the potential of the reset line should increase by about 100 volts so that the discharge in all tubes connected in the circuit jumps to the zero cathode.

The grid of V2b in Fig. 5.6b is normally biased to cut off because the output cathode k_0 of V3 in Fig. 5.6a is returned to the -20V line. When the discharge rests at this cathode, V2b conducts and the negative pulse thus produced at its anode is used to drive the second decade tube V4. A valve or transistor is required in each coupling circuit to amplify the output pulse from the previous tube and to invert its phase.

REVERSIBILITY

Circuits have been designed for double pulse tubes which can count in either direction. In order to make a symmetrical tube count in reverse, it is only necessary to apply the second guide pulse slightly before the first

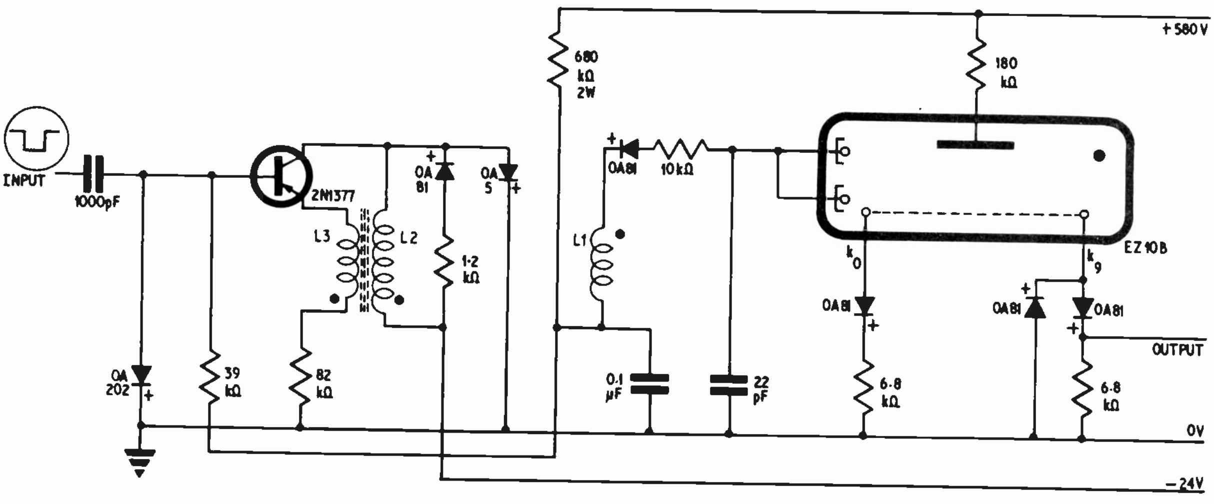


Fig. 5.5. High speed counting circuit for the Elesta EZ10B

PREMIER RADIO

23, TOTTENHAM COURT ROAD, LONDON, W.1 Tel: 01-636 3451

SPECIAL OFFER OF SHURE STEREO CARTRIDGES

Look at our special prices!

M3D	List £8.10.6.	Premier Price £6.19.6
M44-5	List £14.9.1.	Premier Price £10.10.0
M44C	List £12.19.5.	Premier Price £9. 9.0
M44E	List £17.8.4.	Premier Price £13.19.6
M55E	List £20.15.1.	Premier Price £15.15.0
M75-6	List £17.8.4.	Premier Price £13.19.6
M75E	List £25.18.10.	Premier Price £21.0.0

Post and Packing 1/6 each

"NOVA" TRANSISTOR STEREO AMPLIFIER

A superb stereo amplifier offering every facility for the hi-fi enthusiast. Output 10 watts per channel. Frequency response 40–20,000Hz ± 3dB. Inputs for Radio, P.U. Ceramic, P.U. Magnetic Tape. Separate bass and treble controls, Volume and Balance Controls. Mono/Stereo Switch. Also features headphone socket and tape output. Teak case with attractive illuminated front panel. Size 14¼ × 9¾ × 3½in., a.c. 200/250V.

WONDERFUL VALUE AT ONLY **25 gns.** Carr. 10/-.

PICK-UP CARTRIDGES

AT MONEY SAVING PRICES!

GOLDRING G800 (Stereo)	£8.19.6
SONOTONE 9TAHC/D (Stereo)	£2.15.0
ACOS GP91/18C (Mono compat)	£1.13.5
ACOS GP93-1 (Stereo)	£2. 8.7
ACOS GP94 (Stereo)	£2.14.8
B S R X3M (Mono compatible)	£1.16.5
B S R X3H (Mono compatible)	£1.16.5
RONETTE 105 (Stereo)	£1.15.0
RONETTE 106 (Stereo)	£1.15.0

All complete with mounting brackets and instructions. Post and Packing 1/6 each.

COMPLETE STEREO SYSTEM

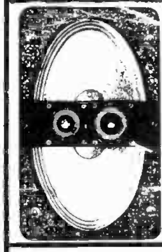
FOR ONLY **39 GNS**

CARRIAGE 35/-

The Premier Stereo System consists of an all transistor stereo amplifier, Garrard Model 2025 auto/manual record player unit fitted stereo/mono cartridge and mounted in teak finish plinth with perspex cover and two matching teak finish loudspeaker systems. Absolutely complete and supplied ready to plug in and play. The 10 transistor Amplifier has an output of 5 watts per channel with inputs for pick-up, tape and tuner also tape output socket. Controls: Bass, Treble, Volume, Balance, Selector. Power on/off, stereo/mono switch. Brushed aluminium front panel. Black metal case with teakwood ends: Size 12″ × 5½″ × 3½″ high (Amplifier available separately if required **£14.19.6.** Carr. 7/6).

WIDE RANGE OF HI-FI STEREO EQUIPMENT ON DEMONSTATION

All leading makes available including Rogers, Armstrong, Dulci, Wharfedale, Goodmans, Goldring, Shure, etc. etc.



E.M.I. 13 × 8in HI-FI SPEAKERS

Fitted two 2½in tweeters and crossover network. Impedance 3 & 15 ohms. Handling capacity 10W. Brand new. 99/6. P. & P. 7/6. Also available without tweeters. 49/6. P. & P. 7/6.

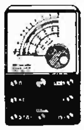
TEAK FINISHED CABINET Size 17¼ × 10 × 7½in. Ideal for above speakers. £5.10.0. P. & P. 7/6.

VERITAS V-149 MIXER

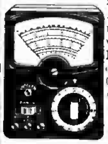
Battery operated 4-channel audio mixer providing four separate inputs. Size 6 × 3 × 2in. suitable for crystal microphone, low impedance microphone with transformer, radio, tape, etc. Max. input 1·5V, max. output 2·5V, gain 6dB. Standard jack plug socket inputs, phonoplugs output. Attractive teak wood grain finish case.

Mono Model **59/6** Stereo Model **69/6** P. & P. 2/6.

MULTI TESTERS



MODEL D14. A really versatile instrument that makes a handy pocket size tool. Measures a.c. or d.c. voltage in three ranges of 0–15–150–1,000 volts. Resistance 0–100,000 ohms. Current 0–150mA d.c. Size only: 3¾ × 2¼ × 1¼in. Complete with battery, test leads and instructions. **49/6** P. & P. 2/6.



POCKET SIZE MODEL. With wide-angle, jewelled meter movement, ceramic long-life, low-loss switching, tough impact resisting case. Sensitivity 20,000 ohms/volt d.c. 10,000 ohms/volt a.c. **19 Ranges:** 0-5-25-50-250-500-2,500 volts d.c. 0-10-50-100-500-1,000 volts a.c. 0-50μA-2·5mA-250mA d.c. 0-6,000 ohms-6 megohms. 10μ μF-0·001 mF-1 mF. −20 to +22dB. Complete battery, test lead and instructions. **£4.19.6** P. & P. 3/6.

'VERITAS' V-313 TAPE HEAD DEFLUXER

A must for all tape users! Tape heads become permanently magnetized with constant use; this leads to background noise that prevents perfect recordings. Simply applied to recording head the V313 leaves head free of magnetism. Cleans any tape head in seconds. **34/6** P. & P. 1/6

HI-FI STEREO HEADPHONES

Designed to the highest possible standard. Fitted 2¼in speaker units with soft padded ear muffs. Adjustable headband. 8 ohm impedance. Complete with 6ft lead and stereo jack plug. **59/6** P. & P. 5/-.

MONO HEADPHONES 2,000 ohm 14/6 P. & P. 2/6.
STEREO STETHOSCOPE SET Low imp. 25/- P. & P. 2/-.
MONO STETHOSCOPE SET Low imp. 10/6 P. & P. 2/-.

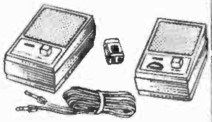
SPECIAL PURCHASE! EKCO "EXPLORER" CAR RADIO

Frustrated Export Order! A truly dependable and selective car radio giving world-wide reception. 8 transistor. 12v. Pos. or Neg. earth operation. 9 wavebands—M.W. 185—570 metres and 8 S.W. bands, 3.2 Mc/s—17.9 Mc/s (90, 60, 49, 41, 31, 25, 19, 16 Metre Bands). Size 2″ h. × 7″ w. × 5¼″ d. Original price £35.

OUR PRICE **21** GNS. P. & P. 7/6.

(Suitable Philips Speaker, baffle and brackets £2.13.0. P. & P. 5/-.)

TWO STATION TRANSISTOR INTERCOMS.



Complete with battery and 50ft connecting wire. Compact size, two way call system. Ideal for home, office, factory, etc. **65/-** P. & P. 4/-.

FOUR STATION INTERCOM. Master unit and 3 slaves. Ideal for office and home. Complete with battery and connecting wire £7.19.6. P. & P. 5/6.

"VERITONE" RECORDING TAPE

SPECIALLY MANUFACTURED IN U.S.A. FROM EXTRA STRONG PRE-STRETCHED MATERIAL. THE QUALITY IS UNEQUALLED.

TENSILISED to ensure the most permanent base. Highly resistant to breakage, moisture, heat, cold or humidity. High polished splice free finish. Smooth output throughout the entire audio range. Double wrapped—attractively boxed.

LP3	3″	250′	P.V.C.	5/6
TT3	3″	450′	POLYESTER	7/6
DT3	3¼″	600′	POLYESTER	11/6
SP5	5″	600′	P.V.C.	8/6
LP5	5″	900′	P.V.C.	10/-
DT5	5″	1200′	POLYESTER	15/-
LP6	5¾″	1200′	P.V.C.	12/6
DT6	5¾″	1800′	POLYESTER	22/6
TT6	5¾″	2400′	POLYESTER	37/6
SP7	7″	1200′	P.V.C.	12/6
LP7	7″	1800′	P.V.C.	15/-
DT7	7″	2400′	POLYESTER	25/-
TT7	7″	3600′	POLYESTER	50/-

TAPE SPOOLS 3″ 1/-, 5″, 5¾″, 7″ 1/9. TAPE CASES 5″, 7″ 2/6.
Post and Packing 3″ 1/-, 5″, 5¾″ 1/6, 7″ 2/-. (3 reels and over Post Free.)

"PREMIER" TAPE CASSETTES

C60	(60 min.)	7/6
C90	(90 min.)	12/6
C120	(120 min.)	17/6

P. & P. 1/-.

CASSETTE HEAD CLEANER

Removes unwanted deposits from delicate tape heads. Fits all cassette recorders. **11/6** P. & P. 1/-

60 R.P.M. Geared Motor. This is a powerful unit, driven by a mains motor of similar type to, but rather larger than the average Tape Deck or Record Player motor. The gear boxes may be detached. It is, in fact, a unit measuring approximately 3¼ × 2¼ × 1¼in thick. The final drive shaft is ¼in wide, 1in long. **35/-.**

A Micro Meter Bargain. Limited quantity only, centre zero 50-0-50 micro amps. This is a Weston Meter enclosed in clear perspex case for flush mounting. Dial size approximately 2¼in wide. The scale is not engraved but has a red part in the centre and a green part to the left of centre. Scale could be cleaned off and re-written to suit your particular requirements. Regular price probably over £5 each, our price **29/6** each.

Battery Record Player. Made by Collaro. This is made up on a unit plate with speed selector and pick-up. The turntable is a heavy one and measures approximately 9½in. Pick-up is fitted with the famous "Studio" cartridge. Price **69/6**, postage and insurance 6/6.

E.H.T. Condenser. 28kV ·0011 mfd. Suitable for transmitting test conditions 6 amp at 300kc/s, Bakelite case, **18/6** each.

85 Watt Tubular Element. Very well made unit. The element is wound on a porcelain former then encased in a brass tube terminated with beaded leads 12in long. Normal mains voltage. Price **5/-** each or **54/-** per doz.

Press to Make Switch. Double pole, 5 amp contacts or can be used as single pole, 10 amp, contacts 250 volt working. Single hole fixing, **2/6** each, **24/-** per dozen.

Door Switch. Contacts open when plunger is depressed. Prevents lights being left on. 15 amp contacts, 230 volt working. Made by Arrow, **3/6** each, **36/-** per dozen.

Rotary Appliance Switch. 16 amp, 230 volt on moulded ceramic base. Operated by pointer knob (not supplied) **2/-** each, **18/-** per dozen.

1/40th h.p. Motor. Made by the French (Cassor) Company. This is an excellent totally enclosed motor, powerful enough to operate small lathe, drilling machine, washing machine, etc. Its speed is 1,450 r.p.m. Made for normal 50 cycle, 230/250 volt mains, totally enclosed, size 2¼ × 3¼in dia. with 1in of ¼ spindle. Price **19/6** plus 4/6 postage and insurance.

Burglar Alarm Kit. Protect your home and family by frightening away the intruder. With our circuit a mains operated bell rings loudly directly the door or window is opened. Kit comprises 12 reed switches, 12 magnets, relay, mains transformer and bell with circuit. Price **49/6.**

HORSTMANN TIME & SET SWITCH

(A 15 amp Switch.) Just the thing if you want to come home to a warm house without it costing you a fortune. You can delay the switch on time of your electric fires, etc., up to 14 hours from setting time or you can use the switch to give a boost on period of up to 3 hours. Equally suitable to control processing. Regular price probably around £5. Special snip price **29/6**, postage and insurance 4/6.

NICAD RECHARGEABLE BATTERIES

3-6V 500mA, size 1¼ × 1¼in dia. type ref. DKZ500 really powerful will deliver 1 amp for ½ hour. Regular price 32/6 our price **17/6** each. New and guaranteed. Other voltages available, single cell 1·2V **6/6**, 10 cell 12V **65/-.**

ELECTRIC CLOCK WITH 25 AMP SWITCH

Made by Smith's these units are as fitted to many top quality cookers to control the oven. The clock is mains driven and frequency controlled so it is extremely accurate. The two small dials enable switch on and off times to be accurately set. Ideal for switching on tape recorders. Offered at only a fraction of the regular price—new and unused only **39/6**, less than the value of the clock alone—post and insurance 2/9.

INDICATOR LAMP

Panel mounting consists of neon lamp in red Plastic lens with resistor in leads for mains operation. **2/6** each, **24/-** per dozen.

BECKASTAT

This is an instant thermostat, simply plug your appliance into it and its lead into wall plug. Adjustable setting for normal air temperatures. 13A loading. Will save its cost in a season **19/6**, post and insurance 2/9.

FLEX BARGAINS

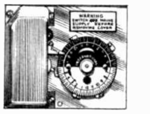
Screened 3 Core Flex. Each core 14/0076 copper P.V.C. insulated and coloured, the 3 cores laid together and metal braided overall. Price **£3.15** per 100yd coil.

15 amp 3 Core Non-Kink Flex. 70/0076 insulated coloured cores, protected by tough rubber sheath, then black cotton braided with white tracer. A normal domestic flex as fitted to 3kW fires. Regular price **3/6** per yd. 50yd coil, **£4.10** or cut to your length **2/6** per yd.

10 amp 3 Core Non-Kink Flex. As above but cores are 28/0076 copper. Normal price **2/6** per yd. 100yd coil **£7.10** or cut to your length **1/9** per yd.

6 amp 2 Core Flex. As above but 2 cores each 23/0076 as used for vacuum cleaners, electric blankets, etc., **39/6** 100yd coil.

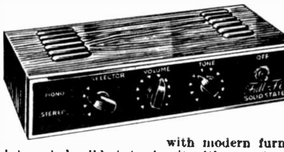
ELECTRIC TIME SWITCH



Made by Smiths these are A.C. mains operated, NOT CLOCKWORK. Ideal for mounting on rack or shelf or can be built into box with 13A socket. 2 completely adjustable time periods per 24 hours, 5 amp changeover contacts will switch circuit on or off during these periods. **59/6**, post and ins. 4/6. Additional time contacts 10/- pair.

THE FULL-FI STEREO SIX

The amplifier sensation of the year



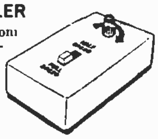
You will be amazed at the fullness of reproduction and at the added qualities your records or tuner will reproduce. Built into metal cabinet elegantly styled and teak finished to blend with modern furnishings, this amplifier uses an integrated solid state circuit with an output power of 6 watts R.M.S.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

Price is **£9.9.0** plus 7/6 post and insurance.

Speakers (with tweeters) in oiled teak finish cabinets to match amplifier, **£8.8.0** pair.

DRILL CONTROLLER

Electronically changes speed from approximately 10 revs. to maximum. Full power at all speeds by finger-tip control. Kit includes all parts, case, everything and full instructions, **19/6** plus 2/6 post and insurance. Or available made up **29/6**, plus 2/6 post.

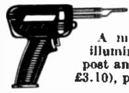


THIS MONTH'S SNIP

3 Stage Permeability Tuner

This Tuner is a precision instrument made by the famous "Cyldon" Company for the equally famous Radiomobile Car Radio. It is a medium wave tuner (but set of longwave coils available as an extra if required) with a frequency coverage 1,620 Kc/s–525 Kc/s and intended to operate with an I.F. value of 470 Kc/s. Extremely compact (size only 2¼in × 2in × ¾in thick) with reduction gear for fine tuning. Snip price this month, **12/6**, with circuit of front end suitable for car radio or as a general purpose tuner for use with Amplifier. Post Free.

SOLDER GUN

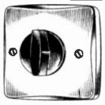


A must for every busy man, gives almost instant heat also illuminates job. 100 watt 220/240V, **39/6** (saves you over 30/-), post and ins. 4/6. BIG JOB 250 watt model, **99/6** (saves you over £3.10), post and ins. 6/6.

DISTRIBUTION PANELS

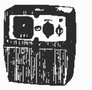
Just what you need for work bench or lab. 4 × 13 amp sockets in metal box to take standard 13 amp fused plugs. Supplied complete with 6 feet of heavy cable and 13 amp plug. Similar advertised at £5. Our price **39/6**, post and ins. 4/6.

VARYLITE



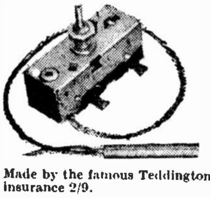
Will dim incandescent lighting up to 600 watts from full brilliance to out. Fitted on M.K. flush plate, same size and fixing as standard wall switch so may be fitted in place of this, or mount on surface. Price complete in heavy plastic box with control knob **£3.19.6.**

BUY TIME SLOT METERS



If you hire out equipment such as T.V. sets by the hour then these slot meters are what you require. We have 3 types, 8d an hour, 1/- an hour and 1/6 an hour. Brand new. Made by the famous Weston Company. Price **£3.19.6**, postage and insurance 6/6.

THERMOSTAT WITH PROBE



This has a sensor attached to a 15A switch by a 14in length of flexible capillary tubing—control range is 20°F to 150°F so it is suitable to control soil heating and liquid heating especially when in buckets or portable vessels as the sensor can be raised out and lowered into the vessel. This thermostat could also be used to sound a bell or other alarm when critical temp. is reached in stack or heap subject to spontaneous combustion or if liquid is being heated by gas or other means not controllable by the switch. Made by the famous Teddington Co., we offer these at **12/6** each. Postage and insurance 2/9.

HI-FI BARGAIN

FULL FI 12-INCH LOUDSPEAKER. This is undoubtedly one of the finest loudspeakers that we have ever offered, produced by one of the country's most famous makers. It has a die-cast metal frame and is strongly recommended for Hi-Fi load and Rhythm Guitar and public address.

Flux Density 11,000 gauss. Total Flux 44,000 Maxwells—Power Handling 15 watts R.M.S. Cone Moulded fibre. Freq. response 30–10,000 c.p.s.—specify 3 or 15 ohms—Mains resonance 60 c.p.s.—Chassis diam. 12in—12⅜in over mounting lugs—Baffle hole 11in diam.—Mounting holes 4, holes —¼in diam. on pitch circle 11⅝in diam.—Overall height 5¼in. A £6 speaker offered for only **£3.9.6** plus 7/6 p. & p. Don't miss this offer, **15in 30 watt £7.10.6.**

Where postage is not stated then orders over £3 are post free. Below £3 add 2/9. Semiconductors add 1/- post. Over £1 post free. S.A.E. with enquiries please.

REED SWITCHES

Glass encased switches operated by external magnet—gold welded contacts. We can now offer 3 types:—

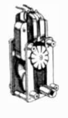
Miniature. 1in long × approximately ⅛in diameter. Will make and break up to ½ amp up to 300 volts. Price **2/6** each, **24/-** dozen.

Standard. 2in long × ⅛in diameter. This will break currents of up to 1 amp, voltages up to 250 volts. Price **2/-** each, **18/-** per dozen.

Flat. 2in long, just over ⅛in thick, approximately ¼in wide. The Standard type flattened out, so that it can be fitted into a smaller space or a larger quantity may be packed into a square solenoid. Rating 1 amp, 200 volts. Price **6/-** each, **£3** per dozen.

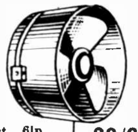
Small ceramic magnets to operate these reed switches **1/3** each, **12/-** per dozen.

ROTISSERIE MOTOR



Very powerful 7 r.p.m., operates from standard A.C. mains. **29/6**, plus 3/6 P. & P.

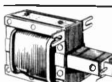
EXTRACTOR FAN



Cleans the air at the rate of 10,000 cubic feet per hour. At the pull of a cord it extracts grease, grime and cooking smells before they dirty decorations. Suitable for kitchens, bathrooms, factories, changing rooms, etc., it's so quiet it can hardly be heard. Compact, 6in casing with 5¼in fan blades. Suitable wherever it is necessary to move air fast. Kit comprises motor, fan blades, sheet steel casing, pull switch, mains connector and fixing brackets.

39/6 + **6/6** post and ins.

230 VOLT SOLENOID



¾in stroke. Size 2¼in × 2in × 1¼in. **14/6**, postage 2/9.

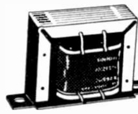
FLUORESCENT CONTROL KITS

Each kit comprises seven items—Choke, 2 tube ends, starter, starter holder and 2 tube clips, with wiring instructions. Suitable for normal fluorescent tubes or the new "Grolux" tubes for fish tanks and indoor plants. Chokes are super-silent, mostly resin filled. Kit A—15-20 w. **19/6.** Kit B—30-40 w. **19/6.** Kit C—80 w. **19/6.** Kit E—65 w. **19/6.** Kit MF1 is for 6in, 9in and 12in miniature tubes, **19/6.** Postage on Kits A and B 4/6 for one or two kits then 4/6 for each two kits ordered. Kits C, D and E 4/6 on first kit then 3/6 for each kit ordered. Kit MF1 3/6 on first kit then 3/6 on each two kits ordered.

DEAC RECHARGEABLE BATTERY

1·2V–2000mA/hr type (2000DKZ). Size 2in dia. × ¾in thick approx. Tremendously powerful, will deliver 4 amp for ½ hour. Regular price over £2 each. Snip price **19/6** each. NEW AND UNUSED.

MAINS TRANSFORMER SNIP



Making a power pack for amplifier or other equipment? These transformers have normal mains primaries (230/240v.) and isolated secondaries two types (1) 12v. 500mA at **8/6**; (2) 15v. 500mA at **8/6.**

THERMOSTATS

Type "A" 15 amp. for controlling room heaters, greenhouses, airing cupboard. Has spindle for pointer knobs. Quickly adjustable from 30–80°F. **9/6** plus 1/- post. Suitable box for wall mounting, 5/-. P. & P. 1/-.

Type "B" 15 amp. This is a 17in long rod type made by the famous Sunvic Co. Spindle adjusts this from 50–550°F. Internal screw alters the setting so this could be adjustable over 30° to 1000°F. Suitable for controlling furnace, oven kiln immersion heater or to make flame-stat or fire alarm. **8/6** plus 2/6 post and insurance.

Type "D". We call this the Ice-stat as it cuts in and out at around freezing point, 2/3 amps. Has many uses one of which would be to keep the loft pipes from freezing, if a length of our blanket wire (16 yds. 10/-) is wound round the pipes. **7/6** P. & P. 1/-.

Type "E". This is standard refrigerator thermostat. Spindle adjustments cover normal refrigerator temperature. **7/6**, plus 1/- post.

Type "F". Glass encased for controlling the temp. of liquid, particularly those in glass tanks, vats or sinks, thermostat is held (half submerged) by rubber sucker or wire clip—ideal for fish tanks—developers and chemical baths of all types. Adjustable over range 50° to 150°F. Price **18/-**, plus 2/- post and insurance.

ELECTRONICS (CROYDON) LTD

Dept. PE, 266 London Road, Croydon CRO 2TH

Also 102/3 Tamworth Road, Croydon

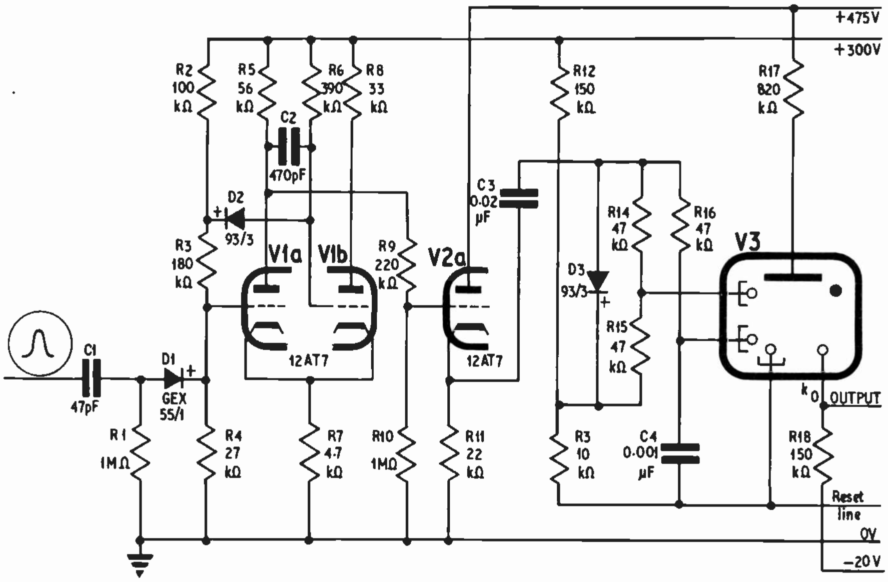


Fig. 5.6a. Input circuit for a double pulse tube

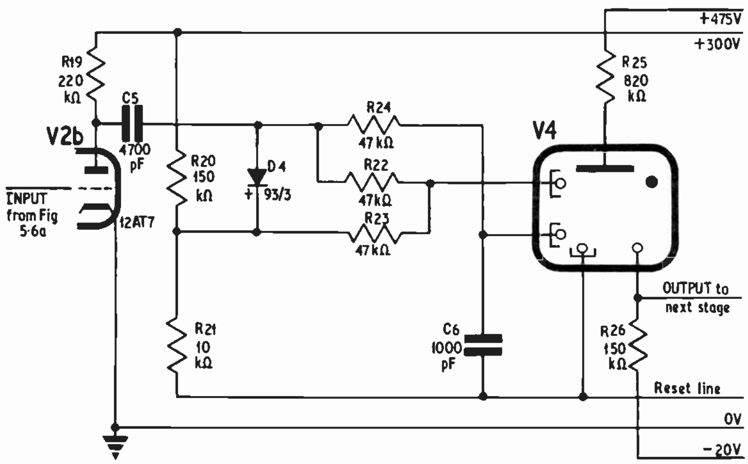


Fig. 5.6b. Double pulse tube coupling circuit for (a) above

Elesta EZ10B fast asymmetrical tube

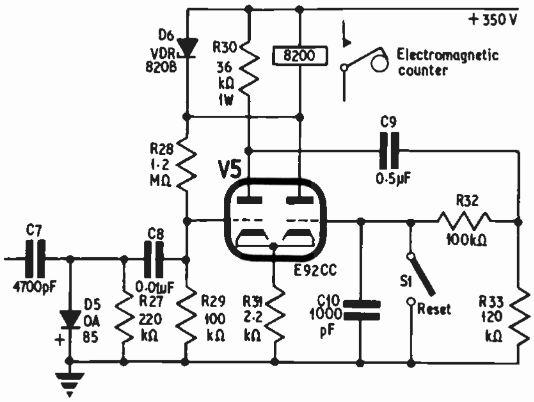
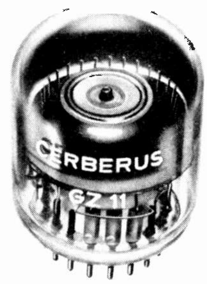


Fig. 5.6c. Coupling a decade tube to an electromagnetic counter



Cerberus GZ11 double pulse tube

guide pulse. A consideration of the principles of operation of these tubes should enable one to understand why they can count in reverse.

The Elesta Company manufacture a 1MHz reversible counting tube operating on somewhat different principles to the other tubes so far described.

FAST DOUBLE PULSE TUBES

Many common double pulse tubes can count at frequencies of up to about 4kHz. Some tubes (such as the Ericsson GS10D) can operate at frequencies up to 10kHz, whilst the Mullard Z505S can operate up to 50kHz. Such tubes operate at a rather greater anode current than the 4kHz tubes and require pulses of smaller duration.

The type of circuit shown in Fig. 5.6 will usually be able to drive such tubes, but the pulse length should be shortened by reducing the value of C2 in Fig. 5.6a to about 82pF. In addition the values of R17 with R12 and R13 will probably need alteration.

The Sylvania and Raytheon Companies of the U.S.A. manufacture tubes which can count at frequencies up to about 100kHz; these tubes employ the double pulse principle, but the conditions of operation are rather critical at such high pulse frequencies.

DRIVING AN ELECTRO-MAGNETIC COUNTER

A decade tube can operate at a much greater speed than an electromagnetic counter, but can indicate only one digit whereas electromagnetic counters can each indicate four to eight digits, depending on the type.

In economical equipment, it is common practice to employ one or more decade tubes to reduce the counting rate by a large factor and then to use the resulting output pulses to operate an electromagnetic counter. This enables a simple circuit to be made which will register many digits.

The output of the circuit in Fig. 5.6b may be fed directly into the electromagnetic register circuit shown in Fig. 5.6c, provided the output cathode of V4 is returned to earth instead of to the −20V supply. Each time the glow reaches the output cathode of V4, the monostable circuit (Fig. 5.6c) is switched, and the counter in the anode circuit of the one section of the double triode registers a count.

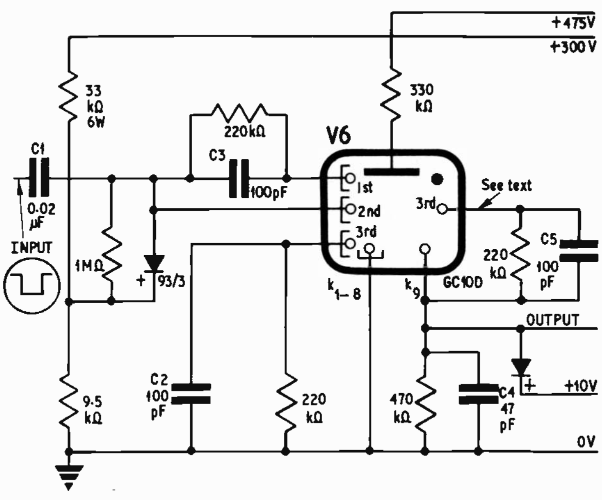


Fig. 5.7. Typical circuit employing a high frequency double pulse tube GC10D

This circuit has been designed by the Sodeco Company of Switzerland for their magnetic counters. The counter employed should have a coil resistance of about 8·2 kilohms. The reset switch should be closed when the decade tubes are reset or the magnetic counter will probably record a spurious pulse when the glow returns to the zero cathode of the final decade tube.

SINGLE PULSE DEKATRON

The Ericsson single pulse "Dekatron" is a unique decade tube which contains 40 cathodes in a ring around the central anode. The basic circuit in which this tube is used is shown in Fig. 5.7. The three groups of electrodes shown on the left-hand side of the tube symbol are the first, second and third sets of guide electrodes. The third guide immediately preceding the output cathode k_0 is brought out to a separate base connection and is shown on the right-hand side of the circuit symbol.

The single pulse "Dekatron", as its name implies, requires only a single pulse to cause it to count. It also has the advantage that it is a fairly fast tube, its upper frequency limit being quoted as 20kHz. It contains hydrogen and emits a blue glow in operation.

When a negative going pulse is applied to the first guide (uppermost in the symbol in Fig. 5.7) and also to the second guide, the glow will initially move to the first guide, since this is strongly primed with ions from the previously conducting main cathode. However, as the current flows to this guide, C3 charges and a potential is built up across it. This results in the discharge being transferred to the second guide.

At the end of the pulse both the first and second guides return to their quiescent bias potential and therefore the discharge moves to the third guide; this is the only guide which is at earth potential and which is strongly primed. However, C2 in the third guide circuit becomes quickly charged to such a potential that the discharge moves one further step to the succeeding main cathode.

The single pulse "Dekatron" requires four separate steps to take place before a count can be registered. However, as these steps take place automatically without an additional pulse being necessary, the single pulse tube can count more quickly than some of the double pulse decade tubes.

ANODE CIRCUIT CAPACITANCE

It is very important to minimise anode circuit capacitance in all types of decade tube circuit, but it is absolutely vital when high speed tubes are being used. Excessive stray anode capacitance will reduce the rate of rise of the tube anode potential at the end of the input pulse and may result in the glow being extinguished. In this case the discharge may be reformed at any point in the tube.

It is a wise precaution, especially when high speed tubes are being employed, to solder the anode resistor directly to the anode tag of the tube base.

APPLICATIONS

Typical examples of the use of decade tubes are in digital voltmeters, synchronous timers for resistance welding, time markers, batching counters, displaying transitor characteristic curves on a cathode ray tube, routing telephone calls, in pulse generators at fairly low frequencies, and so on.

Next month: The concluding article looks at cold cathode indicator and display tubes

R+TV

RADIO & TV COMPONENTS (ACTON) LTD
21d High Street, Acton, London, W.3
Also at 323 Edgware Road, London, W.2
ALL ORDERS BY POST TO OUR ACTON ADDRESS
Goods not despatched outside U.K. Terms C.W.O.
All enquiries stamped addressed envelope.

Complete stereo system – 28 gns.

The new Duo general-purpose 2-way speaker system is beautifully finished in polished teak veneer, with matching vynair grille. It is ideal for wall or shelf mounting either upright or horizontally.
Type 1 SPECIFICATION:–
Impedance 10 ohms. It incorporates Goodmans high flux 6"×4" speaker and 2¼" tweeter. Teak finish 12"×6¾"×5¾". 4 guineas each. 7/6d. p. & p.
Type 2 as type 1. Size 17½"×10¾"×6¾". Incorporating Elac 10½"×6½" 10,000 lines and 2½" tweeter. 3 ohms impedance 5½ guineas plus 7/6d. p. & p.
Garrard Changers from £7.19.6d. p. & p. 7/6d.
Cover and Teak finish Plinth £4.15.0d. 7/6d. p. & p.

Duetto **Integrated Transistor Stereo Amplifier** — **9GNS.** plus 7/6d. p. & p.

The Duetto is a good quality amplifier, attractively styled and finished. It gives superb reproduction previously associated with amplifiers costing far more.
SPECIFICATION
R.M.S. power output: 3 watts per channel into 10 ohms speakers.
INPUT SENSITIVITY: Suitable for medium or high output crystal cartridges and tuners. Cross-talk better than 30dB at 1Kc/s.
CONTROLS: 4-position selector switch (2 pos. mono and 2 pos. stereo) dual ganged volume control.
TONE CONTROL: Treble lift and cut. Separate on off switch. A preset balance control.

The Classic

Teak finished case
8½ GNS.
Plus P. & P. 7/6

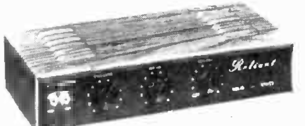
SPECIFICATION: Sensitivities for 10 watt output at 1KHz into 3 ohms. Tape Head: 3mV (at 3¾ i.p.s.) Mag. P.U.: 2mV. Cer. P.U.: 80mV. Tuner: 100mV. Aux. 100mV. Tape/Rec. Output: Tuner. Equalisation for each input is correct to within ±2dB (R.I.A.A.) from 20Hz to 20KHz. *Tone Control Range: Bass:* 13dB at 60Hz. *Treble:* ±14dB at 15KHz. *Total Distortion:* (for 10 watt output) <1.5%. Signal Noise: <−60dB. A.C. Mains 200–250V. Size 12½in long, 4½in deep, 2¾in high. **Built and tested.**

The Viscount

INTEGRATED HIGH FIDELITY TRANSISTOR STEREO AMPLIFIER
13½ GNS.
Plus P. & P. 7/6

SPECIFICATION: *Output:* 10 watts per channel into 3 to 4 ohms speakers (20 watts monoral). *Input:* 6-position rotary selector switch (3 pos. mono and 3 pos. stereo). P.U., Tuner, Tape and Tape Rec. out. Sensitivities: All inputs 100mV into 1.8M ohm. *Frequency Response:* 40Hz–20KHz ±2dB. *Tone Controls:* Separate bass and treble controls. *Treble* 13dB lift and cut (at 15KHz). *Bass:* 15dB lift and 25dB cut (at 60Hz). *Volume Controls:* Separate for each channel. *A.C. Mains Input:* 200–240V, 50–60Hz. *Size:* 12½in × 6in × 2½in teak-finished case. Built and tested. P. & P. 7/6.
Viscount Mark II for use with magnetic pick ups specification as above. Fully equalised for magnetic pick ups. Suitable for cartridges with minimum output of 4mV/cm/sec. at 1kc. Input Impedance 47k. **15 gns. plus 7/6 P. & P.**

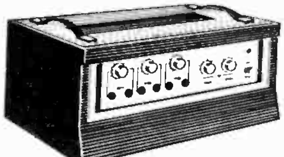
THE RELIANT Mk. II



SOLID STATE GENERAL PURPOSE AMPLIFIER
6½ GNS. Plus P. & P. 7/6
In teak-finished case

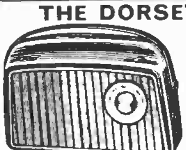
SPECIFICATION: *Output:* 10 watts into a 3 ohms speaker. *Inputs:* (1) for mike (10mV). Input (2) for gram. radio (250mV) individual bass and treble control. *Transistors:* 4 silicone and three germanium. *Mains input:* 220/250 volts. *Size:* 10½ × 4¾ × 2½in. *Mike to suit (crystal):* 12/6 plus 1/6 P. & P. 8 × 5in speaker 14/6 plus 3/– P. & P. Mk. I 5½ gns. plus 7/6 P. & P. Less teak finished case.

50 WATT AMPLIFIER



AC MAINS 200-250V
An extremely reliable general purpose valve Amplifier—with six electronically mixed inputs. Suitable for use with mics, guitars, gram, tuner, organ, etc. Separate bass and treble controls. Output impedance 3, 8 and 15 ohms.
27 GNS. Plus P. & P. 20/-

THE DORSET (600mW Output)



7 transistor fully tunable M.W.-L.W. superhet portaset—with baby alarm facility. Set of parts. The latest modulated and pre-alignment techniques makes this simple to build. Sizes: 12 × 8 × 3in. **MAINS POWER PACK KIT: 9/6 extra.**
£5.5.0 Plus P. & P. 7/6 Circuit 2/6 Free with parts

THREE-IN-ONE HI-FI 10 WATT SPEAKER

A complete Loud Speaker system on one frame combining three matched ceramic magnet speakers with a low loss cross-over network. Peak handling power 10W. Impedance 15 ohms. Flux density 11,000 gauss. Resonance 40–60c/s. Frequency range 50c/s to 20kc/s. Size 13½ × 8¼ × 4½in. By famous manufacturer. List price £7. Our price 74/6 plus 5/– P. & P. Similar speaker to the above minus tweeters in 3 and 15 ohms 44/6 plus 5/– P. & P.

Elegant Seven Mk. III (350mW Output)

7-transistor fully tunable M.W.-L.W. Superhet portable. Set of parts. Complete with all components, including ready etched and drilled printed circuit board—back printed for foolproof construction. **MAINS POWER PACK KIT: 9/6 extra.**
£4.9.6 Plus P. & P. 7/6 Circuit 2 6 Free with parts

POCKET MULTI-METER

Size 3¾ × 2½ × 1¼in. Meter size 2¼ × 1¼in. Sensitivity 1,000 O.P.V. on both a.c. and d.c. volts. 0–15, 0–150, 0–1,000 d.c. current 0–150mA. Resistance 0·100kohms. Complete with test prods, battery and full instructions. 42/6. P. & P. 3/6. **FREE GIFT** for limited period only. 30W Electric Soldering Iron Value 15/- to every purchaser of the Pocket Multi-Meter.

B.S.R. TD2 TAPE DECK

This tape deck takes 5¾in spools complete with two-track heads. Size 13¼in long by 8¾in wide.
£8.19.6 Plus P. & P. 7/6

SPECIAL OFFER

Complete stereo systems comprising BALFOUR 4 speed auto player with stereo head 2 DUO speaker systems size 12 × 6¾ × 5¾in. Plinth (less cover) and the DUETTO stereo amplifier. All above items
19 GNS. Plus P. & P. 20/-

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.

CIRCUIT MONITOR

Any indication of what's happening in any experimental or prototype circuit is always invaluable to designers and experimenters, and the new surge indicating meter from **John Howard Industrial Electronics Ltd.,** should be most useful in this respect.

Believed to be the first of its kind, the meter is simply clipped across the supply to be monitored and any surges which occur on the line of microsecond duration or longer are instantly displayed on a large mirror scale meter. The reading is automatically held for approximately 30 seconds and is reset by a push button control mounted on the front panel.

Two stock models are available with ranges of 0 to 200 volts and 0 to 2 kilovolts f.s.d., price £20. Other ranges can be supplied to order and further details can be obtained from John Howard Industrial Electronics Ltd., 32, Oaks Road, Great Glen, Leicester.

IRON STAND

The new Litegard bench stand has been specially designed to completely cover the soldering iron bit and hot element for complete protection against accidental burns.

The stand may be mounted either horizontally or vertically and there is no danger of grasping the iron at the wrong end. The interior of the stand is fully ventilated and is fitted with a black-anodised heat shield. These features ensure that the soldering iron is maintained at its normal operating temperature and that the external parts of the stand remain cool.

There is an easily replaceable bit cleaning pad and the complete stand costs 25s from any good components shop or direct from **Light Soldering Developments Ltd.,** 28, Sydenham Road, Croydon.

MAINS WIRING SYSTEM

Have you ever wished you could plug your equipment into a socket anywhere around the room, or reduce the liability of accidents caused by trailing mains cables?

The "Extenda-Plug" is a new method of running mains wiring so that the sockets can be clipped onto the wiring track at any convenient position (see photograph). The space between each socket is fitted with safe plastics covering to hide the earthing conductors.

The system is completely safe from young fingers and the sockets do not make contact with the conductors until the hinged top is pressed down into place. To remove the socket this top must be lifted; on doing so the claw contacts are released from the conductors before the socket comes right away. The action of the socket top is deliberately stiff to prevent children pulling the socket off.

Although a non-standard three-pin plug is used, this disadvantage is easily offset by the versatility and safety of the system. Each plug is fused and the pins are different sizes, so it is impossible to plug in the wrong way. The sockets can be fitted one way only, making this system ideal for d.c. supplies as well as a.c.

Typical applications are where several appliances are to be plugged into a common supply source; the total consumption must not exceed the main socket rating, e.g. 13A. The system can be equally well used in re-wiring or where trunking systems are required.

The complete basic kit comprising 3 metres of wiring track, three snap-on socket outlets, three fused plugs, plastics cover strip, junction box and blind end caps, cost £5 9s 6d direct from **Extenda-Plug,** Amhurst Park Works, Tottenham, London, N.15.

Extra parts can be obtained also, and the system can be extended for as long and as complex as required.

LITERATURE

As a preview to the introduction of colour television by the Independent Television Authority, a series of brochures has just been released to help explain their future developments.

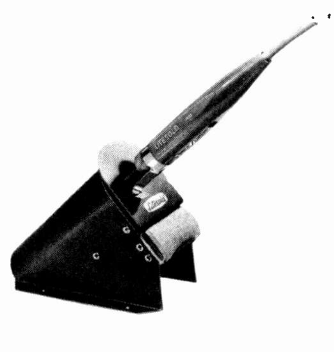
Leaflets of particular interest to readers include *ITA Colour*, *What The Viewer Needs To Know*, and *Good Viewing of Independent Television*.

The leaflet *ITA Colour* explains the first phase of the colour/u.h.f. network and includes a list of the first 60 u.h.f. stations. In simple question and answer form the basic facts about three-channel colour, u.h.f., 625 lines and "duplication" is described in *What The Viewer Needs To Know*.

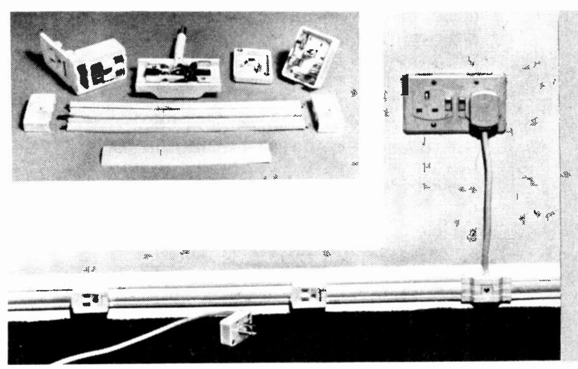
Advice on questions of u.h.f. and v.h.f. reception, stressing the importance of good aerials and low-loss feeders for u.h.f. and v.h.f. reception, choice of station, reception of colour, and problems arising from supply voltage variations are given in *Good Viewing of Independent Television*.

Further details of the leaflets can be obtained from ITA, 70 Brompton Road, London, S.W.3.

Surge meter from John Howard Industrial Electronics



Litegard bench stand manufactured by Light Soldering Developments



Extenda-Plug mains wiring system marketed by Extenda-Plug

Readout—
A SELECTION FROM OUR POSTBAG

correspondents wishing a reply must enclose a stamped addressed envelope

E-waves

Sir—The letter "Strobe Effect" from C. J. Manwell in your August 1969 issue mentions the book *Living Brain* by Dr Grey Walter. This was first published as long ago as 1953, and your readers may be interested to hear of more recent developments in electroencephalography.

The most interesting of these is the discovery of E-Waves (Expectancy, Decision and Intention Waves), which are electrical oscillations in brain-cells arising when acts of will or decisions are made. These impulses can be fitered and passed through suitable electronic circuits and relays, to operate mechanisms which carry out the wishes of the operator without any muscular movement being necessary. For example, the operator could select a particular television channel by merely desiring or willing to do so, without pressing any buttons or carrying out any movements at all.

Further details for those interested can be found in our publication "E-Waves", price 6s, obtainable from our address below.

B. Herbert, M.Sc., B.A.(Oxon.),
Paraphysical Laboratory,
Downton,
Wilts.

Film Trailer

Sir—A Television Servicing and Installation film is being produced by this Company and will be available later this year for rental or purchase by responsible organisations. Perhaps your readers may care to know of the production of this film as there are some rather unique features. We have carefully searched for a film which deals exhaustively with Colour Television and Installation which would clearly and comprehensively give the average service engineer all the information he requires.

The film will be of use to Colleges of Further Education, Technical Schools and Companies who have many service engineers on their pay-roll, such as Television Rental Companies.

Manufacturers of test equipment, of television receivers, of components and other Companies who have an interest in colour television are being invited to supply their latest products for inclusion in the film, this will allow the audiences to become acquainted and familiar with the latest techniques and equipment for speedy and efficient repair, maintenance and installation of colour television receivers.

A precis of this film is available and any of your readers, either manufacturers, students or responsible organisations generally may receive a copy of this if they care to write to us.

Donald Blakey,
Donald Blakey Ltd.,
339 Clifton Drive South,
St. Annes-on-Sea,
Lancs.

Electronics clubs?

Sir—With reference to the letters relating to Electronics Clubs. I would like to be able to ascertain from your readers living in East Sussex as to the demand for such clubs in our county.

May I suggest that interested readers write to this address giving the following information:

(a) Area in which club is required.
(b) A brief outline of their interests in Electronics.
(c) Type of club they envisage, e.g. social, workshop facilities, educational, etc.

Trusting that I may be able to help your readers.

J. A. Dixey,
62 St. Leonards Gardens,
Hove.

Sir—Would anyone who is interested in re-establishing the Wanstead and Woodford Radio Society to be active again in forwarding the hobby of radio and electronics in the London E.11/E.18 area, please contact me at either 82, Granville Road, Walthamstow, E.17., or at The Electronics Laboratory, The University, Canterbury, Kent.

Ken Smith, G3JIX,
Canterbury,
Kent.

Amplify please

Sir—As an amateur constructor of projects in your magazine, I am constantly asked to build guitar and public address amplifiers, rated at. anything from 50 to 100 watts, for pop groups. The look on their faces is both surprising and increasingly frustrating when I shake my head and say that I have no circuit to meet their requirements.

Whilst I agree that various different accessories in use by these "pop" musicians have been previously described in Practical Electronics, it would seem that a feature on a 50 to 100 watt amplifier is not to be forthcoming. It has been suggested to me, that you (P.E.) would rather not "step on manufacturers' toes", which I disbelieve.

In view of these circumstances, I would ask if readers might help, as I surely cannot be the first in this predicament and I would be grateful if you will publish this letter with a view to me getting help and thus relieving my frustration.

J. T. Jones,
Liverpool.

We have just completed the preparation of a 100 watt amplifier, and it is hoped to commence publication in the near future. —*Ed.*

Courses . . .

BRENTFORD

September 22, *Radio Amateurs' Course*, at Brentford Centre for Adult Education, Brentford Secondary Girls' School, Clifden Road, Brentford.

September 24, *High Fidelity and Tape Recording*, at Brentford Centre for Adult Education, Brentford Secondary Girls' School, Clifden Road, Brentford.

Enrolments: September 11, 12, 15 and 16; 6.30–8.30 p.m. Fees: £2 10s for one subject; £1 for each additional subject.

GLASGOW

September 9, 7 p.m. *Radio Amateurs' Course*, at Glasgow College of Nautical Studies, 21 Thistle Street, Glasgow, C.5.

Enrolments: September 9. Fees: £1.

LONDON

September 23, 7.30 p.m. *Radio Amateurs Course*, at Gascoigne Recreation Centre, Gascoigne School, Marley Road, Barking.

Applications should be addressed to the Warden.

·0005 mfd TUNING CONDENSER

Proved design, ideal for straight or reflex circuits. **2/6** each. **24/-** doz.

ELLIOT SEALED CONTACT REED RELAY

Three circuits closed by 3V or 100 MA. **9/6** each.

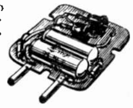
SLIM TUBULAR MICROPHONE

For hand holding or frontal suspension—lever switch—high impedance with lead and plugs for cassette tape recorder but suitable for most amps. **19/6.**

500 MICRO AMP MOVING COIL METER

2in flush mounting round meter ex. Government but unused and perfect. **17/6.**

PP3 BATTERY ELIMINATOR

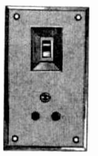


Run your small transistor radio from the mains—full wave circuit—made up ready to wire into your set and adjustable high or low current. **8/6** each.

5000 mfd. 12V CONDENSER

Tubular size 3 × 1in dia., made by Plessey. **4/9** each, **48/-** doz.

5A, 3 PIN SWITCH SOCKETS

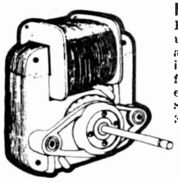


An excellent opportunity to make that bench dis board you have needed or to stock up for future jobs. This month we offer 6 British made (Hicraft) bakelite flush mounting shuttered 5A switch sockets for only **10/-** plus 3/6 post and insurance. (20 boxes post free.)

5in x 5in PRINTED CIRCUIT BOARD

Ideal for dozens of projects. Heavy copper on $\frac{3}{32}$ sheet, 1/6 each or **15/-** per dozen.

MAINS MOTOR

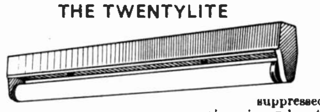


Precision made — as used in record decks and tape recorders—ideal also for extractor fans, blower, heater, etc. New and perfect. Snip at **9/6.** Postage 3/- for first one then 1/- for each one ordered. 12 and over post free.

DIGITAL CLOCK

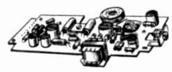
An imposing instrument ideal for modern reception centre or for Managing Director's office—definitely a showpiece to create interest and efficiency—mains frequency controlled so always keeps right time without adjustment—in black semi-matt perspex case—made up, tested and guaranteed—offered for only the cost of components **£29.10.0**, post and insurance 10/-.

ATLAS SLIMLINE FLUORESCENTS
THE TWENTYLITE



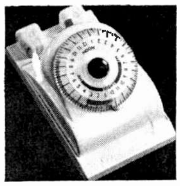
A Fluorescent lighting unit made by the famous Atlas company, with super silent polyester filled choke and radio suppressed starter. The tube springs in and out and the whole unit is beautifully made and finished white enamel. Amazingly economical. If left on all the time costs only one penny per day (uses ¼ unit). Measures 2ft long. Is ideal in Kitchen, Bedroom, Hallway, Porch, Loft, etc. Don't miss this amazing offer, **39/6** with tube. Assembled ready to install. Postage and Insurance 6/6 extra.

1 WATT AMPLIFIER & PREAMP



5 transistors—highly efficient made for use with tapehead G4 but equally suitable for microphone or pick up—limited quantity **39/6**, full circuit diag., also shows tape controls 5/-.

DREAMLAND CLOCK SWITCH



The wonderful DREAMLAND mains operated clock switch will automatically switch your blanket on and off each evening and you will always have a warm bed. It's luminous; you can always see the time and it's a really beautiful unit. An ideal gift. Can also control tape recorder, radio, lamp, etc., up to 500 watts. **39/6** plus 3/6 post and ins.

FLEX CABLE BARGAIN

23/0076 triple core P.V.C. covered, circular, normally sold at 1/6 yd. Our price 100 yd. coil **£3.19.6.** Post and insurance 6/6.

OUT OF SEASON BARGAIN

Famous Norvic electric blanket claimed to be the most reliable in Britain. We offer at less than wholesale price "Corona de luxe" model, this has flame resistant super safe element and double thick fleecy cover attached by press studs—just undo the press studs to wash cover—double bed size 60 × 48in—with control switch giving choice of three heats—in presentation box showing regular price **£9.3.9**—we offer at **£5.19.6**, post and ins. paid.

THERMAL CUTOUT

A miniature device ⅜in dia. on one screw fixing mount—can be used for motor overload protection—fire alarm—Soldering iron switch off, etc. etc. —15 amp contacts open with flame, radiant or conducted heat. **1/6** each, **15/-** doz., **£5** 100.

STEREO CABINET

Size 25 × 14 × 9½in deep—speaker compartment each end—centre portion with hinged lid and removable bottom has platform for autochanger and room for amplifier—two tone (red and grey) rexine covered but loudspeaker ends need metal grills—with handle and clips—**22/6**, carriage and packing 15/-.

2¼kW FAN HEATER

Three position switching to suit changes in the weather. Switch up for full heat (2¼ kW), switch down for half heat (1⅛kW), switch central blows cold for summer cooling—adjustable thermostat acts as auto control and safety cut-out. Complete kit **£3.15.0.** Post and ins. 7/6.

COPPER CLAD ELEMENT

1250 watts—4ft. long but bent to U shape, ideal for overhead heater—just mount reflector above, **12/6** each, plus 4/6 post. **£6** doz. post paid.

500W IMMERSION HEATER

For small process tanks, etc., 200/240V, 4½in into tank, 2¼in outside of tank, dia. approx. 1in, chrome plated **14/6.** Post and Insurance 4/6.

Where postage is not stated then orders over £3 are post free. Below £3 add 2/9. Semiconductors add 1/- post. Over £1 post free. S.A.E. with enquiries please.

ELECTRONICS (CROYDON) LTD

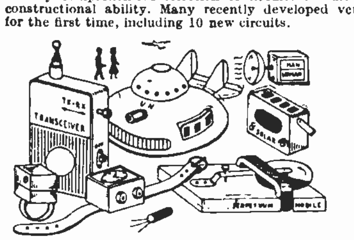
Dept. PE, 266 London Road, Croydon CRO 2TH

Also 102/3 Tamworth Road, Croydon

PRINTED CIRCUIT KIT

BUILD 40 INTERESTING PROJECTS on a PRINTED CIRCUIT CHASSIS with PARTS and TRANSISTORS from your SPARES BOX

CONTENTS: (1) 2 Copper Laminate Boards 4½" × 2½". (2) 1 Board for Matchbox Radio. (3) 1 Board for Wristwatch Radio, etc. (4) Resist. (5) Resist Solvent. (6) Etchant. (7) Cleanser/Degreaser. (8) 16-page Booklet *Printed Circuits for Amateurs*. (9) 2 Miniature Radio Dials SW/MW/LW. Also free with each kit. (10) Essential Design Data, Circuits, Chassis Plans, etc. for 40 TRANSISTORISED PROJECTS. A very comprehensive selection of circuits to suit everyone's requirements and constructional ability. Many recently developed very efficient designs published for the first time, including 10 new circuits.



EXPERIMENTER'S PRINTED CIRCUIT KIT
8/6

Postage & Pack. 1/6 (UK)

Commonwealth:
SURFACE MAIL 2/-
AIR MAIL 8/-
Australia, New Zealand
South Africa, Canada.

(1) Crystal Set with biased Detector. (2) Crystal Set with voltage-quadrupler detector. (3) Crystal Set with Dynamic Loudspeaker. (4) Crystal Tuner with Audio Amplifier. (5) Carrier Power Conversion Receiver. (6) Split-Load Neutralised Double Reflex. (7) Matchbox or Photocell Radio. (8) "TRI-FLEXON" Triple Reflex with self-adjusting regeneration (Patent Pending). (9) Solar Battery Loudspeaker Radio. The smallest 3 designs yet offered to the Home Constructor anywhere in the World. 3 Subminiature Radio Receivers based on the "Triflexon" circuit. Let us know if you know of a smaller design published anywhere. (10) Postage Stamp Radio. Size only 1·62" × ·95" × ·25". (11) Wristwatch Radio 1·15" × ·80" × ·55". (12) Ring Radio ·70" × ·70" × ·55". (13) Bacteria-powered Radio. Runs on sugar or bread. (14) Radio Control Tone Receiver. (15) Transistor P/P Amplifier. (16) Intercom. (17) 1-valve Amplifier. (18) Reliable Burglar Alarm. (19) Light-Seeking Animal, Guided Missile. (20) Perpetual Motion Machine. (21) Metal Detector. (22) Transistor Tester. (23) Human Body Radiation Detector. (24) Man/Woman Discriminator. (25) Signal Injector. (26) Pocket Transceiver (Licence required). (27) Constant Volume Intercom. (28) Remote Control of Models by Induction. (29) Inductive-Loop Transmitter. (30) Pocket Triple Reflex Radio. (31) Wristwatch Transmitter/Wire-less Microphone. (32) Wire-less Door Bell. (33) Ultrasonic Switch/Alarm. (34) Stereo Preamplifier. (35) Quality Stereo Push-Pull Amplifier. (36) Light-Beam Telephone "Photophone". (37) Light-Beam Transmitter. (38) Silent TV Sound Adaptor. (39) Ultrasonic Transmitter. (40) Thyristor Drill Speed Controller.

YORK ELECTRICS

333 YORK ROAD, LONDON, S.W.11

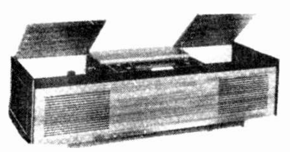
Send a S.A.E. for full details, a brief description and Photographs of all Kits and all 52 Radio, Electronic and Photoelectric Projects Assembled.

STEREOGRAM CABINET £19

An elegant Stereogram Cabinet in modern Veneered Mahogany and cloth covered Front Panel

BLACK LEATHERETTE SIDE PANELS

Dimensions: 52" × 17½" × 12". Speaker positions for Twin 10" × 5" Speakers



SPEAKERS 6/6
2"—75Ω. 2½"—35Ω. P. & P. 2/6.

ACOS MICS. 35/- STANDARD
STICK MIC. 2gns. P. & P. 3/6.

ASSORTED CONDENSERS
10/- for 50. P. & P. 7/6.

ASSORTED RESISTORS
10/- for 50. P. & P. 4/6.

ASSORTED CONTROLS
10/- for 25. P. & P. 7/6.

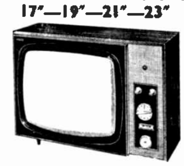
TRANSISTORS
MULLARD MATCHED OUTPUT KIT
9/- OC81D—2 OC81's.
P. & P. FREE.

FERRITE RODS 3/6
6", 8" × ⅜" complete with LW/MW COILS. P. & P. FREE.

17in.—£11.10.0 Carr. 30/-
19in. SLIM-LINE FERGUSON 24 gns.

TWO-YEAR GUARANTEE EX-RENTAL TELEVISIONS

FREE ILLUSTRATED LIST OF TELEVISIONS
17"—19"—21"—23"



WIDE RANGE OF MODELS
SIZES AND PRICES
DEMONSTRATIONS DAILY

RECORD PLAYER CABINET
49/6.
Cloth covered. Size 16½" × 14¼" × 8"
Takes any modern autochanger.
P. & P. 7/6.

SINGLE PLAYER CABINETS
15/6. P. & P. 7/6.

TRANSISTOR CASES 19/6.
Cloth covered, many colours.
Size 9½" × 6½" × 3½". P. & P. 3/6.
Similar cases in plastic 7/6.

TWO-YEAR GUARANTEED REGUNNED TUBES
70° & 90° 14in.—69/6, 17in.—89/6, 21in.—99/6. 110° 17in., 19in. & 21in.—99/6. 23° (not bonded)—119/6. Exchanged Bowls. Carr. 10/6.

DUKE & CO. (LONDON) LTD.

621/3 Romford Road, Manor Park, E.12
Phone 01-478 6001-2-3 — Stamp for Free List.

ELECTROVALUE

RAPID MAIL ORDER SERVICE

EVERYTHING BRAND NEW AND TO EXACT SPECIFICATION • NO SURPLUS GOODS

AMPLIFIER KITS

PEAK SOUND P.W. DOUBLE 12

Complete stereo kit including cabinet, but less panel and other metalwork. **£23** net. Available in separate packages as follows: Main amplifier kit **£3.19.6** per channel, net. Accessories **19/-** mono, **36/-** stereo.
Pre-amplifier kit **£1.7.0** per channel, net. Accessories **13/6** mono, **27/3** stereo.
Tone control kit **19/-** per channel, net. Accessories **8/9** mono, **22/6** stereo.
Power supply kit **£4.10.0** mono or stereo, net.
Cabinet kit **£2.12.6** net. Metalwork available separately from other sources, details on request.

30 WATT (designed by Dr. A. R. Bailey). Published May 1968 W.W., modified November 1968 W.W.
Full kit for main amplifier **£9.9.6** (less power supply). Transistors only for main amplifier **£7.9.6.** PC board supplied free with above kit. Heat sinks for output transistors **8/6** extra.
Power supply kit, unregulated, November 1969 circuit **£4.14.0.** Regulated version, 60V 1·6A or 0·8A, current limiting, re-entrant characteristic: does not need re-set button **£8.10.0.** Transformer only: 0–25–45–50V 2A **58/-.**
8 x 8 watt Stereo only. Peak Sound SA 8 x 8 kit. Sensitivity 50mV into 1 MΩ, output into 5Ω. Complete with cabinet and power supply. Kit complete **£16.10.0** net. Built and tested **£21** net.

BARGAINS IN BRAND NEW ELECTRONIC COMPONENTS

Ultra low-noise resistors (under 0·1μV/V) Electrosil TR5: Metal oxide, 2% tolerance, range 10Ω to 1 MΩ. All values in E24 series available. ½W rating. 1–24 **10d.** each; 25–99 **9d.** each; 100 up **8d.** each. (Ohmic values may be mixed to obtain quantity price.)
Potentiometers, carbon track, long plastic spindles: Single gang linear 220Ω to 2·2MΩ **2/6** each; log 4·7KΩ to 2·2MΩ **2/6** each. Dual gang stereo-matched lin or log 10K to 1MΩ **8/6** each. Stereo balance log/anti-log 10K, 47K, 1MΩ only, **8/6** each. All types available with ½A D.P. switch **2/3** extra.

TRANSISTORS, etc.

2N696	5/6	2N3704	3/9	BC107	3/6	BFY51	4/3
2N697	6/-	2N3705	3/5	BC108	3/-	MC140	6/3
2N706	3/5	2N3707	4/-	BC109	3/6	MJ480	21/-
2N1302	4/-	2N3794	2/11	BC125	12/-	MJ481	27/-
2N1303	4/-	2N4286	2/11	BC126	12/-	MJ491	31/-
2N1304	4/-	2N4289	2/11	BC148	3/3	MPF103	11/6
2N1305	4/-	2N4291	2/11	BC149	4/3	MPF105	7/6
2N2147	18/9	cheapest FET: 2N5163	5/-	BC169	2/3	OA47	1/9
2N2926yellow	1/9			BC183L	2/-	OA90	1/3
2N2926green	2/3	40361	12/6	BC184L	2/3	OA91	1/3
2N3053	5/3	40362	16/9	BD124	16/-	OA202	2/-
2N3054	15/6	AD149	17/6	BFX85	8/3	P346A	5/9
2N3055	16/6	AD161 }	14/-	BFX88	7/9	TPMD	
2N3702	3/6	AD162 }	pr.	BFY50	4/9	(=ORP12)	6/-
2N3703	3/3						

Large capacitors, high ripple current types. 2000μF 25V **7/-**; 2000μF 50V **9/3**; 5000μF 25V **10/3**; 5000μF 50V **17/6**. S-DeC **30/6**; 2-DeC DeCstore **69/6**; 4-DeC **119/6**.

● **DISCOUNTS** (on all but net items): 10% for *total* order value of £3 or over. 15% for *total* order value of £10 or over.

● **POSTAGE** and packing: on orders up to £1 add 1/–. Over £1 post free in U.K. Overseas orders welcomed: carriage charged at cost.

● **CATALOGUE** gives further details of above products and much information on semiconductor characteristics etc. **1/6** post free.

ELECTROVALUE

(Dept. P.E.10)

28 ST. JUDES ROAD, ENGLEFIELD GREEN, EGHAM, SURREY. *Tel:* Egham 5533

R.S.T. VALVE MAIL ORDER CO.

BLACKWOOD HALL, WELLFIELD RD., S.W.16

Special 24 Hour Mail Order Service

AZ31	10/-
CIC	20/-
CY30	12/6
DAF91	4/6
DAF96	7/6
DCC90	10/6
DF91	4/-
DF96	7/6
DH3/91	£6
DH77	4/9
DK91	6/-
DK92	9/-
DK96	7/9
DL66	25/-
DL92	6/3
DL94	6/9
DL96	7/6
DLS10	12/6
DLS16	30/-
DLS19	30/-
DW4350	7/6
DY86	6/-
DY87	5/-
E88CC	12/-
E180F	17/6
E182CC	22/6
EABC80	6/6
EAF42	10/-
EB91	3/-
EBC33	8/6
EBC41	9/9
EBC90	4/9
EBF80	7/6
EBF83	9/-
EBF89	6/6
EBL21	12/-
EBL31	27/6
ECC33	15/-
ECC40	17/6
ECC81	6/-
ECC82	5/9
ECC83	6/3
ECC85	5/-
ECC88	7/6
ECF80	6/6
ECF82	6/6
ECH35	11/6
ECH42	11/-
ECH81	5/9
ECH83	8/6
ECL80	5/9
ECL82	7/-
ECL83	10/3
ECL86	9/-
ECLL800	30/-
EF9	20/-
EF37A	7/-
EF39	8/-
EF41	10/-
EF80	4/3
EF86	6/6
EF89	5/6
EF91	2/9
EF92	2/6
EF98	15/-
EF183	6/6
EF184	7/-
EF804	21/-
EFP60	10/-
EH90	7/6
EL33	12/6
EL34	10/6
EL41	10/6
EL42	10/6
EL81	9/-
EL84	4/9
EL85	7/9
EL86	8/3
EL90	6/3
EL95	6/6
EL360	24/-
EL500	20/6
EL821	7/6
EL822	16/-
ELL80	20/-
EM34	21/-
EM80	7/6
EM81	8/3
EM84	7/6
EN32	25/-
EY51	7/6
EY81	7/-
EY83	8/6
EY84	9/-
EY86	7/-
EZ40	8/3
EZ41	9/6
EZ80	5/6
EZ81	5/6
GT1C	57/6
GZ30	10/-
GZ32	10/-
GZ34	11/-
GZ37	15/-
H63	18/-
HL41DD	13/6
KT61	17/6
KT66	21/-
KT67	45/-

KT81(7C5)	22/6
KT81(GEC)	35/-
KT88	30/-
KTW61	8/6
KTW62	10/-
ML4	17/6
N78	19/-
PC86	11/6
PC88	11/6
PC97	8/9
PC900	8/6
PCC84	6/6
PCC89	10/6
PCC189	10/6
PCF80	6/9
PCF86	9/-
PCF801	9/9
PCF802	9/9
PCF806	13/-
PCL82	7/9
PCL83	10/3
PCL84	8/6
PCL85	9/3
PCL86	9/3
PENB4	20/-
PEN45DD	12/-
PFL200	14/-
PL36	10/9
PL81	8/-
PL82	8/6
PL84	7/-
PL500	14/6
PX4	14/-
PX25	12/6
PY32	10/9
PY33	10/9
PY81	5/9
PY82	4/9
PY83	7/-
PY800	9/6
PY801	9/6
PZ30	10/-
QQV02/6	45/-
QQV03/10	27/6
QQV03/20	105/-
QQV04/15	105/-
QQV06/40	90/-
QQV5/10	70/-
QS70/20	5/6
QS75/20	5/6
QS75/60	20/-
QS83/3	7/3
QS92/10	4/-
QS95/10	5/6
QS108/45	15/-
QS150/15	8/-
QS150/30	6/-
QS150/36	20/-
QS150/45	20/-
QS150/80	20/6
QS1200	7/3
QV03-12	12/-
QV04-7	12/6
QV05-25	9/-
QV06-20	27/6
R10	15/-
R17	8/-
R18	7/6
R19	7/9
RG5/500	80/-
S130	40/-
S130P	40/-
SP41	5/6
SP61	5/-
STV280/40	25/-
STV280/80	95/-
SU2150	12/6
SU2150A	12/6
U19	35/-
U24	24/-
U25	15/6
U26	15/6
U191	13/9
U301	12/6
U404	7/6
U801	23/6
UABC80	6/6
UAF42	10/6
UBC41	9/3
UBC81	9/3
UBF80	7/-
UBF89	7/6
UCC85	7/6
UCH21	9/6
UCH42	10/6
UCH81	7/-

UCL82	6/9
UCL83	10/-
UF41	10/6
UF89	7/6
UL41	12/-
UL84	7/-
UU6	21/-
UU7	21/-
UU8	21/-
UY41	8/6
UY85	5/6
VP4B	25/-
VR105/30	6/6
VR150/30	6/-
W81	12/6
X81	45/-
Z66	15/-
Z319	25/-
Z759	23/-
Z803U	15/-
OA2	6/-
OB2	6/-
OC3	5/6
OZ4	4/6
1B3GT	7/3
1CP31	£6
IR5	6/-
2D21	6/6
2E26	20/-
3A5	12/6
3B28	40/-
3C45	65/-
4X150A	95/-
5R4GY	10/6
5U4G	5/6
5V4G	8/-
5Y3GT	6/-
5Z4G	7/-
6/30L2	15/-
6AK5	5/-
6AK6	12/6
6AL5	3/-
6AM6	3/6
6AN8	10/-
6AQ4	4/-
6AQ5	6/3
6AS6	6/-
6AS7	15/-
6AT6	4/9
6AU6	5/-
6B4G	20/-
6BA6	5/-
6BE6	5/-
6BH6	9/-
6BJ6	9/-
6BK4	21/6
6BN6	7/6
6BQ7A	7/-
6BR7	17/-
6BR8	12/6
6BS7	25/-
6BW6	14/6
6BW7	13/-
6C4	5/-
6CB6	5/-
6CD6G	24/-
6CH6	7/6
6CL6	8/6
6CW4	12/-
6D4	15/-
6DK6	9/-
6F23	16/-
6F24	14/-
6F25	15/-
6F28	14/-
6F32	2/9
6J5G	4/-
6J6	3/6
6J7G	6/-
6K3	2/9
6K7	1/9
6K7G	2/-
6K8G	3/-
6L6G	7/9
6Q7G	6/-
6SG7	6/-
6SJ7M	7/-
6SL7GT	6/-
6SN7GT	5/6
6V6G	4/6
6X4	4/6
6X5G	4/6
6X5GT	6/-
7B6	11/6
7B7	7/6
7C5	22/6
7C6	15/-
7H7	6/6
7S7	45/-
7Y4	8/6
10F1	14/9
10P13	13/6
11E3	70/-
12AC6	10/-
12AD6	11/-
12AE6	9/6
12AT6	4/9
12AT7	6/-
12AU7	5/9

12AX7	6/3
12BA6	6/-
12BE6	6/3
13E1	20/-
12K7GT	7/-
12K8GT	8/-
12Q7GT	6/-
20L1	20/-
20P4	20/-
20P5	20/-
25Z4	6/3
25Z5GT	8/-
25Z6GT	8/6
30C15	15/-
30C17	16/-
30C18	15/-
30F5	17/-
30FL1	16/-
30FL12	19/-
30FL14	15/6
30L15	17/-
30L17	17/-
30P12	16/-
30P19	15/-
30PL1	16/-
30PL13	18/6
30PL14	15/-
35L6	9/-
35L6GT	9/-
35W4	4/6
35Z4GT	8/6
50C5	6/3
50CD6G	31/-
80	7/6
85A1	25/-
85A2	7/3
90AG	45/-
90AV	45/-
90C1	12/-
90CG	25/-
90CV	25/-
150B2	11/6
150B3	8/6
801	9/6
803	35/-
807	9/-
811	35/-
813	75/-
866A	15/-
872A	57/6
5651	7/3
5654	8/-
5672	7/-
5687	10/-
5691	25/-
5749	10/-
5763	12/-
5842	65/-
5963	10/-
6057	10/-
6058	10/-
6059	18/-
6060	6/-
6061	12/-
6062	14/-
6063	7/-
6064	7/-
6065	9/-
6067	10/-
6080	25/-
6096	8/-
6146	27/6
9003	9/-
TRANSISTORS	
IN21	3/6
IN22	5/-
IN429	12/6
IN1192	17/6
IN3065	13/9
IS113	4/6
IS131	4/3
IS420R	12/6
2152	4/3
2G210	12/6
2G309	5/-
2G381	5/-
2G382	6/-
2G401	5/-
2G402	6/-
2G403	10/6
2G414	6/-
2G415	6/-
2G416	6/6
2G417	6/-
2N247	9/6
2N274	9/6
2N410	3/6
2N555	12/6
2N585	7/6
2N599	12/6
2N696	10/-
2N697	12/6
2N700A	6/6
2N1040	20/-
2N1132	19/6
2N1301	6/6
2N1304	6/-
2N2062	7/6
2N2068	20/-

2N2147	12/6
2N2160	15/0
2N2369A	4/6
2N2398	30/-
2N2904	10/-
2N2904A	12/6
2N2926	5/3
2N3819	13/-
2S002	20/-
2S003	12/-
2S004	11/-
2S005	48/-
2S006	20/-
2S012	50/-
2S012A	55/-
2S013	20/-
2S018	60/-
2S108	60/-
2S301	12/6
2S320	9/-
2S702	15/-
45L	45/-
AC107	10/-
AC126	6/6
AC127	7/6
AC128	6/6
AC176	7/6
ACY17	7/6
ACY18	5/3
ACY19	6/6
ACY20	5/-
ACY21	6/-
ACY22	3/6
ACY28	4/6
AD140	16/-
AD161	11/-
AF114	6/6
AF115	6/6
AF116	6/-
AF117	6/6
AF118	10/-
AF125	6/3
AF178	12/6
AF186	17/6
AFY19	22/6
AS220	7/6
ASZ21	12/6
ASZ23	30/-
ATZ10	30/-
AUY10	39/6
BC107	7/6
BC108	5/-
BC109	7/6
BCY31	13/6
BCY33	7/6
BCY34	6/-
BCY39	24/-
BCY40	12/-
BCZ11	5/-
BDY11	27/6
BDY12	32/-
BFY51	3/6
BFY52	4/6
BPY10	21/6
BSY27	9/6
BSY28	5/-
BSY51	7/6
BSY53	7/6
BSY95A	5/6
BSX82	40/-
BTY88	19/6
BTY95100R	140/-
BY100	5/6
BY114	5/-
BYZ11	9/6
BYZ12	12/-
BYZ13	7/6
BYZ18	15/-
CDT1313	12/6
CG64	2/6
CK707	2/6
CRS1/05	7/6
CV102	3/6
CV103	3/6
CV425	3/6
CV2226	20/-
CV2258	25/-
CV2290	5/-
CV2919	2/6
CV1782	30/-
CV7183	30/-
DD003	3/6
DD190	9/9
DD226A	7/6
EW99	5/-
GET7	5/-
GET8	8/-
GET16	7/3
GET20	10/-
GET88	5/-
GET102	6/-
GET114	4/-
GET115	9/-
GET116	15/-
GET571	5/-
GET872	6/-
GET874	5/-
GET875	6/-

GET880	9/-
GET885	5/-
GEX54	2/6
GEX541	15/-
GJ3M	3/6
GJ5M	3/6
GJ6M	3/6
GJ7M	6/6
HD2967	4/-
HG5002	4/-
JK9A	22/6
JK10A	15/-
JK10B	15/-
JK19A	22/6
JK21A	12/6
K835A	5/-
MAT101	8/6
MAT120	7/9
NKT128	6/-
NKT142	8/-
NKT211	6/-
NKT214	4/-
NKT216	7/6
NKT217	8/-
NKT218	6/-
NKT221	5/6
NKT223	6/-
NKT224	4/6
NKT225	3/6
NKT227	5/6
NKT228	6/-
NKT251	5/-
NKT265	9/6
NKT274	5/-
NKT304	8/-
NKT352	8/-
NKT404	12/6
NKT452	12/6
NKT675	6/-
NKT676	5/-
NKT677	5/-
NKT678	6/-
NKT713	7/6
NKT777	8/-
OA2	6/3
OA7	4/-
OA10	3/-
OA47	3/-
OA70	2/-
OA79	2/6
OA81	2/6
OA85	2/6
OA86	4/-
OA91	2/6
OA200	3/3
OA202	4/3
OA210	7/6
OAZ200	11/-
OAZ201	10/-
OAZ202	8/6
OAZ204	8/6
OAZ206	8/6
OAZ208	6/6
OAZ222	9/6
OAZ224	10/-
OAZ225	10/-
OAZ242	4/6
OAZ246	4/6
OAZ290	9/6
OAZ292	9/6
OC16	20/-
OC19	7/6
OC20	15/-
OC22	10/-
OC23	11/6
OC24	15/-
OC25	9/-
OC26	7/-
OC28	12/-
OC29	15/-
OC35	12/6
OC36	12/6
OC41	6/-
OC42	5/-
OC43	9/-
OC44	4/-
OC44M	5/6
OC45	3/6
OC45M	4/-
OC46	5/6
OC47	7/6
OC57	16/-
OC58	17/6
OC59	18/6
OC70	4/-
OC71	3/6
OC72	5/-
OC73	7/6
OC74	6/-
OC75	6/-
OC76	5/-
OC77	8/-
OC78	5/-
OC81	5/-
OC81D	3/-
OC81DM	3/-
OC81M	5/6
OC81Z	9/-
OC82	6/-

Postage 6d. valve, transistors post free

OPEN DAILY TO CALLERS 9 a.m.—5.30 p.m. No early closing

C.W.O. No C.O.D. Tel. 01-769 0199 & 1649

SEND S.A.E. FOR FREE LIST OF 6,000 TYPES, VALVES AND TRANSISTORS

SEMICONDUCTORS & COMPONENTS

BRAND NEW (Saturday callers only 5% Discount) **GUARANTEED**

TRANSISTORS

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
2G301	4/-	2N3014	7/6	2N5366	10/-	BC108	3/6	BFY56A	11/-	NKT238	6/-		
2G302	4/-	2N3053	6/6	2N5367	11/6	BC109	3/6	BFY75	6/-	NKT240	6/-		
2G303	4/-	2N3054	11/6	2N5457	7/6	BC113	6/6	BFY76	6/-	NKT241	6/6		
2G306	8/6	2N3055	15/-	2S005	15/-	BC115	6/6	BFY77	11/6	NKT10419	6/-		
2G308	6/-	2N3133	6/-	2S020	37/6	BC116	12/6	BFY90	12/6	NKT10439	6/-		
2G309	6/-	2N3134	6/-	2S102	6/6	BC118	6/6	BFW58	7/6	NKT10519	6/-		
2G371	3/-	2N3135	6/-	2S103	6/6	BC121	4/-	BFW59	6/6	NKT20329	8/6		
2G374	5/6	2N3136	6/-	2S104	6/6	BC122	4/-	BFW60	6/6	NKT20339	10/6		
2G381	4/6	2N3390	10/6	2S501	5/6	BC125	13/6	BSX19	5/6	NKT80111	15/6		
2N404	6/6	2N3391	7/6	2S502	5/6	BC126	13/6	BSX20	5/6	NKT80112	19/6		
2N696	5/-	2N3391A	6/-	2S503	5/6	BC140	11/-	BSX21	8/6	NKT80113	22/6		
2N697	5/-	2N3392	6/6	3N83	37/6	BC147	5/-	BSX26	10/6	NKT80211	18/6		
2N698	4/6	2N3393	6/6	3N128	18/6	BC148	4/6	BSX27	10/6	NKT80212	18/6		
2N706	2/6	2N3394	5/6	3N140	19/6	BC149	5/-	BSX28	6/-	NKT80213	18/6		
2N706A	2/6	2N3402	7/6	3N141	21/6	BC157	4/-	BSX60	19/6	NKT80214	18/6		
2N708	4/-	2N3403	7/6	3N142	16/6	BC158	3/6	BSX61	12/6	NKT80215	18/6		
2N709	12/6	2N3404	8/6	3N143	19/6	BC159	4/-	BSX76	4/6	NKT80216	18/6		
2N718	6/-	2N3405	12/6	3N152	24/-	BC160	12/6	BSX77	6/6	OC20	21/6		
2N726	5/-	2N3414	5/6	R.C.A.:—		BC167	3/6	BSX78	6/6	OC22	8/-		
2N727	5/-	2N3415	6/6	40250	16/6	BC168	3/6	BSY10	5/6	OC23	8/-		
2N743	4/6	2N3416	9/6	40251	17/6	BC169	3/6	BSY11	5/6	OC24	7/6		
2N744	4/6	2N3417	11/6	40253	8/6	BC170	3/6	BSY24	4/-	OC25	8/-		
2N753	5/6	2N3570	12/6	40254	10/6	BC171	3/6	BSY25	4/-	OC26	6/6		
2N914	3/6	2N3572	12/6	40309	10/6	BC172	3/6	BSY26	4/-	OC28	8/6		
2N916	3/6	2N3605	5/6	40310	13/-	BC182	4/6	BSY27	4/-	OC30	8/-		
2N918	6/-	2N3606	5/6	40311	10/6	BC183	4/6	BSY28	4/-	OC35	6/6		
2N929	5/6	2N3607	4/6	40312	13/6	BC184	4/6	BSY29	4/-	OC36	6/6		
2N930	6/6	2N3662	9/6	40314	11/-	BC212L	5/-	BSY32	5/-	OC38	10/6		
2N987	10/6	2N3663	10/-	40315	11/-	BCY10	5/6	BSY36	5/-	OC41	4/6		
2N1090	6/6	2N3702	4/-	40316	12/6	BCY12	5/6	BSY37	5/-	OC42	4/-		
2N1091	6/6	2N3703	4/6	40317	11/-	BCY30	7/6	BSY38	4/6	OC44	4/-		
2N1131	8/6	2N3704	5/6	40319	14/-	BCY31	4/6	BSY39	4/6	OC45	2/6		
2N1132	8/6	2N3705	4/6	40320	11/-	BCY32	7/6	BSY40	6/6	OC46	3/-		
2N1302	4/-	2N3706	4/6	40323	10/6	BCY33	5/6	BSY51	10/6	OC70	3/-		
2N1303	4/-	2N3707	4/-	40324	12/6	BCY34	5/6	BSY52	6/-	OC71	2/6		
2N1304	4/6	2N3708	4/-	40326	10/6	BCY38	5/6	BSY53	9/-	OC72	2/6		
2N1305	4/6	2N3709	4/-	40329	7/6	BCY39	6/6	BSY54	6/-	OC74	4/6		
2N1306	5/-	2N3710	4/-	40344	8/-	BCY40	7/6	BSY56	6/-	OC75	4/6		
2N1307	5/-	2N3711	4/-	40347	10/-	BCY42	3/-	BSY78	9/6	OC76	3/-		
2N1308	6/-	2N3819	9/-	40348	11/-	BCY43	3/-	BSY79	9/6	OC77	4/-		
2N1309	6/-	2N3820	21/6	40360	12/6	BCY54	7/6	BSY82	10/6	OC78	3/-		
2N1420	7/6	2N3823	17/6	40361	12/6	BCY58	4/6	BSY83	11/6	OC78D	3/-		
2N1507	5/6	2N3854	5/6	40362	14/6	BCY59	4/6	BSY84	12/6	OC81	4/-		
2N1525	7/6	2N3854A	5/6	40370	8/6	BCY60	19/6	BSY85	13/6	OC81D	3/-		
2N1526	7/6	2N3855	5/6	40467	16/6	BCY70	5/6	BSY87	10/6	OC82	3/-		
2N1527	7/6	2N3855A	6/-	40468A	16/6	BCY71	9/6	BSY90	11/6	OC82D	3/-		
2N1605	9/6	2N3856	6/-	AC107	6/-	BCY72	5/-	BSY95A	3/6	OC83	4/6		
2N1613	6/6	2N3856A	6/-	AC126	4/-	BCZ10	4/6	BSW41	8/6	OC84	5/-		
2N1631	8/6	2N3858	5/-	AC127	5/-	BCZ11	4/6	BSW70	5/6	OC123	4/6		
2N1632	8/6	2N3858A	6/-	AC128	4/-	BD121	19/6	D16P1	7/6	OC139	6/6		
2N1637	8/6	2N3859	5/6	AC176	6/-	BD123	23/6	D16P2	8/-	OC140	6/6		
2N1638	8/6	2N3859A	6/6	AC187	12/-	BD124	12/-	D16P3	7/6	OC170	6/-		
2N1639	8/6	2N3860	6/-	AC188	12/-	BF115	5/6	D16P4	8/-	OC171	6/-		
2N1711	6/6	2N3877	9/-	ACY17	5/-	BF117	10/6	GET102	6/-	OC200	5/6		
2N1889	8/-	2N3877A	9/6	ACY18	5/-	BF167	6/6	GET113	4/-	OC201	5/6		
2N1893	8/-	2N3900	10/6	ACY19	5/-	BF173	7/6	GET114	4/-	OC202	8/6		
2N2147	17/6	2N3900A	11/6	ACY20	5/-	BF177	11/6	GET116	6/-	OC203	5/6		
2N2148	12/6	2N3901	19/6	ACY21	5/-	BF178	10/6	GET118	4/-	OC204	5/6		
2N2160	14/6	2N3903	8/-	ACY22	4/-	BF179	11/6	GET119	4/-	OC205	7/6		
2N2193	5/6	2N3904	8/6	ACY28	4/-	BF180	7/6	GET120	6/6	OC207	7/6		
2N2193a	5/6	2N3905	8/-	ACY40	4/-	BF181	6/6	GET873	3/-	OCP71	8/6		
2N2194A	4/6	2N3906	8/6	ACY41	5/-	BF184	7/6	GET880	6/-	ORP12	8/6		
2N2217	6/-	2N4058	6/6	ACY44	8/-	BF185	5/6	GET887	4/-	ORP60	10/-		
2N2218	6/-	2N4059	5/-	AD140	8/-	BF194	6/6	GET889	4/6	ORP61	10/-		
2N2219	6/-	2N4060	5/-	AD149	8/-	BF195	5/6	GET890	4/6	P346A	5/6		
2N2220	5/-	2N4061	5/-	AD150	15/6	BF196	5/6	GET896	4/6	TIS34	17/6		
2N2221	5/-	2N4062	5/6	AD161	7/6	BF197	5/6	GET897	4/6	TIS43	8/6		
2N2222	5/-	2N4244	9/6	AD162	7/6	BF198	5/6	GET898	4/6	TIS44	3/-		
2N2287	21/6	2N4255	8/6	AF106	11/6	BF200	10/6	MAT100	6/-	TIS45	4/-		
2N2297	6/-	2N4254	8/6	AF114	5/-	BF224	6/6	MAT101	6/-	TIS46	4/-		
2N2302	12/6	2N4255	7/6	AF115	5/-	BF225	6/6	MAT120	6/-	TIS47	4/-		
2N2303	7/6	2N4284	3/6	AF116	5/-	BF237	6/6	MAT121	6/-	TIS48	4/-		
2N2368	6/6	2N4285	3/6	AF117	5/-	BF238	6/6	MJ400	21/6	TIS49	4/-		
2N2369	7/6	2N4286	3/6	AF118	12/6	BFX12	5/6	MJ420	22/6	TIS50	5/6		
2N2369A	5/-	2N4287	3/6	AF119	4/-	BFX13	5/6	MJ421	22/6	TIS51	4/-		
2N2410	10/6	2N4288	3/6	AF124	5/-	BFX29	12/6	MJ430	20/6	TIS52	4/-		
2N2411	6/6	2N4289	4/6	AF125	5/-	BFX30	9/-	MJ440	19/-	TIS53	6/-		
2N2412	6/6	2N4290	3/6	AF126	5/-	BFX43	8/6	MJ480	20/6	TIS60	6/6		
2N2483	5/6	2N4291	3/6	AF127	5/-	BFX44	8/6	MJ481	27/6	TIS61	6/6		
2N2484	5/6	2N4292	3/6	AF139	7/6	BFX68	13/6	MJ490	22/6	ZTX107	3/6		
2N2539	4/6	2N4433	5/6	AF178	12/6	BFX68A	13/6	MJ491	29/6	ZTX108	3/6		
2N2540	4/6	2N4434	5/6	AF179	11/6	BFX84	8/-	MPF102	8/6	ZTX109	3/6		
2N2613	7/9	2N4435	5/6	AF180	12/6	BFX85	10/-	MPF103	7/6	ZTX300	4/-		
2N2614	7/6	2N5027	10/6	AF181	8/6	BFX86	8/-	MPF104	7/6	ZTX301	4/-		
2N2645	6/-	2N5028	11/6	AF239	7/6	BFX87	10/-	MPF105	8/6	ZTX302	5/-		
2N2646	11/6	2N5029	9/6	AF279	13/6	BFX88	5/-	MPS3638	6/6	ZTX303	5/-		
2N2696	6/6	2N5030	8/6	AF280	13/6	BFX92A	12/6	NKT0013	8/6	ZTX304	7/6		
2N2711	8/6	2N5172	4/6	AFZ11	5/6	BFY10	4/6	NKT124	8/6	ZTX500	5/-		
2N2712	8/6	2N5174	12/6	AFZ12	6/6	BFY11	4/6	NKT125	6/-	ZTX501	5/-		
2N2713	9/-	2N5175	12/6	ASY26	5/6	BFY17	4/6	NKT126	7/6	ZTX502	6/-		
2N2714	9/-	2N5176	13/6	ASY27	8/6	BFY18	4/6	NKT128	5/6	ZTX503	5/-		
2N2865	12/6	2N5232	8/6	ASY28	5/6	BFY19	4/6	NKT135	5/6	ZTX504	12/6		
2N2904	8/-	2N5232A	9/-	ASY29	4/6	BFY20	12/6	NKT137	6/6				
2N2904A	8/-	2N5245	12/6	ASY36	5/-	BFY21	8/6	NKT210	6/-				
2N2905	8/-	2N5246	12/6	ASY50	5/-	BFY24	9/-	NKT211	6/6				
2N2905A	8/-	2N5249	13/6	ASY51	6/6	BFY25	5/-	NKT212	5/6				
2N2906	8/-	2N5249A	13/6	ASY53	5/-	BFY26	4/-	NKT213	6/6				
2N2906A	8/-	2N5305	7/6	ASY54	5/-	BFY29	10/-	NKT214	4/6				
2N2907	8/-	2N5306	8/-	ASY62	5/-	BFY30	10/-	NKT215	4/6				
2N2923	4/-	2N5307	7/6	ASY63	3/6	BFY36	4/-	NKT216	6/6				
2N2924	4/6	2N5308	7/6	ASY72	5/-	BFY37	5/-	NKT217	8/6				
2N2925	4/6	2N5309	12/6	ASY83	5/-	BFY41	10/-	NKT219	6/6				
2N2926		2N5310	8/6	ASY86	6/6	BFY43	13/6	NKT223	6/6				
,, Green	3/-	2N5354	5/6	ASZ20	7/6	BFY50	4/6	NKT224	5/-				
,, Yellow	2/9	2N5355	5/6	ASZ21	7/6	BFY51	4/6	NKT225	5/-				
,, Orange	2/6	2N5356	10/6	AUY10	20/-	BFY52	4/6	NKT229	6/-				
2N3011	5/-	2N5365	9/6	BC107	3/6	BFY53	5/6	NKT237	8/-				

PANEL METERS

38 Series—FACE SIZE 42 × 42mm. All prices for 1-9 pieces. 50μA, 37/6; 100μA, 35/-; 200μA, 32/6; 500μA, 27/6; 50-0-50μA, 35/-; 100-0-100μA, 32/6; 500-0-500μA, 25/-; 1MA, 25/-; 5MA, 25/-; 10MA, 25/-; 50MA, 25/-; 100MA, 25/-; 500MA, 25/-; 1A, 25/-; 5A, 25/-; 10V, 25/-; 20V, 25/-; 50V, 25/-; 300V, 25/-; 500V, 25/-

SILICON RECTIFIERS

PIV	50	100	200	400	600	800	1000	12000
1A	2/9	3/-	3/3	3/6	3/9	4/-	4/6	—
3A	3/-	—	—	4/6	—	6/-	—	—
6A	—	—	5/-	6/6	7/6	9/-	10/-*	—
10A	8/-	12/6	13/6	16/6	16/6	19/6	23/-	30/-
17A	—	15/6	16/9	21/-	21/-	26/-	32/6	43/6

*5A only 1A Types are plastic

DIODES & RECTIFIERS

IN461	1/6	IS130	2/6	BAX13	2/6	BYZ10	9/-	OA73	2/-
IN914	1/6	IS132	2/6	BAX16	2/6	BYZ11	7/6	OA79	1/9
IN916	1/6	IS131	3/-	BAY18	3/6	BYZ12	6/6	OA81	1/6
IN4007	4/6	AA119	2/-	BAY31	1/6	BYZ13	5/-	OA85	1/6
IS010	3/-	AAZ13	2/-	BAY38	2/6	FST3/4	4/6	OA90	1/6
IS021	4/-	AAZ15	2/6	BY100	4/6	FST3/8	6/-	OA91	1/6
IS025	5/-	AAZ17	2/6	BY103	4/6	OA5	2/6	OA95	1/6
IS113	3/-	BA100	2/-	BY122	7/6	OA9	2/-	OA182	2/-
IS120	2/6	BA102	4/-	BY124	3/-	OA47	2/-	OA200	2/-
IS121	2/6	BA115	1/6	BYX10	5/6	OA70	1/6	OA202	2/-

INTEGRATED CIRCUITS

RCA

CA3005	30/-	CA3020	30/-	CA3028A	25/-	CA3041	32/6
CA3011	20/-	CA3021	42/6	CA3028B	35/-	CA3042	32/6
CA3012	25/-	CA3022	35/-	CA3035	35/-	CA3043	35/-
CA3013	30/-	CA3023	32/6	CA3036	20/-	CA3044	32/6
CA3014	30/-	CA3026	27/6	CA3039	25/-	CA3045	32/6
CA3018	25/-					CA3046	25/-
CA3019	25/-					CA3051	25/-

Data and application sheets 2/- per type

Motorola

MC724P	Quad 2 Input Gates	19/6
MC789P	Hex Inverter	19/6
MC790P	Dual JK Flip Flop	32/6
MC799P	Dual Buffer	29/6

Fairchild

	1–6	6–11	12+
L900 Buffer	11/-	9/6	8/4
L914 Dual Gate	11/-	9/6	8/4
L923 JK Flip Flop	14/-	12/6	11/9
L709 Operational Amplifier	27/6	23/-	21/-

Quantity Prices on Application

General Electric

PA230	Low Level Amplifier	27/6
PA234	Audio Amplifier	26/6
PA237	2 watt Audio Amplifier	45/-

Mullard

FCH211	Hextuple DTL Inverter Gate	28/6
FCH221	Triple 3 Input DTL Line	28/6
FCJ101	3 Input JK Flip Flop	35/-
TAA241	Operational Amplifier	47/6
TAA243	Operational Amplifier	47/6
TAA263	Linear A.F. Amplifier	18/6
TAA320	Most L.F. Pre-Amplifier	15/6

THYRISTORS

PIV	50	100	200	300	400
1A	5/-	5/6	7/6	8/-	9/6
3A	6/-	7/6	8/-	9/-	10/6
5A	—	8/-	9/-	—	12/6
7A	—	11/-	13/-	14/-	19/6
25A	27/6	30/-	33/-	—	37/6

Also 12A, 100 PIV, 15/-; 600 PIV, 35/6

VEROBOARD

	0·1 Matrix	0·15 Matrix
2½ × 3¾in	3/6	4/-
2½ × 5in	4/3	4/9
3¾ × 3¾in	4/3	4/9
3¾ × 5in	5/6	5/6
3¾ × 17in	16/-	21/6
3¾ × 17in (plain)	—	11/6
5 × 17in (plain)	—	15/6
Vero Pins (bag of 36)	3/-	3/-

Vero Cutter, 9/-

HEAT SINKS

4·8 × 4 × 1in Finned for Two TO-3 Trans., 9/6. 4·8 × 2 × 1in Finned, for One TO-3 Trans., 6/6. For SO-1, 6d. For TO-5, 1/- Finned. For TO-18, 1/- Finned. For TO-18, 1/- Finned.

CAPACITORS

A large and comprehensive range available: Electrolytic, Polyester, Ceramic, Polystyrene, Silver Mica, Tantalum, Trimmers

Examples:
2,000mF 25V, 8/6
2,500mF 50V, 13/6
3,000mF 25V, 10/6
5,000mF 50V, 19/6

RESISTORS

Carbon Film
¼ watt 10%, 4d.
½ watt 5% Hy-stab, 6d.
½ watt 5%, 5d.
1 watt 10%, 6d.
2 watt 10%, 1/-

WIRE-WOUND

3 watt 5% (up to 270 ohms only), 1/6
5 watt 5% (up to 8·2kΩ only, 2/-
10 watt 5% (up to 25kΩ only), 2/9

POTENTIOMETERS

Carbon:
Log. and Lin., less switch, 3/3.
Log. and Lin., with switch, 4/6.
Wire-wound Pots (3W), 6/6.
Twin Ganged Stereo Pots, Log. and Lin., 7/6.

PRESETS

Miniature and Sub-miniature (0·2W), Vertical and Horizontal, 1/6.

THERMISTORS

Large range in stock from 1·1 ohm to 150kΩ at 25°C. (See catalogue for full list.)
We are happy to quote for quantity supplies to manufacturers, etc.

Telephone 01-452 0161/2/3

A MARSHALL & SON
28 CRICKLEWOOD BROADWAY, LONDON, N.W.2

CALLERS WELCOME
HRS. 9-5.30 Mon-Sat

NEW PRICES ON NEW COMPONENTS

RESISTORS

High stability, carbon film, low noise. Capless construction, molecular termination bonding.

Dimensions (mm): Body; ¼W; 8 2·8
½W; 10 4·3
Leads; 35

10% ranges; 10 Ohms to 10 Megohms (E12 Renard Series)
5% ranges; 4·7 Ohms to 1 Megohm (E24 Renard Series)

Prices—per Ohmic value.

		each	10 off	25 off	100 off
¼W	10%				
¼W	10%	2d	1/6	3/3	10/4
¼W	5%	2½d	1/9	3/8	11/8
½W	10%	2½d	1/9	3/8	11/7
½W	5%	3d	2/–	4/–	12/10

CAPACITORS

Subminiature Polyester film, Modular for P.C. mounting. Hard epoxy resin encapsulation. Radial leads.

±100% tolerance. 100 Volt Working.

Prices—per Capacitance value (μF)

	each	10 off	25 off	100 off
0·001, 0·002, 0·005, 0·01, 0·02	6d	4/3	8/4	30/–
0·05	8d	6/–	12/6	41/8
0·1	10d	7/1	15/6	51/–
0·2	1/2	10/–	20/10	68/6
0·5	2/–	17/6	37/6	125/–

Polystyrene film, Tubular, Axial leads. Unencapsulated.

±5% or ±1pf tolerance. 160 Volt Working.

Prices—per Capacitance value (μμF)

	each	10 off	25 off	100 off
10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82, 100, 120, 180, 220, 270, 330, 390	5d	3/7	7/9	24/–
470, 560, 680, 820, 1,000, 1,500	6d	4/–	8/8	26/8
2,200, 3,300, 4,700, 5,600	7d	5/–	10/10	33/4
6,800, 8,200, 10,000, 15,000	8d	6/–	13/–	40/–
22,000	9d	6/9	18/–	45/4

Polystyrene film, Tubular, Axial leads. Professional Grade. Hard Epoxy Resin encapsulation.

±1% tolerance. 100 Volt Working.

Prices—per Capacitance value (μμF)—except where stated)

	each	10 off	25 off	100 off
100, 120, 150, 180	1/3	10/2	21/2	64/6
220, 270, 330, 390, 470, 560, 680, 820	1/3	10/8	23/1	71/–
1,000, 1,200, 1,500, 2,200, 2,700	1/6	13/10	29/11	92/–
3,300, 3,900, 4,700, 5,600	1/9	14/1	31/–	96/–
6,800, 8,200, 10,000, 12,000	1/9	15/2	32/10	101/–
15,000, 18,000	2/–	15/11	34/9	107/4
22,000, 27,000	2/3	17/3	37/10	115/–
33,000, 39,000	2/6	20/1	43/6	133/9
47,000, 56,000	2/9	22/1	47/10	147/4
68,000	3/–	24/9	53/8	165/4
82,000	3/3	26/1	56/6	173/9
0·1μF	3/6	27/5	59/4	182/8
0·12μF	3/9	30/3	65/10	202/–
0·15μF	4/3	34/2	73/7	228/–
0·18μF	5/–	37/10	81/11	252/3
0·22μF	6/–	47/–	101/10	313/4
0·27μF	6/9	53/9	116/8	358/4
0·33μF	7/3	58/10	126/11	390/–
0·39μF	7/9	65/–	140/10	433/4
0·47μF, 0·5μF	9/9	75/2	137/7	500/–

POTENTIOMETERS (Carbon)

Miniature, fully enclosed, rear tags, carbon brush wiper. Long life, low noise. Body dia., ¾in. Spindle, 1in. ¼in. ¼W at 70°C. ±20% ¼M, ±30%. ¼M Lin. 100 Ohms to 10 Megohms, Log. 5 Kohms to 5 Megohms.

Prices—per ohmic value.	each	10 off	25 off	100 off
	2/3	20/–	45/10	186/8

GANGED STEREO POTENTIOMETERS (Carbon)

½W at 70°C. Long Spindle.
Logarithmic and Linear: 5k + 5k to 1M + 1M.

Prices per ohmic value	each	10 off	25 off	100 off
	8/–	70/–	162/6	575/–

SKELETON PRE-SET POTENTIOMETERS (Carbon)

High quality pre-sets suitable for printed circuit boards of 0·1in. P.C.M. 100 Ohms to 5 Megohms (Linear only).
Miniature: 0·3W at 70°C. ±20% below ½M, ±30% above ¼M. Horizontal (0·7in. × 0·4in. P.C.M.) or Vertical (0·4in. × 0·2in. P.C.M.).
Subminiature: 0·1W at 70°C. ±20% below 2·5M, ±30% above.

Prices—per ohmic value	each	10 off	25 off	100 off
Miniature (0·3W)	1/–	8/9	18/9	66/8
Subminiature (0·1W)	10d	7/1	14/7	46/8

JACK PLUGS

¼in. Type P1. Standard. Screened. Heavily chromed.
¼in. Type SE/P1. Side-entry version of type P1.
¼in. Type P2. Standard. Unscreened. Unbreakable moulded cover.
¼in. Type P3. Tip-Ring-Sleeve Stereo version of Type P1.
¼in. Type P4. Tip-Ring-Sleeve Stereo version of Type P2.
3·5mm Type P5. Standard. Screened. Aluminium cover.
3·5mm Type P6. Standard. Unscreened. Unbreakable moulded cover.

Prices—	each	10 off	25 off	100 off
P1.	3/–	26/8	62/6	233/4
SE/P1.	3/6	30/10	66/8	280/–
P2.	2/6	23/4	54/2	200/–
P3.	6/6	60/–	137/6	500/–
P4.	6/2	56/6	127/6	455/–
P5.	2/2	19/2	43/9	158/4
P6.	1/8	15/–	33/4	116/8

JACK SOCKETS

¼in. Type S3. Stereo version for use with P3 or P4 plugs.
¼in. Type S.5. Standard. Moulded body. Chrome insert.
3·5mm Type S.6. Standard. Moulded body. Chrome insert.
Available with make or break contacts on Tip, Ring and Sleeve.

Prices—	each	10 off	25 off	100 off
S3	3/3	30/–	68/9	250/–
S5	2/9	25/–	56/8	216/8
S6	1/6	13/4	33/4	100/–

ELECTROLYTIC CAPACITORS (Mullard). —10% to +50%.

Subminiature (all values in μF)

4V	8	32	64	125	250	400
6·4V	6·4	25	50	100	200	320
10V	4	16	32	64	125	200
16V	2·5	10	20	40	80	125
25V	1·6	6·4	12·5	25	50	80
40V	1	4	8	16	32	50
64V	0·64	2·5	5	10	20	32
Price	1/4	1/3	1/2	1/–	1/1	1/2

Small (all values in μF)

4V	800	1,250	2,000	3,200
6·4V	640	1,000	1,600	2,500
10V	400	640	1,000	1,600
16V	250	400	640	1,000
25V	160	250	400	640
40V	100	160	250	400
64V	64	100	160	250
Price	1/6	2/-	2/6	3/-

POLYESTER CAPACITORS (Mullard)

Tubular, 10%, 160V: 0·01, 0·015, 0·022μF, **7d.** 0·033, 0·047μF, **8d.** 0·068, 0·1μF, **9d.** 0·15μF, **11d.** 0·22μF, **1/–.** 0·33μF, **1/3.** 0·47μF, **1/6.** 0·68μF, **2/3.** 1μF, **2/8.**

400V: 1,000, 1,500, 2,200, 3,300, 4,700pF, **6d.** 6,800pF, 0·01, 0·015, 0·022μF, **7d.** 0·033μF, **8d.** 0·047μF, **9d.** 0·068, 0·1μF, **11d.** 0·15μF, **1/2.** 0·22μF, **1/6.** 0·33μF, **2/3.** 0·47μF, **2/8.**

Modular, metallised. P.C. mounting, 20%, 250V: 0·01, 0·015, 0·022μF, **7d.** 0·033, 0·047μF, **8d.** 0·068, 0·1μF, **9d.** 0·15μF, **11d.** 0·22μF, **1/-.** 0·33μF, **1/5.** 0·47μF, **1/8.** 0·68μF, **2/3.** 1μF, **2/9.**

SEMICONDUCTORS: OA5, OA81, **1/9.** OC44, OC45, OC71, OC81, OC81D, OC82D, **2/–.** OC70, OC72, **2/3.** AC107, OC75, OC170, OC171, **2/6.** AF115, AF116, AF117, ACY19, ACY21, **3/3.** OC140, **4/3.** OC200, **5/–.** OC139, **5/3.** OC25, **7/–.** OC35, **8/–.** OC23, OC28, **8/3.**

SILICON RECTIFIERS (0·5A): 170 P.I.V., **2/9.** 400 P.I.V., **3/–.** 800 P.I.V., **3/3.** 1,250 P.I.V., **3/9.** 1,500 P.I.V., **4/–.** (0.75A): 200 P.I.V., **1/6.** 400 P.I.V., **2/–.** 800 P.I.V., **3/3.** (6A): 200 P.I.V., **3/–.** 400 P.I.V., **4/–.** 600 P.I.V., **5/–.** 800 P.I.V., **6/–.**

SWITCHES (Chrome finish, Silver contacts): 3A 250V, 6A 125V. Push Buttons: Push-on or Push-off **5/-.** Toggle Switches: SP/ST, **3/6.** SP/DT, **3/9.** SP/DT (with centre position) **4/-.** DP/ST, **4/6.** DP/DT, **5/-**

ROTARY SWITCHES (Wafer)

High quality. Rear tags. Long spindle, ¼″ Dia.
1p/12w, 2p/6w, 3p/4w, 4p/3w, 2p/3w.

Prices—	each	10 off	25 off	100 off
All Types	4/6	38/4	83/4	283/4

PRINTED CIRCUIT BOARD (Vero).

0·15in Matrix: 3¾in × 2½in, **3/3.** 5½in × 2½in, **3/11.** 3¾in × 3¾in, **3/11.** 5in × 3¾in, **5/6.**
0·1 Matrix: 3¾in × 2½in, **4/-.** 5in × 2½in, **4/6.** 3¾in × 3¾in, **4/6.** 5in × 3¾in, **5/3.**

Send S.A.E. for January, 1969 Catalogue

DUXFORD ELECTRONICS (PE)

97/97A MILL ROAD, CAMBRIDGE

Telephone: CAMBRIDGE (0223) 63687

(Visit us—at our new Mail Order, Wholesale & Retail Premises) MINIMUM ORDER VALUE 5/- C.W.O. Post and Packing 1/6

BI-PRE-PAK
LIMITED

FULLY TESTED AND MARKED

AC107	3/-	OC170	3/-
AC126	2/6	OC171	4/-
AC127	2/6	OC200	3/6
AC128	2/6	OC201	7/-
AC176	5/-	2G301	2/6
ACY17	3/-	2G303	2/6
AF114	4/-	2N711	10/-
AF115	3/6	2N1302-3	4/-
AF116	3/6	2N1304-5	5/-
AF117	3/6	2N1306-7	6/-
AF239	12/6	2N1308-9	8/-
AF186	10/-	2N3844A	5/-
AF139	10/-	Power	
BFY50	4/-	Transistors	
BSY25,	7/6	OC20	10/-
BSY26	3/-	OC23	10/-
BSY27	3/-	OC25	8/-
BSY28	3/-	OC26	5/-
BSY29	3/-	OC28	7/6
BSY95A	3/-	OC35	5/-
OC41	2/6	OC36	7/6
OC44	2/6	AD149	10/-
OC45	2/6	AUY10	30/-
OC71	2/6	2N3055	15/-
OC72	2/6	Diodes	
OC73	3/6	AAY42	2/-
OC81	2/6	OA95	2/-
OC81D	2/6	OA70	1/9
OC83	4/-	OA79	1/9
OC139	2/6	OA81	1/9
OC140	3/6	IN914	1/6

FREE!
PACKS OF YOUR OWN CHOICE UP TO THE VALUE OF **10/-** WITH ORDERS OVER **£4**

TRY OUR X PAKS FOR UNEQUALLED VALUE

XA PAK

Germanium PNP type transistors, equivalents to a large part of the OC range, i.e. 44, 45, 71, 72, 81, etc.

PRICE £5 PER 1000

POST & PACKING 4/6 U.K.

XB PAK

Silicon TO-18 CAN type transistors NPN/PNP mixed lots with equivalents to OC200-1, 2N706a, BSY27/29, BSY95A.

PRICE £4.5.0 PER 500
PRICE £8 PER 1000

POST & PACKING 2/6 U.K.

XC PAK

Silicon diodes miniature glass types, finished black with polarity marked, equivalents to OA200, OA202, BAY31-39 and DK10, etc.

PRICE £4.10.0 PER 1000

POST & PACKING 2/6 U.K.

ALL THE ABOVE UNTESTED PACKS HAVE AN AVERAGE OF 75% OR MORE GOOD SEMICONDUCTORS. FREE PACKS SUSPENDED WITH THESE ORDERS. ORDERS MUST NOT BE LESS THAN THE MINIMUM AMOUNTS QUOTED PER PACK.

NEW TESTED AND GUARANTEED PAKS

B2	4	Photo Cells, Sun Batteries inc. Book of Instructions	10/-
B77	2	AD161–AD162 NPN/PNP Trans. Comp. Output. Pair	10/-
B79	4	IN4007 Sil. Rec. Diodes 1000 P.I.V. 1 amp. Miniature	10/-
B81	10	Reed Switches, mixed types large and small	10/-
B89	2	5SP5 Light Sensitive Cells. Light Res. 400 Ω Dark 1M Ω	10/-
B91	8	NKT163/164 PNP Germ. TO-S equivalent to OC44, OC45	10/-
B92	4	NPN. Sil. Trans. AO6 = BSX20, 2N2369 500 MHz, 360mW	10/-
B93	5	GET113 Trans. equiv. to ACY17-21 PNP Germ.	10/-
B94	6	NPN Sil. Planar Epitaxial Trans. CS4 similar to BSY38 or BC108	10/-
B96	5	2N3136 PNP Sil. Trans. TO-18, HFE 100–300 I.C. 600mA. 200 MHz	10/-
B98	10	XB112 and XB102 equiv. to AC126, AC156, OC81/2, OC71/2, NKT271, etc.	10/-
B99	200	Capacitors, Electrolytics paper, silver mica, etc. Post and packing, this Pak 2/6	10/-
H4	250	Mixed Resistors. Post and Packing 2/-	10/-

RETURN OF THE UNBEATABLE P.1 PAK. NOW GREATER VALUE THAN EVER

FULL OF SHORT LEAD SEMICONDUCTORS AND ELECTRONIC COMPONENTS, APPROX. 170. WE GUARANTEE AT LEAST 30 REALLY HIGH QUALITY FACTORY MARKED TRANSISTORS PNP AND NPN, AND A HOST OF DIODES AND RECTIFIERS MOUNTED ON PRINTED CIRCUIT PANELS. IDENTIFICATION CHART SUPPLIED TO GIVE SOME INFORMATION ON THE TRANSISTORS.

PLEASE ASK FOR PAK **P.1** ONLY **10/-**

2/- P. & P. on this Pak.

Huge Clearance of UHF/VHF TUNER UNIT REJECTS

Stocks almost exhausted! Place your orders now ! ! !

FANTASTIC TRANSISTOR VALUE

TU. 2. CONTAINING 2 AF186's & 2 AF178's. PRICE 10/- EACH UNIT.
TU. 3. CONTAINING 2 AF186's & 2 AF178's. PLUS WAVEBAND SLIDER SWITCH. PRICE 12/6 EACH UNIT.
P & P 2/6d. EACH UNIT

All the Units have many other components, e.g., Capacitors, Resistors, Coils, and Tuning Condensers, etc. ALL TUNER UNITS ARE SUPPLIED WITH CONNECTION DATA.

NEW UNMARKED UNTESTED PAKS

B78	12	Intergrated Circuits, Data and Circuits of types, supplied with orders	10/-
B80	8	Dual Trans. Matched O/P pairs NPN. Sil. in TO-S can	10/-
B82	10	OC45, OC81D and OC81 Trans. Mullard glass type	10/-
B83	200	Trans. manufacturer's rejects all types NPN, PNP, Sil. and Germ.	10/-
B84	100	Silicon Diodes DO-7 glass equiv. to OA200, OA202	10/-
B66	150	High quality Germ. Diodes. Min. glass type	10/-
B86	50	Sil. Diodes sub. min. IN914 and IN916 types	10/-
B87	100	Germ. PNP Trans. equiv. to OC44, OC45, OC81, etc.	10/-
B88	50	Sil. Trans. NPN, PNP. equiv. to OC200/1, 2N706A, BSY95A, etc.	10/-
B60	10	7 Watt Zener Diodes Mixed Voltages	10/-

PRE-PAK. N.605 POWER TRANSISTOR EQUIVALENT TO NKT301-2-3-4 **5/- each**

COMPLIMENTARY SET NPN/PNP GERM. TRANS. **2/6 pair**

Make a Rev. Counter for your Car. The 'TACHO BLOCK'. This encapsulated block will turn any 0-1mA meter into a linear and accurate rev. counter for any car. **20/- each**

FREE CATALOGUE AND LISTS for: —
ZENER DIODES
TRANSISTORS, RECTIFIERS
FULL PRE-PAK LISTS
& SUBSTITUTION CHART

MINIMUM ORDER 10/- CASH WITH ORDER PLEASE. Add 1/- post and packing per order. OVERSEAS ADD EXTRA FOR AIRMAIL.

MULLARD DATA BOOK
Semiconductor and Valve Data and Equivalents. Postage 6d. **3/6 EACH**

FREE! A WRITTEN GUARANTEE WITH ALL OUR TESTED SEMICONDUCTORS

BI-PRE-PAK LTD
DEPT. A, 222-224 WEST ROAD, WESTCLIFF-ON-SEA, ESSEX
TELEPHONE: SOUTHEND (0702) 46344

Practical Electronics Classified Advertisements

MISCELLANEOUS

PROJECT BUILDERS note—Having trouble obtaining special components? We will endeavour to supply ALL parts for your project. Standard and special items, e.g., coils, p.c. boards, etc. Carbon Film Resistors **13/-** per 100, Japanese I.F.T.'s **3/-** each. S.A.E. for component catalogue, SRY ELECTRONICS, 11 Rosedene Avenue, Croydon, CRO 3DN. Tel. 01-684 0402.

MORE ROBOTS

Synthetic Animals with "BRAINS" of their own. The LATEST range of projects include: an electronic 'animal' which "LEARNS", an Electro Chemical device capable of "REPRODUCING" itself! Other projects SURE TO INTRIGUE YOU are an audio transmitter/receiver which has quite an amazing range and requires NO LICENCE; also TEN new projects, one of which is an electronic dice machine. HOSTS OF EASY-TO-CONSTRUCT projects, for anyone with a basic knowledge of Electronics. DON'T WAIT. SEND 3/- for your list—NOW!

To: 'BOFFIN PROJECTS'
incorporating
BIONIC DESIGNS, 4 CUNLIFFE RD.
STONELEIGH, EWELL, SURREY
Designed by GERRY BROWN and JOHN SALMON and presented on T.V.

PROFESSIONALLY MADE CONTROL PANELS from **4d.** sq. in. 16/18 gauge aluminium, cut, drilled, spray painted and legend. Send full size drawing for quotation. C. S. CONDUIT, 7 Millbrook, Salisbury, Wilts.

HI-FI loudspeaker systems for the home constructor, cabinet kits, the new range of Peerless speakers, speaker kit systems and cross-over networks. BAF wadding, speaker fabric (samples on request) and all other necessary components. Send 5d in stamps to: AUDIOSCAN, Dept. PE, 4 Princes Square, Harrogate, Yorks.

BUILD IT in a DEWBOX quality cabinet 2in × 2½in × any length. DEW LTD., Ringwood Road, Ferndown, Dorset. S.A.E. for leaflet. Write now—right now.

ETCHED PRINTED CIRCUIT BOARD KITS. Full instructions. **19/6**, c.w.o. CIRCUITETCH, 12 Cambridge Rd., St. Albans, Herts.

MUSICAL MIRACLES. Send S.A.E. for details of Rhythm Modules, Versatile Bass-pedal unit, self-contained with unique effects, kits for waa-waa pedals. Also new 50μA meters **25/-** post paid. HURRY! D.E.W. LTD. 254 Ringwood Road, Ferndown, Dorset.

UFO DETECTOR CIRCUITS, data. 10s. (refundable). Paraphysical Laboratory (UFO Observatory), Downton, Wilts.

ONE OFF PRINTED CIRCUIT BOARDS. Cheaply made to customers' requirements. Send s.a.e. for details: D. R. MANN, 12 Randolph St., Nottm.

Send 1/- for
STATE OF THE ARTISTS LIST OF
Comps and full data, applications on latest dc/uhf low noise N/FET. 2N5245. 10/- ea. also Sprague 'UNICIRCUIT' ULN2111A, d.i.l. for FM/SSB det, 60db wdebnd amp/lim, etc. £1.10.6 ea. C.W.O. 6d. p.p. per order to:
T. ADVISER
2 Crown Acre, Brockenhurst, Hants

RATES : 1/3 per word (minimum 12 words). Box No. 1/6 extra. Advertisements must be prepaid and addressed to Advertisement Manager, "Practical Electronics" IPC MAGAZINES LTD., Fleetway House, Farringdon Street, London, E.C.4

MISCELLANEOUS *(continued)*

CLEARING LABORATORY, scopes, V.T.V.M's, V.O.M's, H.S. recorders, transcription turntables, electronic testmeters, calibration units, P.S.U.'s, pulse generators, D.C. null-potentiometers, bridges, spectrum analysers, voltage regulators, sig-gens, M/C relays, components, etc. Lower Beeding 236.

COMPUTER IN YOUR POCKET. Home, college, workshop. 5in pocket slide rules, **17/6**, 10in desk/bench slide rules, **25/-**. Full instructions. DEPT. PE, 19 Paynesfield Avenue, S.W.14.

LIGHT GUIDES

0·031" AND 0·063" DIA. TOTAL GLASS FIBRE OPTIC LIGHT GUIDES WITHIN A PVC SLEEVE

5'	10'	15'	25'	50'	
19/6	34/6	47/6	72/3	132/3	0·031" dia.
£3.2	£5.16	£8.2	£12.8.6	£23	0·063" dia.

STRICTLY C.W.O.
FIBRE LIGHT, Dept. P.E.B.
31 STOKE ROAD, GUILDFORD, SURREY

EDUCATIONAL

GET INTO ELECTRONICS—big opportunities for trained men. Learn the practical way with low-cost Postal Training, complete with equipment. A.M.I.E.R.E., R.T.E.B., City & Guilds, Radio, T/V, Telecoms., etc. For FREE 100-page book, write Dept. 856K, CHAMBERS COLLEGE, 148 Holborn, London, E.C.1.

CITY & GUILDS AND R.T.E.B. EXAMS. Specialised ICS home-study course will ensure success. For details of wide range of exam. and diploma courses in Radio, T.V. and Electronics, also new practical courses with kits, write to ICS (Dept. 577), Intertext House, Stewarts Road, London, S.W.8.

TECHNICAL TRAINING in Radio, TV & Electronics thro' world-famous ICS. For details of proven home-study courses write: ICS, Dept. 561, Intertext House, Stewarts Road, London, S.W.8.

ENGINEERS. A technical certificate or qualification will bring you security and much better pay. Elem. and adv. private postal courses for C.Eng., A.M.I.E.R.E., A.M.S.E. (Mech. & Elec.), City & Guilds, A.M.I.M.I., A.I.O.B. and G.C.E. exams. Diploma courses in all branches of Engineering—Mech., Elec., Auto, Electronics, Radio, Computers, Draughts., Building, etc. For full details write for FREE 132-page guide. BRITISH INSTITUTE OF ENGINEERING TECHNOLOGY (Dept. 125K), Aldermaston Court, Aldermaston, Berks.

RADIO OFFICERS see the world. Sea going and shore appointments. Trainee vacancies in Sept. and Jan. Grants available. Day and Boarding students. Stamp for prospectus. WIRELESS COLLEGE, Colwyn Bay, Wales.

SERVICE SHEETS

LARGE SUPPLIER OF SERVICE SHEETS
T.V., RADIO, TRANSISTORS, TAPES, CAR RADIOS
Only 5/- each, plus LARGE S.A.E.
(Uncrossed P.O.'s please, returned if service sheets not available.)
FREE TV FAULT TRACING CHART OR TV LIST ON REQUEST
C. CARANNA
71 BEAUFORT PARK, LONDON, N.W.11
MAIL ORDER ONLY

SERVICE SHEETS (1925-69) for televisions, radios, transistors, tape recorders, record players, etc., by return post, with free fault-finding guide. Prices from **1/-**. Over 8,000 models available. Please send S.A.E. with all orders/enquiries. HAMILTON RADIO, 54 London Road, Bexhill, Sussex.

SERVICE SHEETS, Radio, TV, 5,000 models. List **1/6**. S.A.E. enquiries. TELRAY, 11 Maudland Bank, Preston.

RADIO TELEVISION, over 8,000 Models. JOHN GILBERT TELEVISION, 1b Shepherds Bush Rd., London, W.6. SHE 8441.

HI-FI EQUIPMENT

RELIABLE GUIDE to best value in Hi-Fi. Audio Supply's Seventy-page illustrated catalogue (**6/6**), 18 Blenheim Road, London, W.4.

FOR SALE

£6,000 IN VOUCHERS GIVEN AWAY. See free Cat. for details. Tools, Materials, Mechanical, Electrical, thousands of interesting items. WHISTON, Dept. PVE, New Mills, Stockport SK12 4HL.

MORSE MADE EASY !!

FACT NOT FICTION. If you start **RIGHT** you will be reading amateur and commercial Morse within a month (normal progress to be expected).

Using scientifically prepared 3-speed records you automatically learn to recognise the code **RHYTHM** without translating. You can't help it, it's as easy as learning a tune. 18 W.P.M. in 4 weeks guaranteed.

For details and course C.O.D. ring S.T.D. 01-660 2896 or send 8d. stamp for explanatory booklet to:
G3HSC (Box 19), 45 GREEN LANE, PURLEY, SURREY

COSSOR D.B. OSCILLOSCOPE, Model 1035, with spare c.r.t. **£22.10.0.** Billericay 52508.

FIRST GRADE ELECTRONIC COMPONENTS at record low prices. S.A.E. list. DIXEY, 72 Roxborough Road, Harrow, Middx.

MINIATURE DYNAMIC MICROPHONES. High impedance, size $\frac{7}{8} \times \frac{5}{8} \times \frac{3}{16}$ in. Also work as mini speakers, suit transistor circuits, **7/6** each, 3 for **20/-**. Tested, guaranteed. Ardente 10kΩ edgewise volume controls, **3/6** each, 3 for **10/-**. DREW, 77 The Crescent, Southwick, Sussex.

BACK NUMBERS, full set less Feb. 67, offers, 99 Faringdon Ave., Blackpool.

GRAND CLEARANCE SALE
EVERYTHING MUST GO

PRECISION METERS. Brand new and boxed, size 3½in sq. Type 1, 0–500V FSD. Type 2, 0–150mA. Fully guaranteed. Moving coil movement. List **£3.5.** Our price **30/-** each, p.p. 2/6. **Two for 55/-**, post free.

TANK AERIALS. Fully interlocking copper plated, one foot sections. Ideal for scooter aerials or for TX/RX work. **Six sections 4/6**, p.p. 1/6. **12 sections for 10/-**, post free.

RADIATION METERS. Pocket type. Brand new in maker's cartons. Only **9/6 each**, p.p. 1/6. **Two for 17/6**, post free.

GOVERNMENT SURPLUS WIRELESS EQUIPMENT. Handbook gives current details and information on most British and American wireless equipment. Only **35/-**, p.p. 5/-.

TELEPHONE DIALS. Only 6/- each. **Four for £1**, post free.

TELEPHONE EXCHANGES. PMBX TYPE. Ex-GPO, in good condition and ready to use. Cord type, **£12.10**, carr. 50/-. Cordless type **£15**, carr. 15/-.

SMOOTHING UNITS. Excellently made pieces of equipment. 12V or 24V d.c. input gives a fully smoothed, fully regulated d.c. output. Robust metal case. Brand new in maker's cartons. Price **55/-**, p.p. 5/-.

MINIATURE 1½in moving coil speakers. Only **3/6** each, p.p. 1/-. **36/- per doz.**, post free.

HEAVY DUTY POWER SUPPLY UNITS. Famous manufacture. Input 200/250V 50 cycles a.c. Output 250V d.c. at 175mA, 6·3V/12V at 4 amps. Robust rack mounting cabinet. List **£42**, brand new and boxed, **59/6**, carr. 10/-.

MEDIUM WAVE FERRITS STABE AERIALS. Fit most transistor radios only **3/6** each, p.p. 6d. **Two for 6/-**, post free and **Four for 10/-**, post free.

MONSTER CONSTRUCTORS' PARCEL. Two 1½in dia. moving coil speakers. One 12V heavy duty DPDT switching relay. Up to 20 amp switching plus many low current contacts. Twelve wire wound resistors. One brand new parachute complete with full cords. Over 100 sq. ft of silky material. One 5ft whip aerial. Twelve electrolytic condensers. Twelve small plastic boxes suitable for containing your transistorised units. One telephone dial. One miniature 10 henry 60mA smoothing choke. **All for 30/-**, carr. 5/-.

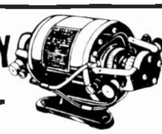
PRINTED CIRCUIT TOP BAND SUPERHET CHASSIS. Uses standard components. Complete with circuit. Only **15/-**, post free.

RHEOSTAT DIMMER UNITS. Will control up to 50V at 3 amps. Compact metal case ideal for Lab work. Only **15/-**, p.p. 2/6. **2 for 30/-**, post free.

MINIATURISED TRANSISTORISED BFO UNIT. A miniature tunable B.F.O. unit that will enable your set to receive CW or SSB. Compact single hole fixing. This unit will fit anywhere. Ideal for all Ex-Govt. Communication and Commercial Receivers. Complete with fitting instructions. Only **39/6**, p.p. 2/6.

GLOBE SCIENTIFIC LTD
DEPT. P.E.38, BRIDGEND, LEEDS 1

240 VOLT ELECTRICITY ANYWHERE



BEST EVER 200/240 VOLT "MAINS" SUPPLY FROM 12 VOLT CAR BATTERY
Exclusive World Scoop Purchase. The fabulous **Mk.2D American Heavy Duty Dynamotor** Unit with a **Massive 220 watt** output and giving the most **Brilliant 200/240** volt performance of all time. Marvellous for **Television, Drills, Power Tools, Mains Lighting, AC Fluorescent Lighting** and all **200/240** volt Universal AC/DC mains equipment. Made at tremendous cost for U.S.A. Govt. by Delco-Remy. This magnificent machine is unobtainable elsewhere. **Brand New and Fully Tested. Only £4.19.6 + 10/6** postage. C.O.D. with pleasure, refund guarantee. Please send S.A.E. for illustrated details.
Dept. PE, STANFORD ELECTRONICS
Rear Derby Road, North Promenade
BLACKPOOL, Lancashire

SITUATIONS VACANT

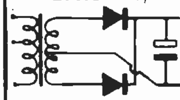
A.M.I.E.R.E., A.M.S.E. (Elec.), City & Guilds, G.C.E., etc., on "Satisfaction or Refund of Fee" terms. Wide range of Home Study Courses in Electronics, Computers, Radio, T.V., etc. 132-page Guide—FREE. Please state subject of interest. BRITISH INSTITUTE OF ENGINEERING TECHNOLOGY (Dept. 124K), Aldermaston Court, Aldermaston, Berks.

MULTI TAPE COPYING CHANNELS. Vacancy for man 23 upwards, to take charge of Channels after training. Responsibility for planning production schedules, product quality and stock control. Professional recording equipment. Ability to carry out 1st line maintenance an advantage. London area. Write Box No. 22.

TERRIFIC TRANSISTORS!

New. No seconds. No re-marks
Orders over 10/- post free.

BC168	2/3	**BC107**	3/-
BC169	2/6	**2N706**	2/7
BD121	18/-	**2N3707**	4/-
BFY51	4/-	**2N4058**	4/6
BF167	5/3	**2N3794**	3/-
BF178	9/-	**2N4289**	3/-



MINI MAINS PACK COMPS. 17/6

Mini Mains Trans.
MT9, 9-0-9V, 80mA 12/6
MT6, 6-0-6V, 100mA 13/6
MT12, 12-0-12V, 50mA 13/6
Submin. bridge rect., 30Vrms, 150mA, 3/6

AMATRONIX LTD. (Mail order only)
396 Selsdon Rd., South Croydon, Surrey CR2 0DE

SITUATIONS VACANT *(continued)*

SERVICE ENGINEERS—we are an old established electronics company, but headed by a young management team, and we need you to help us. Age is no barrier to a high salary as you will find out when you join us. If you have experience in T.V., Radio or Hi-Fi Service and want a job that looks ahead, phone MICHAEL ADLER at 01-636 9606.

TECHNICAL TRAINING by ICS
IN RADIO, TELEVISION AND ELECTRONIC ENGINEERING

First-class opportunities in Radio and Electronics await the **I C S trained man.** Let I C S train YOU for a well-paid post in this expanding field.

I C S courses offer the keen, ambitious man the opportunity to acquire, quickly and easily, the specialized training so essential to success. Diploma courses in Radio/TV Engineering and Servicing, Electronics, Computers, etc. Expert coaching for:

- **C. & G. TELECOMMUNICATION TECHNICIANS' CERTS.**
- **C. & G. ELECTRONIC SERVICING.**
- **R.T.E.B. RADIO AND TV SERVICING CERTIFICATE.**
- **RADIO AMATEURS' EXAMINATION.**
- **P.M.G. CERTIFICATES IN RADIOTELEGRAPHY.**

Examination Students Coached until Successful.

NEW SELF-BUILD RADIO AND ELECTRONIC COURSES
Build your own 5-valve receiver, transistor portable, signal generator, multimeter and valve volt meter—**all under expert guidance.**

POST THIS COUPON TODAY and find out how I C S can help YOU in your career. Full details of I C S courses in Radio, Television and Electronics will be sent to you by return mail.

MEMBER OF THE ASSOCIATION OF BRITISH CORRESPONDENCE COLLEGES

INTERNATIONAL CORRESPONDENCE SCHOOLS

A WHOLE WORLD OF KNOWLEDGE AWAITS YOU !

International Correspondence Schools
(Dept. 152), Intertext House, Stewart Road,
London, S.W.8.

NAME ....
Block Capitals Please

ADDRESS ....

....

.... 10/69

RECEIVERS AND COMPONENTS

(continued)

WE ARE BREAKING UP COMPUTERS

EX COMPUTER PRINTED CIRCUIT PANELS 2in × 4in packed with semi-conductors and top quality resistors, capacitors, diodes, etc. Our price, 10 boards 10/-. P. & P. 2/-. With a guaranteed minimum of 35 transistors.

SPECIAL BARGAIN PACK. 25 boards for £1. P. & P. 3/6. With a guaranteed minimum of 85 transistors. 100 boards 65/-. P. & P. 7/6. With a guaranteed minimum of 350 transistors.

GIANT PANELS. 5½in × 4in, min. 20 transistors, 9 × 56 µH inductors, resistors, diodes, etc. 3 for £1. P. & P. 2/-.

PANELS with 2 power transistors sim. to OC28 on each board + components. 2 boards (4 × OC28) 10/-. P. & P. 2/-.

TRIM POTS. On 2in × 4in boards + Ta caps and other components. 100Ω, 500Ω, 15K., 20K. State requirements. 5 boards 10/-. P. & P. 2/-.

NPN GERMANIUM TO5 1 WATT POWER TRANSISTORS. On small heat sink, on 2in × 4in panel. 5 for 10/-. P. & P. 2/-.

POWER TRANSISTORS. Sim. to 2N174 ex-eqt. On Finned Heat Sink (10D). 4 for £1. P. & P. 5/-.

DIODES. Ex eqpt., Silicon, 150 PIV, 10 amp. 4 for 10/-. 150 PIV, 20 amp. 4 for £1. Post free.

OVERLOAD CUT OUTS. Panel mounting in the following values . . . 5/- each. 2, 3, 4, 10 amp. P. & P. 1/-.

MINIATURE GLASS NEONS, 12/6 doz. P. & P. 1/-.

PAPST FANS. Powerful Extractor/Blower fans. 230/250V. 100 c.f.m., 2,800 r.p.m. 50/- post free.

MICRO SWITCHES. Miniature button type. 10/- doz. P. & P. 1/6.

TOGGLE SWITCHES LONG ARM. Ex eqpt., SPST 13/6 doz., DPST 15/- doz., DPDT 22/6 doz. P. & P. all types 2/- doz.

NEW SPRAGUE. 0·22µF 250V small capacitors. 5/- doz. P. & P. 1/-.

NEW SPRAGUE ELECTROLYTICS. 4µF 150V. 5/- doz. P. & P. 1/-.

LARGE CAPACITY ELECTROLYTICS. 4½in, 2in diam. Screw terminals. 7/6 each post free.

4,000mF	72V d.c. wkg.
10,000mF	25V d.c. wkg.
25,000mF	12V d.c. wkg.

KEYTRONICS, 52 Earls Court Road
London, W.8. Mail order only
Tel. 01-478 8499

R & R RADIO

51 Burnley Road, Rawtenstall
Rossendale, Lancs
Tel.: Rossendale 3152

VALVES BOXED, TESTED & GUARANTEED

BF80	3/-	PCC84	3/-	PY81	3/6
EBF89	3/6	PCF80	3/-	PY82	3/-
ECC82	3/-	PCF82	3/6	U191	4/6
ECL80	3/-	PCL82	4/-	6F23	5/-
EF80	1/6	PCL83	4/-	30F5	2/6
EF85	3/-	PL36	5/-	30L15	5/-
EY86	4/-	PL81	4/-	30P12	4/6
EZ40	4/6	PL83	4/-	30C15	5/-
EBC41	4/6	PY33	5/-	50CD6G	7/6

Transistor Audio Pack, 2G339A, 2G381A, 2G371B 10/- each post 6d.
POST, ONE VALVE 9d. TWO TO SIX 6d.
OVER SIX POST PAID.

PACKS OF MIXED 4BA and 6BA plated screws and nuts. Min. quantity of 150 items per pack. 10/- per pack incl. postage. For specific requirements send S.A.E. WESTEK, P.O. Box 7, Rickmansworth, Herts.

RECEIVERS AND COMPONENTS

(continued)

TAPE HEADS

BSR BRAD. 2-TRACK 39/6 pair

BSR MARR. 4-TRACK 39/6 pair

MICHIGAN REC./PLAY MED. IMP. 4-TRACK 37/6

REUTER — COLLARO ERASE 4-TRACK 15/-

BOGEN ERASE UL218/6 4-TRACK 27/6

COSMOCORD ERASE T.E. 2/9 4-TRACK 15/-

TRANSISTORISED FM TUNER
6 TRANSISTOR HIGH QUALITY TUNER. SIZE ONLY 6in × 4in × 2½in 3 I.F. stages. Double tuned discriminator. Ample output to feed most amplifiers. Operates on 9V battery. Coverage 88-108Mc/s. Ready built ready for use. Fantastic value for money **£6.7.0**

SUB-MIN. TRANSISTOR LW/MW/FM TUNER
Similar to above. Complete with aerial, tuners, dial and instructions **£14**

TUNER DULCI FMT7S STEREO **£23**

COMPACT TRANSISTOR FM TUNER
Oiled Walnut cabinet, brushed gold front panel, vertical styling, internal batteries **£9.19.6**

FM MULTIPLEX STEREO ADAPTOR
Printed circuit biscuit, 4 trans. 6 diodes 9V with full instructions **£4.19.6**

LOUDSPEAKERS

12" TWIN CONE 10 watt PEAK 15 ohm **35/-**

12" 25 watt, 15 ohm, **GUITAR SPEAKER** 25-13K **£5.7.0**

10" 10 watt, 15 ohm, **CERAMIC — MAGNET** **49/6**

2" 40 ohm
2½" 80 ohm **6/6**

CABINET Teak 23½ · 13½ · 9½", contemp. 12" legs for Tape Recorder and Tuner or Amplifier, etc. **99/6**

RELAYS 4 pole changeover, ideal for models. 1½ · 1½ · ½", 700 ohm 9-24v, 185 ohm 6-12v, 430 ohm 12-18v **10/-**

TWEETER Horn type Hi-Fi 3" 16 ohm, 10W CR/0.3k Ω 18,000 c/s **25/-**

CROSSOVER NETWORK 3kc/s, 16 or 3 ohm **14/-**

MULTIMETERS from **32/-**

CHARGER TRANSFORMER. 4 Amp. 2/6/12 volt **21/6** 3/- P/P

SUPER SILICON RECT. T.V., etc., 1,200 PIV 800mA, 5/-; or complete with instr. resistor, condenser, 6/6; 400 PIV HW 6A, 6/-; 200 PIV HW 6A, 6/-. BY100 type, 6 for 10/-.

Jumper lead 6'. Croc clips to Phono plug and Std. Jack Adaptor **7/6**

TRANSISTORS
2N3638A 5/-, 2N3643 5/6, AC138 5/-, AC141 6/-, ACY20 3/8, ACY21 4/-, AD140 5/-, AF178 11/8, AF186 10/-, BC108 3/-, BC109 3/-, BCY33 4/6, BF181 7/-, NKT213 5/6, NKT226 5/6, OA91 1/6, OAZ270 3/6, OC35 5/-, OC45 2/-, OC81D 2/3, OC82 4/-, OC200 3/3.
GET103-113-118-119-887-889-890-896-7-8 3/-

CHANGER DECKS

UA25 BSR with template, Mono.	List £6.19.6
UA25 BSR with template, Stereo.	List £7.9.6
1025 Garrard with template, Mono.	List £7.7.6
1025 Garrard with template, Stereo.	List £7.17.6

PLINTH in simulated teak. Complete with Clearview rigid perspex cover for 1025. P/P on Decks or Plinth and Cover 7/6 **£4.15.0**

SWITCH ROTARY RECIPROCATING 4 Position, 15amp. Single hole fixing, with instructions. List 14/7 **5/6**

C60 CASSETTE 10/3. C90 14/3. 3 Post free

Stamped envelope for full selection and bargain offers in MULTIMETERS, RADIOS, BABY ALARMS, INTERCOMS, WALKIE-TALKIES, RECTIFIERS, SINCLAIR, DULCI, AND EAGLE Lists. UNDER £1—P. & P. 6d., £1 to £3—1/6, over £3—2/6. C.O.D. 3/6. MAIL ORDER ONLY.

DURHAM SUPPLIES

367 KENSINGTON STREET
BRADFORD 8, YORKSHIRE

SILICON PLANAR TRANSISTORS. 100% tested and full data supplied with orders. NPN types for organ projects, 25 for £1. PNP types sim. to 2N3702 and germanium sim. to ACY22, 50 for £1. Post free. WESTEK, P.O. Box 7, Rickmansworth, Herts.

INTEGRATED CIRCUITS at lowest price. GE Type PA234, 1 Watt Audio Amplifier 17/6 each inc. data. Newest GE Silicon NPN planar transistor 2N5172. Epoxy for economy. Passivated for reliability. 25 volt 200mW hfe, 100 min. 1/9 each. C.W.O. P. & P. 1/- per order. JEF ELECTRONICS, 12 York Drive, Grappenhall, Warrington, Lancs. Mail Order Only.

RECEIVERS AND COMPONENTS

(continued)

TRANSISTOR PANELS

INTEGRATED CCT'S TAKEN FROM PANELS

A — Quad 2 I/P Gate	5/-	With Circuit and Pin Connections
B — Dual 4 I/P Gate	5/-	
C — Dual 2 Level Gate	5/-	
D — Dual "D" Flip Flop	5/-	
F — Single I/P Gate	5/-	Post Paid

EX GOVMT. RECEIVER R.209 covering 1—20 mc/s 12V D.C. Input £12.10.0 Post Paid (Tested).

50 VARIOUS TRANSISTORS on Panels 15/- Post Paid.

20—OC45	£1
20—OC76	£1
40—TK28c	£1

COMPUTER PANELS with 40 sil. pnp or npn transistors, Diodes and res., 22/6 Post Paid.

COMPUTER PANELS WITH SEMI-CONDUCTORS. Postage 6d per panel

8—OC42 or GET875 + 24—OA81	7/6
24—A1678 (V405A) 550 mc/s PNP + 24 Diodes	15/-
4—OC170 + 2—OC139 + 2—OC42	7/6
9—ASZ20 + 1—T2040 + 27 Diodes	7/6
4—OC42 + 6—GET875 + Diodes	7/6
2—OC170 + 1—2G306 + OC42	4/-
5—OC23 + 15—OA10	25/-
6—2N388 + 2—2G403 + 2—T2040	8/6
8—ASZ20 + 80 Diodes	7/6
6—ASZ21 + 15—OA91	6/-
9—SB240 + 18—OA47	10/-
12—2G106 + 24 Diodes	9/6
8—OC72 + 8—OA10	10/-
6—2N388	7/6
8—OC76 + 8—OA10	7/6
12—2N388	10/-
12—A1678 (V405A) 550 mc/s PNP + 22 Diodes	10/-
36—OA5	6/-
6—GET872 + 8—OA10	5/-
4—OC42	3/-
12—ASZ20 + 80 Diodes	9/6
4—GET872 + 8—OA10	3 for 12/-
4—2G106 + 1—2N2410	4/-
2—OC42 + 8—OA47	3/-
2—GET872 + 4—OA10 + RF Chokes	3 for 10/-
24—Sil. h.f. Transistors	15/-
3—GET872 + 3—GEX541, ETC.	22/6
3—OC23 + 6—OA10 + 2—OA5	16/-

TEST CARDS. 6 transistors 20 for 20/-

ELECTROLYTICS 25,000 @ 12V, 16,000 @ 12V, 15,000 @ 10V, 10,000 @ 30V, 4,000 @ 60V, 3,000 @ 80V, 2,000 @ 50V, 1,200 @ 180V, 8/6 Post Paid.

ZENER DIODES—2·4, 2·7, 3·6, 4·75, 5·25, 5·75, 6·2, 6·8, 7·5, 13, 15, 16, 18, 20, 27, 30, 33 volts. 3/6 each, mostly 1 watt

POLYSTYRENE CAPACITORS. 125V, 18, 22, 120, 220, 270, 330, 390, 560, 820, 1,000, 1,200, 1,800, 2,200, 2,700, 3,300, 3,900, 4,700, 5,600, 6,800, 8,200, 0·01, 0·012, 0·015, 2/6 doz. Post/Packing, 1/-.

BRAND NEW BOXED CHASSIS containing 2—OC35, 2—OC29 12 WW resistors 25/-. Postage 1/6

NEW CROSS RADIO
6 OLDHAM ROAD, MANCHESTER 4

BRAND NEW ELECTROLYTICS, 15/16 volts, 0·5, 1, 2, 5, 6, 8, 10, 15, 20, 30, 40, 50, 100, 200 mfds. 8/- per dozen, postage 1/-. The C.R. SUPPLY CO., 127 Chesterfield Rd., Sheffield, S8 0RN.

BOOKS AND PUBLICATIONS

SURPLUS HANDBOOKS

19 set Circuit and Notes	6/6 P.P. 6d
1155 set Circuit and Notes	6/6 P.P. 6d
H.R.O. Technical Instructions	5/6 P.P. 6d
38 set Technical Instructions	5/6 P.P. 6d
46 set Working Instructions	5/6 P.P. 6d
88 set Technical Instructions	7/- P.P. 6d
BC. 221 Circuit and Notes	5/6 P.P. 6d
Wavemeter Class D Tech. Instr	5/6 P.P. 6d
18 set Circuit and Notes	5/6 P.P. 6d
BC.1000 (31 set) Circuit & Notes	5/6 P.P. 6d
CR.100/B.28 Circuit and Notes	10/- P.P. 9d
R.107 Circuit and Notes	7/- P.P. 6d
A.R.88D. Instruction Manual	18/- P.P. 6d
62 set Circuit and Notes	6/6 P.P. 6d
52 set Sender & Receiver Circuits	7/6. post free

Circuit Diagrams 5/- each post free. R.1116/A, R.1224/A, R.1355, R.F. 24, 25, & 26. A.1134, T.1154, CR.300, BC.342. BC.312. BC.348.J.E.M.P. BC.624. 22 set.

Resistor Colour Code Indicator... 2/6 P.P. 6d

S.A.E. with all enquiries please.
Postage rates apply to U.K. only.
Mail order only to:
Instructional Handbook Supplies
Dept. P.E., Talbot House, 28 Talbot Gardens
Leeds 8

GEATRONIX LIMITED

EDUCATIONAL ELECTRONIC EQUIPMENT

MANUFACTURERS OF

NORKIT

A new HOBBY for the automation age

★ Simple building bricks to build your own ELECTRONIC BRAINS.

★ Easy to understand handbooks to guide you.

★ Learn about LOGIC, BINARY arithmetic and BOOLEAN algebra.

★ Modules are rapidly assembled and dismantled to use again.

★ Make machines that play games, control model railways, etc. and control automatic machines of any description.

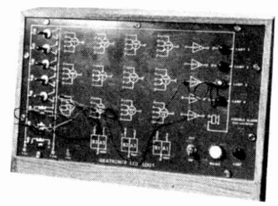
Telephone: SOUTHEND 62521

NORKIT JUNIOR **£8 . 16 . 0**
(as shown)

NORKIT SENIOR **£17 . 12 . 0**
Handbooks supplied for each kit or available separately 6/- each

LOGIC DEMONSTRATION UNIT TYPE LDU.1

A new teaching aid for rapidly setting up and demonstrating logic circuits. Stackable patching leads are used to interconnect logic symbols on a mimic diagram. The symbols are connected to appropriate components inside the unit. Switches and pushbuttons are provided to simulate input conditions and outputs are indicated by lamps and an audible alarm.



£68 . 0 . 0

GEATRONIX LTD., 28 REDSTOCK RD., SOUTHEND-ON-SEA, ESSEX

CITY AND COUNTY OF BRISTOL
BRISTOL TECHNICAL COLLEGE
CAREERS IN RADIO AND RADAR

Marine Radio Officers

2 year full-time course leading to the Second and First Class P.M.G. Certificates and the B.O.T. Radar Maintenance Certificate.
Conversion Course (Second Class to First Class).
R.T. Licences (Full or Restricted).

Licensed Aircraft Radio Engineers

2 year full-time course covering the Aircraft Radio Engineers Licences categories A & B, issued by the Board of Trade (Civil Aviation) followed by a 6-months' course for Radar Rating (A & B) in association with the above.

Courses for Qualified Marine Radio Officers

Single Side Band Techniques (2 weeks)
Marine Electronics Diploma Course (3 months)
Advanced Marine Electronics Diploma Course (3 months)

Training is given on the latest types of Marine and Aircraft equipment in approved Laboratories at
THE SCHOOL OF RADIO AND RADAR
Senior Lecturer-in-Charge: F. E. Barltrop

For further information, apply:
Registrar
Bristol Technical College
Ashley Down
BRISTOL 7

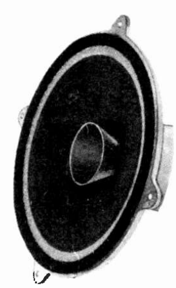
AMAZING MINI·DRILL

Indispensable for precision drilling, grinding, polishing, etching, gouging, shaping. Precision power for the enthusiast. Shockproof. Completely portable power from 4½ volt external battery. So much more scope with MINI-DRILL. Super Kit (extra power, interchangeable chuck) 79/6 p.p. 2/6.
De Luxe Professional Kit with 17 tools 130/- p.p. 4/6.
Money Ref. Guarantee.

MERLIN SUPPLY CO.
PE10 Nailsea, Bristol BS19 2LP

12in. "SUPERB" £15

The exceptional quality and performance of the "Superb" brings truly exceptional sound from a single loudspeaker, recreating the musical spectrum virtually flat ±5db. 20 to 17,000 c.p.s. The unit consists of the latest double cone, woofer and tweeter cone together with a massive Baker "FERROBA" magnet assembly having a flux density of 16,500 gauss and a total flux of 176,000 Maxwells. Bass resonance 22-26 c.p.s. Rated 20 watts. Voice coils available 8 or 15 ohms. Suitable for all High Fidelity Systems. A high quality loudspeaker providing clear reproduction of the deepest bass and highest treble.



Further details and 48 page Enclosure Manual 5/9 post paid.

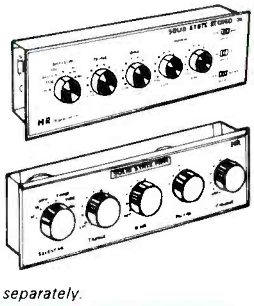
Baker Reproducers Ltd
Bensham Manor Road Passage, Thornton Heath, Surrey. 01-684-1665

Published approximately on the 15th of each month by IPC Magazines Limited, Tower House, Southampton Street, London, W.C.2. Printed in England by The Chapel River Press, Andover, Hants. Sole Agents for Australia and New Zealand—Gordon & Gotch (A/sia) Ltd.: South Africa—Central News Agency Ltd.: Rhodesia, Malawi and Zambia—Kingstons Ltd. East Africa—Stationery and Office Supplies Ltd. Subscription Rate (including postage): For one year to any part of the world £2 2s. 0d.

ENGLANDS LEADING COMPONENT & EQUIPMENT CENTRES

SOLID STATE–HIGH FIDELITY
AUDIO EQUIPMENT

Mono or Stereo Audio, Equipment developed from Dinsdale Mk.II—each unit or system will compare favourably with other professional equipment selling at much higher prices.



COMPLETE SYSTEMS FROM
£15.5.0

THE FINEST VALUE IN HIGH FIDELITY—CHOOSE A SYSTEM TO SUIT YOUR NEEDS AND SAVE POUNDS

All units available separately.

SEND FOR *FREE BROCHURE* (No. 21) *TODAY!*

DEMONSTRATIONS DAILY AT '303' EDGWARE ROAD

INTEGRATED TRANSISTOR AMPLIFIERS

MA66 12 WATTS STEREO
We are pleased to offer two new designs with the choice of either mono or stereo systems. These BRITISH DESIGNED UNITS favour the user in so many ways—with fantastic power and quality with far greater adaptability, with freedom for battery or mains operation.

For complete listening satisfaction choose either the—

MA7 MONO **£8.10.0** OR THE STEREO MA66 **£16.10.0**
POST PACKING 5/– EITHER MODEL
OPTIONAL MAINS UNIT PS20 62/6d. p.p. 4/–

Illustrated leaflets 12 and 14 FREE on request.

ELECTRONIC ORGANS KITS TO BUILD YOURSELF AND COMPLETE UNITS
Acclaimed by everyone

THE MAYFAIR 89 GNS
BROCHURE 9

The MAYFAIR

A completely new development in portable electronic musical instruments and a new field for the home constructor. The 'MAYFAIR' produces a multitude of the most pleasing sounds with a wide range of tone colours suitable for classic or popular music. The organ is **fully polyphonic, that is full cords can be played over the entire keyboard.** Supplied as a kit of parts which includes 165 transistors, printed circuits panel, special fully sprung and depth of touch adjusted keyboard, attractive vynair covered cabinet with carry handle. A complete detailed and illustrated construction manual is provided with circuits and full parts list. All items may be purchased separately. All parts supplied are fully guaranteed. Full after sales service

Deferred terms available
COMPLETE KIT
Deposit £29.19.0
12 monthly payments of £7. Total £113.19.0
BUILT AND TESTED
Deposit £36.8.0 and
12 monthly payments of £9. Total £144.8.0

The GROSVENOR

is designed for the more ambitious musician and has a much wider range than most commercial organs. **It comprises two four-octave (49 note) keyboards and a thirteen-note pedal board.** It has four pitches (i.e., 8ft. 4ft. 2ft. 1ft) on the upper or solo keyboard, three pitches (i.e., 16ft, 8ft, 4ft) on the lower or accompaniment keyboard, two pitches (i.e., 16ft, 8ft) on the pedal board. Variable sustain on the solo keyboard and variable vibrato on both keyboards. It has 15 voices in the solo tone-forming unit. 10 voices in accompaniment tone-forming unit and 4 voices in the pedal tone-forming unit. **All components and kit sections are available separately including the Oak Console at £65.18.0.**

A complete detailed and illustrated construction manual is provided with circuits and full parts list. All items may be purchased separately. All parts supplied are fully guaranteed. Full after sales service and advice freely available.

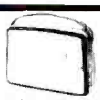
Once built the 'MAYFAIR' or 'GROSVENOR' will then provide years of enjoyable entertainment.
Call in—See them for yourself

THE GROSVENOR
KITS FROM £220 terms available
BROCHURE 9B

PRACTICAL ELECTRONICS – ELECTRONIC ORGAN KIT

We are able to supply Parts as described in this series. Details on request.

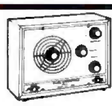
ORGAN COMPONENTS: COMPLETE RANGE IN STOCK · 49 AND 61 NOTE KEYBOARDS · 2 TO 5 AMP GOLD CONTACTS · COILS AND CHOKES · REVERBERATION SPRINGS AND UNITS · STOP TABS AND ASSEMBLIES · PEDAL BOARDS · RHODIUM AND GOLD CLAD WIRE. ALSO PRINTED CIRCUITS ETC. COMPLETE RANGES FOR TRANSISTORISED ORGANS. ASK FOR NEW PRICE LISTS WITH DETAILS. LEAFLET 9B
ALL ENQUIRIES TO: ORGAN DEPT. MR. ELVINS



DO IT YOURSELF MW/LW PORTABLE

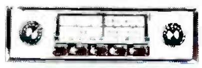
New printed circuit design with full power output. Fully tunable on both mw/lw bands. 7 transistors plus diode, push-pull circuit. Fitted 5 inch speaker, large ferrite aerial and Mullard transistors. Easy to build with terrific results. All local and Continental stations.

TOTAL COST TO BUILD £6.19.6. P.P. 4/6
Send for Brochure 1



NEW MODELS
NOMBREX
TRANSISTORISED Test Equipment

MODEL		PRICE £	s	d.	Leaflet No.
29s	RF. Gen.	21	0	0	35
29x	Xtal RF Gen.	29	10	0	35
30	Audio Generator	19	10	0	24
31	R.F. Generator	12	10	0	25
32	C.R. Bridge	10	10	0	26
33	Inductance Bridge	20	0	0	29



QUALITY CAR RADIOS

A precision engineered car radio that's perfect company for long hours on the road. Has quick push-button operation for immediate station selection and choice of Medium or Long wave frequency. Output of 3½ watts ensures crisp, top quality sound even at high motoring speeds. Includes full accessories and instructions.

POSITIVE/NEGATIVE EARTH PRICE £12.12.0 pp. 4/6
MANUAL as above £8.19.6. but with single MW/LW Push Button

SCOOP! STAAR RECORD PLAYER

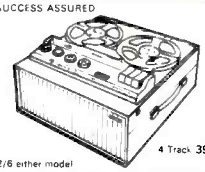
Deck. Plays 33,45,78 records, 9 volt operated. With mono cartridge. Brand new. As illustrated. 59/6 post 3/6.

MULLARD 1 WATT AMPLIFIER

9 volt. 5 transistor unit complete with volume control.
Output to 3 ohms. Ideal for use with Staar record Deck. 45/- post 3/-.
Send for leaflet 2.

BUILD A QUALITY TAPE RECORDER

To get the best out of your MAGNAVOX DECK, you need a MARTIN RECORDAKIT. This comprises a special high quality 6 valve amplifier and pre-amplifier which comes to you assembled on its printed circuit board—in fact everything needed down to the last screw FOR MAKING A SUPERB TAPE RECORDER, which, when built, will compare favourably with instruments costing twice as much, yet you need no experience or technical skill to bring this about. THE INSTRUCTIONS MANUAL MAKES BUILDING EASY AND SUCCESS ASSURED



4 Track **39 gns.**

P.P. 22/6 either model
Kit comprises: Deck, Amplifier, Cabinet and speaker, with MICROPHONE 7 in 1,200 ft. tape, spare spool
ALL UNITS AVAILABLE SEPARATELY — Today's Value £60.
ASK FOR BROCHURE 6.

VHF FM SUPERHET TUNER MKII

· 5-MULLARD TRANSISTORS & 4 DIODES · 300 Kc/s BANDWIDTH · PRINTED CIRCUIT CONSTRUCTION · HIGH FIDELITY REPRODUCTION MONO AND STEREO

A popular VHF FM Tuner now used throughout the country for quality reception of monophonic and, with the decoder stereophonic broadcasts. There is no doubt about it—VHF FM gives the the *real sound*. Excellent stability economically priced.

PARTS TOTAL COST **£6.19.6.**
DECODER £5.19.6.
(CABINET 20/- EXTRA) ASK FOR LEAFLET 3.

MANUFACTURERS—DISTRIBUTORS

We publish a QUANTITY, SEMI-CONDUCTOR BULLETIN listing over 500 different devices available FROM STOCK in medium to large quantities at KEEN PRICES coupled with PROMPT DELIVERIES.
TO OBTAIN YOUR COPY, WRITE TO US (on Company Headed Notepaper please) requesting our SEMI-CONDUCTOR BULLETIN. For TELEPHONE QUOTATIONS, PHONE (01) 723 1008/9 Extn. 4 (01) 723 0401 Extn. 4.

We purchase medium to large quantities of Transistors and Devices excess to Manufacturers and Distributors requirements.

Write or phone 723-0401 extn. 4.

NEW—MALLORY LONG LIFE MERCURY BATTERIES 50% OFF LIST PRICES

•RM12 1.35 volts 3600 m/aH size 2" x ½ dia. **OUR PRICE 5/– each**

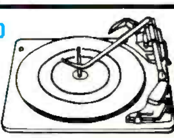
• RM625 10.35 volts 350 m/aH Pack of 8. Size 2¼ x ½ dia
OUR PRICE 10/– each
Easily split into eight 1.35v. cells. These cells are ideal for any application where SMALL SIZE HIGH CAPACITY and LONG LIFE are required.
QUANTITIES AVAILABLE.

TRANSISTORS—SEMICONDUCTORS

COMPLETELY NEW 1969 LIST OF 1000 types. Send for your FREE COPY TODAY. (list 36)

S.C.R.'s from 5/-
Field Effect Transistors from 7/6
Power Transistors from 5/-
Diodes and Rectifiers from 1/6

GARRARD RECORD DECKS



BRAND NEW
All below list price

	£	s	d
2025 Mono/Stereo GKS 25	8	8	0
3000LM Mono/Stereo 9 TAHC	9	16	6
SP25 Mk II	9	19	6
AT60 Mk II	13	0	0
AP75	19	0	0
SL55	11	19	6
SL65	14	14	0
SL75	29	0	0
SL95	35	0	0
A70 Mk II	12	12	0
B.S.R. UA25 Mono	5	19	6
MA65	9	19	6
MA70	12	12	0
MA75	15	5	0
401 Garrard	28	10	0

Carriage/Packing 7/6d. all models
Complete range of accessories available
Send for New 8 page brochures 16. 17

HI-FI equipment to suit EVERY POCKET

VISIT OUR NEW HI FI CENTRE at 309 EDGWARE ROAD AND SAVE UP TO £40 ON SEPARATE UNITS OR THE SYSTEM OF YOUR CHOICE

for *all* leading makes
AMPLIFIERS
TUNERS
DECKS
SPEAKERS
MICROPHONES
TEST EQUIPMENT
HEADPHONES
CARTRIDGES, etc.
All with Terrific Savings

It will PAY YOU to pay us a VISIT!

COMPLETE SYSTEMS *from* £46 – Saves £12.10.0!
Send for new 8-page illustrated Hi-Fi list 16/17.

Fully Illustrated CATALOGUE

COMPLETELY NEW 9th EDITION (1969)

The most COMPREHENSIVE—CONCISE—CLEAR COMPONENTS CATALOGUE

Complete with 10/- worth discount vouchers FREE WITH EVERY COPY

* 32 pages of transistors and semi-conductor devices, valves and crystals.
* 210 pages of components and equipment.
* 70 pages of microphones, decks and Hi-Fi equipment.

6,500 ITEMS
320 BIG PAGES

Send today 7'6 Post etc 2/-

HENRY'S RADIO LTD

OPEN MON.–SAT. 9 a.m.–6 p.m. THURS. 9 a.m.–1 p.m.

303 Edgware Road, London, W.2. Mail Order Dept. all types of Components, Organ Dept. (01) 723-1008/9
309 Edgware Road, London, W.2. High Fidelity Sales, P.A. and Test Equipment, Record Decks (01) 723–6963