PRACTICAL
ELECTRONICS

JULY 1969

THREE SHILLINGS

YOURS TO COMMAND!

.........WITH THIS PULSED LIGHT BEAM TRANSMITTER AND PHOTO-ELECTRIC RECEIVER

THE RELIABLE SOLDERING INSTRUMENT!

SEND COUPON FOR LATEST LEAFLET

ADCOLA PRODUCTS LTD
ADCOLA HOUSE
GAUDEN ROAD
LONDON SW4

NAME..

ADDRESS ....

....

....

....

PE170

NEWMARKET TRANSISTORS

NKT11	9/3	NKT452	12/6	BCY71	9/3	2N930	8/-
NKT12	7/3	NKT453	8/-	BCY72	4/6	2N1131	8/6
NKT72	5/-	NKT603F	6/6	BDY20	22/3	2N1132	10/-
NKT73	5/-	NKT613F	7/3	BFX29	11/6	2N1302	4/6
NKT124	8/6	NKT674F	5/-	BFX30	13/3	2N1303	4/6
NKT125	5/9	NKT677F	4/6	BFX84	6/6	2N1304	5/-
NKT126	5/-	NKT713	5/-	BFX85	8/-	2N1305	5/-
NKT135	5/-	NKT717	8/-	BFX86	6/6	2N1306	6/6
NKT137	6/6	NKT734	5/-	BFX87	8/-	2N1307	6/6
NKT210	5/9	NKT736	6/6	BFX88	7/3	2N1308	8/6
NKT211	5/-	NKT773	4/6	BFY50	5/-	2N1309	8/6
NKT212	5/-	NKT781	5/-	BFY51	4/6	2N1613	5/9
NKT213	6/6	NKT10419	5/-	BFY52	5/-	2N1711	6/6
NKT214	4/6	NKT10519	5/9	BFY53	4/6	2N1893	12/6
NKT215	5/-					2N2217	7/3
NKT216	10/-					2N2217A	15/6
NKT217	10/9					2N2218	8/6
NKT219	5/-					2N2218A	10/-
NKT223	5/9					2N2219	10/9
NKT224	4/6					2N2219A	12/6
NKT225	4/6					2N2220	7/3
NKT229	5/-					2N2221	8/6
NKT237	7/3					2N2221A	10/-
NKT238	4/6					2N2222	10/9
NKT239	5/-					2N2222A	12/6
NKT240	4/6					2N2297	9/3
NKT241	5/-					2N2368	4/6
NKT242	3/-					2N2369	4/6
NKT243	14/-					2N2369A	5/-
NKT244	3/-					2N2483	8/6
NKT245	3/9					2N2484	10/9
NKT261	3/9					2N2220A	10/9
NKT262	3/9					2N2904	10/9
NKT264	3/9					2N2904A	12/-
NKT271	3/9					2N2905	15/6
NKT272	3/9	NKT10339	6/6	BFY90	29/6	2N2905A	18/-
NKT274	3/9	NKT10439	7/3	BSX19	4/6	2N2906	12/6
NKT275	3/9	NKT12329	11/6	BSX20	4/6	2N2906A	13/3
NKT281	5/-	NKT12429	14/-	BSX60	16/6	2N2907	14/-
NKT302	16/6	NKT13329	5/-	BSX61	10/-	2N2907A	20/9
NKT304	13/3	NKT13429	5/-	BSY95A	3/9	2N3053	5/9
NKT351	11/6	NKT35219	22/3	2N696	5/-	2N3055	20/9
NKT401	18/-	NKT16229	11/6	2N697	5/-	2G345	4/-
NKT402	19/3	NKT20329	12/6	2N706	3/-	2G371	4/-
NKT403	16/-	NKT20339	8/6	2N706A	3/-	2G378	4/-
NKT404	13/3	BC107	4/6	2N708	4/6	OC22	10/-
NKT405	14/9	BC108	3/-	2N709	11/6	OC204	6/-
NKT406	13/3	BC109	4/6	2N914	5/-	OC44	6/-
NKT420	40/-	BCY55	70/-	2N918	11/6	OC45	6/-
NKT451	13/3	BCY70	5/-	2N929	7/3	ASZ17	10/-

FERRANTI TRANSISTORS

ZTX300	1/11
ZTX302	3/-
ZT44	12/9
ZT1613	7/9
ZT1700	17/9
ZT1701	22/6
ZT3055	20/6
KR54	27/6
KR56	27/6
ZR12	16/9
ZS170	1/11

Quantity Discount:

25/49	5%	all one type
50/99	10%	
100/299	15%	
300/999	20%	
1,000	25%	

ORGAN BUILDERS!
SILICON N.P.N. TRANSISTORS SUITABLE FOR USE IN DIVIDER CIRCUITS—1/6 each or £5 per 100.

UNMARKED TRANSISTORS (tested) similar to: 2N753 **1/6**, BSY28 **1/6**, BSY65 **1/6**, OC44 **1/6**, OC71 **1/-**, OC72 **1/-**.
ORP12 CADMIUM SULPHIDE LIGHT-SENSITIVE RESISTORS 9/- each.

GIANT-SIZE SELENIUM SOLAR CELLS—PRODUCE UP TO 6mA AT ·6 VOLTS FROM DAYLIGHT! 67mm. diameter **10/-** each. 50mm. x 37mm.. 2 for **10/-**.

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

Spot Face Cutter **7/6**. Pin Insert Tool **9/6**. Terminal Pins **3/6** for 36.
Special Offer! Spot Face Cutter and 5 2½ x 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.

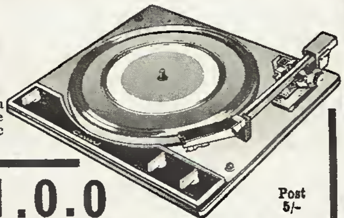
Lasky's Radio

LASKY'S RADIO ESTABLISHED OVER 36 YEARS

SPECIAL OFFER

Garrard AP75

WITH AD-76K STEREO MAGNETIC CARTRIDGE



AP75 3 speed single play deck with Synchro-Lab motor—offered with the outstanding **AD-76K** stereo magnetic cartridge

LASKY'S PRICE £21.0.0 Post 5/-

AUTOCHANGERS	
1025 less cartridge	£6 9 6
1025 with GCM21 mono cartridge	£6 19 6
2025TC with GCM21 mono cartridge	£7 19 6
SL55 with J2006 stereo cartridge	£11 19 6
SL65 less cartridge	£14 15 0
AT60 Mk. II less cartridge ..	£14 10 0
SL75 less cartridge	£28 10 0
SL95 less cartridge	£35 0 0
A70 Mk. II less cartridge ..	£13 19 6
B.S.R.UA-47 less cartridge ..	£5 9 6

SINGLE PLAYERS	
SP25 Mk. II less cartridge ..	£11 19 6
AP75 less cartridge	£18 10 0
SRP22 Mains model less cartridge	£6 12 10
SRP22 Battery model less cartridge	£7 15 3
TRANSCRIPTION DECKS 401	£28 10 0

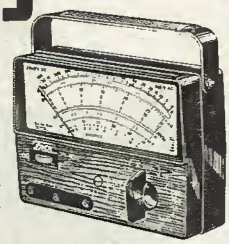
GARRARD BASES:
WB1 £3. 6. 11; WB4 Mk. II £5. 8. 11; WB5 £5. 8. 11.

CLEARVIEW PERSPEX COVERS:
SPC1 £3. 5. 0; SPC4 Mk. II £4. 6. 6.

Postage on all above 5/- extra

TEST METERS

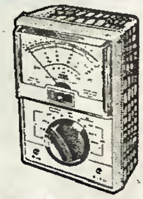
TMK Model PL-436



20,000 O.P.V. Multitester for the amateur or professional. Features mirror scale and wood grain finish front panel. SPEC.: DC/V ranges: 0·6, 3, 12, 30, 120, 600V at 20K/O.P.V. AC/V ranges: 3, 30, 120, 600V at K/O.P.V. DC current: 50μA, 0·6, 60, 600mA. Resistance: 10K, 100K, 1M and 10M ohms end scale (65, 650, 6·5K and 65K ohms centre scale). Decibels: –20 to +57dB in four ranges. Operates on 2 × 1·5V U7 type batteries. Size: $5\frac{7}{8} \times 4\frac{5}{8} \times 2\frac{3}{8}$ in. Complete with test leads, battery and instructions.

LASKY'S PRICE £7.19.6 Post 5/-

TTC Model C-1000



A really tiny 1,000 O.P.V. pocket multi-tester with "big" meter performance. Precision 2 jewel meter movement. Hand calibrated to ±3% accuracy on full scale of DC ranges, 4% on AC ranges. $2\frac{1}{8}$ in. square meter. SPECIFICATIONS: AC/V ranges: 0–10, 50, 250, 1,000V at 1K/O.P.V. AC/V ranges: 0–10, 50, 250, 100V at 1K/O.P.V. DC current: 0–1–100mA. Resistance: 0–150K/ohms (3,000 ohms centre scale). Decibels: —10 to +22dB. Operates on one penlight cell. Two colour buff/green case—size only $3\frac{1}{2} \times 2\frac{1}{2} \times 1$ in. Click stop range selection switch. Ohms zero adjustment. Complete with test leads, battery and ins.

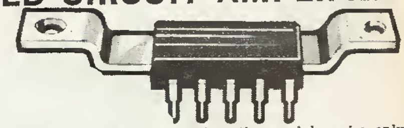
LASKY'S PRICE 39/6 Post 2/6

EXCLUSIVE FIRST

PRESENTING THE IC-403

INTEGRATED CIRCUIT AMPLIFIER MODULE

AVAILABLE **NOW!**



Originally developed for computer and space projects these tiny modules—size only 25 × 10 × 5 millimetres—represent the most amazing breakthrough in circuit design since the introduction of the transistor. The actual circuit—no bigger than a pinhead—is encapsulated in solid plastic fused with the heatsink and connecting pins to make an almost indestructible unit. The IC-403 is an integrated power and pre-amplifier requiring only the addition of tone and volume controls, power source and speaker to form a complete audio amplifier of 3W output. There are many applications for this unique device, wherever high efficiency and ultra compact size is required, i.e. miniature P.A. and audio amplifiers, intercoms, electronic organs, tape recorders, etc., etc.

SPECIFICATION (ratings at 25°C): Output power typically 3W from 250mV input. Frequency response 20Hz to 80KHz ± 3dB. Power amp. distortion 0·3% (at 1W, 400Hz). Pre-amp. gain 24dB. Power amp. gain 26dB. Max. operating voltage 21V. Min. operating load 7·5 ohms. Noise level —75dB. Pre-amp. input imp. 2M/ohms. Pre-amp. and power amp. D.C. input current 50mA.

THE IC-403 IS AVAILABLE FROM STOCK EXCLUSIVELY FROM LASKY'S —COMP. WITH INS. DATA AND SUGGESTED CIRCUIT APPLICATIONS

LASKY'S PRICE ONLY 52/6 Post 2/6

PORTABLE PLEASURE

BATTERY/MAINS MW-LW BRIEFCASE RADIOGRAM THE NRP-840

A portable radiogram of ultra slim "briefcase" proportions. Very smart impact resistant plastic cabinet with leather grain finish. The NRP.840 operates on 220/240V AC mains with built-in AC converter or 6 × 1½V (U2 type) batteries. The radio section covers full AM (medium band) 5,400-1,600Kc/s and Long wave 150–370Kc/s. MW reception through an internal ferrite aerial plus 7 section telescopic antenna for LW. The gram section has three speeds 33, 45 and 78 rpm, which are easily selected on a rotary control. Plays all sizes of records, 7, 10 and 12in. Lightweight spring loaded pick-up arm with crystal cartridge automatically switches turntable off when in rest position. Supplied complete with mains lead, centre spindle adaptor, batteries and instructions. The ideal unit for your summer pleasure anywhere, anytime. Size: 13 × 9½ × 3ins. Available in black or red; please specify when ordering.

LASKY'S PRICE £21.0.0 Post 5/-

GET YOUR LASKY'S AUDIO-TRONICS PICTORIAL
16 colour pages in large 16 × 11in. format packed with 1,000's of items from our vast stocks. Hi-Fi, Radio, Electronics, Test equipment, components, etc., etc.
Send 1/- for post only and inclusion on our regular mailing list.

Branches

207 EDGWARE ROAD, LONDON, W.2 Tel.: 01-723 3271
Open all day 9 a.m.–6 p.m. Monday to Saturday

33 TOTTENHAM CT. RD., LONDON, W.1 Tel.: 01-636 2605
Open all day 9 a.m.–6 p.m. Monday to Saturday

152/3 FLEET STREET, LONDON, E.C.4 Tel.: 01-353 2833
Open all day Thursday, early closing 1 p.m. Saturday

High Fidelity Audio Centres

42-45 TOTTENHAM CT. RD., LONDON, W.1 Tel.: 01-580 2573
Open all day 9 a.m.–6 p.m. Monday to Saturday

118 EDGWARE ROAD, LONDON, W.2 Tel.: 01-723 9789
Open all day Saturday, early closing 1 p.m. Thursday

ALL MAIL ORDERS AND CORRESPONDENCE TO: 3-15 CAVELL ST., TOWER HAMLETS, LONDON, E.1 Tel.: 01-790 4821

a complete stereo system for 28 gns!

The new Duo general purpose two way system is beautifully finished in polished teak veneer, with matching vynair grille. It is ideal for wall or shelf mounting either upright or horizontally. **SPECIFICATION:** Impedance 10 ohms. It incorporates Goodmans high flux 6 × 4in and 2½in tweeter. Teak finish 12 × 6¾ × 5¾in. 4 guineas each, P. & P. 7/6. Garrard Changers from £7.19.6, P. & P. 7/6. Cover and Teak finish Plinth £4.15.0, P. & P. 7/6.

THE DUETTO — 9 GNS

Integrated Transistor Stereo Amplifier + 7/6 P. & P.

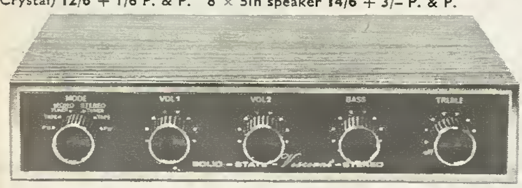
The Duetto is a good looking quality amplifier, attractively styled and finished. It gives superb reproduction previously associated with amplifiers costing far more. **SPECIFICATION:** R.M.S. power output: 3 watts per channel into 10 ohms speakers. **Input Sensitivity:** Suitable for medium or high output crystal cartridges and tuners. Crosstalk 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 RELIANT

Solid State General Purpose Amplifier

6½ GNS
+ 7/6 P. & P.

SPECIFICATION: **Output:** 10 watts into a 3 ohms speaker. **Inputs:** (1) for mike (10 m.v.). Input (2) for gram, radio (250 m.v.) individual bass and treble control. **Transistors:** 4 silicon and three germanium. **Mains input:** 220/250 volts. **Size** 10½ × 4½ × 2½in. **Price:** 6½ guineas in teak finished case. Less teak case 5½ guineas. P. & P. 7/6. **Mike to Suit:** (Crystal) 12/6 + 1/6 P. & P. 8 × 5in speaker 14/6 + 3/- P. & P.



THE VISCOUNT — 13½ GNS

+ 7/6 P. & P.

Integrated High Fidelity Transistor Stereo Amplifier

SPECIFICATIONS: **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. 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:** 12½ × 6 × 2½in in teak finished case. Built and tested. P. & P. 7/6.

Goods not despatched outside U.K. Terms C.W.O. All enquiries s.a.e.

RADIO & TV COMPONENTS (ACTON) LTD.
21d High Street, Acton, London, W.3

Orders by post to our Acton address please, also at 323 Edgware Road London, W.2

LINEAR INTEGRATED CIRCUITS

G.E. Type PA230 LOW LEVEL AMPLIFIER	21/-
G.E. Type PA234 1 WATT AUDIO AMPLIFIER	23/-
RCA Type CA3020 ½ WATT WIDE-BAND AMPLIFIER	32/-
RCA Type CA3035 ULTRA HIGH GAIN AMPLIFIER	30/-
MULLARD Type TAA 263 A.F. AMPLIFIER	15/9
MULLARD Type TAA 310 RECORD/PLAYBACK AMPLIFIER	32/-
MULLARD Type TAA 320 MOS FET WITH BIPOLAR TRANSISTOR	13/5
G.E. Type 2N5302 DARLINGTON PAIR	11/6
G.E. Type D13T1 PROGRAMMABLE UNIJUNCTION TRANSISTOR	10/8

Add 1/- each to the above for data sheets, if required. Data sheets only 1/6 each, post free.

Selection from our range of STOCK transistors

ACY18	4/5	BC184L	3/2	TIS50	3/9	2N2924	4/4
ACY19	5/3	BC212L	3/9	2N696	4/9	2N2926	3/-
ACY20	4/6	BC213L	3/9	2N697	5/-	2N3053	6/8
ACY21	4/11	BC214L	4/-	2N706	3/3	2N3055	19/6
ACY22	2/10	BCY70	5/4	2N1132	10/9	2N3702	3/6
ASY26	6/2	BCY71	10/4	2N1302	3/11	2N3703	3/3
ASY27	8/-	BCY72	4/6	2N1303	3/11	2N3704	3/9
ASY28	6/2	BD121	18/-	2N1304	5/-	2N3705	3/4
ASY29	8/-	BFY50	5/-	2N1305	5/-	2N3707	4/-
BC107	3/3	BFY51	4/6	2N1306	6/5	2N3708	2/5
BC108	3/-	BFY52	5/-	2N1307	6/5	2N3819	9/-
BC109	3/3	BSY95A	3/11	2N1308	9/6	2N3820	18/9
BC182L	3/2	TIS44	1/9	2N1309	9/6	2N4058	4/6
BC183L	2/5	TIS49	2/6	2N2906	13/-	2N4059	3/5

Send 2/- now for our new Components Catalogue packed with details of a host of components available by return.

We stock a wide range of international Rectifier products (including Transistors, Solar Cells, Rectifiers, Zener Diodes, SCRs, etc.) plus professional quality high stability Carbon Film Resistors, Capacitors, Plugs and Sockets, Veroboard, Switches, etc.

ALL components offered are brand new and guaranteed to conform to the manufacturer's published specifications.

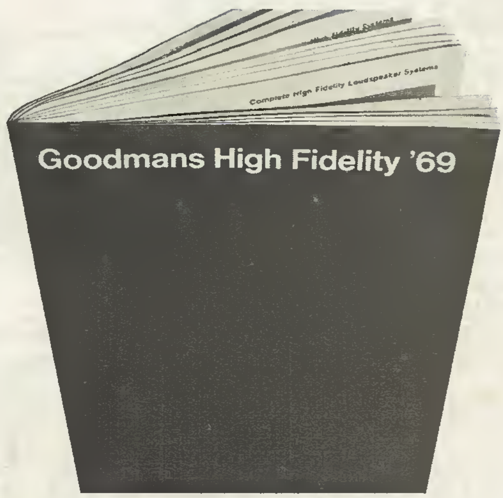
Cash Discounts: Order over £5—10%; order over £10—15%.

Cash with order please. Post and Packing (U.K. and Ireland) 1/6.

Overseas Orders Welcome. (Carriage at cost.)

KINVER ELECTRONICS LTD.

STONE LANE, KINVER, STOURBRIDGE, WORCS.



New Edition–Now Out

Thinking of High Fidelity—first read Goodmans 28 page High Fidelity Manual. It contains interesting articles on Stereo; an Introduction to High Fidelity; Stage-built systems; as well as full details of Goodmans High Fidelity audio products.

Send for your free copy

Please send me a free copy of Goodmans Manual

Name ______________________________

Address ____________________________

P.E.7

Goodmans Loudspeakers Limited

Axiom Works, Wembley, Middlesex. Tel: 01-902 1200

PREMIER RADIO

23, TOTTENHAM COURT ROAD, LONDON, W.1 Tel: 01-636 3451

OXFORD ST. 23 TOTTENHAM COURT RD. DOMINION

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, 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 DEMONSTRATION

All leading makes available including Rogers Armstrong Dulci, Wharfedale, Goodmans, Goldring, Shure, etc. etc.

GARRARD RECORD UNITS

1025 Stereo/Mono cart.	£7.19.6	Teak Plinth with perspex cover as above £5.10.0. Carr. 6/6 extra.
2025 Stereo/Mono cart.	£8.19.6	
3000 with 9TAHCD	£9.19.6	
Carriage 7/6 extra		
AT60 MKII less cart.	£13.19.6	
SP25 MKII less cart.	£11.19.6	
AP75 less cart.	£19.0.0	Teak Plinth with perspex cover £7.10.0 Carr. 7/6 ex.
SL75 less cart.	£29.0.0	

SL95 less cart. £38.10.0. Carriage 10/- extra.

GOLDRING RECORD UNITS

GL68 less cart. £22.7.0. GL75 less cart. £35.15.5. Carriage 10/- extra.

PICK-UP CARTRIDGES

at money-saving prices

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 £11.11.0
M44C list £12.19.5	Premier price £10.10.0
M44E list £17.18.4	Premier price £13.19.6
M55 list £20.15.1	Premier price £16.19.6
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.

GOLDRING G800 (Stereo)	£9.19.6
B. & O. SP1 (Stereo)	£5. 5.0
PICKERING V15/AC2 (Stereo)	£8.10.0
SONOTONE 9TAHC/Diamond (Stereo)	£2.15.0
ACOS GP91/1SC (Mono compatible)	£1.13.5
ACOS GP93-1 (Stereo)	£2. 8.7
ACOS GP94-1 (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.

HI-FI STEREO HEADPHONES

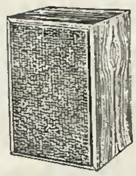
Designed to the highest possible standard. Fitted 2½″ speaker units with soft padded ear muffs. Adjustable headband. 8 ohm impedance. Complete with 6ft. lead and stereo jack plug. **59/6** P. & P. 5/-.

MONO HEADPHONES 2000 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/-.

"PREMIER" SPEAKER SYSTEM



Specially designed oiled teak cabinet with vynair front. Size 12½″ high 7½″ wide, 6½″ deep. Fitted 6½″ EMI 8 ohm Bass speaker with rolled surround and matching 3″ EMI tweeter. Fully lagged. **£7.19.6.** Carr. 7/6.

MULTI TESTERS

MODEL DI4. A really versatile instrument that makes a handy pocket size tool. Measures AC or DC voltage in three ranges of 0–15–150–1000 volts. Resistance 0–100,000 ohms. Current 0–150 mA D.C. Size only: 3⅝ × 2¼ × 1⅛in. 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: 0-5-25-50-250-500-2500 volts DC. 0-10-50-100-500-1000 volts AC. 0-50 uA-2·5 mA-250 mADC. 0-6000 ohms-6 megohms, 10u uf-0·001 mfd-1 mfd. −20 to +22dB. Complete battery, test lead and instructions **£4.19.6** P. & P. 3/6.

WELLER SOLDERING TOOLS

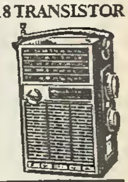
"Expert" Solder Gun. Saves time and simplifies soldering in the home and service dept. Two position trigger gives instant dual heat. 100/140 watt. 240 volt A.C. 67/6 P. & P. 2/-.

"Marksman" Soldering Iron. Lightweight, conventional 3/16″ pencil bit. Ideal for regular bench use and all those jobs around the home. 25 watts. 240 volt. A.C. 31/6 P. & P. 2/-.

MONO GRAM AMPLIFIER

2½ watts output. Uses EL84 valve, double wound mains transformer. Ideal for use with any record deck. Volume/on/off and tone controls on flying leads. Output impedance 3 ohms. Size overall 5¼″w. × 5½″d × 3″h. A.C. 200/240V. ONLY 69/6. P. & P. 5/-.

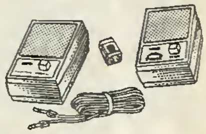
JULIETTE NA.5018 5 BAND 18 TRANSISTOR MAINS/BATTERY RADIO



Covers AM 540–1600Kc/s. Marine 1·6–4·6Mc/s. FM 88–108Mc/s. VHF 108–134Mc/s. PB 148–174Mc/s. Ferrite bar aerial for AM/MB. Telescopic aerial for FM/VHF/PB. 4″ P.M. Speaker. Operates on AC 250V or D.C. by four 1·5 V batteries. Size: 9⅜″ × 5¾″ × 3⅜″.

PREMIER PRICE **33** GNS. P. & P. 10/-.

TWO STATION TRANSISTOR INTERCOMS.



Complete with battery and 50ft. connecting wire. Compact size, two way call system. Ideal for home, office, factory, etc. **49/6** 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.

"PREMIER" TAPE CASSETTES

C60	(60 min.)	10/6
C90	(90 min.)	15/-
C120	(120 min.)	20/-

P. & P. 1/-.

CASSETTE HEAD CLEANER

Removes unwanted deposits from delicate tape heads. Fits all cassette recorders **15/-** P. & P. 1/-.

"VERITONE" RECORDING TAPE

SPECIALLY MANUFACTURED IN U.S.A. FROM EXTRA STRONG PRE-STRETCHED MATERIAL. THE QUALITY IS UNEQUALLED.

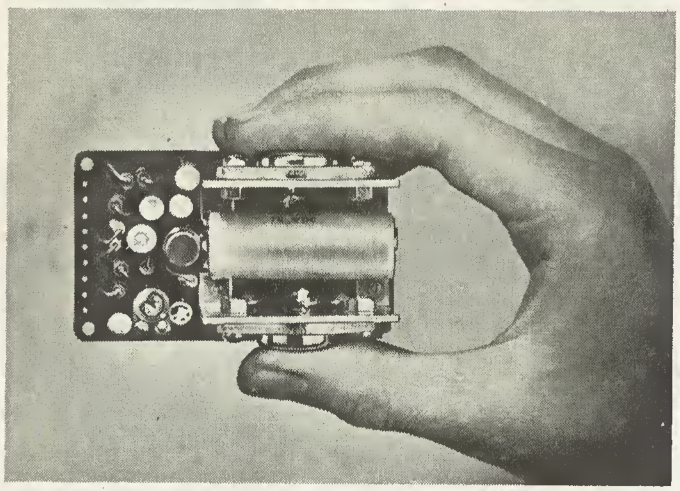
TENSILISED to ensure the most permanent base. Highly resistant to breakage, moisture, heat, cold or humidity. High polished splice free finish. Smooth output throughout the entire audio range. Double wrapped—attractively boxed.

LP3	3″	250′	P.V.C.	5/6	DT6	5¾″	1800′	POLYESTER	22/6
TT3	3″	450′	POLYESTER	7/6	TT6	5¾″	2400′	POLYESTER	37/6
DT3	3¼″	600′	POLYESTER	11/6	SP7	7″	1200′	POLYESTER	12/6
SP5	5″	600′	P.V.C.	8/6	LP7	7″	1800′	P.V.C.	15/-
LP5	5″	900′	P.V.C.	10/-	DT7	7″	2400′	POLYESTER	25/-
DT5	5″	1200′	POLYESTER	15/-	TT7	7″	3600′	POLYESTER	50/-
LP6	5¾″	1200′	P.V.C.	12/6					

TAPE SPOOLS 3″ 1/-, 5″, 5¾″, 7″ 1/9. **TAPE CASES** 5″ 5¾″, 7″ 2/6.

Post and Packing 3″ 1/-, 5″, 5¾″ 1/6, 7″ 2/-. (3 reels and over Post Free.)

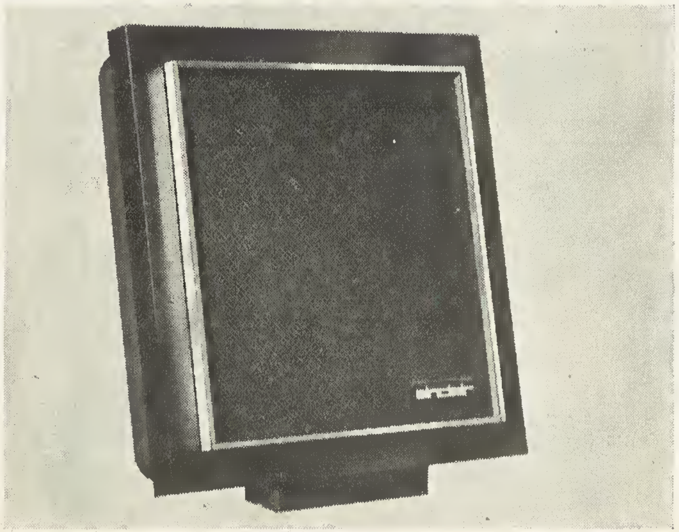
sinclair



Z.12 - for all you want from any amplifier

The Z.12 is a most versatile integrated amplifier and pre-amp in which power, compactness and true high-fidelity standards are combined within a unit of very modest price. The most widely used unit of its kind in the world, the Z.12 has an output of 12W R.M.S. continuous sine wave (24W peak) or 15W music power (30W speak). It has Class B ultralinear output which can be fed into any loudspeaker from 3 to 15 ohms. (Two 3 ohm speakers can be used in parallel.) Frequency response—15 to 50,000Hz ± 1dB; input sensitivity—2mV into 2 K/ohms. The Z.12 will operate from any power source between 6 and 20V d.c. As such, a car battery or the PZ.4 are eminently suitable, giving much wider than usual scope in the applications to which the Z.12 may be put. As well as hi-fi, these include systems for P.A. electronic guitars, organs, intercom systems, laboratory, education or industry. You will find the Z.12 in use in such instances again and again. The Sinclair Z.12 is supplied ready built, tested and guaranteed, complete with manual of circuits and instructions for matching it to your precise requirements. Two may be used in stereo when, with the Stereo 25 and PZ.4 together with two Q.14s, you will have an ideal high fidelity assembly.

89/6



Q.14 - the unique loudspeaker

New materials and original design techniques have been used to produce speaker of fantastic quality at a most attractive price. Experts and reviewers have enthusiastically endorsed its performance. The shape and size of the Q.14 make it far more adaptable to its environment than is the case with conventionally styled speakers so that it is much easier to position this speaker in the room in which it is to be heard. The Sinclair Q.14 has a substantially flat frequency response from 60 to 16,000Hz and outstandingly good transient response. It will comfortably handle up to 14W loading and is positively brilliant in stereo. Measuring 9¾in square by 4¾in deep, this loudspeaker is finished in matt black with solid aluminium bar trim.

Try the Q.14 in your own home without delay. If you are not delighted with it, your money including cost of return postage to Sinclair will be refunded immediately.

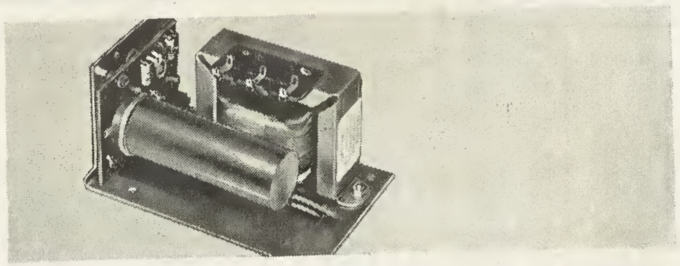
£7.19.6

+ 2/11 P/T Surcharge

Stereo 25 de-luxe pre-amp/control unit

This is a very elegantly styled unit, which, although designed basically for use with the Z.12, is readily adaptable for use with any high quality power amplifier system. The switched input selector allows for Pick-up, Radio and Auxiliary and there are controls for bass cut and lift, treble cut and lift, volume and stereo balance. P.U. input is equalised to R.I.A.A. curve from 50 to 20,000Hz ± 1dB and the instructions manual provided gives matching details for pick-ups, shows how to connect up, etc. The front panel of the Stereo 25 is finished in brushed and polished aluminium embellished in black. The control knobs are in solid aluminium to match. Size 6¼ × 2½ × 2½in plus knobs. Supplied built, tested and guaranteed.

£9.19.6



PZ.4 - stabilised power supply unit

Designed specially to meet the power requirements for an assembly of two Z.12s and the Stereo 25, this heavy duty transistorized power supply unit has stabilised output of 18V d.c. at up to 1·5A. It is for a.c. mains operation 200/250V.

Supplied built, tested and guaranteed.

99/6

SINCLAIR MICROMATIC

Whether you buy your Micromatic in kit form or built ready for use, you must not deny yourself the thrill of owning this fantastically small British receiver. Smaller than a matchbox, it has power, range and selectivity that must be experienced to be believed. The high quality magnetic earpiece supplied with the set ensures excellent reproduction indoors and out. The Micromatic tunes over the medium waveband and has A.G.C. to counteract fading from distant stations. Bandpass tuning makes reception of Radio 1 easier; in fact you will find this set performing in some cases where other sets cannot be heard at all. The Micromatic is housed in a neat black case given an elegantly modern appearance by the attractive aluminium front panel and matching tuning control.

Kit in fitted pack with magnetic earpiece, instructions and free solder

49/6 *+1/1d P/T Surcharge*

Built, tested and guaranteed, inc. magnetic earpiece

59/6 *+1/1d P/T Surcharge*

Mallor Mercury Cell type RM.675 (2 required) 2/9 each

YOUR SINCLAIR GUARANTEE

Should you not be completely satisfied with your purchase when you receive it from us, your money will be refunded in full at once and without question.

FULL SERVICE FACILITIES AVAILABLE TO ALL PURCHASERS.

Goods sent post free in U.K. and overseas by surface mail. Air mail extra at cost.

Please send POST FREE ....

....

....

....

For which I enclose cash/cheque/money order

NAME ....

ADDRESS ....

....

....

PE.669

SINCLAIR RADIONICS LTD., 22 NEWMARKET ROAD, CAMBRIDGE

OCA3-52731

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 £5.5.0 PER 500
PRICE £10 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 £5 PER 1000

POST & PACKING 2/6 U.K.

ALL THE ABOVE UNTESTED PACKS HAVE AN AVERAGE OF 75% OR MORE GOOD SEMI-CONDUCTORS. 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 comp. with Coils and Magnets	10/-
B85	24	Integrated Circuits on Panels. Data supplied with orders	10/-
B89	2	5SP5 Light Sensitive Cells. Light Res. 400 Ω Dark 1M Ω	10/-
B90	10	Latest Type Reed Switches. Green Glass GPO type	10/-
B91	8	NKT163/164 PNP Germ. TO-5 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/-

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.

TRANSISTORS ONLY 1/- EACH
SILICON • PLANAR • N.P.N. • P.N.P

All these types available

2N929	2N706	2S131	2S103	2N696	2N1613	2S733	BFY10
2S501	2N706A	2S512	2S104	2N697	2N1711	2N726	2S731
BSY38	2N3011	2S102	2N2220	2N1507	2N1893	2N2484	2S732

All tested and guaranteed for gain and leakage—unmarked. Manufacturers' fall outs from the new PRE-PAK range.

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. State 4 or 6 cylinder. **20/-each**

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-5 can	10/-
B82	10	OC45, OC81D and OC81 Trans. Mullard glass type	10/-
B83	200	Trans. Newmarket reject and other types NPN and PNP	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**

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.

THERE IS ONLY ONE BI-PRE-PAK LTD BEWARE OF IMITATIONS

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

L.S.T. ELECTRONIC COMPONENTS LTD.

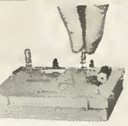
1N914	2/-	AC107	14/6	BF159	15/-	OAZ242	3/6
1S113	3/-	AC126	6/6	BF163	9/-	OAZ243	6/-
1S120	2/6	AC127	6/-	BF167	6/6	OAZ246	3/6
1S130	2/6	AC128	4/-	BF173	7/6	OAZ269	3/6
1S131	2/6	AC176	7/6	BF180	6/-	OAZ270	3/6
1S132	2/6	AC187	12/-	BF181	7/-	OAZ271	3/6
2G301	4/-	AC188	12/-	BF184	7/6	OC19	5/-
2G302	3/9	ACY17	5/8	BFW57	7/6	OC20	33/-
2G339A	5/-	ACY18	3/4	BFW58	6/6	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 }	15/-	ACY22	2/4	BFX29	8/5	OC26	12/-
2N388A }		AD140	15/-	BFY50	6/-	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	6/-	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	4/-
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	18/-	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	3/6	ORP63	9/-
2N3054	15/-	BC134	6/-	NKT281	5/6	SX631	7/4
2N3055	15/-	BC147	6/-	NKT403	15/-	SX636	16/8
2N3702	4/-	BC148	6/-	NKT405	15/-	SX638	12/-
2N3703	4/-	BC149	6/-	NKT713	5/6	SZ20C	15/-
2N3704	4/6	BC154	12/-	NKT773	5/6	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	4/8	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

- 40 Silicon Planar Transistors. TO-18 case. NPN and PNP mixed. Similar V405A, P346A, etc. Not tested or coded. Guaranteed minimum 50% good 10/-
- 40 Silicon Planar Transistors. TO-18 case. NPN type similar 2N706, BSY95A, 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/-
- 100 Germanium PNP Transistors. TO-1 case. Type similar NKT274/6, etc. Not tested or coded. Minimum 50% usable 10/-
- 20 Germanium Transistors 2G371B. Case SO-2. Fully tested to makers specifications PNP. Equal to OC71 range. Not coded 10/-
- 30 Micro alloy diffused Transistors. (MAT type) Not tested or coded. PNP 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.
EXPORT SPECIAL: 10% of the above SALE goods are reserved for export until August 1969.



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/–

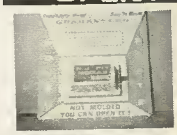
ALUMINIUM CHASSIS
6 × 4 × 2½in with reinforced corners 6/9 each (P. & P. 1/6). Ally panel to fit, 1/6. Paxolin panel to fit, 2/–. Many other sizes in stock up to 12 × 8 × 2½in (see catalogue)

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/–
X—261	Mic. FM Transmitter	35/–
X—271	Telephone Transmitter	35/–
X—241	R/Player Transmitter	35/–
X—291	Guitar Transmitter	35/–
X—371	Wireless Sentry	35/–

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/–	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/–	7/6	—	20/–
100	—	10/–	10/–	—	22/–
200	8/6	—	12/6	42/–	35/–
300	—	11/–	—	—	—
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

CRS3/40 (3M1) 400V 3A 7/6
HIGH GATE REQUIREMENT SCR

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/-

TIS43A 6/9
SIMILAR 2N2546 TIS43, 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

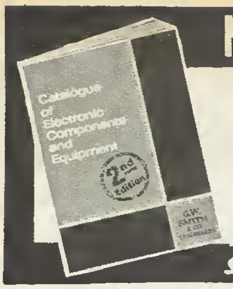
MIN. POLYESTER CAPACITORS. Printed circuit type 250V d.c. working. 0·01, 0·015, 0·022, 7d each. 0·033, 0·047, 8d each. 0·068, 0·10, 9d.

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. Semiconductors offered bear Manufacturers' original markings and are subject to our full replacement guarantee if not to published specifications. We DO NOT offer "Re-marked" semiconductors. Catalogue (1968) free on request. 1969 edition shortly available. Post and Packing (First class) 1/- per order. Retail and Trade supplied. Export enquiries particularly welcome. **GIRO No. 388-3159**



NEW CATALOGUE

Nearly 200 pages giving full details of a comprehensive range of COMPONENTS, TEST EQUIPMENT, COMMUNICATION EQUIPMENT AND HI-FI EQUIPMENT. Each section greatly enlarged and fully illustrated. Thousands of items many at bargain prices. FREE DISCOUNT COUPONS VALUE 10/-.

SEND NOW—ONLY 7/6 P&P 1/-

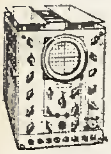
GARRARD

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

SRP22 Mono	£6.10.0	*SP25 MKII	£11.19.6
SRP22 Stereo	£6.19.6	*SL55	£11.19.6
*1025 Mono	£7.10.0	A70 MKII	£12. 0.0
*1025 Stereo	£7.15.0	*AT60MKII	£13.10.0
*2025 Stereo	£7.19.6	*SL65	£14.14.0
*2025T/C		AP75	£19. 0.0
Mono/Stereo	£8.17.6	401	£28. 7.6
*3000 Stereo	£9.19.6	SL75	£29. 0.0
		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.

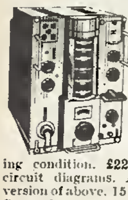
TYPE 13A DOUBLE BEAM OSCILLOSCOPES



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/-.

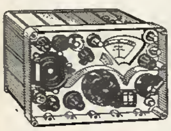
ADMIRALTY B.40 RECEIVERS

Released by the Ministry. High quality 10 valve receiver manufactured by Murphy. Coverage in 5 bands 650 kc/s–30 Mc/s. I.F. 500 kc/s. Incorporates 2 R.F. and 3 I.F. stages, band-pass filter, poise limiter, crystal controlled B.F.O., calibrator. O/F output, etc. Built-in speaker. output for phones. Operation 150/230 V a.c. Size 19½ × 13½ × 16in. Weight 114 lb. Offered in good working condition. **£22.10.0.** Carr. 30/-. With circuit diagrams. Also available B.41 L.F. version of above. 15 Kc/s–700 Kc/s. **£17.10.0** Carr. 30/-



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/-.

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 300 MV to 300V RMS. Resistance ·02–500MΩ. Price £72.**

VM.78 **A.C. MILLIVOLT METER. Transistorised 1 MV–300V. Frequency 1 c/s to 1 Mc/s. Price £55.**

VM.79 **UHF MILLIVOLT METER. Transistorised. A.c. range 10 MV–3V. D.c. current range 0·01μ/A–0·3 MA. Resistance 1 ohm–10 megohms. Price £125.**

H1B **AUDIO SIGNAL GENERATOR. 15 c/s–50 kc/s. sine or square wave. Price £30.**

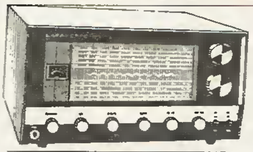
J1B **AUDIO SIGNAL GENERATOR. 15 c/s–50 kc/s. Price £30.**

J2B **AUDIO SIGNAL GENERATOR. As per J1B except fitted with output meter. Price £35.**

TT1S **TRANSISTOR TESTER. £37.10.0 Carriage 10/- per item.**

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,** carriage 30/-.

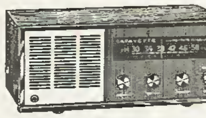


LAFAYETTE SOLID STATE HA600 RECEIVER

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 ● Crystal calibrator ● Variable BFO ● Noise limiter ● S meter ● 24in Bandspread ● 230 V a.c./12 V d.c. neg. earth operation ● RF gain control. Size 15in × 9¾in × 8¼in. Weight 18 lb. EXCEPTIONAL VALUE. £45. Carr. 10/-. S.A.E. for full details.

LAFAYETTE PF-60 SOLID STATE VHF FM RECEIVER

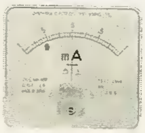
A completely new transistorised receiver covering 152–174 Mc/s. Fully tuneable or crystal controlled (not supplied) for fixed frequency operation. Incorporates 4 INTEGRATED CIRCUITS. Built in speaker and illuminated dial. Squelch and volume controls. Tape recorder output. 75 Ω aerial input. Headphone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



Variable Voltage TRANSFORMERS

Brand new, guaranteed and carriage paid.
High quality construction. Input 230 V 50–60 cycles.
Output full variable from 0·260 V. Bulk quantities available.
1 amp.—**£5.10.0;** 2·5 amp.—**£6.15.0;** 5 amp.—**£9.15.0;**
8 amp.—**£14.10.0;** 10 amp.—**£18.10.0;** 12 amp.—**£21.0.0;**
20 amp.—**£37.0.0.**

CLEAR PLASTIC PANEL METERS

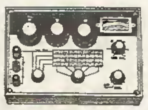


First grade quality Moving Coil panel meters available ex-stock. S.A.E. for illustrated leaflet. Discounts for quantity. Type MR 38P. 1 21/32in square fronts.

50μA 37/6	500-0-500μA 25/-	50mA 25/-	150V. D.C. 25/-
50-0-50μA 35/-	1mA 25/-	100mA 25/-	300V. D.C. 25/-
100μA 35/-	1-0-1mA 25/-	150mA 25/-	500V. D.C. 25/-
100-0-100μA 32/6	2mA 25/-	200mA 25/-	750V. D.C. 25/-
200μA 31/6	5mA 25/-	300mA 25/-	15V. A.C. 25/-
500μA 37/6	10mA 25/-	500mA 25/-	50V. A.C 25/-
	750mA 25/-	3V. D.C. 25/-	150V. A.C. 25/-
	1 amp 25/-	10V. D.C. 25/-	300V. A.C. 25/-
	2 amp 25/-	20V. D.C. 25/-	500V. A.C. 25/-
	5 amp 25/-	100V. D.C. 25/-	8 meter 1mA. 29/6
	20mA 25/-		VU meter 38/6

Postage Extra. Larger sizes available—send for lists.

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



A new portable bridge offering excellent range and accuracy at low cost. Ranges: R. 1Ω–11·1 megΩ 6 Ranges ±1%. L.1 μH – 111 HENRYS 6 Ranges –2%. C. 10pF ±1110 mFd. 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/-.

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.

AMERICAN TAPE

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

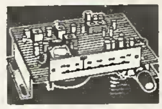
3in. 225ft. L.P. acetate	3/6
3¼in. 600ft. T.P. mylar	10/-
5in. 600ft. std. plastic	8/6
5in. 900ft. L.P. acetate	10/-
5in. 1,200ft. D.P. mylar	15/-
5in. 1,800ft. T.P. mylar	22/6
5¾in. 1,200ft. L.P. acetate	12/6
5¾in. 1,200ft. L.P. mylar	16/-
5¾in. 1,800ft. D.P. mylar	22/6
5¾in. 2,400ft. L.P. mylar	39/6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

RECORDING HEADS

Reuter ½-track. As fitted to Collaro Mk. IV and Studio Decks. High imp. record play back, low imp. erase. Brand new. **19/6** pair. **COSMOCORD ½-track heads.** High imp. record/playback 65/-. Low imp. erase 20/-. **MARRIOTT ½-track heads.** High imp. record/playback 65/-. Low imp. erase 20/-. Post extra.

★ 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.
£6.19.6. P. & P. 3/6.

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 × 3¾in. Complete with instructions and leads. **£7.19.6.** P.&P. 4/-.

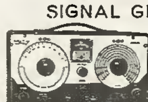
MODEL ZQM TRANSISTOR CHECKER

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.

TE-20RF SIGNAL GENERATOR

Accurate wide range signal generator covering 120 kc/s–260 Mc/s on 6 bands. Directly calibrated variable R.F. attenuator. Operation 200/240V a.c. Brand new with instruction. **£15.0.0.** P. & P. 7/6. S.A.E. for details.

ARF-100 COMBINED AF-RD SIGNAL GENERATOR



A.F. SINE WAVE 20–200,000 c/s. Square wave 20–30,000 c/s. O/P. **HIGH IMP. 21V.** P/P600Ω 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.

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.

NOW OPEN IN EDGWARE ROAD

Our new walk around shop is now open at 311 Edgware Road fully stock with all Hi-Fi, Communication and Test Equipment. *Call into your nearest shop—Edgware Road for all Equipment—Lisle Street for all Equipment and Components.*

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.

RACAL RA-17

First ministry release of these world famous communication receivers. Frequency range 500 Kc/s–30 Mc/s. Available in excellent condition fully tested and guaranteed. **£150.** Carr. 40/–.

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/–.

MARCONI CT44/ TF956 AF ABSORPTION WATTMETER

1 μ/watt to 6 watts.

£20. Carr. 20/–.

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/–.** Carr. 10/–.

AVOMETERS

Supplied in excellent condition, fully tested and checked. Complete with prods, leads and instructions. Model 47A **£9.19.6** P. & P. 7/6.

SOLARTRON CD. 1016 OSCILLOSCOPE

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

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/–.

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
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/–

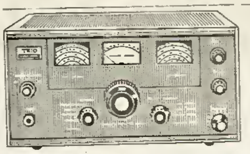
ECHO HS-606 STEREO HEADPHONES

Wonderfully comfortable. Lightweight adjustable vinyl headband. 6ft. cable and stereo jack plug. 25–17,000 cps. 8 ohm imp. **67/6** P. & P. 2/6.

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.**

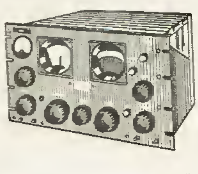
TRIO COMMUNICATION RECEIVER MODEL 9R-59DE



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 445Kc/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 COMMUNICATION RECEIVER IN STOCK £69

HAMMARLUND SP600JX COMMUNICATION RECEIVER

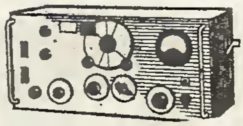


High quality professional dual conversion communication receivers. Few available again in this country at a reasonable price. Frequency range 540 Kc/s–54 Mc/s in 6 bands, variable tuning or 6 channel crystal controlled. 2·5 watt output into 600 ohms. Input 110/230V a.c. 20 valve circuit incorporating: 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.

LAFAYETTE LA-224T TRANSISTOR STEREO AMPLIFIER

19 transistors, 8 diodes, IHF music power, 30W at 8Ω. Response 30–20,000 ± 2dB at 1W. Distortion 1% or less. Inputs 3mV and 250mV. Output 3–16Ω. 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.

MARCONI TEST EQUIPMENT



EX-MILITARY RECONDITIONED.
TF 144G STANDARD SIGNAL GENERATORS, 85Kc/s–25Mc/s, **£25,** carr. 30/–. TF.885, VIDEO OSCILLATOR. 0·5Mc/s, **£45.** Carr. 30/–. T.F. 195M. BEAT FREQUENCY OSCILLATOR 0–40Kc/s, 200/250V a.c. **£20,** carr. 30/–. TF.142E. Distortion Factor Meter, **£20.** carr. 20/–. All above offered in excellent condition fully tested and checked. TF. 1100 VALVE VOLTMETER, Brand New, **£50.** T.F. 1267 TRANSMISSION TEST SET, Brand New **£75.** TF.1371. Wide Band Millivolt Meter, **£50.**

MULTIMETERS *for EVERY purpose!*

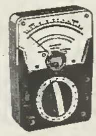
LAFAYETTE DE-LUXE 100 KΩ/VOLT "LAB TESTER"

Giant 6½in. scale. Built-in meter protection. 0/·5/2·5/10/50/250/500/1,000V d.c. 0 / 3 / 10 / 50 / 250 / 500 /1,000V a.c. 0/10/100μA /10 / 100 / 500 MA / 2·5 / 10A. 0/ 1K / 10K / 100K / 10M / 10MΩ.—10 to 49·4dB **£18.18.0.** P. & P. 5/–.

MODEL AS-100D. 100KΩ/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 / 200MΩ. —20 to +17dB. **£12.10.0.** P. & P. 3 6.

MODEL TE-90 50,000 O.P.V. MIRROR SCALE OVERLOAD PROTECTION

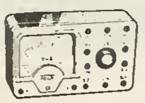


0/3/12/60 / 300 / 600 / 1,200V d.c. 0/6/30/120/300/1,200V a.c. 0-03/6/60/600MA d.c. 16kΩ / 160kΩ / 1·6/16MΩ. —20 to +63dB. **£7.10.0.** P. & P. 3/–.

MODEL TE-70. 30,000 O.P.V.

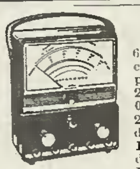
0/3/15/60/300/600/1,200V. d.c. 0/6/30 / 120 / 600 / 1,200V. a.c. 0/30μA / 3/30 / 300mA. 0/16K/160K/1·6M / 16megohm. **£5.10.0.** P. & P. 3/–.

MODEL 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 KΩ **39/6.** P. & P. 1/6.

TE-900 20,000Ω VOLT GIANT MULTIMETER

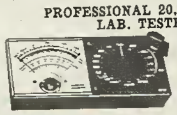


6in. full view meter. 2 colour scale, overload protection. 0/2·5/10/250/1,000/5,000V a.c. 0 / 25 / 12·5 / 10 / 50 / 250 / 1,000 / 5,000V d.c. 0 / 50μA / 110 / 100 / 500mA 10A d.c. 20K / 200K / 20 MΩ. **£15.** P. & P. 5/–.

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 MegΩ dB.—20 to +81dB. Overload Protection. **£12.10.0.** Carr. 3/6.

PROFESSIONAL 20,000 O.P.V. LAB. TESTER



Automatic overload protection, mirror scale. Ranges: 1/10/50 / 250 / 500 / 1,000 volts, d.c. and a.c 0–500μA, 10mA, 250mA. Current: 0/20K, 200K. 2 megohm. Decibels: —20 to +22dB, **£5.19.6.** P. & P. 2/6.

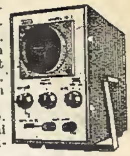
MODEL TE 80. 20,000 O.P.V.

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 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.

TO-2 PORTABLE OSCILLOSCOPE



A general purpose low cost economy oscilloscope for everyday use. Y amp. Bandwidth 2 CPS–1 MHZ. Input imp. 2 megΩ 25 P.F. Illuminated scale. 2in tube. 115 × 180 × 230mm. Weight 8lb. 220/240V a.c. Supplied brand new with handbook **£22.10.0.** Carr. 10/–.

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/-.

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/-.

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. 3/6
500 W.	£3.10.0,	P. & P. 6/6
1,000 W.	£5.10.0,	P. & P. 7/6
1,500 W.	£6.10.0,	P. & P. 8/6
7,500 W.	£15.10.0,	P. & P. 20/–

TE22 SINE SQUARE WAVE AUDIO GENERATORS

Sine: 20c/s to 200 Kc/s on 4 bands. Square: 20c/s to 30Kc/s. Output impedance 5,000 ohms. 200/250V. A.C. Supplied brand new and guaranteed with instruction manual and leads. **£16.10.0.** Carr. 7/6.

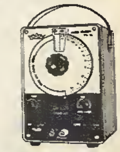
TE111. DECADE RESISTANCE ATTENUATOR

Variable range 0–111dB. Connections. Unbalanced T and Bridge T. Impedance 600Ω 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 600Ω load resistance with internal/external switch. Brand new **£27.10.0.** P. & P. 5/-.

TE-20D RF SIGNAL GENERATOR

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

TY75 AUDIO SIGNAL GENERATOR

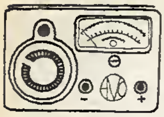


Sine Wave 20c/s to 200kc/s. Square Wave 20c/s to 30kc/s. High and low impedance output. Output variable up to 6 volts. 220/240 volts a.c. Size 210 × 150 × 120mm. Brand new with instructions. **£16.** Carr. 7/6.

Full range of all components ● Valves ● Semi-conductors ● Test equipment ● Receivers ● Hi-fi equipment ● All at discount prices.

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

Also see oppos. page



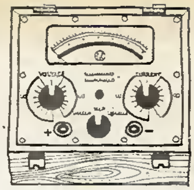
Multiminor – inexpensive, pocket-sized for the service engineer or hobbyist.

Model 7 – for the electrical engineer, general purpose use 50 ranges.

Model 8 – for the electronic, radio and TV engineer.

Model 9 – similar to model 8 but controls marked with graphical symbols.

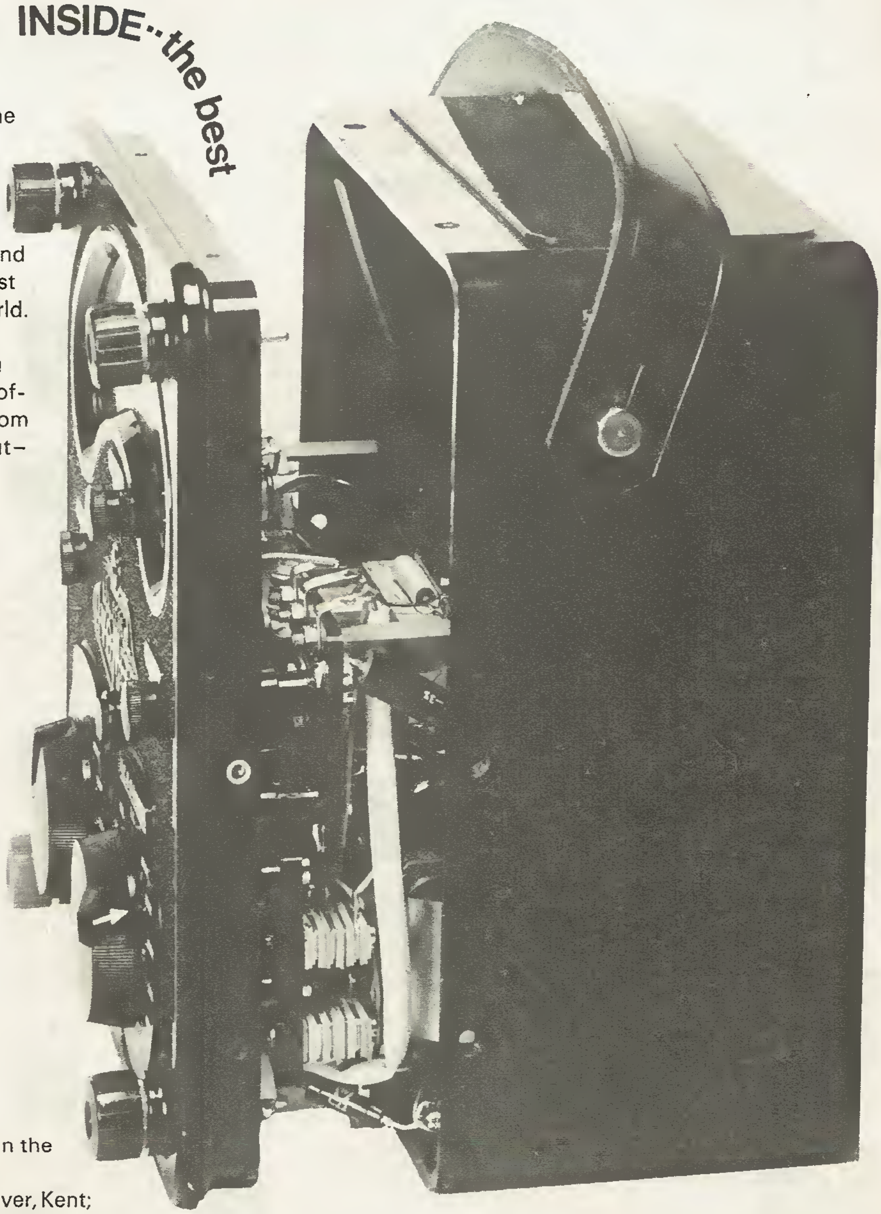
Model 40 – for the power engineer, extra robust, 40 ranges.



Precision Avometer – high accuracy for the laboratory engineer.

OUTSIDE··the lot

INSIDE··the best



On the outside, Avometers haven't changed much over the years. But inside every genuine Avometer – right across the range from pocket-size Multiminors to 0.3% Precision Avometers – you'll find the up-to-date guts of the most famous multimeters in the world. Outside – the same familiar functional case and knobs you grew up on. Inside – the state-of-the-art circuitry you'd expect from the world leader. Inside and out – multimeters to meet every laboratory, test and servicing requirement.

THORN

Full details and specifications in the Avo Short Form Catalogue.
Avo Limited, Avocet House, Dover, Kent;
Telephone: Dover 2626; telex 96283

VOL. 5 No. 7
July 1969

PRACTICAL ELECTRONICS

A PLACE IN THE QUEUE

A TANTALISING profusion of new type semiconductors and other kind of circuit devices flow steadily from the component manufacturers. Tantalising, that is, to the amateur who reads accounts of these products and their capabilities, and likely effects upon future developments in electronic circuit design, but realises they are not likely to come his way for a long while, if indeed at all.

The recipients of these new products are of course the electronic equipment makers. The more exciting and trend-setting components usually are initially earmarked for the requirements of the armed forces (who, more often than not, have financed the original R and D work); then come the industrial users, and finally the mass consumer product market.

How does the amateur fare in this progressive dissemination of the latest advances in component technology? He has no officially recognised place in the queue, that much is obvious. But on the other hand a limited range of these devices do eventually find their way onto the retail market as branded items, often primarily intended as service replacements for the trade. An even wider variety of devices make their due appearance as unmarked "surplus" components. The manner of their distribution is somewhat devious, the name of the maker frequently not known and type number obscure. Availability of these supplies is fortuitous and dependent upon the caprices of mass production methods and professional user demand. Still to the amateur they are valuable, if not essential; and they are generally remarkably cheap.

Unfortunately, however, this has lead to the amateur being stigmatised in some quarters as just a user of surplus components, with the inference that sub-standard or, at least, untested parts are good enough for him always—and for all purposes. This is unfair as a generalisation, and is demonstrably entirely untrue in very many cases. This kind of misrepresentation has harmed the image of the private enthusiast, and perhaps its most serious effect has been the obscuring of genuine contributions made by individuals towards extending the general usefulness of electronics for the ordinary person in every day life. Ideas of amateur origin have been adopted commercially on more than a few occasions, it is well to remember.

The component manufacturers could well ponder this and consider whether a wider range of their products could not be made available—via distributors—to the amateur fraternity. It must be in their interest to help sustain a body of individuals who are in tune with developing technology, although so often barred from useful active experimental work because of non-availability of vital parts.

F. E. Bennett—*Editor*

THIS MONTH

CONSTRUCTIONAL PROJECTS

SPECIAL SERIES

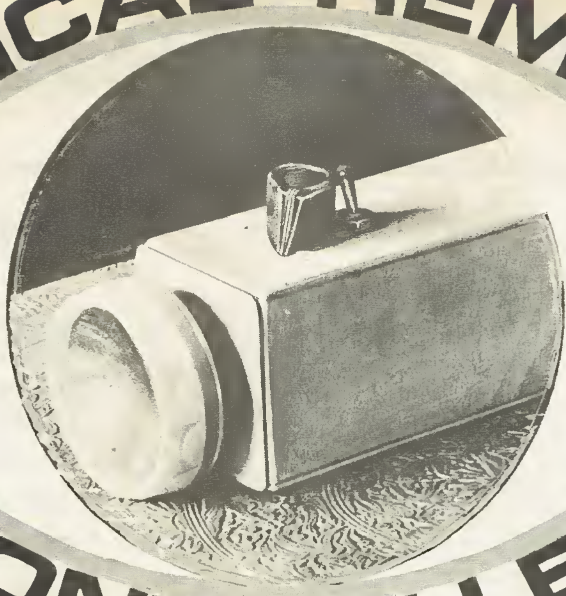
GENERAL FEATURES

NEWS AND COMMENT

Our August issue will be published on Monday, July 14

All correspondence intended for the Editor should be addressed to: The Editor, PRACTICAL ELECTRONICS, IPC Magazines Ltd., Tower House, Southampton Street, London, W.C.2. Advertisement Offices: PRACTICAL ELECTRONICS, IPC Magazines Ltd., Fleetway House, Farringdon Street, London, E.C.4. Phone: 01-236 8080.
Subscription Rates including postage for one year, to any part of the world, 42s.

OPTICAL REMOTE CONTROLLER



BY D. BOLLEN

A PERSON watching television, who is comfortably planted in a soft armchair, may be temporarily subjected to a sudden blast of energetic music. A possible cure for such a condition is to climb out of the armchair and adjust the television volume control, whereupon he might find himself straining forward to catch the whispered words of a particularly interesting but softly spoken personality.

Another case occurs where the discriminating viewer requires his picture to be as crisp as a good photograph, with correct contrast settings. As most television sets have inadequate black-level correction, a picture adjusted for a bright daylight scene will consist of pure white patches on a featureless black background when the shot changes to a night scene.

Clearly, some form of remote control is called for, which allows fine and continuous adjustment of a control within the set, without the inconvenience of a bulky screened cable draped across the room.

The optical remote controller described here uses a beam of modulated light, in place of interconnecting wires, to achieve a continuously variable and almost linear adjustment of a potentiometer setting in a remote receiver or instrument, situated at distances of up to 30ft away.

Although there are many possible applications for such a control, when it is used with a television set, the sound level can be increased, diminished, or turned off altogether, merely by rotating the knob on the transmitter or operating a switch.

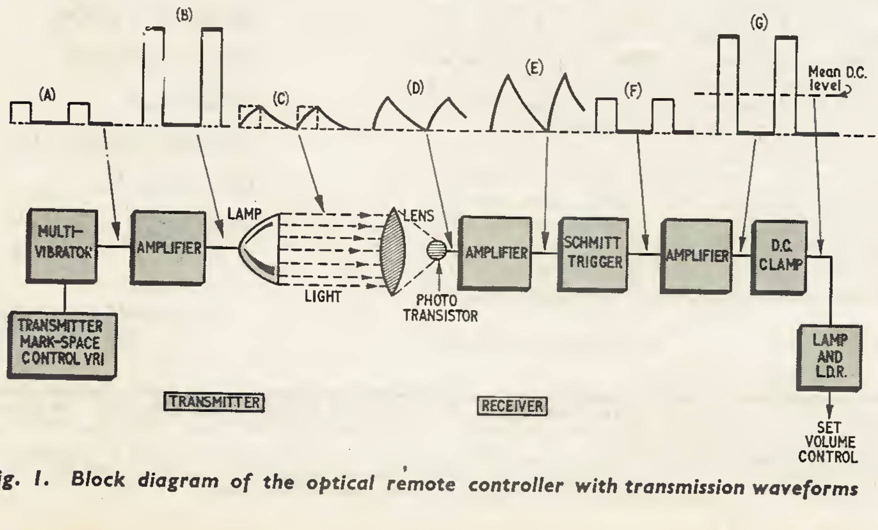


Fig. 1. Block diagram of the optical remote controller with transmission waveforms

Strong background lighting, whether from sunlight or from high powered mains bulbs, does not affect the operation of the controller.

HOW IT WORKS

The block diagram in Fig. 1 illustrates the sequence of operations. A square wave (A) is obtained from an astable multivibrator, which has a repetition frequency of about 25Hz, and a variable on-off or mark/space ratio controlled by potentiometer VR1.

The transmitter amplifier increases the amplitude of the waveform (B) to a level sufficient to drive a low consumption torch bulb. The bulb is mounted in a suitable reflector to throw a beam of light towards the receiver. Tungsten filament bulbs possess considerable thermal inertia, apparent even at 25Hz, and the original steep-sided square wave is degraded into the form of an exponential sawtooth.

Although the modulated light waveform (C) differs from the command signal, it still carries the necessary information. When shown on an oscilloscope, the relative positions of the peak and trough of the sawtooth will shift in sympathy with the on-off ratio of the square wave input signal, demonstrated by the diagram in Fig. 2.

Passing to the receiver (Fig. 1), a lens is used to focus light from the distant transmitter on to the sensitive area of a phototransistor. Signal (D) appears at the collector of the phototransistor and is amplified (E) to give reliable switching of a sensitive Schmitt trigger circuit.

The Schmitt performs the useful function of converting the sawtooth back to a square wave (F) closely resembling the multivibrator output in the transmitter. Once again, the signal is amplified to drive a torch bulb (G), but this time rectification and smoothing takes place so that the signal is converted to d.c.

Thus, the brightness of the receiver bulb will correspond to the mean d.c. level of (G), determined by the VR1 setting in the transmitter, and is virtually unaffected by distance of receiver from transmitter.

Finally, a light dependent resistor is arranged to pick up light from the receiver bulb and translate this to a resistance value. The l.d.r. forms one arm of a potentiometer so that the position of the sliding contact on VR1 in the transmitter is reproduced by the l.d.r. at the receiver output.

TRANSMITTER CIRCUIT

The transmitter circuit is given in Fig. 3. TR1 and TR2 form an astable multivibrator, with on-off timing set by C1, C2, and base bias resistors R2 and R3 in conjunction with VR1. Potentiometer VR1 serves to alter the base resistance in an equal and opposite manner and thus determines the on-off ratio of the multivibrator square wave output, without affecting repetition frequency.

The signal is then passed via limiting resistor R5 and capacitor C3 to the Darlington pair TR3, TR4. The transmitter bulb forms the collector load of TR4. D1 helps to ensure a clean switching waveform at all input levels.

As the supply voltage is only 6V, and the bulb load resistance increases with current flow, additional protection against thermal runaway is not required.

When operating, the light output from the transmitter bulb will increase or diminish, depending on the setting of VR1, but the output signal does not change very much.

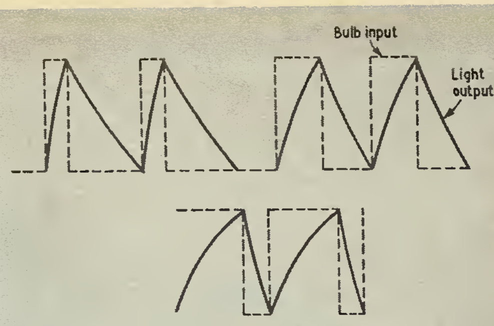
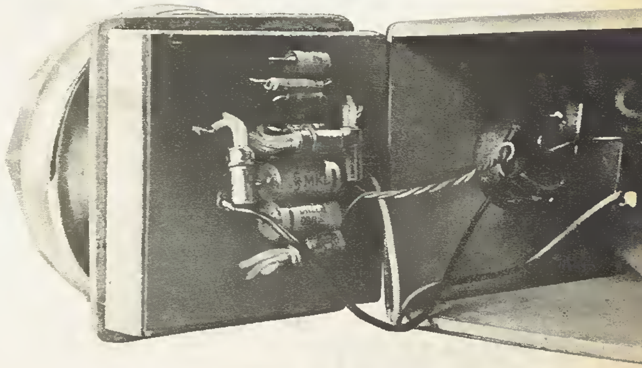


Fig. 2. Waveforms of bulb input and light output in synchronism



The transmitter case opened

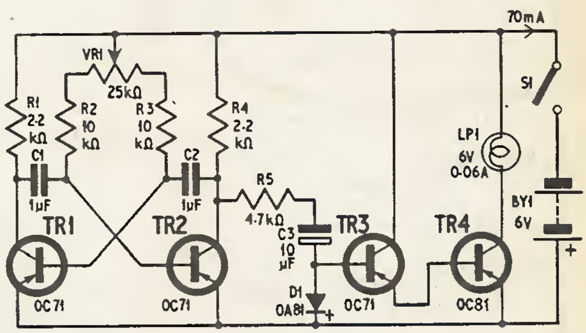


Fig. 3. Circuit diagram of the transmitter

It is important to distinguish between visible mean light level and the actual swing or change in output per cycle. The former is akin to a steady d.c. state and the latter may be likened to a.c.

The human eye is a poor instrument for measuring modulated light. However, as the working frequency is only 25Hz, there will be a noticeable flicker, but as only a dim light is radiated the effect will not be distracting.

With the battery specified, over 100 hours operation at the rate of four hours per day will be achieved. As an alternative, a small 6V motorcycle accumulator could be used.

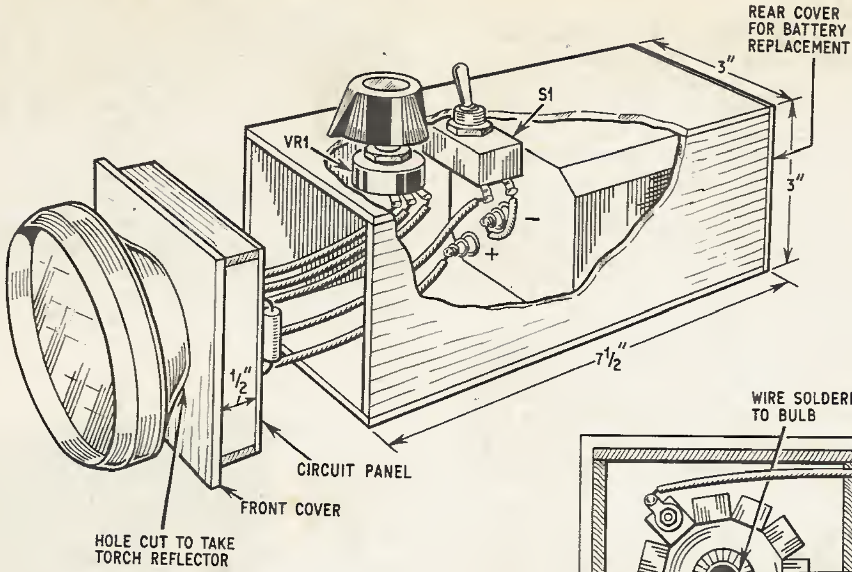


Fig. 4. Case construction and fitting the electronics in the transmitter case

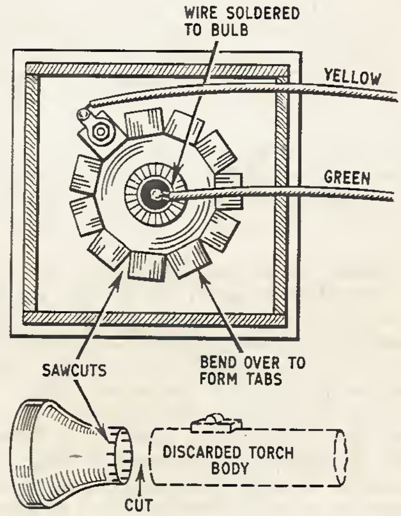


Fig. 5. Method of mounting torch head reflector after cutting from the torch body

COMPONENTS . . .

TRANSMITTER

Resistors
- R1 2·2kΩ
- R2 10kΩ
- R3 10kΩ
- R4 2·2kΩ
- R5 4·7kΩ

All ±10%, ½W carbon

Potentiometer
VR1 25kΩ linear carbon

Capacitors
- C1 1μF polyester 60V
- C2 1μF polyester 60V
- C3 10μF elect. 6V

Transistors
TR1, TR2, TR3 OC71 (3 off)
TR4 OC81 *or* NKT271

Diode
D1 OA81

Lamp
LP1 6V 0·06A m.e.s. bulb

Switch
S1 Single pole on-off toggle

Battery
BY1 6V Type 996

Miscellaneous
Torch reflector assembly
Knob, s.r.b.p. panel, ¼in plywood

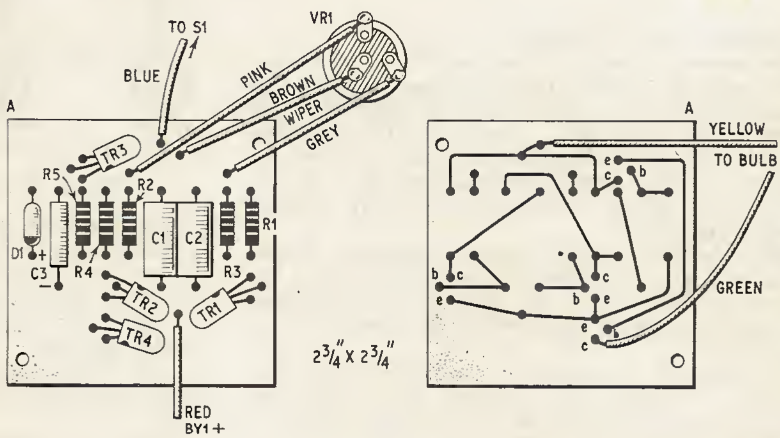


Fig. 6. Component layout and wiring of the transmitter

TRANSMITTER CONSTRUCTION

The transmitter box is made up as shown in Fig. 4, from $\frac{1}{4}$in plywood, with all joints epoxy resin glued. The rear cover can be provided with fabric or metal hinges and a fastener, to allow quick access for battery replacement. VR1 and S1 are mounted on the top face of the box; S1 is positioned as an end stop to prevent the battery sliding forward when the transmitter box is tipped.

The front cover, combining circuit panel and reflector unit, is made a tight push fit in the end of the transmitter box by means of a wooden flange constructed of $\frac{1}{2}$in strips of thin plywood, this also acting as a mount for the circuit panel.

Reflector details are given in Fig. 5. A $2\frac{1}{2}$in reflector assembly can be cut from the body of an inexpensive or old torch; the neck of the reflector housing is also cut, to make bend-over tabs.

The original reflector had a pre-focus bulb holder; packing was introduced to reduce the diameter of the holder so that m.e.s. bulb could be fitted. The bulb was held secure by the plastic threaded ring provided with the torch. If the reflector tends to revolve in its hole in the front cover, a dab of glue under the tabs will make it firm.

TRANSMITTER CIRCUIT PANEL

As there are no crossovers, the underside wiring diagram in Fig. 6 can be traced if an etched circuit panel is required. Alternatively, the transmitter circuit panel may be drilled and wired underneath with short lengths of single strand tinned copper wire. Also in Fig. 6 is the component layout diagram, including colour coded wiring from panel to S1, VR1, and LP1.

When the panel is completed, it should be tested, by connecting to LP1, VR1, S1, and to a 6V battery with a milliammeter temporarily in the negative lead. Current consumption will be found to vary as VR1 is rotated, but should not exceed 70mA.

The flicker rate, best observed out of the corner of one eye, should remain constant at all settings of VR1, irrespective of bulb brightness. The position of the bulb in the reflector is adjusted to throw an even patch of light, approximately 9in diameter, at a distance of roughly 9 feet.

RECEIVER CIRCUIT

A phototransistor is used in the receiver circuit of Fig. 7, to pick up the modulated light signal from the transmitter, but there is scope for experiment with other light sensitive devices. An l.d.r., such as the ORP60, can be wired in place of TR1 without further modification.

Although results will be inferior, both with regards to effective range and change of receiver output resistance, due to the lower sensitivity and slower time response of the ORP60, these disadvantages can be set against the higher cost of an OCP71.

A silicon photodiode was also tried, this time feeding straight into C2 with R1 omitted from the circuit. This gave a good time response but range was still poor. All the devices mentioned have a spectral response extending into the infra-red region and are a suitable match to a filament bulb.

Considering the circuit in Fig. 7, and bearing in mind the earlier diagram (Fig. 1) with its waveform sequence, TR2 amplifies the sawtooth signal from the collector of TR1, and passes it, via C3, to the input of Schmitt trigger TR3 and TR4. VR1 presets the Schmitt trigger level, and R4 might need some individual adjustment to bring the trigger level within the range covered by VR1.

The Schmitt itself is a sensitive version, responding to an r.m.s. input of less than 75 millivolts. Zener diode D1 is included to ensure stable operation over long periods, where fluctuations of supply voltage might interfere with VR1 trigger level setting.

With VR1 set to just bias TR3 off, TR4 is hard on, thus holding down the base of TR5 so that the bulb just glows dimly or not at all. VR2 adjusts the working point of TR6 and the current flowing through the bulb under static conditions.

On receipt of a signal, the Schmitt commences to switch, and feeds negative going pulses to the base of TR5, tending to switch TR5 on, depending on the on-off ratio of the command signal. Hence, the bulb will tend to glow more brightly while C4 acts to smooth signal pulsations, to prevent them being passed on to the l.d.r.

It will be seen that TR5 not only amplifies but also rectifies, and the bulb, coupled only by light to the l.d.r., provides a smooth, analogue function with no unwanted interaction. The l.d.r. resistance is wholly dependent on bulb brightness which, in turn, is determined by the signal from the transmitter.

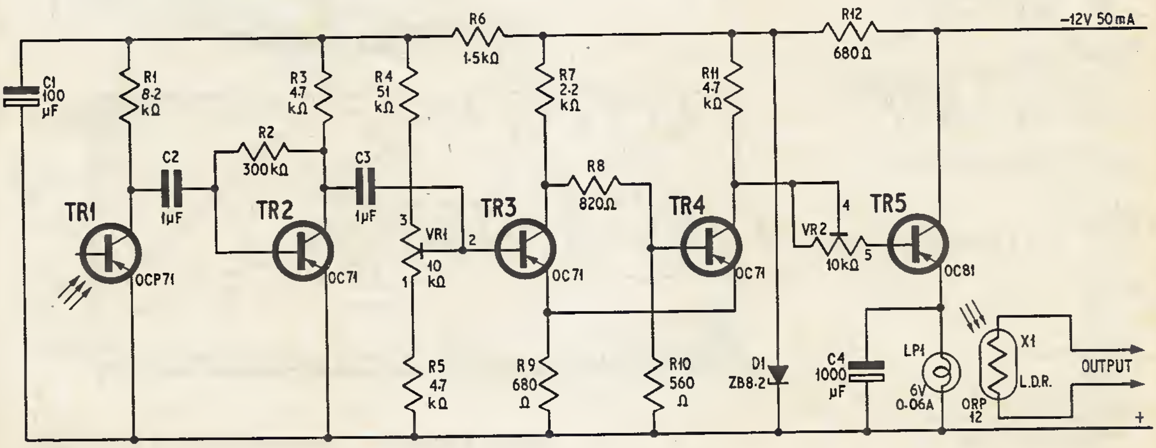


Fig. 7. Circuit diagram of the receiver

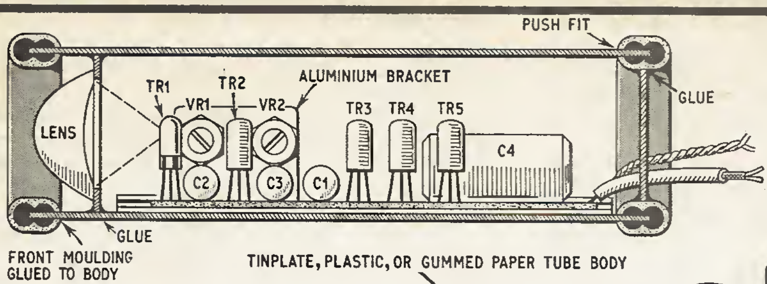


Fig. 8. Component panel mounted inside the receiver case

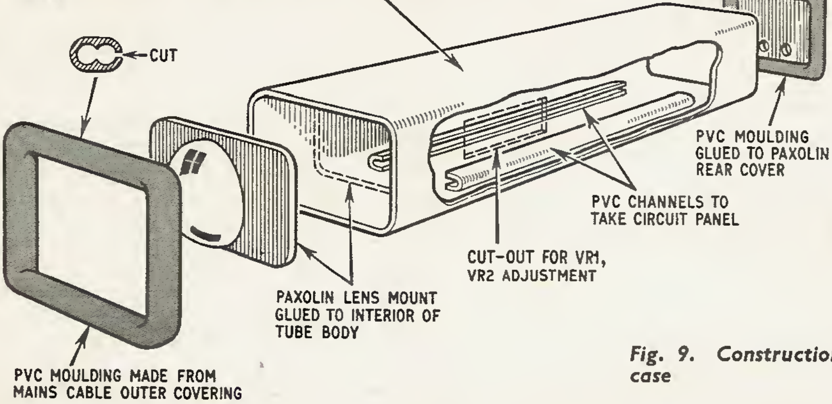


Fig. 9. Construction of the receiver case

COMPONENTS . . .

RECEIVER

Resistors

R1 8·2kΩ
R2 300kΩ
R3 4·7kΩ
R4 51kΩ
R5 4·7kΩ
R6 1·5kΩ
R7 2·2kΩ
R8 820Ω
R9 680Ω
R10 560Ω
R11 4·7kΩ
R12 680Ω
All ±10%, ½W carbon

Potentiometers

VR1 10kΩ linear miniature carbon
VR2 10kΩ linear miniature carbon

Capacitors

C1 100μF elect. 15V
C2 1μF polyester 60V
C3 1μF polyester 60V
C4 1,000μF elect. 12V

Transistors

TR1 OCP71 (phototransistor)
TR2, TR3, TR4 OC71 (3 off)
TR5 OC81 *or* NKT271

Light Dependent Resistor

X1 ORP12

Diode

D1 ZB 8·2 (8·2V) Zener diode

Lamp

LP1 6V 0·06A m.e.s.

Miscellaneous

Lens
S.R.B.P. panel
Twin screened cable
Mains cable covering

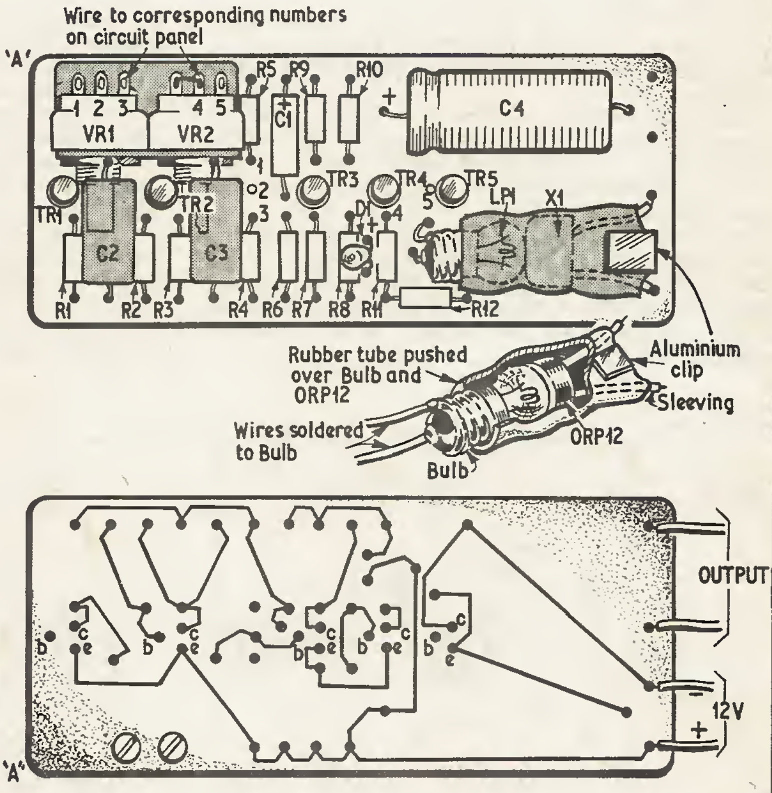
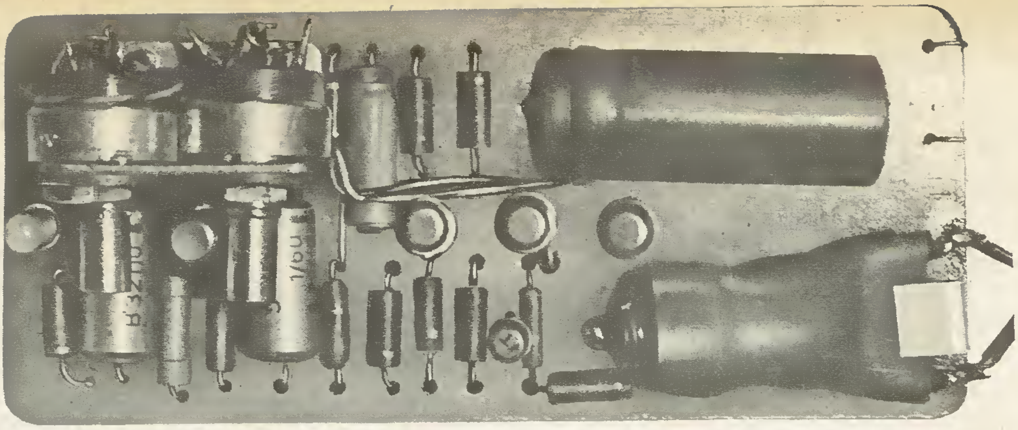


Fig. 10. Component layout and wiring of the receiver



The completed receiver panel

RECEIVER CONSTRUCTION

It is assumed that the receiver will take its supply from the equipment it controls, the requirement being a nominal 12 volts at about 50mA. Without a power pack, a compact form of construction can be used, and the receiver will be small and inconspicuous.

Fig. 8 gives a cross-section view of the receiver, while Fig. 9 shows the receiver case constructional details. The receiver panel slides along two runners made of p.v.c. taken from a short length of 5A house wiring cable; this ensures positive location and ease of focusing.

The lens is a "bull's eye lantern" type, with a short focal length. If other types are available, their focal length can be checked by focusing the image of a window upon a wall and noting the distance of the lens from the wall.

Obviously, the purpose of the lens is to focus a sharp image of the distant light source upon the sensitive area of the phototransistor. This is similar in effect to the use of a highly directional aerial in a radio receiver, increasing gain and reducing off-axis interference. For short ranges (not more than 9ft) the lens can be dispensed with, but the phototransistor must be hooded against stray light from mains bulbs.

The receiver tube body can be fashioned in several ways, the simplest being from stout gummed paper covered with self-adhesive plastic, but metal or some form of plastic moulding will obviously be much more durable. A circular hole is cut in the lens mount slightly smaller than the lens itself, the lens and mount being glued inside the tube body as shown.

P.V.C. cable covering is again used for the trim at the front of receiver box; this is glued in place. The rear cover is not glued to the tube body but is made a push fit, to facilitate easy removal and positioning of the circuit panel. Two holes are drilled in the paxolin part of the rear cover to take screened output cable and twisted supply leads.

RECEIVER CIRCUIT PANEL

The receiver panel construction follows the same lines as the transmitter panel, being either etched copper or wired underneath (Fig. 10). VR1 and VR2 preset potentiometers can be mounted, as shown, on a small aluminium bracket.

The lamp and l.d.r. assembly requires some explanation. A short length of thin rubber tubing, sometimes found on old capacitors, is pushed over the bulb to exclude ambient light. After insulated sleeving is put on the l.d.r. leads, the l.d.r. is pushed into the other end of the rubber tube to make contact with the bulb.

A small clip, made from a piece of scrap aluminium, clamps the rubber tube around the l.d.r. leads and makes a lightproof seal. The clip is squeezed in place with a pair of pliers. Tinned copper wires are soldered to the body and centre contact of the bulb and are pushed through the circuit panel to hold the bulb-l.d.r. unit in place. The l.d.r. leads are terminated in a similar manner. As the bulb is very much underrun it is unlikely that it will ever need replacing until the glass becomes black with age.

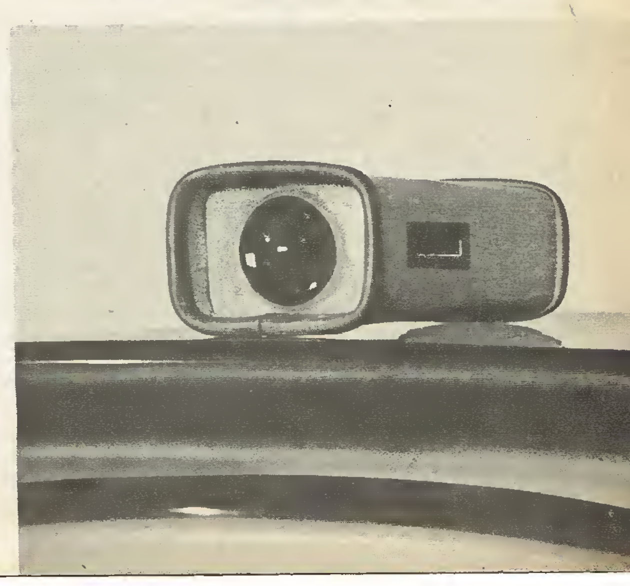
TESTS AND ALIGNMENT

When completed, the receiver panel can be tested in daylight, with a precautionary milliammeter connected in the negative supply lead. It is convenient to use a 12V battery for initial testing.

Connect an ohmmeter to the l.d.r. output terminals, and set VR2 near minimum resistance. Try the effect of rotating VR1; a position should be found where the circuit panel current consumption suddenly jumps up, and the ohmmeter pointer swings to indicate a low value of resistance.

Reset VR1 to just below this trigger point and VR2 so that the ohmmeter reads about 1 megohm. If it is

The receiver mounted on a television set



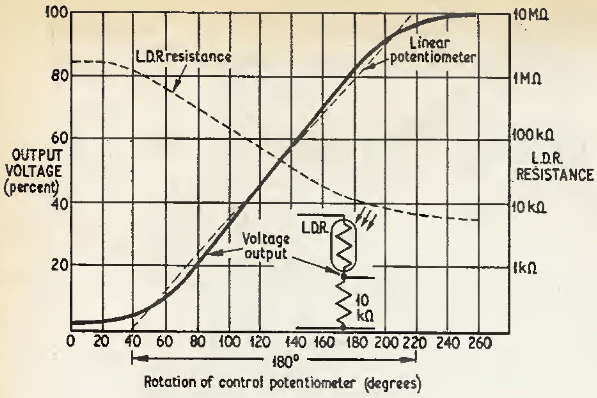


Fig. 11. Graph showing output controlled resistance for angular rotation of the transmitter control

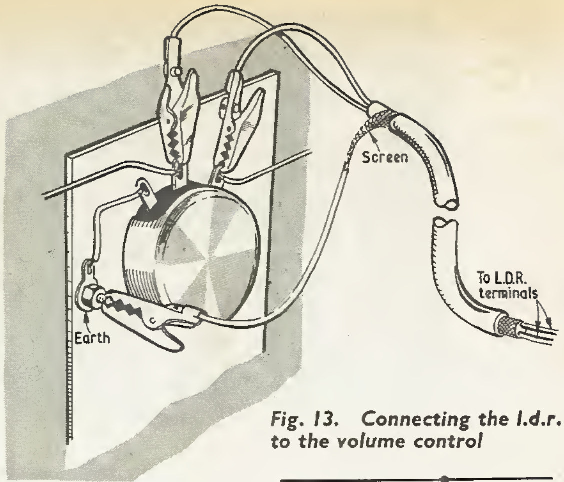


Fig. 13. Connecting the l.d.r. to the volume control

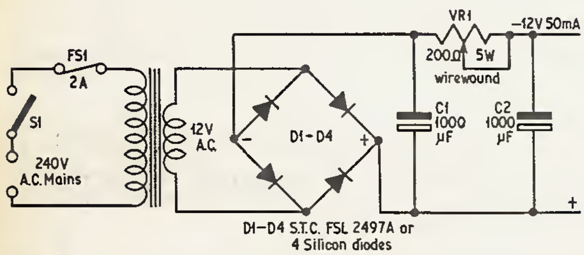


Fig. 12. Suitable power supply for controller receiver

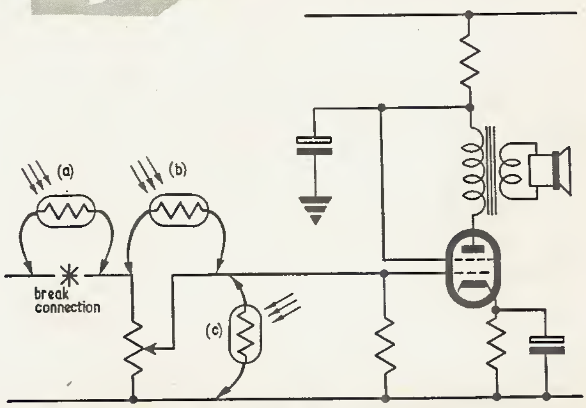


Fig. 14. Connections to volume control

found that nothing happens when VR1 is trimmed, adjust the value of R4.

Next, switch on the transmitter and point its beam at the phototransistor. The ohmmeter should show a resistance decrease. Rotate the transmitter control and observe the ohmmeter readings. Look for a smooth response and a minimum resistance of around 10 kilohms at the extreme setting of the transmitter control.

If all is well it will be found possible to set the receiver output for any value between, say, 10 kilohms and 100 kilohms from the transmitter.

At very short ranges the phototransistor may become saturated with light from the transmitter, especially when a lens is fitted, and this will diminish the coverage of output resistance swing. Depending on the required application and working range, VR1 and VR2 settings will determine the output characteristic.

As a guide, VR2 in the minimum resistance position will yield low values of output resistance to suit the low input impedance of transistor circuits. The high resistance position will give values suited to valve circuits, up to several megohms. VR1, once correctly adjusted, should not need readjustment, but this control is mainly responsible for high sensitivity with long range working.

OUTPUT CHARACTERISTIC

The graph in Fig. 11 gives a typical receiver output response. The dashed line shows the change of l.d.r. resistance plotted against angular rotation of the transmitter control, and is seen to range from about 2 megohms to 8 kilohms. The solid line indicates the departure from true linearity with the l.d.r. connected in series with a 10 kilohm fixed resistor, as a potentiometer.

Although there is some flattening at both ends of the curve, the mid-position of rotation of the transmitter control yields a straight line very close to the ideal.

The lowest attainable l.d.r. output resistance will be slightly less than 1 kilohm, and the maximum resistance above 20 megohms, a range sufficiently large to control almost any apparatus function.

POWER SUPPLY

As the controller receiver has to draw its supply from the equipment it controls, arrangements must be made to secure a source of smoothed d.c. when operating mains powered equipment; a suitable circuit is shown in Fig. 12.

The method of obtaining low voltage a.c., prior to rectification and smoothing, will depend on the nature of the controlled equipment. Tappings can be taken from valve heater chains, and heater transformers, but if any doubt exists it is better to use a small 12V a.c. transformer, and rectifier, which can be fitted to a panel, along with the other components shown in Fig. 12. This power pack can be installed in a vacant corner of the controlled equipment.

The 200 ohm variable resistor serves the double purpose of smoothing resistor and output voltage adjuster.

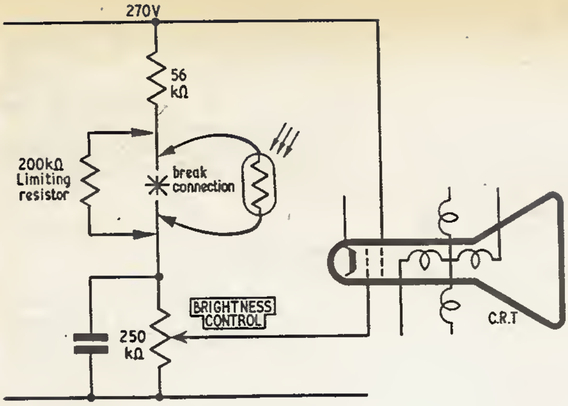


Fig. 15. Preferred connection to brightness control. *SWITCH OFF MAINS SUPPLY WHILE CONNECTING AND BEWARE OF CHARGED CAPACITORS*

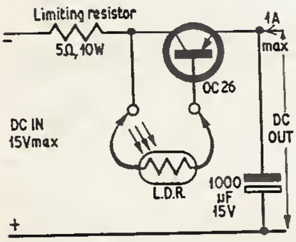


Fig. 16a. Remote controlled power supply

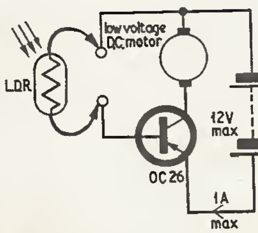


Fig. 16b. Remote motor speed control

SOME APPLICATIONS

Taking first the example of remote control of television or radio sound, crocodile clips can be fitted to the receiver l.d.r. screened lead, to facilitate a temporary connection to the television volume control (Fig. 13). This avoids making any permanent alterations to the television or radio set. The clips can be quickly removed at any time, but make sure there is no risk of accidentally shorting.

When the intention is to install the controller as a permanent fixture, soldered joints are obviously to be preferred. Three different ways of connecting the l.d.r. to a typical audio output stage are shown in Fig. 14.

With the l.d.r. at point (a), in series with the input wire to the volume control, the signal may be fully attenuated. In position (b) the l.d.r. allows almost full control of volume, from a whisper to nearly maximum sound output, if the potentiometer in the set is initially set so that its slider is near the earthed end of the track.

The arrangement (c) works in reverse, that is, when the transmitter control is rotated towards the maximum position, the sound level will decrease.

The advantage with (b) and (c) connections is that the volume control can be used normally when the controller is inoperative, without disconnecting or shorting across the controller receiver output.

Fig. 15 gives a representative television brightness circuit; the important point to watch here is that the maximum dissipation of the l.d.r. is not exceeded. In the case of the ORP12, absolute maximum ratings of 110V peak and 200mW are laid down by the manufacturer. About the only possible place for the l.d.r., therefore, is in series with the "live" lead to the brightness potentiometer, with a 200 kilohm limiting resistor placed in parallel with the l.d.r. (Fig. 15).

Preliminary checks should be made to see that the h.t. rail voltage is not more than, say, 290V, and the current to the brightness control does not exceed about 1mA. Since the ORP12 is commonly used where a television set already has an automatic brightness control, the manufacturer's circuits could be obtained as a guide to necessary modifications.

If automatic brightness is present in the receiver, it is a simple matter to connect the controller l.d.r. output leads in place of the existing l.d.r. terminals within the set. Remote volume control in transistor equipment would follow similar lines as with valve equipment.

The relatively low dissipation of the controller receiver output can be enhanced by using the l.d.r. to bias a power transistor. Two circuits are given in Fig. 16.

In the first case (Fig. 16a) an OC26 in series with a 15V maximum d.c. supply will permit remote control of output from 0 to 15V and 0 to 1A, depending on the load. Such a supply could form the basis of control of a wide range of devices or equipment.

In Fig. 16b an OC26 is again used for electric motor speed control and might be suitable for models, tape drives, and servo applications. With both circuits, the controller receiver can draw its supply from the common d.c. source, if this is 12V.

Proportional opto-electronic control of a servo, where the servo output shaft faithfully follows movement of the transmitter potentiometer spindle, is quite feasible, but such circuits are necessarily more complicated and are beyond the scope of this article.

FINAL SETTING-UP

If the controller receiver has a "bull's eye" lens, transmitter to receiver optical alignment can be observed visually, because the lens will act as a "cat's eye" reflector. Alignment is generally not critical, except at extreme range limits. It is sufficient, in most cases, for some light from the transmitter to fall on the phototransistor.

It is surprising, when working with modulated light, what small intensities are required for efficient operation. The procedure to adopt with final setting-up is as follows.

Align transmitter and receiver, set transmitter control to mid-way position and adjust VR2 in the controller receiver to obtain desired average sound volume. If VR1 in the receiver has been trimmed correctly, it should be possible to adjust the sound level from the transmitter.

Depending on how the l.d.r. is connected, the sound level may not quite drop to zero when the transmitter control is rotated to minimum, but it should be found that turning off the transmitter switch will cause a sharp reduction of the remaining sound.

If desired, the transmitter box can be mounted on a heavy base, by means of a locking ball-joint (such as is used with a camera tripod) to allow convenient optical alignment of the transmitter beam. Normally, though, a small table of suitable height will serve, or else the transmitter box can be clipped or fixed to the arm of a chair. Much will depend on the intended application and room layouts. ★

APOLLO II

Now that the final stage of the first *Apollo* programme reaches its climax with astronauts Neil Armstrong, Michael Collins and Edwin Adrian making ready for man's first landing on the Moon, a dream comes true. It is a far cry from Leonardo Da Vinci to the *Apollo's* lunar module and its complex back up systems.

The motivation for the ambition is still the same, to know more and more about man's environment. There will be many who have waited for this moment since schooldays as well as many who are still enjoying (or enduring) schooldays, when on July 16 the tall assembly from the *Saturn 5* rocket to the moon ship has its final moments of count-down. The work of its preparation on the site which began about the middle of April will again demonstrate the extent of technology's advancement.

SPACEWATCH

By Frank W. Hyde

It is planned that Armstrong and Aldrin the two astronauts chosen for the actual landing on the moon will spend about 22 hours performing their allotted tasks such as gathering moon-dust and samples of rock for analysis back on earth. In the meantime Collins will be circling the moon while waiting for the two "first men on the moon" to rejoin him for the journey back to earth. The first man in fact to set foot on the moon will be Armstrong and he will pass back to Aldrin, in the moon lander, a sackful of lunar dirt. This will make certain that even if the stay has to be cut short for any reason there will at least be a sample brought back.

There are indeed a number of problems involved, even in gathering samples, for the survival packs which the astronauts wear on their backs make them top heavy. Though the lunar gravity is but one sixth of that of the earth a fall could be dangerous. For this reason long tongs are to be used so that it will not be necessary for the astronauts to bend down. The setting up of the other equipment will require a hoist system for unloading as well as loading the mooncraft.

Among the experiments to be set up will be the solar wind probe, seismic unit, radioisotope thermal electric generator, superthermal ion detector, magnetometer and the central station for passing back to earth continuous information via the radio link set up. The unit is expected to continue to send back information for at least a year. Thus the time that the astronauts spend on the moon will be fully occupied particularly if they are to attempt television pictures for transmission direct to earth.

The final touch down of the lunar module will come after the physical contact of the four foot long "cat's whiskers" (attached to the landing legs) with the surface of the moon which will result in the shutting off of the motor. The module will then drop under lunar gravity. The sequence of operation after separation from the command module is that the main motor between the landing legs is used to control the descent and is fired for brief periods to keep the craft on the correct course. This will bring the craft to within 500 feet of the surface of the moon and about 1,200 feet from the landing site. The speed at this point will be about 40 miles an hour forward and about 10 miles an hour downwards.

The crew will have two minutes or thereabouts to select the final landing site. The final control is then brought into operation by rockets at the four corners of the module to slow the descent to about 5 feet per second. After completing the tasks allotted the upper section of the lunar module will use its ascent engine to return to lunar orbit. This part of the mission will be computer controlled but the actual docking with the command unit will be manual. After transfer to the command module of men and materials the lunar module will be jettisoned and the three astronauts will begin the return journey to Earth. There are two "launch windows" for *Apollo 11* the first is July 15 to 22 and, if this is missed for any reason, another is available between August 13 and 21.

FUTURE MOON LANDINGS

There are to be nine future moon landings the final landing being sometime in 1972. They will be launched at the rate of two or three a year. The crew for *Apollo 12* have already been named and are all naval officers. Charles Conrad, Richard Gordon (these two are already veterans for they were both in Gemini crews) and Alan Bean, the third man for *Apollo 12* who is new to spaceflight missions. Conrad and Bean will land on the moon and spend about five hours there.

Though the actual landing site is not yet fixed it is not likely to be the same as *Apollo 11*. It is expected that a larger load of apparatus will be landed on the trip. Subsequent trips will take equipment to different points along the moon's equator and the lowlands and highlands will be explored.

NEW ORBITING OBSERVATORY

A *Nimbus* weather observatory has been launched which will enable more accurate weather predictions to be made up to two weeks in advance. The *Nimbus*, the most advanced weather craft so far built, is a butterfly shaped satellite which weighs 612 kilograms and is in an orbit which varies from 675 to 703 miles from earth. Its orbital time is 107·5 minutes. It is ten feet tall and is powered by solar panels and two new nuclear powered generators known as SNAP 19. These represent the first use of nuclear energy in space for civilian purposes.

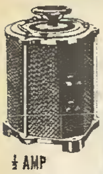
In addition to the infra red sensors essential to weather forecasting *Nimbus* has very advanced television cameras which can take day or night pictures of cloud formations around the world. It will measure for the first time the atmosphere's temperature from ground to space, and also for the first time be able to interrogate other weather data gathering instruments such as ocean buoys, balloons, aeroplanes and ships and relay these data for processing.

Nimbus will take part in a large experiment by the U.S.A. known as BOMEX. Its object is to understand how the Sun features in the control of weather by the amount of water lifted from the oceans and distributed by wind currents round the world. An area of nearly 100 square miles east of Barbados will be explored by ten oceanographic ships, 24 aircraft, and dozens of balloons and buoys. The manpower will include some 1,500 scientists. The experiment is to last from May to July.

Included in the *Nimbus* tasks is one to track elk in Yellowstone Park. The animal carries a two-way radio round its neck.

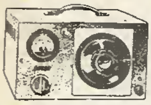
Some of the "backroom boys" who have played an important part in making the Apollo lunar probe missions great successes

VARIABLE VOLTAGE TRANSFORMERS



◄ 50 AMPS

½ AMP ►
£3.10.0.



PORTABLE TYPE
£9. 5. 0.

INPUT 230/240v. A.C. 50/60— OUTPUT VARIABLE 0-260v. BRAND NEW
Keenest prices in the country. All Types (and Spares) from ½ to 50 amp. from stock.

SHROUDED TYPE
1 amp, £5. 10. 0. 2.5 amps, £6. 15. 0. 4 amps, £9. 0. 0. 5 amps, £9. 15. 0. 8 amps, £14. 10. 0. 10 amps, £18. 10. 0. 12 amps, £21. 0. 0. 15 amps, £25. 0. 0. 20 amps, £37. 0. 0. 37.5 amps, £72. 0. 0. 50 amps, £92. 0. 0.

OPEN TYPE (Panel Mounting) ½ amp, £3. 10. 0. 1 amp, £5. 10. 0. 2½ amps, £6. 12. 6.

PORTABLE TYPE
1.5 amp. portable fitted metal case, voltmeter, lamp, switch, etc. £9.5.0. Similar to above 2.5 amp. £11.7.6.

L.T. TRANSFORMERS
All primaries 220-240 volts

Type No.	Sec. Taps	Price	Carr.
1	30, 32, 34, 36 v. at 5 amps.	£4/5/0	6/–
2	30, 40, 50 v. at 5 amps.	£6/5/0	6/6
3	10, 17, 18 v. at 10 amps.	£4/10/0	4/6
4	6, 12 v. at 20 amps.	£5/17/6	6/6
5	17, 18, 20 v. at 20 amps.	£6/12/6	6/6
6	6, 12, 20 v. at 20 amps.	£6/5/0	7/6
7	24 v. at 10 amps.	£4/15/0	5/6
8	4, 6, 24, 32 v. at 12 amps.	£6/10/0	6/6

STROBE! STROBE! STROBE!
Build a Strobe Unit, using the latest type Xenon white light flash tube. Solid state timing and triggering circuit. 230/250v. A.C. operation.
ECONOMY KIT. Flash rate 1-36 flash per second. All components including Unijunction, thyristor, tube and circuit. £5/5/0 plus 3/6 P. & P.
INDUSTRIAL KIT. Flash rate 1-80 f.p.s. Ideally suitable for schools, laboratories, etc. Incorporates double wound transformer which isolates both tube and timing circuit from mains. Stabilized timing circuit and high power tube. £8/8/0 plus 6/- P. & P.

NEW MODEL HIGH FREQUENCY TRANSISTORISED MORSE OSCILLATOR
Adjustable tone control. Fitted with moving coil speaker, also earpiece for personal monitoring. Complete with morse key. 45/- plus 3/6 P. & P.

DRY REED SWITCHES
2 × 1 amp Dry Reeds (makes contacts). Mounted in 870 ohm 9-18 v. coil. Size 3″ × 3¼″ × ½″. New. Price 8/6 per pair. Post Paid. Six of the above mentioned units (12 Reeds). Fitted in metal box. Size 4″ × 3¼″ × 1½″. Mfg. by Elliott Bros. New. 45/- each. Post Paid.

BODINE TYPE N.C.1 GEARED MOTOR

(Type 1) 71 r.p.m. Torque 10lb. inch. Reversible. 1/70th h.p., 50 cycle, ·38 amp.
(Type 2) 28 r.p.m. Torque 20lb. inch. Reversible. 1/80th h.p., 50 cycle, ·28 amp.
The above two precision made U.S.A. motors are offered in 'as new' condition. Input voltage of motor 115v. A.C. Supplied complete with transformer for **230/240v. A.C. input.** Price, either type **£2. 17. 6** plus 6/6 P. & P. or less transformer £2. 2. 6 plus 4/6 P. & P.

SPEEDIVAC HIGH VOLTAGE HIGH FREQUENCY GENERATOR
Input 100/110 volts or 200/250 volts AC/DC. Output 19KV variable. Ideal for testing insulation, vacuum, leakage path, gas discharge lamps, neon, etc. A useful ozone and HF supply. Manufactured by Edwards High Vacuum Ltd. Brand new in maker's polished wooden carrying case. Offered at fraction of maker's price. **£10.0.0** plus 7/6d. P. & P.

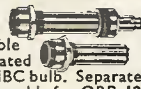
CT82 NOISE GENERATOR

Ideal for alignment of all types of communication and VHF receivers. Self contained audio output meter and mains power supply.
100Kc/s to 160Mc/s Frequency range 43 ohm or 75 ohm impedance. Noise figure range to 20db.
In rugged alloy case with instructions for use. Offered untested but in excellent condition, less mains lead. £7/19/6, P. & P. 10/-.

LIGHT SENSITIVE SWITCH

Kit of parts, including ORP12 Cadmium Sulphide Photocell, Relay, Transistor and Circuit, etc., 6-12 volt D.C. op. price **25/-** plus 2/6 P. & P. ORP 12 including circuit, 10/6 each, plus 1/- P. & P.
A.C. MAINS MODEL Incorporates Mains Transformer, Rectifier and special relay with 3, 5 amp mains c/o contacts. Price inc. circuit 47/6 plus 2/6 P. & P.

LIGHT SOURCE AND PHOTO CELL MOUNTING



Precision engineered light source with focusible lens assembly and ventilated lamp housing, to take MBC bulb. Separate photo cell mounting assembly for ORP. 12 or similar cell. Both units are single hole fixing. Price per pair **£2.15.0.** P. & P. 3/6.

UNISELECTOR SWITCHES *NEW*

4 Bank 25 Way 24 v. D.C. operation £5.17.6 plus 2/6 P. & P.
8 Bank 25 Way 24 v. D.C. operation. £7.12.6 plus 4/6 P. & P.

MINIATURE UNISELECTOR SWITCH

Ex-Equipment
3 banks of 11 positions plus homing bank. 40 ohm coil. 24-36 v. D.C. operation. Tested. 22/6, plus 2/6 P. & P.

DEMONSTRATION TRANSFORMER
(STENZYL TYPE)

Two separate removable coils tapped at 0. 110. 220 volts, and 6. 12. 36 volts respectively. A composite apparatus designed for class demonstration. Electro magnetic induction, jumping ring, induction lamp, relationship between field intensity and ampere turns, induction melting, are just a few of the possible experiments. New modified model. **£14.10.0,** P. & P. 10/-.

RELAYS
Bulk purchase enables us to offer the following new SIEMENS, PLESSEY, etc. miniature plug in relays complete with base, at highly COMPETITIVE PRICES

Coil Ω	Working Voltage	Contacts	Price
280	6-12	2 c/o	14/6
280	9-18	4 c/o	15/6
700	12-24	2 c/o	12/6
700	16-24	4 c/o	15/6
700	16-24	4M 2B	12/6
1250	20-40	2 c/o H.D.	12/6
2500	30-50	2 c/o H.D.	12/6
9000	40-70	2 c/o	10/-

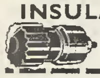
H.D. = Heavy Duty. POST PAID

'AVO' MODEL 47A

Ex-Admiralty in good condition, complete with instructions, leads and case. £9/19/6, P. & P. 10/-.

'AVO' MODEL 48A
Ex-Admiralty in good condition with instructions, leads, plus D.C. Shunts for 120 Amp and 480 Amp. A.C. Transformer for 60 Amp. and 240 Amp. Multiplier for 3600 volt. Complete outfit in fitted case. **£15/0/0, P. & P. 10/-.**

INSULATED TERMINALS



Available in red, white, yellow black, blue and green.
New 17/- per doz. 2/- P. & P.

A.C. CONTACTOR

2 make + 2 break (or, 2 c/o.). 15 amp. contacts. 230/240V. A.C. operation. Brand new. Price 22/6 plus 1/6 P. & P.

SERVICE TRADING CO

All Mail Orders—Also Callers—Ample Parking Space
57 BRIDGMAN ROAD, LONDON, W.4 Phone 995 1560
SHOWROOM NOW OPEN CLOSED SATURDAY

Personal callers only
9 LITTLE NEWPORT ST. LONDON, W.C.2. Tel. GER 0576

NEW 1969 EDITION

RADIO AMATEUR'S HANDBOOK
By A.R.R.L.
45/- Postage 4/6

SERVICING ELECTRONIC ORGANS, by Carl R. Pittman. 30/-. Postage 1/-.

USING SCOPES IN TRANSISTOR CIRCUITS, by Robert G. Middleton. 32/-. Postage 1/-.

TRANSISTOR POCKET BOOK, by R. G. Hibberd. 25/-. Postage 1/-.

ELECTRONIC MUSICAL INSTRUMENT MANUAL, by Alan Douglas. 55/-. Postage 1/-.

TELEVISION ENGINEERS' POCKET BOOK, by J. P. Hawker. 21/-. Postage 1/-.

HI FI YEAR BOOK, 1968/9, edited by Miles Henslow. 15/-. Postage 1/-.

RAPID SERVICING OF TRANSISTOR EQUIPMENT, by Gordon J. King. 30/-. Postage 1/-.

RADIO COMMUNICATION HANDBOOK, by R.S.G.B. 63/-. Postage 4/6.

CATALOGUE, 2/-.

THE MODERN BOOK CO.
BRITAIN'S LARGEST STOCKIST
of British and American Technical Books
19-21 PRAED STREET
LONDON, W.2
Phone: PADdington 4185
Closed Saturday 1 p.m.

COMPONENTS
BY RETURN OF POST

MULLARD POLYESTER CAPACITORS (±10%)
400 Volt; 0·001μF, 0·0015μF, 0·0022μF, 0·0033μF, 0·0047μF, 0·0068μF, 0·01μF, **6d.** 0015μF, 0·022μF, 0·033μF, **7d.** 0·047μF, **8d.** 0·068μF, 0·1μF, **9d.**

160 Volt; 0·01μF, 0·015μF, 0·022μF, **6d.** 0·33μF, 0·047μF, 0·068μF, **7d.** 0·1μF, **8d.** 0·15μF, 0·22μF, **10d.** 0·33μF, **1/2d.** 0·47μF, **1/4d.** 0·68μF, **2/–.** 1·0μF, **2/6d.**

250 Volt. P.C. Mounting Miniature ±20%; 0·01μF, 0·015μF, 0·022μF, 6d. 0·033μF, 0·047μF, 7d. 0·068μF, 0·1μF, 8d. 0·15μF 10d. 0·22μF, 1/–.

SUB-MINIATURE ELECTROLYTIC CAPACITORS (−10%, +50%)
all values in μF

6 Volt	50	100	200	320	1/– each
10 Volt	6·4	10	16	20	
10 Volt	25	64	125	200	
15 Volt	10	16	25	40	
25 Volt	6·4	10	16	25	
40 Volt	8	16	32	50	

CERAMIC DISC CAPACITORS
150pF, 270pF, (±20%) 330pF, 470pF, 680pF, 1000pF, (−20% +80%)
5d. each

HIGH STAB RESISTORS (CARBON FILM) Very Low Noise
0·5 watt 5% 4·7 ohms to 2·2 M ohms **2d each**
0·5 watt 10% 4·7 ohms to 10 M ohms **2d each**

SKELETON PRE-SET POTENTIOMETERS
Miniature, Linear, 100, 250, 500 ohms and Decades to 1 M ohm 0·3W, ±20% ⩽ ¼M ±30% > ¼M Horizontal or Vertical printed Circuit Mounting 1/- each.

DIODES—OA85, OA91, 1/6 each.

SILICON RECTIFIERS
BY236 0·5 amp 800 volt 3/– each 4 for 11/–.

C.W.O. POST AND PACKING ADD 1/– ON ORDERS UNDER £1.
MAIL ORDERS ONLY TO
YATES ELECTRONICS (FLITWICK) LTD.
29 LYALL CLOSE, FLITWICK, BEDS.

UNLIMITED!

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

SIMPLE GUITAR TREBLE BOOSTER

As some readers may know a basic treble boost unit consists of a preamplifier inserted between the guitar and amplifier which incorporates a high pass filter. This filter raises the response of the preamplifier to the harmonics of the guitar signal, producing a much higher pitched note.

Connecting the guitar straight through to the amplifier gives a rather flat sound lacking in the verve and impact sought by lead guitarists.

The primary windings of a valve output transformer are used as the filter in this design (the secondary winding not being used), see Fig. 1. The primary windings are connected across the input of the preamplifier. At low frequencies the impedance offered by the transformer is quite small and thus these notes are shorted to "earth" and not amplified. At high frequencies the impedance is large and the input signal is only slightly attenuated before amplification.

The capacitor C1 serves as a d.c. blocking capacitor preventing the transformer windings shorting the base of the transistor TR1 to the negative supply line.

Any high gain *npn* silicon transistor may be used for TR1, suitable types being BC108, 2N1711, and 2N2926.

In the present design no control to regulate the amount of treble boost has been incorporated as this was thought unnecessary. If a control is required then a potentiometer, with a value of approximately 25kΩ, should be connected between point (a) and (b) in Fig. 1.

The preamplifier may be housed in its own case or built into the existing guitar amplifier. The type of battery used in the prototype was a PP3 type and should last for 100 hours depending on use.

S. J. Price,
Bristol.

VARIABLE WAA-WAA

I would firstly like to recommend the excellent *Waa-Waa Pedal* circuit designed by B. H. Baily in Practical Electronics July 1968 issue. For anyone making this device I would like to suggest a useful addition.

By using the low frequency oscillator shown in Fig. 2, a continuous "waa-waa" effect can be produced at any desired speed.

The pedal controlled potentiometer VR2 in Mr. Baily's circuit is replaced by an *npn* silicon transistor, TR2, with its emitter connected to the negative line and its collector to the junction of C4 and C5. The base is connected to the output of the oscillator via a fixed 500kΩ resistor, R10, and a 1MΩ potentiometer (linear), VR3, which varies the effect from a "twangy" to a mellow "waa-waa". The capacitor C7 cuts out thump from the oscillator.

Component values are not critical and TR3 and TR4 can be almost any *npn* type, e.g., 2N1302. The transistor type for TR2 is more critical and a silicon type should be used, as the leakage current must be very small. If no meter is available to select a transistor with low leakage, complete the rest of the circuit first and then try several transistors to get best performance. Two types found suitable were BSY27 and BSY38.

The potentiometer VR4 varies the oscillator frequency from about 1 to 8Hz. It is connected so that it is turned fully anti-clockwise for minimum resistance, which then gives approximately linear frequency control.

The connections from C10 and C8 to C9 must be as direct as possible and not by wires longer than 2in.

M. P. R. Hamer,
Bath.

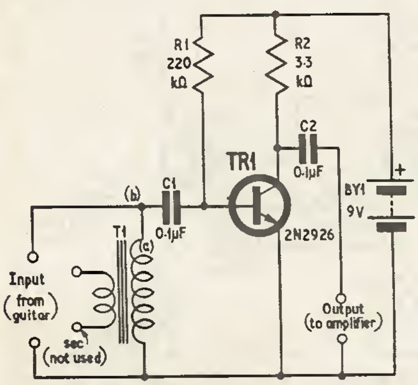


Fig. 1. Guitar treble booster circuit

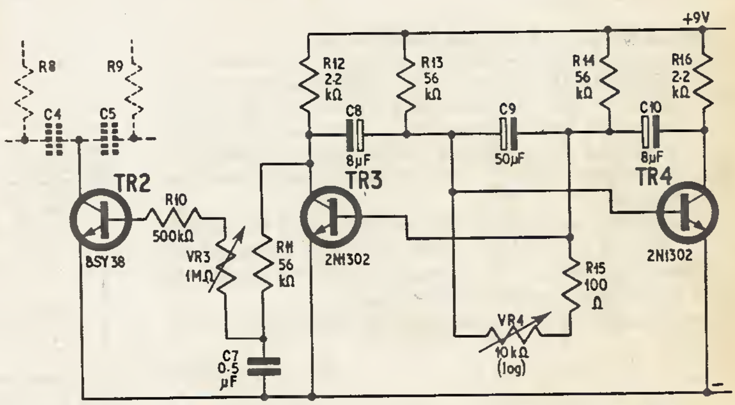


Fig. 2. Circuit diagram for variable "waa-waa" sound effect

BLOW OUT THE LIGHT

A REMARK made by the author of the *Sound Operated Switch*, March 1969 issue, spurred me into experimentation, and I have "developed" an advanced type of electronic candle.

In the circuit the base of TR5 is connected to the collector of TR4, so that with no input the bulb LP1 is on; when a signal is applied at the input the bulb is extinguished.

The original connection between TR5 collector and the negative supply is broken, and another NKT277 transistor (TR6) and a phototransistor (TR7) is inserted between these points as shown in Fig. 3.

The input transducer for the switch is a 200 ohm moving coil earpiece insert. The phototransistor TR7 is concealed behind the bulb, making sure that light can pass from the bulb to TR7 emitter.

When a lighted match or lighter is held near LP1 the light from the match falls on TR7 causing it to conduct, making TR6 base go more negative and causing it to conduct. If the ambient noise level is not too great TR5 will also be conducting and LP1 will light up. The light from this will fall on TR7 thus forming positive feedback and LP1 will stay alight when the match is removed.

To extinguish the bulb it is only necessary to blow on it, blowing on the input transducer at the same time.

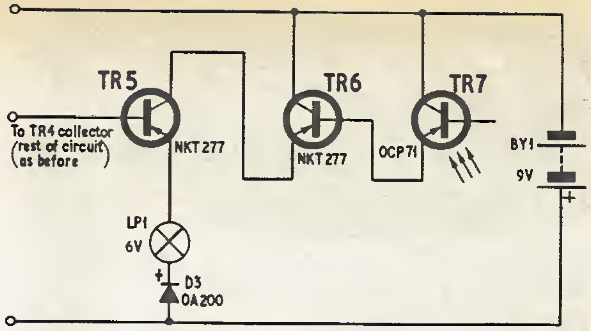


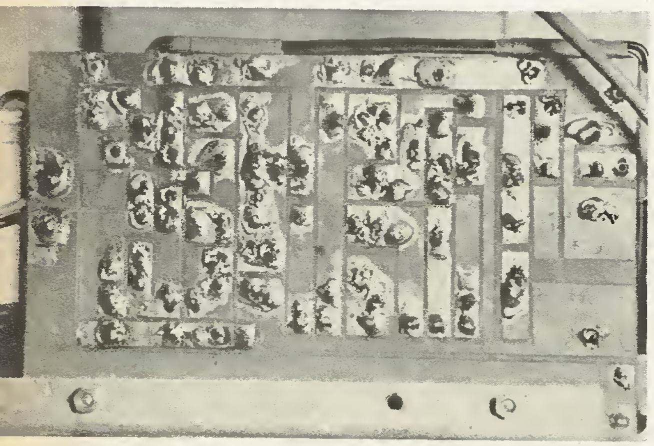
Fig. 3. Sound operated electronic candle

This will cause TR5 to switch off, extinguishing the bulb and thus interrupting the light to TR7 which remains off when the blowing is stopped.

Potentiometer VR1 should be adjusted so that ambient noise will not operate the switch. Also, TR7 should be positioned so that only light from the bulb, or match, will fall on the bulb. If the bulb still persists in lighting up when it is not intended to, a resistor should be placed between TR6 base and TR7 emitter.

T. J. Coombs,
Liss,
Hampshire.

PRINTED CIRCUITS



Underside view of a printed board for a 5 watt amplifier

QUITE a lot has been written recently about the awkward or risky techniques for making printed circuits. I have evolved a safe, simple and non messy method, using no paints or chemicals.

Once the chosen circuit wiring has been planned it should be drawn full scale on graph paper and taped to the copper side of the laminate board. Cut along the lines with a sharp knife to mark the copper and mark in the holes to be drilled. Remove the paper and now cut right through the copper foil. Next prise up the corner of each unwanted piece of copper and peel from the board.

Before drilling the holes, any rough edges of copper should be smoothed down. Once all drilling is completed the board is ready for soldering.

With a little care, strips of copper only ½mm wide can be removed, so the circuits can be really compact.

I have used this method successfully several times, the most complex circuit so far being a seven transistor 5 watt amplifier built on a board measuring 5in × 3in, see photograph.

J. Magee, Glasgow, S.2.

OSCILLOSCOPE PRE-AMPLIFIER

AN ADDITIONAL ×10 on the y-scale of an oscilloscope is often desirable and the circuit in Fig. 4 was developed to fill this need. Noise is sufficiently low not to blur the trace and the frequency response is 50Hz to 9MHz ± 0·5dB, wide enough for most low cost oscilloscopes.

The input impedance is 6kΩ at 1kHz and the maximum input signal is 0·5V peak to peak. The output impedance is 600Ω. The pre-amplifier gives a gain of 20dB (×10) and current drain is 8mA.

The rise time t_r is ≃ 34ns and the delay time t_d is ≃ 15ns.

K. J. Matthews,
Seaford,
Sussex.

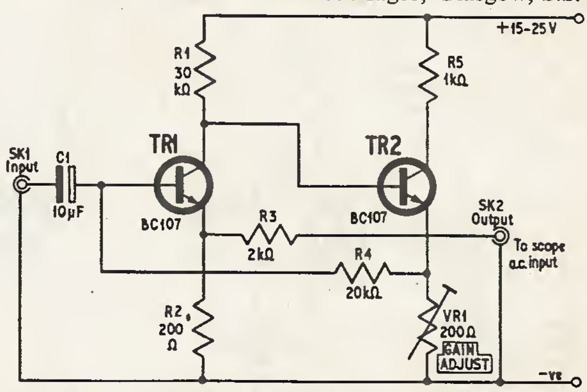


Fig. 4. Circuit diagram of the 20dB oscilloscope pre-amplifier

PE ORGAN PART 3

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

LAST month we completed the 12 oscillator units; now we go on to tackling the frequency dividers which will provide the rest of the pitches necessary, by division of the oscillator frequency in octave sub-multiples.

METHOD OF DIVISION

In Fig. 3.1 is given the block diagram of an oscillator and divider unit which shows how the note of B is successively divided to produce octave frequencies over seven stages of division.

The circuit of a divider unit is shown in Fig. 3.2. This consists of seven similar bistable generators which are in effect triggered switches; for if we consider the first divider, an incoming synchronising pulse from the oscillator unit causes the circuit to change from one state to the other, that is one side fully conducting, the other side cut off.

One complete cycle of the bistable circuit occurs for every two input pulses so that the pulse repetition frequency of the output from either of the collectors is thus half that of the input frequency so that division by two has taken place, so producing the octave below the generator frequency which is taken off via C4 for subsequent routing to the manual contact assembly.

Each bistable stage continues this 2:1 square wave division as the synchronising pulses are maintained down the chain with the result that seven additional octave notes are generated in addition to the basic oscillator product.

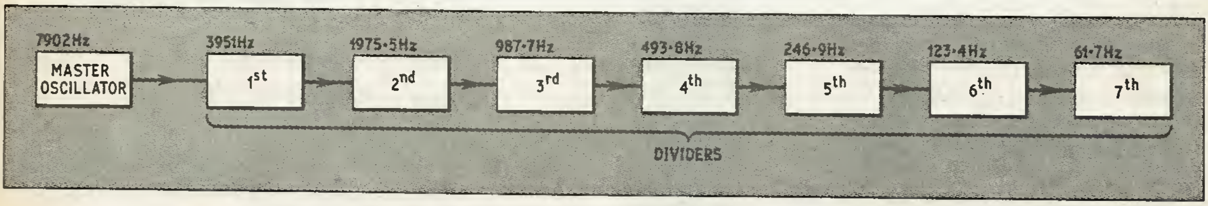


Fig. 3.1. Block diagram of an oscillator and divider showing how the note of B is divided into octave submultiples

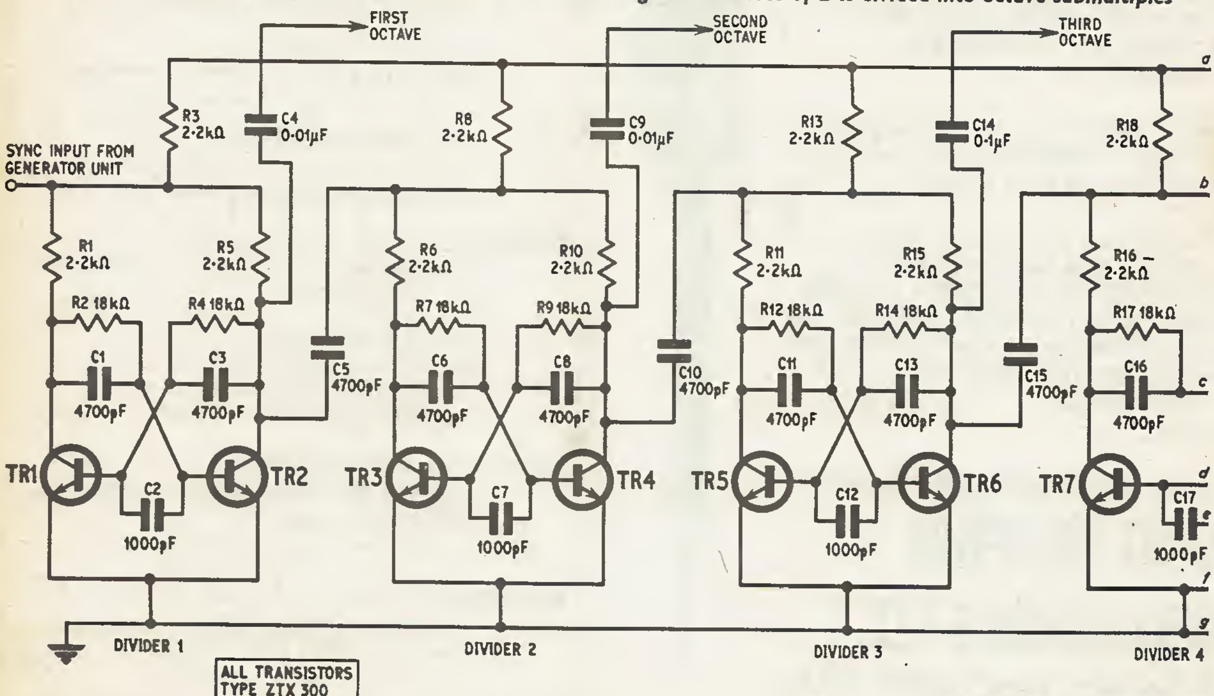


Fig. 3.2. Circuit diagram of a divider unit

DIVIDERS AND KEYBOARD WIRING

This series is expected to extend to 12 parts. Total cost of material for the organ is likely to be around £250

PRINTED BOARDS

Since the divider units are repetitive in their bistable complement, the choice of printed boards is an obvious one for a standardised assembly, as all component parts will fit in the same way on each board. Other advantages are the reduced risk of crosstalk and economy in the use of solder, a point sometimes overlooked.

Fig. 3.4 shows the etching and drilling layout for part of one divider board. Since the copper patterns for all seven stages are identical, only a section of the complete board is shown. However, a complete etched board is shown in the photograph.

For those constructors who do not fancy the prospect of etching boards, these can be obtained ready drilled from Mecelex Ltd., Whycliffe Mills, High Church Street, New Basford, Nottingham.

COMPONENT MOUNTING

In Fig. 3.3 is given the component layout for three bistables on the board section. Since the component assembly pattern for each stage is identical, with the exception of some of the output capacitors, the mounting and soldering of components can be swiftly completed.

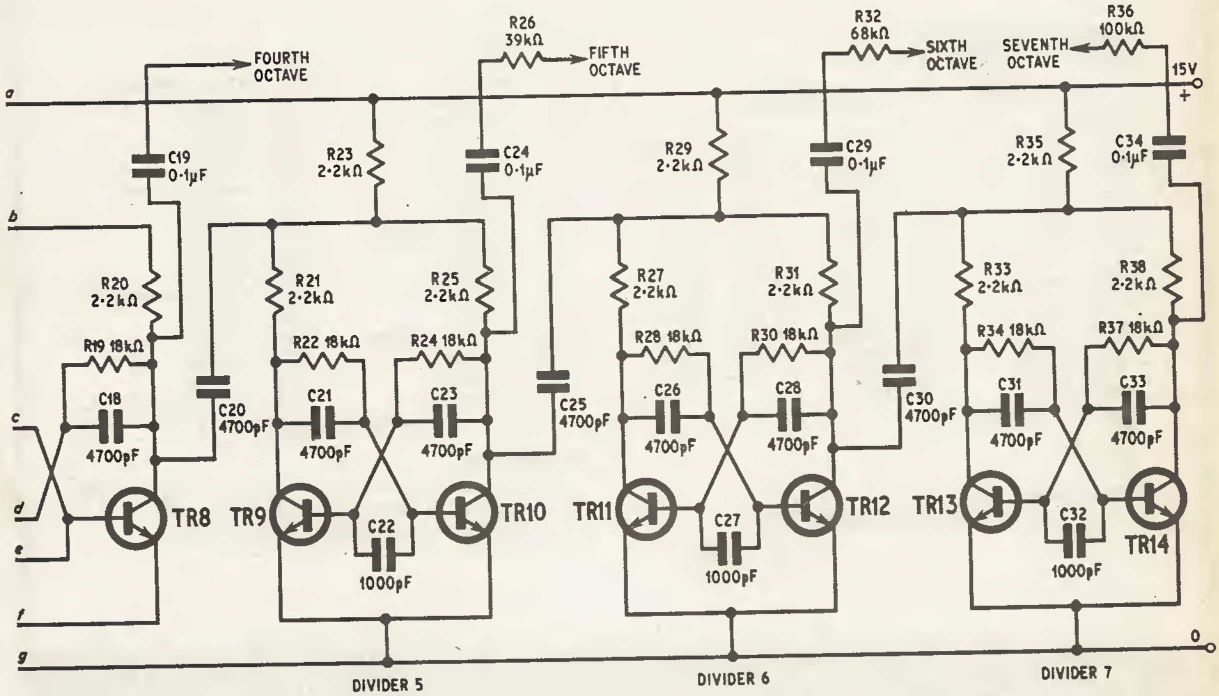
The accompanying photographs show a completely assembled board. Note here that one of the leads of the output capacitors is left to protrude for ¼in of its length. This is to provide an anchorage for equalising resistors which will be attached later.

TESTING THE DIVIDERS

Last month we checked the oscillators with a 30,000pF capacitor across each of the coils. Now using one of these rough tuned oscillators we can check each divider in turn, taking the output from one stage at a time through a 100 kilohm resistor into a small amplifier and loudspeaker or high impedance headphones, which, of course, do not require the attenuating resistor.

If an oscilloscope is available the waveforms can be examined directly.

In making these functional checks the +15V supply from P.S.U.1 will feed both the oscillator and dividers. As an additional aid to smoothing a 1,000μF 25V electrolytic capacitor should be connected across the supply line and it is as well to retain this when assembling the tone generation system in the console.



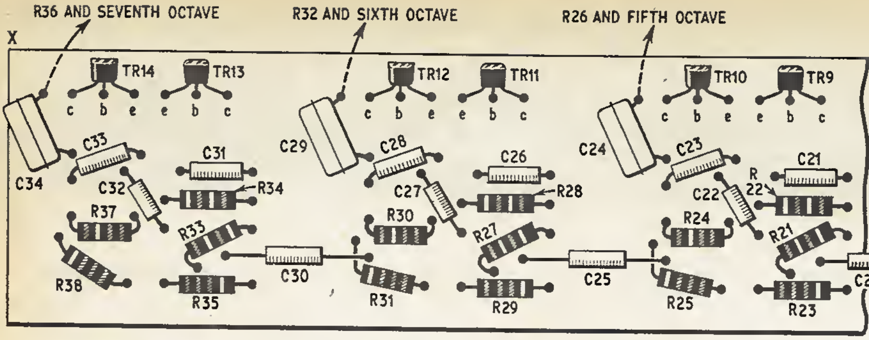
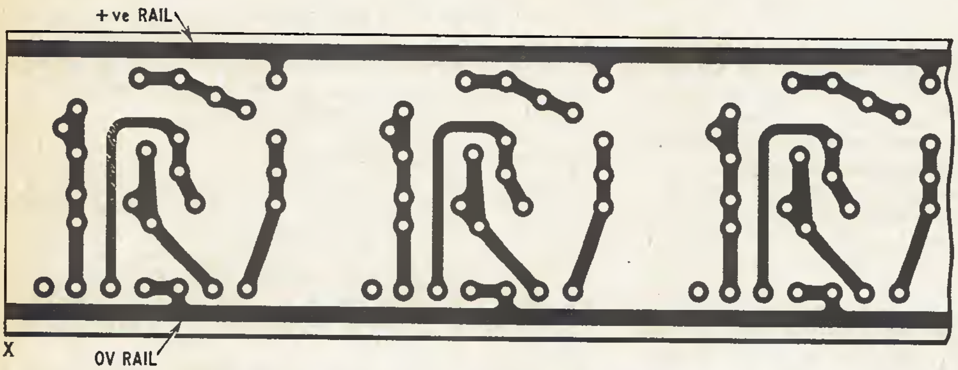


Fig. 3.3. Component layout on top side of divider board. Three stages are shown; the complete board can be seen in photo at the bottom of the page

Fig. 3.4 (below). Printed circuit for divider unit board. Three stages only are shown full size, the pattern being repeated to cover seven stages in all. See photograph below



COMPONENTS . . .

DIVIDER UNIT (12 REQUIRED)

Resistors

R1	2 2kΩ	R14	18kΩ	R27	2·2kΩ
R2	18kΩ	R15	2·2kΩ	R28	18kΩ
R3	2·2kΩ	R16	2·2kΩ	R29	2·2kΩ
R4	18kΩ	R17	18kΩ	R30	18kΩ
R5	2·2kΩ	R18	2·2kΩ	R31	2·2kΩ
R6	2·2kΩ	R19	18kΩ	R32	68kΩ
R7	18kΩ	R20	2·2kΩ	R33	2·2kΩ
R8	2·2kΩ	R21	2·2kΩ	R34	18kΩ
R9	18kΩ	R22	18kΩ	R35	2·2kΩ
R10	2·2kΩ	R23	2·2kΩ	R36	100kΩ
R11	2·2kΩ	R24	18kΩ	R37	18kΩ
R12	18kΩ	R25	2·2kΩ	R38	2·2kΩ
R13	2·2kΩ	R26	39kΩ		

All 10%, ½ watt carbon

Transistors

TR1–TR14 ZTX300 (Ferranti) (14 off)

Capacitors

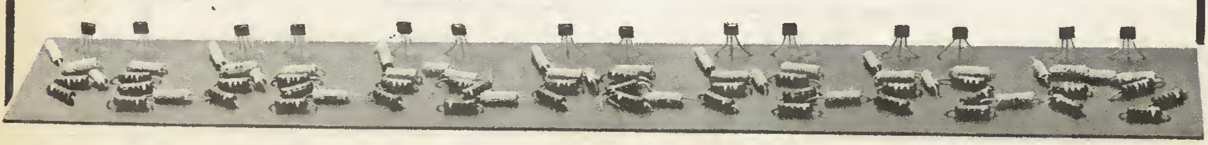
C1	4,700pF	C18	4,700pF
C2	1,000pF	C19	0·1μF polyester
C3	4,700pF	C20	4,700pF
C4	0·01μF polyester	C21	4,700pF
C5	4,700pF	C22	1,000pF
C6	4,700pF	C23	4,700pF
C7	1,000pF	C24	0·1μF polyester
C8	4,700pF	C25	4,700pF
C9	0·01μF polyester	C26	4,700pF
C10	4,700pF	C27	1,000pF
C11	4,700pF	C28	4,700pF
C12	1,000pF	C29	0·1μF polyester
C13	4,700pF	C30	4,700pF
C14	0·1μF polyester	C31	4,700pF
C15	4,700pF	C32	1,000pF
C16	4,700pF	C33	4,700pF
C17	1,000pF	C34	0·1μF polyester

All polystyrene unless otherwise stated.

Miscellaneous

Copper clad board 14½in × 1⅞in. Stranded core single p.v.c. wire in colours as required

Material for board retaining bars (see text)



If any one of the bistables fails to divide, it is almost certainly a faulty transistor which needs to be replaced.

BOARD RETAINING BARS

The long narrow shape of the divider boards was decided on because there is a convenient place for the 12 sets on the left-hand side of the console kneeboard which isolates them from possible power line effects.

Referring to the rear view photograph of the console given in last month's article, it will be seen that these boards are held in place by four slotted hardwood bars. Details of two bars with a pair of boards in position are given in Fig. 3.5.

The two bars "b" should be attached to the kneeboard by way of the fixing screw and separated by a distance of 13½in (measured from inner edge of bars). Using a $\frac{7}{64}$in drill, pilot holes can be made for screwing in the 3½in lengths of 2B.A. brass rod. Bars "a" are drilled to just clear the threads of the rods so that these are a push fit. The retaining nuts can be loosely threaded on at this point, but the boards should not be positioned as some further wiring has to be done.

EQUALISING RESISTORS

Now, in all bistable systems the lower notes tend to be louder than the upper ones. The dividers amplify as well as divide, at least they pass through the condition when they amplify during the switching period. So we have to reduce the lower octaves somewhat to prevent the sound from being bass heavy.

With individual contacts and precious metal busbars, it is easy to cut the bars and introduce resistors as required. But with the flat graphited bars used in the Harmonics keyswitches, it is not so easy and the method of holding the bars in slotted plastic blocks does not encourage much alteration, so we add equalising resistors to some of the divider outlet capacitors as follows:

The seventh octave outlets,	100 kilohms.
The sixth octave outlets,	68 kilohms.
The fifth octave outlets,	39 kilohms.

All of these being ½ watt, 10% types.

In addition, there might be one or two other dividers which tend to be too loud and may need the odd resistor of values in the range 27, 33 or 39 kilohms, to equalise. This cannot be predicted and might not occur.

COLOUR CODED OUTLETS

Naturally with so many tone outlets to consider, we must adopt a colour coding system, and this can be based on the international resistor colour code.

The wiring colour code that will apply to each oscillator and divider board is as follows:

Generator output F	black
1st octave	brown
2nd octave	red
3rd octave	orange
4th octave	yellow
5th octave	green
6th octave	mauve
7th octave	white.

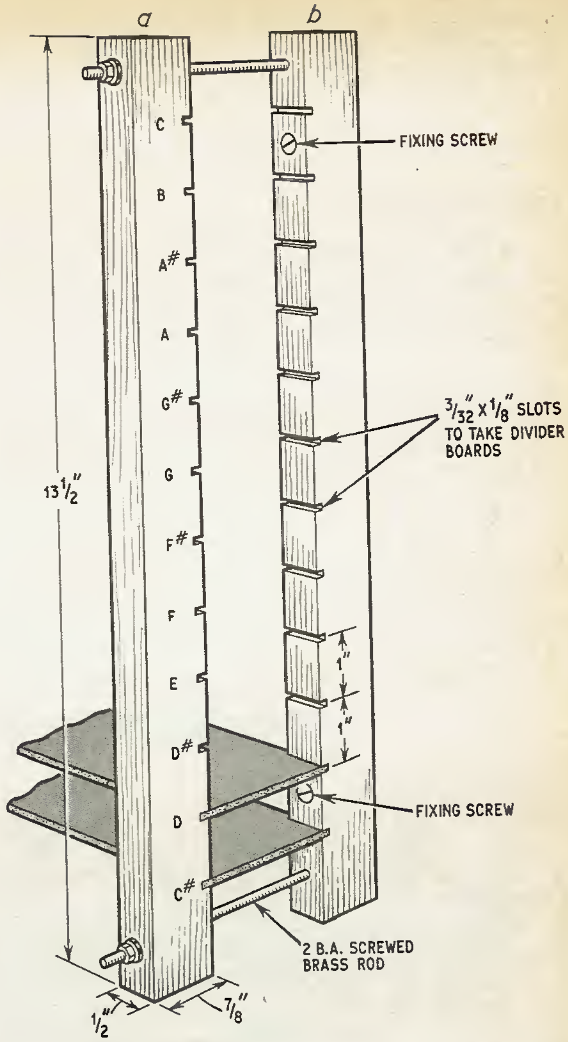


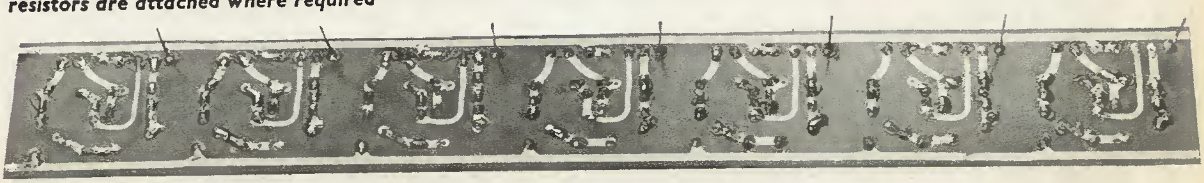
Fig. 3.5. Retaining bars "a" and "b" for divider boards Note signs are added to bar "a" to aid in board identification when oscillators are tuned

It is important, when making up the cable forms, to keep each set together in a bunch and tie a small label to each bunch with its note sign, otherwise they will all look the same and will have to be sorted out all over again.

MOUNTING OF OSCILLATORS

To ascertain the correct lengths of the black leads from the oscillator outputs F to the keyboard, these oscillator units should now be mounted in their final position.

Underside of divider board showing soldered connection. Note protruding output capacitor wires to which equalising resistors are attached where required



First make up a wood shelf 21in × 4in × ¼in. This should then be fixed to the rear keyboard support rail using angle brackets (see photograph below). Six oscillators are attached to the shelf by screws. The remaining six are angularly disposed along the console side, to the fore of the divider bars.

TONE ROUTING

To connect the tone sources to the keyboards involves three processes. Firstly connect the dividers to the upper keyboard; then connect from the upper to the lower one; and finally connect again to the upper one to extract the pedal notes which run from 32·7Hz to 349·2Hz.

Fig. 3·6 gives the frequency breakdown of the tone generation system. It will be noted that the highest frequency is B at 7,902Hz. Since there are 12 notes in the octave, we cannot divide 12 into 61 to include top C, and as this note is rarely used it is thought better to ensure generation of bottom C 32·7Hz which is often required.

PITCH PAD WIRING

If we refer to Fig. 2.1 showing the printed circuit of the upper contact assembly, we can see the 16ft wiring pads starting at bottom C on the lower extreme left of the board. The first octave here has no coupler connections to the 8ft row, so we start by taking the white wire from the C divider and soldering it to the extreme left-hand pad. Then we take the white wire from the C sharp divider and solder it to the C sharp pad next to the C; and so on using all the white wires from the different dividers.

When we get to B, we start again with the mauve wire from the C divider, then the mauve wire from the C sharp divider and so on.

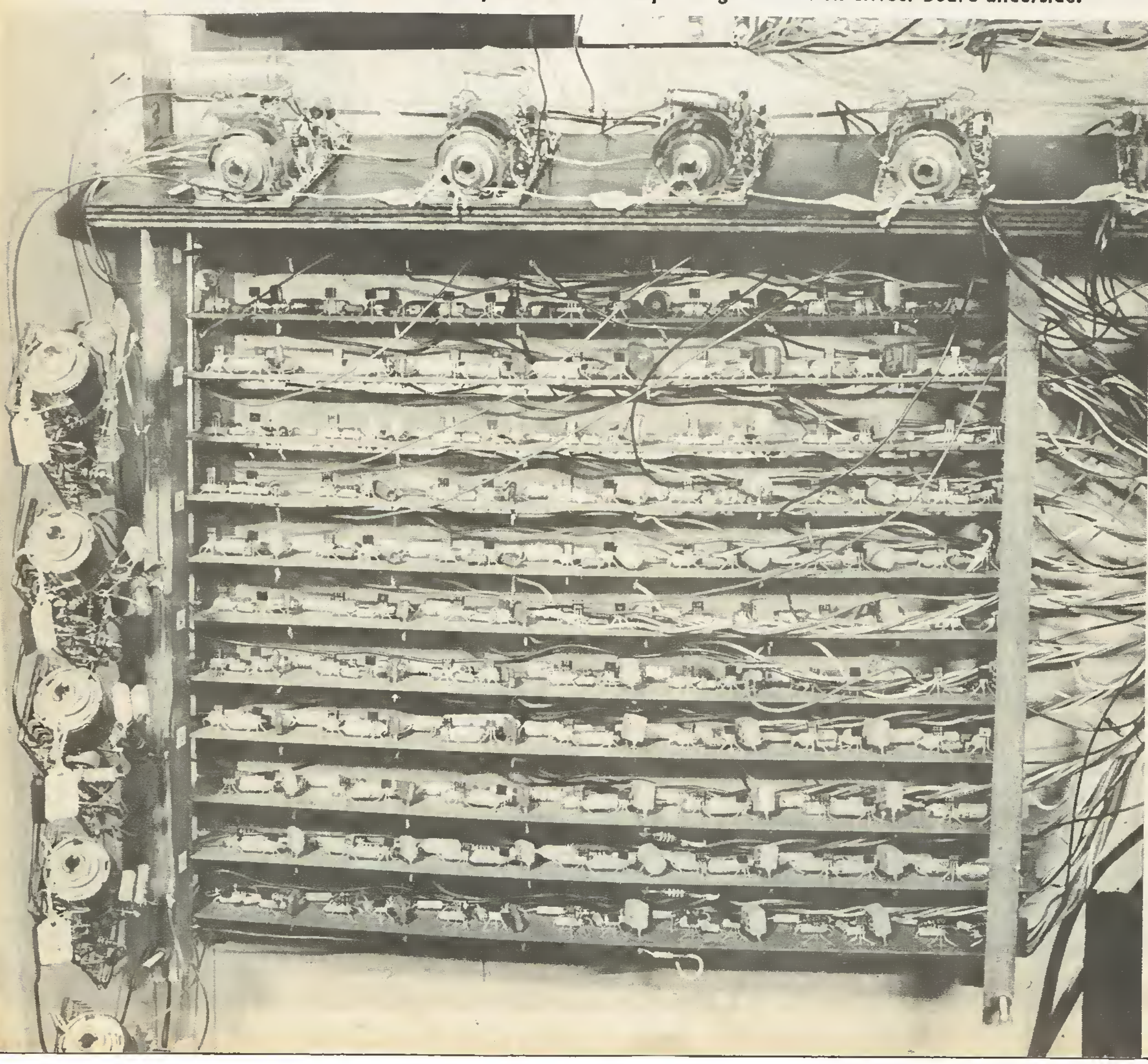
Eventually we come to the end of the 16ft pitch row of pads and at this point we go back one octave and solder to the 8ft pads above.

When we come to the end of the 8ft we again go back one octave and use the 4ft pads. In the end we find we have wires left over for the 2ft pads and if all that has gone before is correctly carried out, all of these remaining wires will be black.

Considerable care should be exercised in soldering to these printed circuit boards and *only* resin as a flux can be used. Excessive heat will affect the bond between the copper and the laminate, so make sure the iron is hot and complete the joints quickly.

If further clarification of this wiring is required, a diagram of a complete printed board can be obtained by purchasers of the manual contact assemblies from Harmonics Ltd.

Oscillators and dividers shown wired and in position. Note equalising resistors on divider board underside.



This shows how the complete tone generation system is evolved from the 12 fundamental frequency oscillators. These frequencies are divided down in their octave sub-multiples through the 12, seven octave dividers each of these being identified by their preceding note sign B, A sharp, etc. The frequencies given in Hertz are only to one place of decimals, the lowest being 32·7Hz and the highest 7,902Hz, these constituting the frequency limits of the organ. The pedal frequency range extends from 32·7Hz to 349·2Hz. When wiring from the dividers to the printed circuits of the manual contact assemblies, this chart should be used.

OUTLET WIRING COLOURS

DIVIDER	WHITE 7	MAUVE 6	GREEN 5	YELLOW 4	ORANGE 3	RED 2	BROWN 1	OSCILLATORS BLACK
B	61·7	123·4	246·9	493·8	987·7	1975·5	3951	7902
A#	58·2	116·5	233	466·1	932·3	1864·6	3729·3	7458·6
A	55	110	220	440	880	1760	3520	7040
G#	51·9	103·8	207·6	415·3	830·6	1661·2	3322·4	6644·8
G	48·9	97·9	195·9	391·9	783·9	1567·9	3135·9	6270·9
F#	46·2	92·4	184·9	369·9	739·9	1479·9	2959·2	5919·9
F	43·6	87·3	174·6	349·2	698·4	1396·9	2793·8	5587·6
E	41·2	82·4	164·8	329·6	659·2	1318·5	2637	5274
D#	38·8	77·7	155·5	311·1	622·2	1244·5	2489	4978
D	36·7	73·4	146·8	293·6	587·3	1174	2344·3	4698·6
C#	34·6	69·3	138·6	277·1	554·3	1108·7	2217·4	4434·9
C	32·7 16FT CCC	65·4 8FT CC	130·8	261·6 MIDDLE C	523·2	1046·5	2093 8FT TOP C	4186 4FT TOP C

BUSBAR OUTLETS

The tone signals fed into the upper manual are automatically distributed to the proper busbars by the printed wiring.

The busbar outlets are coloured: blue for 16ft, grey for 8ft, yellow for 4ft and red for 2ft. There is also a black earth wire at each end which is most important.

WIRING TO LOWER MANUAL

Now, the problem is to cross connect the upper tone inlets to those of the lower manual. This is in fact easy, since it merely means looping across from A to A, B to B, etc., along the whole keyboard. For this we need stranded core single p.v.c. wires in the following colours:

C	black	F sharp	light blue
C sharp	brown	G	dark blue
D	red	G sharp	mauve
D sharp	orange	A	grey
E	yellow	A sharp	white
F	green	B	pink.

Attach about a foot of each colour to the lower manual pads using the upper manual printed circuit board as a guide. These wires are now brought out past the springs at the rear. If the lower keyboard is placed in position and the top one laid on its back, connections to the latter can be easily made.

There are two busbar pitch outlets, 8ft and 4ft, the wires being identified by the colours: grey for 8ft, yellow for 4ft and black for earth.

PEDAL CABLES

Before putting the upper keyboard back on its supports the pedal cables must be attached. There is a small problem here because we must only attach as many wires as there are pedal key contacts.

If the full 30 wires were soldered on and it was decided to use a short compass pedalboard of 13 notes, the wires not used would certainly pick up hum and noise. We will assume, however, that the full 30 notes are to be used and here once more we need the 12 core cable.

The wire lengths to be used should be in the order of 3ft to span from the keyboard to the pedal plug position.

WIRING TO UPPER MANUAL

There are two and a half octaves of pedal notes at 16ft pitch plus one extra at 8ft; but as the tone networks are different for each of these, they must be wired separately.

For the 30 16ft notes we go back to the 16ft wiring pads of the upper contact assembly (see Fig. 2.1). Using the 12 note colour code as before, connect a black lead to the extreme lower left 16ft pad, then brown to the pad adjacent and so on until all 30 wires are connected.

For the 8ft notes we do exactly the same but starting one octave higher up, that is the 13th pad along on the 16ft row or the second C from the left.

At this point, if all soldering is secure both keyboards can be screwed into position on the support rails. Be sure none of the busbar outlet wires are trapped between the keyboards and their wooden supports or that the switch plungers do not catch on any of the wiring and fail to return.

Next month we start construction of the amplifier and power supply units.

To be continued

COLD CATHODE TUBES

Part THREE

By J.B.Dance M.Sc.

TRIGGER TUBES

COLD cathode trigger tubes are basically very similar to cold cathode diodes, but contain an additional electrode known as the trigger or starter. This electrode can be used to initiate a discharge between the main anode and the cathode, but once the main discharge has started, it will not be affected by any variations of the trigger electrode potential. The main discharge can be extinguished only by a reduction of the main anode to cathode potential. The symbol for the trigger tube is shown in Fig. 3.1.

A trigger tube may be considered as a double diode, the trigger being one of the anodes and the cathode being common to both anodes. The trigger to cathode gap and the main anode to cathode gap each have their own striking and maintaining voltages, those for the trigger electrode normally being much lower than those for the main anode, since the trigger to cathode gap is much smaller than the main anode to cathode spacing.

Trigger tubes can replace valves and transistors in many types of switching circuit, but cannot operate at such high speeds. The trigger electrode is used as a high impedance input electrode; whilst its function is to initiate conduction, it has no effect on the main gap current of a conducting tube.

In many circuits trigger tubes are operated with a main anode voltage greater than the main anode maintaining voltage but less than the main anode striking voltage. No main gap current will therefore flow at first.

If, however, the potential of the trigger electrode is now increased, thé trigger to cathode gap will strike as soon as the potential across it reaches the trigger striking voltage.

The ions formed in the trigger discharge are so numerous that a space charge of positive ions is formed in the region of the cathode and this results in the main gap striking voltage being lowered almost to the maintaining voltage of this gap. The main gap therefore strikes, since the potential applied across it is greater than its maintaining voltage.

Some trigger tubes have twin trigger electrodes. In such tubes conduction in the main gap can be initiated by a discharge from either trigger to the cathode. Such tubes are used in reversible counting circuits which will either add or subtract and in other circuits where two isolated inputs are required.

RELAY OPERATION

A circuit designed by Ericsson Telephones for the operation of a relay, from an input which cannot supply much power, is shown in Fig. 3.2. The tube employs a priming anode to ensure prompt striking; it is connected to the 10 megohm resistor in the circuit shown. The electrode connected to the junction of R4 and R5 is a shield anode; tubes employing a shield anode can control more power, since a higher anode voltage can be employed before the trigger electrode loses control.

The Elesta ER21A trigger tube for a.c. operation

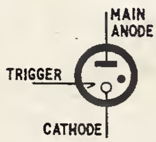


Fig. 3.1. Graphical symbol for a cold cathode trigger tube

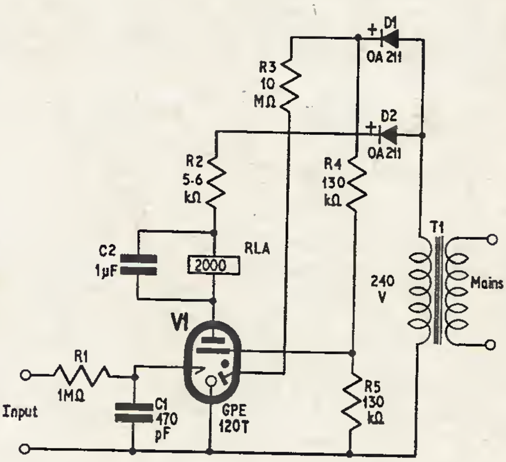


Fig. 3.2 The trigger tube used to operate a relay

In the circuit in Fig. 3.2, the alternating mains supply voltage is half wave rectified and is applied to the circuit without being smoothed so that conduction in the trigger tube will cease when the power supply voltage falls towards the end of a half cycle. If a smoothed power supply voltage is used, some means of extinguishing the discharge in the tube would be needed, since the charged smoothing capacitors would tend to hold the tube on.

When the input potential is raised above the trigger striking voltage, the trigger gap strikes and the main gap will also pass a current as soon as a positive going half cycle of the power supply reaches the anode. The relay therefore closes if the input potential exceeds the trigger striking voltage of $123 \cdot 5 \pm 2 \cdot 5$V. The capacitor connected across the relay keeps the latter energised during the half cycles when the tube is non-conducting; it therefore prevents the relay from "chattering".

since the relay contacts RLA1 are now open. However, when the level does reach the upper contact, the trigger voltage will fall and the relay will be de-energised. This will result in the pump which is forcing more liquid into the tank ceasing to function. The contacts close again and the level must now fall below the level of the tip of the lower probe before the motor is switched on again.

It can be seen that the use of the two contacts at different levels prevents the pump from being switched on and off too frequently as the level changes slightly.

TIMING CIRCUITS

A timing circuit will cause a relay to operate or produce an output pulse at a certain preset time after an input pulse has been applied to the circuit. The timing interval may range from a small fraction of a second to many hours. Such circuits are widely used in industrial

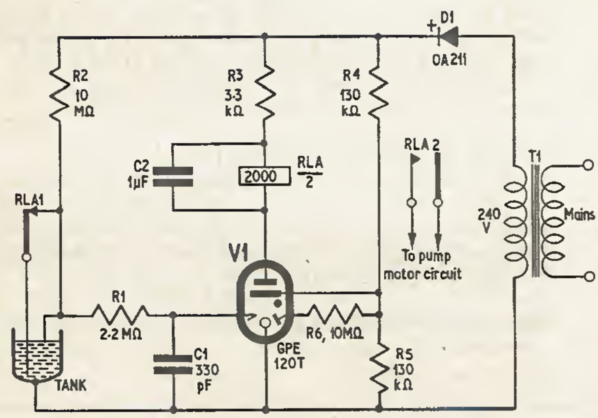


Fig. 3.3. A circuit for controlling liquid levels

The Cerberus GR44 trigger tube; this tube has twin trigger electrodes and a priming anode

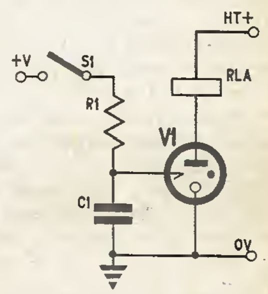


Fig. 3.4. A basic timer circuit

LEVEL CONTROL

The application of the circuit in Fig. 3.2 to the control of liquid levels in a metal tank may be illustrated by the circuit in Fig. 3.3. The liquid must have at least a limited conductivity.

The relay contacts RLA1 are closed when the relay is not energised. The 10 megohm resistor forms a potential divider with the resistance of the liquid between the probes and the tank. If the conductivity of the liquid is adequate to ensure that the resistance between the probes and the tank is much less than 10 megohms, the trigger electrode voltage will be only a little above the cathode potential and the tube will not pass a current. The relay will therefore remain de-energised.

When liquid is taken from the tank and the level falls below that of the tips of both probes, the latter will no longer be in contact with the liquid. The trigger voltage will therefore rise and the tube will fire, the main gap conducting in the half cycles when the anode is positive with respect to the cathode. The relay therefore operates and contacts RLA1 open. The relay may be used to switch on an electric motor (by means of an additional pair of relay contacts RLA2) which pumps more liquid into the tank.

When the liquid rises, the circuit will not be affected until the level reaches that of the tip of the upper probe, automation systems, but are also useful as photographic timers in the home.

Trigger tube timing circuits depend on the time taken for a capacitor to charge through a resistance for their operation. The basic circuit is shown in Fig. 3.4. When a voltage V is applied to the resistor R1 by the closure of the switch S1, the capacitor C1 begins to charge. The tube fires when the voltage across C becomes equal to the striking voltage of the tube used.

The capacitor charges exponentially from zero to the voltage V. It can be shown that the voltage V_c across the capacitor at a time t after the application of the voltage V is given by the equation:

$$V_c = V(1 - e^{-t/RC})$$

The tube will fire when the voltage V_c becomes equal to the trigger striking voltage, V_s'. This occurs after a time t where

$$t = RC \log_e \left\{\frac{V}{V - V_s'}\right\}$$

The product RC is known as the time constant of the circuit; R is in megohms and C is in microfarads.

A simple timing circuit designed by Ericsson Telephones is shown in Fig. 3.5. A stabilised source of

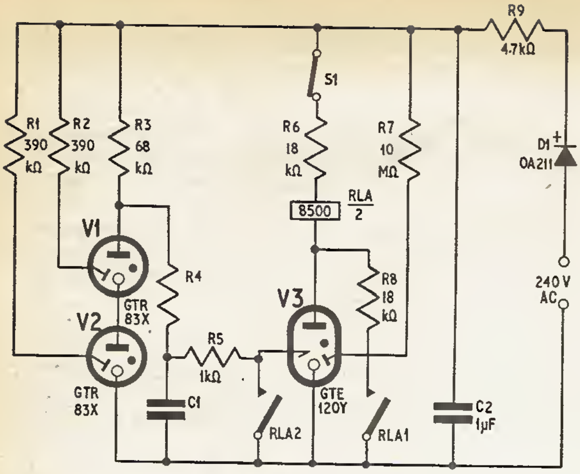


Fig. 3.5. Simple timer using a relay that operates at 4·5mA

voltage is used to supply the trigger resistor and capacitor to prevent mains voltage variations from affecting the duration of the timing intervals. When the mains voltage is first applied to the circuit, the capacitor C1 begins to charge through the resistor R4. After a time equal to 1·28*RC* seconds the tube will fire and the relay will close.

Contacts RLA2 close and discharge C1 via the 1 kilohm resistor and contacts RLA1 close so that the relay energising current no longer flows through the trigger tube. The circuit will be reset and the relay de-energised when the reset switch S1 is opened or when the mains supply is interrupted. The electrode connected to the 10 megohm resistor is a priming anode.

A more sophisticated version of this timer, which will provide a wide range of time intervals, is shown in Fig. 3.6. The circuit is basically similar to that in Fig. 3.5, but the time interval may be pre-selected by means of a six-position switch S1 together with the two-position switch S2 and the potentiometer VR1 connected to S1. The approximate time intervals obtained are shown in Fig. 3.6, but these will be affected by component tolerances.

The principle of operation is the same as that of the circuit in Fig. 3.5. The circuit in Fig. 3.6 may be supplied from a source of alternating voltage in the range 200 to 225 volts if the 1·2 kilohm resistor in the h.t. line is shorted out.

This circuit can be used in a photographic enlarger timer (Fig. 3.7). The contacts marked RLA3 are an additional set of normally closed contacts on the relay of the Fig. 3.6 circuit. When the photographer is ready to commence the exposure, he closes the switch S4 and the enlarger lamp is illuminated. This action also applies the mains voltage to the timer circuit. After the pre-set time interval, the relay is energised and contacts RLA3 open, thus ending the exposure.

It is now only necessary to open the switch S4 in order to prepare the equipment for use again.

LIGHT OPERATED RELAY

The circuit in Fig. 3.8 (published by the Cerberus Company) enables the relay to be energised when a beam of light falls on the cadmium sulphide photoconductive cell X1. The GR16 trigger tube is designed for operation from either a.c. or d.c., therefore no rectifier is required in the power supply line. The tube has an internal shield electrode which should be biased appropriately.

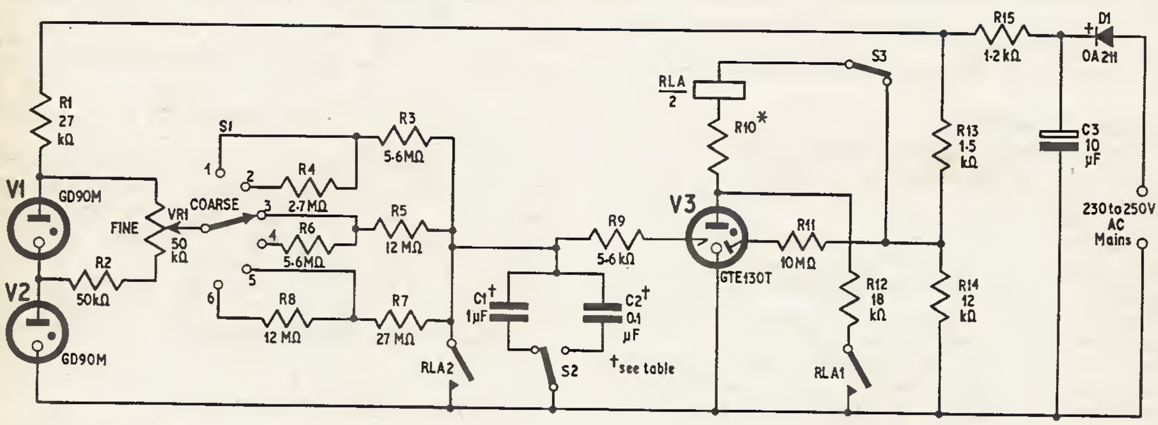


Fig. 3.6. A more comprehensive timer with range switches. The value of R10 is equal to 4 kilohms minus the relay resistance, The relay must operate at a current of less than 13mA

Table 3.1

Switch position	Time (seconds) C1	Time (seconds) C2	Switch position	Time (seconds) C1	Time (seconds) C2
1	1·0	10	4	3·1	31
2	1·5	15	5	4·8	48
3	2·1	21	6	7·0	70

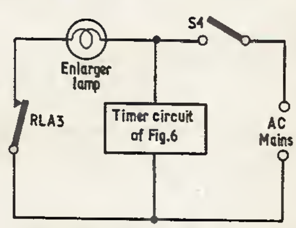


Fig. 3.7. The circuit in Fig. 3.6 can be used with a photographic enlarger

When no light falls on the photoconductive cell, its resistance will be high compared with the resistor R1, therefore the potential of the trigger electrode is not very different from the cathode potential. If a beam of light falls onto the photocell, the resistance of the cell falls from some megohms to a much lower value (typically, a few hundreds of ohms). The voltage drop is now occurring mainly across the resistor R1, so a relatively high voltage is applied to the trigger electrode. The tube therefore fires on those half cycles of the mains potential which result in the anode being positive. If the light beam is now removed, the trigger tube no longer fires.

The optimum value of the resistor R1 depends on the sensitivity required and on the type of photoconductive cell being employed. Typical values for R1 are within the range 470 kilohms to 2·7 megohms. The relay used contains a number of shorted turns so that it can be operated from a pulsed current without chattering.

There is a difference between the light intensities at which the relay is just de-energised as the light intensity slowly falls and that at which it will be just energised as the light intensity rises again. This has the advantage that it prevents the circuit from repeatedly switching itself on and off if there are some relatively small alterations of the light intensity. Such repeated switching would be undesirable if the unit were used to control street lighting or to switch the lighting on in an office.

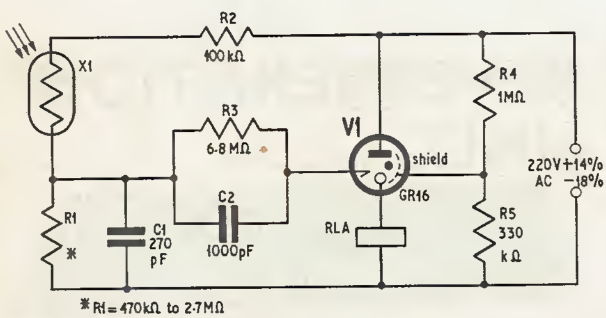


Fig. 3.8. Trigger tube can also be used in light sensitive circuits

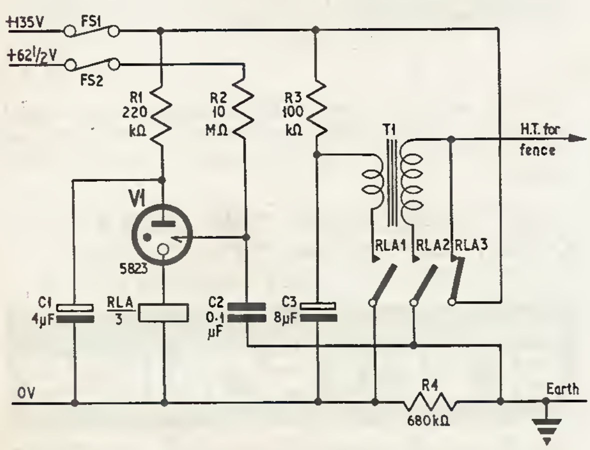


Fig. 3.9. An electric fence high voltage supply

If a circuit is required in which the relay will open when the photocell is in darkness, it is only necessary to interchange the resistor R1 and the photocell, the 100 kilohm resistor R2 being omitted. As in the case of the circuit of Fig. 3.8, there will be a switching interval between the light intensity at which the relay is energised and that at which it will be de-energised.

ELECTRIC FENCE CIRCUITS

A simple electric fence circuit using a high current cold cathode diode was discussed last month. A further circuit using a trigger tube (designed by the Philips Company) is shown in Fig. 3.9. A single pulse is applied to the electric fence when an animal touches it.

No current is taken from the power supply except during the time an animal is in contact with the fence. If the insulation of the fence with respect to earth is good (over ten megohms), two small 62½ volt batteries will last at least one season, since the time for which current is being taken from the batteries is a very small fraction of the total operating time. The circuit uses the Philips/Mullard 5823 cold cathode trigger tube which contains a coated cathode; an equivalent type is the Z900T.

In the circuit in Fig. 3.9, a relay with two pairs of normally open contacts (RLA1 and RLA2) and one pair of normally closed contacts (RLA3) is required. The transformer is a valve output transformer.

When a resistance (normally that of an animal) is placed between the fence and earth, a current flows from the battery through this resistance and returns to the battery via resistor R4. The voltage thus developed across the latter resistance adds to that already present at the trigger electrode of V1 and causes the tube to fire. This causes C1 to discharge and a current passes through the relay. The contacts RLA1 and RLA2 therefore close, whilst contacts RLA3 open. Capacitor C3 discharges through the primary winding of transformer T1 and contacts RLA1, thus resulting in the generation of a pulse of about 2,800 volts across the secondary winding; it is this pulse which is applied to the fence.

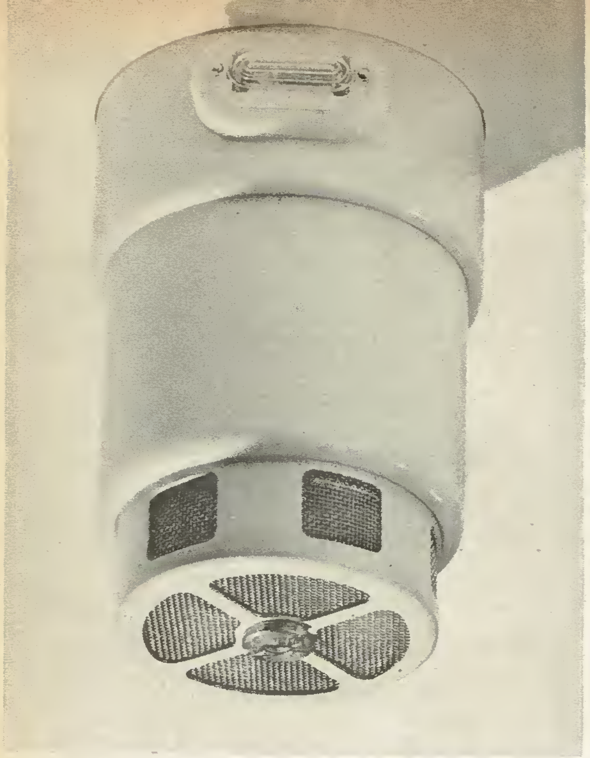
The tube ceases to conduct after a period of about 3 milliseconds and the relay is de-energised. The contacts then return to their quiescent position and the capacitors are charged via the appropriate resistors.

It is recommended that the insulation resistance between the fence and earth should be at least six megohms, since both the battery life and the pulse frequency are affected by inadequate insulation. If the insulation resistance is smaller than this recommended value, it may be necessary to reduce the value of R1 to prevent the circuit from operating continuously even if no animal is in contact with the fence.

COUNTING CIRCUITS

Trigger tubes can be used for counting electrical pulses. Counting circuits are widely used in industry (for example, for counting the number of articles coming off a production line), in electronic instruments such as digital voltmeters and in instruments used in nuclear physics. However, the use of trigger tubes for counting is now less common than it was some years ago.

The most common type of trigger tube counting circuit employs a ring of ten trigger tubes, one of the tubes conducting at any one time. The tube which is conducting emits a red glow and this indicates the number of pulses which have been counted by the



The Minerva ionisation chamber smoke detector. This unit is mounted on the ceiling and gives early warning of fire. A trigger tube is employed to operate a relay

circuit. If the zero tube is initially glowing and an input pulse is received by the circuit, the succeeding tube will fire (thus indicating that the circuit has made one count); the previously glowing zero tube will then be extinguished. The next pulse will result in the tube which indicates the digit two glowing.

This process continues, the glow passing step by step around the ring of tubes until, at the tenth pulse, the zero tube again conducts. At this instant an output pulse is provided which can be fed to another group of ten tubes which counts the number of tens. This latter group of ten tubes will provide an output pulse for each hundred pulses applied to the first ring. Thus forty tubes (four rings of ten tubes in each) can be used to count up to 9,999.

Other types of trigger tube counting circuit have also been used, including binary systems and the so-called biquinary counters which employ a ring of five combined with a ring of two; in the latter system a scale of ten can be constructed using only seven trigger tubes.

OTHER USES

Trigger tubes are used for a wide variety of other purposes. They may, for example, be used in a type of voltage stabilising circuit, which provides a stabilisation of a few per cent at output currents of up to some tens of milliamps. They are also widely used in industrial automation. A particularly interesting use of a special electrometer low current trigger tube is in ionisation smoke detectors. These detectors, which are normally ceiling mounted, will give an early warning of invisible smoke particles before a fire has done an appreciable amount of damage. They are widely used for protecting computers, nuclear reactors, and art treasures.

Next month: Arc discharge tubes

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.

PHOTO WATCHDOG

Now that the holiday period has begun, many readers will be thinking of ways of making their homes secure during their vacation. One of the more obvious methods is to convince the would-be intruder that the house is occupied, and so deter his intrusion.

A photo-electric switch particularly suitable for deterring burglars is now being produced by **Andrew Stephens (1947) Co.**, 61 Dickson Road, Blackpool, Lancashire. This switch operates from a.c. mains and can handle up to 6 amps. The switch automatically switches any lights on at night and off at daybreak, so creating the impression that the house is occupied at all times, particularly during the evenings when the intruder is most likely to pay a visit.

The circuitry is contained in a weatherproof housing with a fixing bracket and consists of a highly sensitive photocell and a specially designed bimetal relay.

The switch can be used on any landing or porch, in the garage, as a child's nightlight, and possibly used for automatically switching on a small electric fire (1kW) in a bedroom.

SHORT-CIRCUIT DETECTOR

Detecting and localising short-circuits in any cable form is always a bugbear that causes time consuming delays in servicing work, and any apparatus that eases this problem is always to be welcomed. To help relieve this problem **I.T.T. Modular Electronics Division** (formerly known as S.T.C.) is now marketing a Swiss short-circuit detector in the U.K.

It is claimed that the detector localises short-circuits rapidly and enables these particular faulty cables to be identified from among many others. Also, it is claimed that concealed cable runs, in pairs, can be traced in concrete to a depth of 30cm.

The detector comprising a probe, transistor amplifier and headphones, operates in conjunction with a transistor oscillator generating a fixed frequency of approximately 1,400Hz. The oscillator is attached to the cable run; the probe is then moved along the cable, being kept as close as possible and with its axis in the direction of the magnetic field, detecting the oscillator output tone in a pair of headphones. When the short-circuit is reached the tone falls away to practically zero, indicating the point of failure in the cable.

Two output voltages are available from the oscillator, for use as determined by the nature of the short circuit path. The loudness of the tone in the headphones can be adjusted to suit aural conditions.

The I.T.T. short circuit detector costs £25 17s 6d; the oscillator can be provided as an extra at £12 12s. Both units are available through I.T.T. Electronic Services, Edinburgh Way, Harlow, Essex.

CONNECTORS

The 159 series of multi-way connectors from **Painton Co. Ltd.**, has now been modified and redesigned to give better and more robust working. The solder tag connections have been modified and the mouldings improved to give greater resistance to any displacement due to vibrations.

The connectors are manufactured with 7 to 71 poles and a descriptive leaflet number PS10 is available from Painton Co. Ltd., Kingsthorpe, Northampton.

One of the ideal applications for these connectors will be to connect the P.E. Organ foot pedals to the main console.

SWITCH KIT

Intended mainly for engineers, but ideal for experimenters and educational laboratories is the Print Switch kit from **Plessey**. Practically any multiple arrangement of rotary switching can be set-up, and pre-production samples made in a very short period of time.

The switch consists of a special printed circuit wafer, lightweight rotor, precious metal faced contacts and an arrangement of dual compression springs and rollers for indexing. The printed circuit wafer allows numerous switch configurations to be obtained by simply removing any unwanted interconnections with a special hand tool, provided with the kit. Contacts press-fit into the moulded rotor in one of 12 switch positions, the assembly being attached to the board by a retainer. Side plates up to 10in depth are available and will accommodate wafers at multiples of 0·2in pitches.

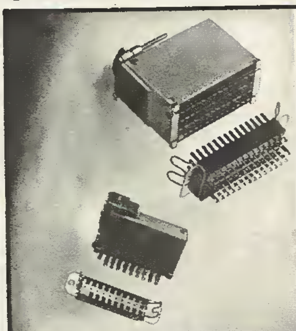
The kit is packaged in a case with full instructions and cost approximately £35. Further details of the PrintSwitch kit can be obtained from Plessey Co. Ltd., Professional Components Division, Abbey Works, Titchfield, Hampshire.

NEW ADDRESSES

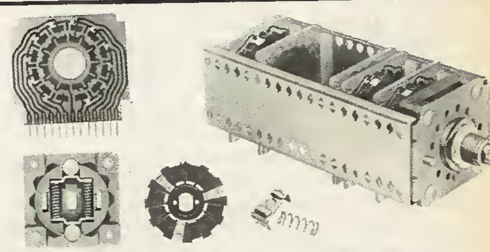
The well-known component specialists **Home Radio** have moved into larger premises just a short distance their from original shop in Mitcham. The name of the business has at the same time been changed to Home Radio (Components) Ltd.

With more space at their disposal, an even larger range of components can now be stocked and no doubt this expansion will be reflected in the next issue of their catalogue. Personal shoppers and mail order shoppers should note the new address: Home Radio (Components) Ltd., 234–240, London Road, Mitcham, Surrey.

Another company which has also moved house due to recent expansion is S.D.C. Products (Electronics) Ltd. All future orders for their well-known "breadboard" systems should now be addressed to **S.D.C. Electronics (Sales) Ltd.**, 34, Arkwright, Astmoor Industrial Estate, Runcorn, Cheshire.



Painton multi-way connectors



PrintSwitch from Plessey Components Division

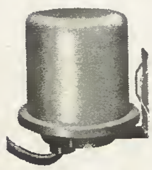
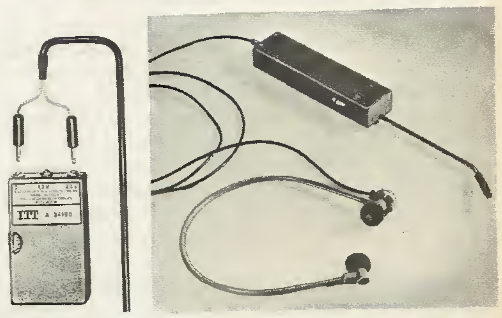


Photo-electric switch made by Andrew Stephens



I.T.T. Oscillator and short-circuit detector

BOOK REVIEWS

VHF-UHF MANUAL

By G. R. Jessop, C.Eng., MIERE, G6JP
Published by the Radio Society of Great Britain
244 pages, $9\frac{1}{4}$in $\times$ $6\frac{1}{2}$in. Price 21s

THE interest of amateur radio enthusiasts in the v.h.f. and u.h.f. fields is ever growing and, with the increasing "overcrowding" of the lower frequency bands, this trend is very likely to continue.

Much of the equipment employed by amateur operators using these bands is home constructed and this book has been published with the intention of giving "a wide range of material for each of the bands, so the constructor has a selection of designs from which to choose—together with a suitable amount of basic information on general matters."

The result is a concisely written manual which covers a wide range of basic information such as; propagation and the effects of weather; details of equipment for mobile users; single sideband equipment; a comprehensive chapter on various aerials, giving polar diagrams, discussing feeders, impedance matching and giving constructional details.

The final chapter is entitled "Aerial Test Gear and Accessories" and comprises such items as reflectometers, power meters, grid dip oscillators and power supplies.

Both transistor, valve and hybrid circuits of transmitters and receivers are given and layout diagrams and photographs of equipment are shown.

In all a manual that no operative v.h.f. or u.h.f. amateur should be without—a worthy addition to the range of RSGB publications.

M.K.

POPULAR ELECTRONICS AND COMPUTERS

By F. G. Rayer, A.I.E.R.E.
Published by Arco Publications Ltd.
190 pages, $8\frac{3}{4}$ in. $\times$ $5\frac{1}{2}$ in. Price 36s

THE choice of title for this book is perhaps unfortunate, because the only part describing computers is chapter nine (16 pages), and even then in such condensed elementary detail to be hardly worth advertising in the title at all.

A larger part is devoted to radio in its many facets, about which the author is best known. Indeed, he has written other books on this subject.

No newcomer to electronics can complain of a lack of books on basic theory, and it is becoming all too common for electronics and radio books to be prefaced by several chapters of the same kind of details, from atoms to amplifiers, from electrons to a.c. theory. This one does not deviate from this course, and one is led to ask how much are we really getting for our money on popular electronic circuits and computers.

All the more puzzling is the cramming of a wide range of subjects in only 190 pages, none of which is really given justice in its description. Had the first 72 pages of basics been dropped, the space could have been more usefully spent on more satisfying descriptions of the other subjects, not least being the computer section.

M.A.C.

MEETINGS

INSTITUTION OF PHYSICS AND THE PHYSICAL SOCIETY

LONDON

July 2–4. Conference on *Lasers In Medicine*, Chairman Prof. O. S. Heavens, at The Medical School of Middlesex Hospital, London, W.1.

Further details, time of conference and registration forms available from The Meetings Officer, 47, Belgrave Square, London, S.W.1.

SOCIETY OF ELECTRONIC AND RADIO TECHNICIANS

EVESHAM

July 4–7. Symposium on *Maintenance In Electronics* at Wood Norton Hall, Evesham.

The inclusive charge for this residential symposium is fifteen guineas for members and nineteen guineas for non-members. Further details and registration forms are available from the Secretary, Faraday House, 8–10, Charing Cross Road, London, W.C.2.

LONDON RADIO CONTROLLED MODELS SOCIETY

LONDON

July 10, 7.30 p.m. *General Discussion*, at The Two Chairman, Dartmouth Street, London, S.W.1.

Further details from the Secretary, H. C. Farley, 24, Dacre Crescent, Kimpton, Hitchin, Herts.

INSTITUTION OF ELECTRICAL ENGINEERS

WARWICK

July 8–10. Conference on *Measurement Education*, at University of Warwick.

Further details, time of conference and registration forms available from The Secretary, I.E.E., Savoy Place, London, W.C.2.

MULLARD MEETINGS

The 1969/70 season of Mullard meetings for the radio and television trade opened at Southampton on May 5. This year's talk is devoted to integrated circuitry. Between now and the end of April 1970 it will be given at 76 centres in the U.K.

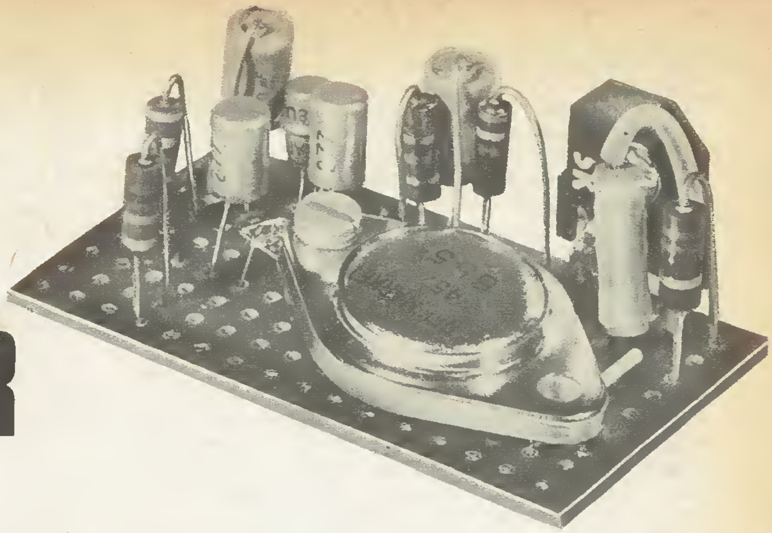
Apart from members of the retail trade, these meetings are attended by representatives of many other branches of the electronics industry, students from technical colleges, and also amateurs who are interested in the latest technical developments.

The programme for June and July is as follows:

June 17. Five Bridges Hotel, Gateshead, Durham.
18. County Hotel, Carlisle, Cumberland.
23. Grosvenor Restaurant, Glasgow.
25. George Hotel, Edinburgh.
July 1. City Cafe, Londonderry, N. Ireland.
3. The King George VI Youth Centre, Belfast, N. Ireland.
9. Dolphin Hotel, Swansea.
10. Park Hotel, Cardiff.

All meetings commence at 7.45 p.m. and readers wishing to attend any of these meetings should apply for tickets to Mr Ian Nicholson, Films and Lectures Organisation, Mullard Ltd., Mullard House, Torrington Place, London, W.C.1.

SERIES VOLTAGE REGULATOR



THIS unit gives a stabilised output voltage from an unstabilised input. The output can be varied between approximately 7 and 12 volts, at currents up to approximately 400mA, or up to 1A if the output transistor is mounted on a heat sink.

The unit may be used on its own, or made up into a bench mounted variable voltage stabilised supply, or it may be built into additional equipment, such as test gear. As well as giving a stabilised output, the unit acts as a smoothing circuit, giving a considerable reduction in ripple from the unstabilised input.

BASIS OF OPERATION

When discussing voltage regulators, it is advisable to lead up to the final circuit in a number of progressive stages, and this approach will be adopted here.

A very simple form of voltage stabiliser is shown in Fig. 1a. Here, the circuit consists simply of a limiting resistor (R1) wired in series with a Zener diode (D1). The unstabilised input is applied across this combination, and the stabilised output is taken from across the zener diode.

This circuit has a number of applications, but suffers from severe disadvantages: the output power is very limited (unless large—and expensive—Zener diodes are used); the output voltage is not variable; the output voltage varies (by a small amount) with changes in input voltage.

Fig. 1b shows an improvement on this basic circuit. Here, TR1 is wired as an emitter follower, with its base fed from the stabilised Zener diode output. The emitter of an emitter follower tends to "follow" very closely the voltage on its base; thus, the voltage on the emitter of TR1 tends to remain *almost* the same as that across the Zener diode, irrespective of the current flowing in TR1 emitter. R_z, in the emitter of TR1, represents the output load seen by this regulator.

This circuit has the advantage that the output power is handled by TR1, and negligible power need be handled by the Zener diode D1. Disadvantages are: the output voltage is not variable; the transistor has an output impedance of several ohms, so that the output voltage will vary by a certain amount with the output current; and the output voltage is not *fully* stabilised.

This improved circuit can be made to give a variable output voltage by wiring a variable resistor (VR1) across the Zener diode, as in Fig. 1c, and connecting the base of TR1 to the moving arm of VR1. The main disadvantage of this modified circuit is that the output impedance is still quite high.

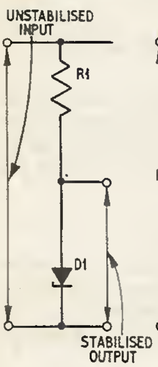


Fig. 1a. Basic regulator circuit

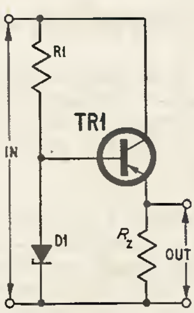


Fig. 1b. Higher output basic regulator

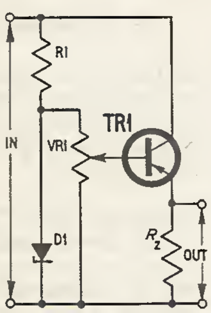


Fig. 1c. A variable version of 1b

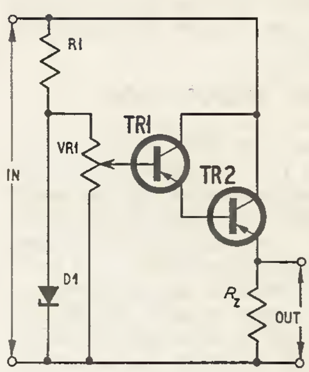


Fig. 1d. Series regulator using a super-alpha pair

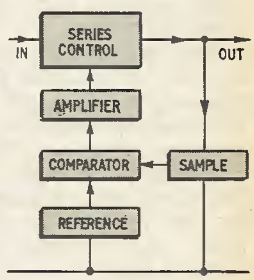


Fig. 1e. Block diagram of a feedback system for voltage regulation

SUPER-ALPHA PAIR

The next step in circuit development is shown in Fig. 1d. Here, the single transistor of the earlier figures has been replaced by two transistors, TR1 and TR2, connected as a super-alpha pair. This simple modification results in a circuit that has a very low output impedance, and thus good voltage regulation; the output voltage is fully variable.

Of the two transistors, TR2 handles the major part of the output power, TR1 handling only a small fraction of the total output. As it stands, this circuit makes a very useful bench mounted variable voltage stabilised supply.

It should be noted, however, that the output is not fully stabilised, there still being some small variation in output voltage with load, and a fair degree of change in output voltage (possibly 1 per cent) for a large (say 10 per cent) change in the input voltage. To overcome these snags, a negative feedback circuit needs to be introduced to this series controlled unit.

The method of feedback is best understood with reference to the block diagram, Fig. 1e. Here, a

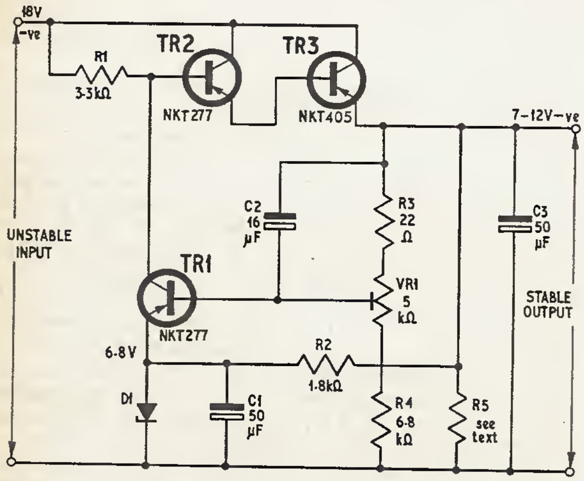


Fig. 2. Complete circuit diagram of the series voltage regulator

sample of the output voltage is compared with the reference voltage, and the difference between the two is fed to the series control circuit via an amplifier. In this way, any change in the output voltage, irrespective of the cause, is fully countered.

THE SERIES VOLTAGE REGULATOR CIRCUIT

The full circuit diagram of the series voltage regulator is shown in Fig. 2. TR2 and TR3 are the super-alpha pair series control transistors, connected in the emitter follower mode. The base of TR2 is fed from the collector of TR1, to which it is direct coupled.

The sample voltage is obtained from VR1 via R3 and R4, which are connected in series across the output of the unit, and this sample voltage is fed to the base of TR1. The reference voltage is obtained from the Zener diode, D1, which is fed directly to the emitter of TR1. This Zener voltage is derived, via R2, from the output of the unit; thus, the reference voltage is unaffected by variations in the unstabilised input voltage. TR1 is connected as a common emitter amplifier, with collector load R1.

When operating, the sample voltage is compared with the reference voltage in TR1; if the sample voltage has become more negative, the collector current of TR1 will increase and hence the voltage drop across R1 will increase, making TR1 collector (and TR2 base and TR3 emitter) go less negative (more positive). The change in output voltage is thus countered.

Ripple is reduced in a similar way, but in this case the a.c. from the output is fed as a sample directly to the base of TR1 via C2, but the a.c. is prevented from affecting the reference voltage by C1—the decoupling capacitor across the Zener diode.

Any ripple that still remains in the output is further reduced by C3. R5 acts as a permanent output load, ensuring that the output voltage remains constant between no load and full load operating conditions.

CONSTRUCTION

Start construction by cutting the Veroboard panel to size and break the copper strips as shown in Fig. 3.

Commence assembly by securing the solder tag to the NKT405 power transistor and the transistor to the

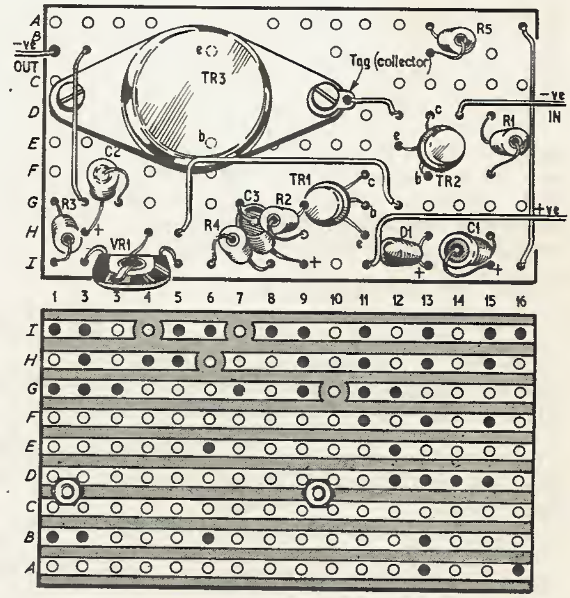


Fig. 3. Layout and wiring details of the Veroboard

board with two short 4B.A. screws and nuts, then solder the transistor in place on the panel. Finally, solder the rest of the components in place, taking care to assemble the capacitors and the Zener diode with the correct polarity.

VARIATIONS OF THE CIRCUIT

The power handling capabilities of the unit when built on the Veroboard panel are limited; with the output voltage set at 12V, currents of 400mA can be handled, while at 8V only approximately 250mA can be passed.

If greater power than this is required, TR3 should be mounted on a suitable heat sink, using the insulating bushes and washer that are supplied with the power transistor. The size of the heat sink is not critical, and as a general guide to the experimenter, it can be said that as long as the power transistor does not get more than

COMPONENTS . . .

Resistors
R1 3·3kΩ
R2 1·8kΩ
R3 22Ω
R4 6·8kΩ
R5 1kΩ ¼W to 220Ω 1W (see text)
All ±10%, ¼W carbon except where stated

Potentiometer
VR1 5kΩ skeleton pre-set

Capacitors
C1 50μF elect. 15V
C2 16μF elect. 15V
C3 50μF elect. 15V

Semiconductors
TR1 NKT277
TR2 NKT277
TR3 NKT405
D1 Any 6·8V Zener diode

Miscellaneous
Veroboard
4B.A. fixings
P.V.C. covered wire

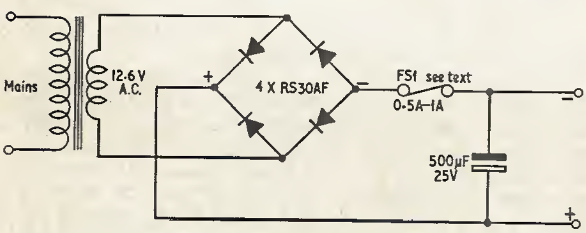


Fig. 4. Circuit of a suitable power supply for use with the series voltage regulator

just slightly warm under any given set of operating conditions, the design is satisfactory. Using a heat sink of about 7in × 7in, currents up to 1A can be handled.

If the unit is to be used under constantly loaded conditions, R5 can be left out of the circuit. When the regulator is to be used only occasionally as a general purpose power supply under variable load conditions, R5 can be made 1 kilohm. If the unit is to be made into a general purpose bench mounted power supply, R5 should be made 220 ohms or less.

USING THE REGULATOR

The unit is perfectly simple to use, it being necessary merely to connect an unstabilised 18V supply to the input and take the stabilised output from the lead connected to TR3 emitter.

The input voltage is in no way critical, as long as it is a few volts greater than the required stabilised voltage. The input voltage does not have to be particularly well smoothed.

As a safety precaution, a fuse should be inserted in the unstabilised supply circuit. The fuse should be 500mA maximum if the power transistor is to be mounted on the Veroboard panel, and 1A if TR1 is to be mounted on a heat sink. A suitable circuit for the unstabilised power supply is shown in Fig. 4. ★

NEWS BRIEFS

Fifteenth International V.H.F.-U.H.F. Convention

THE FIFTEENTH V.H.F.-U.H.F. Convention was held on April 26 at the Winning Post Hotel, Whitton. The Convention, organised by the RSGB, was attended by some 260 members—a slight increase on last year's attendance.

An exhibition of home constructed equipment was the centre-piece in the "display" hall and this was surrounded by various commercial firms' stands and a selection of RSGB publications which included the new V.H.F.-U.H.F. Manual (see *Book Reviews*).

During the afternoon some seven lectures were held in rooms adjoining the display and later in the evening the convention dinner was served in the largest of the rooms. During the after-dinner speeches, members of the RSGB were urged by Colonel I. St. Q. Severin O.B.E., of the Cabinet Office, to "use or loose" those frequency bands allotted them by the GPO. The Convention closed with the presentation of the V.H.F. Committee Cup to Mr D. Dall G5AHK for his entry in the amateur constructed equipment display, and the G5RV Trophy to Mr R. Ham BRS15744.

Transducer Equipment for N.A.S.A.

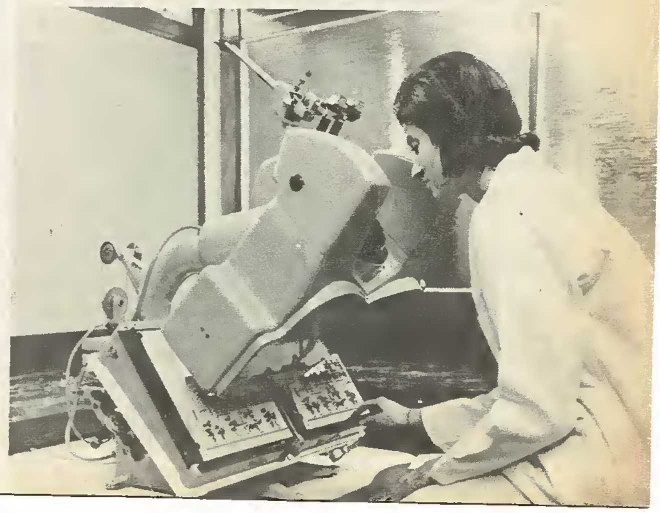
THE National Aeronautical Space Administration have recently ordered 40 channels of transducer equipment from the Wayne Kerr Corporation in the U.S.A.

The system is positioned in the instrument capsule of the Saturn Rocket being used in the Apollo programme and will measure the position of vital components to within a few millionths of an inch. The eight measurement channels will relay vital mechanical information back to earth whilst the rocket is in orbital flight.

Design Awards Presented Aboard QE2

HIS Royal Highness The Prince Philip, Duke of Edinburgh, presented the 1969 Council of Industrial Design Awards, together with his own prize for Elegant Design, on board the new Cunard *Queen Elizabeth 2* at Southampton on Thursday, May 29.

The photograph below shows a "Vision Comparascope", made by Vision Engineering Ltd., being used for inspecting a printed circuit panel. The Comparascope is the winner of this year's Capital Goods Section and is designed to compare the object to be checked with a master. Images of the two objects (that being checked and the master) are accurately superimposed on one another in such a way that the operator sees in sequence the master object and the object being checked. Thus any difference between the two "winks" at the operator as it appears and disappears.



Report from AUSTRALIA

BY D. F. MOODY

WHO wants to be taught by T.V.? I must admit that the thought does not appeal to me at all. I remember my school days with a sort of "glow"—that warm, learned feeling when staying behind to talk over a particularly interesting topic, with the chalk dust lingering in the air. Where would all this be with teaching machines and educational television?

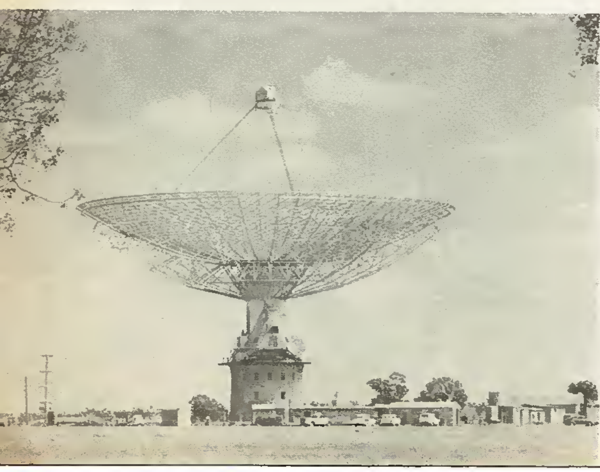
OUTBACK RADIO

The facts are though that here in Australia, and all over the world, there is a growing teacher shortage, classes are getting bigger and more unmanageable, and educational authorities are looking to electronics to solve their problems for them. I gather that it will not be long now before all the colleges of London University will be hooked up into a common closed circuit television network.

In Australia, remoteness rather than overcrowding is more of a problem, and this is overcome by the use of radio as much as possible. For example the University of New South Wales has recently begun transmitting lecture material through its own radio station to registered students in remote areas. Of course, the "outback" has had a radio system operating for over thirty years now. The system—The Royal Flying Doctor Service—is well known, and covers an area of over 1½ million square miles and, from fourteen base stations, provides the isolated communities of this area with a medical, educational and social service.

Probably the medical service is the more commonly known one outside of Australia. The Darwin radio station, for example, transmits medical schedules twice each day. In these "medical skeds", a doctor prescribes treatments to patients scattered over thousands of square miles, with aircraft standing by to bring to hospital those too ill for distant treatment.

The New South Wales radio telescope, one of many situated throughout Australia, used for satellite tracking and space communications



There are nearly 6,000 homestead transceivers and, in communities where it is not possible or desirable for children to be sent away to school, these sets are used in the so-called "Schools of the Air". A typical set up is with about seventy transceivers hooked up together through a base station. Thus the teacher at the base station is able to talk to all the seventy or more children at once, and they are able to talk back, both to the teacher and to one another. These radio lessons are also supplemented by correspondence courses.

These transceivers (which are locally known as "pedal radio" from the early form of set which was powered by a pedal) also provide isolated homesteads with some form of community life, with such organised activities as "Brownies of the Air", and a daily "galah" or gossip session for the womenfolk.

Although this network is of vital importance to the lives of the outback inhabitants, it is only a drop in the ocean compared with the other uses of the radio spectrum. But surely it would be most satisfying to Marconi's ghost to find that here true use is being made of radio communication for the benefit of man. I don't know what he would think if the use of his invention was solely limited to supplying entertainment for the over indulged masses.

SPACE IN AUSTRALIA?

Sure there is space in Australia! It is some 20 times the area of the U.K. and has only 20 per cent of the population.

However, the sort of space I'm referring to is deep space, and it may not be realised that Australia has a growing interest in this activity. Apart from the planned radio-telescope, which will be one of the largest in the world, Australia has six NASA space-tracking and communication stations, which places her second only to the United States.

Concerned mainly with tracking, reception, and command signalling of satellites and deep-space probes, these stations provide NASA with essential elements of their world wide Space Tracking and Data Acquisition Network (STADAN). They are staffed by Australians, and require a total of 800 engineers, technicians and supporting staff.

Why is Australia so interested in satellite technology? Because it holds the solution for providing Australia with high capacity international telephone and television links, and for providing the sparsely populated areas with a television service, when direct transmission from satellites to home receivers becomes a practical proposition. It would then be possible to provide an educational television service to everyone in Australia, no matter where they lived.

Who would want to be taught by television? I guess I would.

ELECTRONIC COMPONENTS AND EQUIPMENT

HR

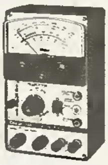
• NEW RECOMMENDED LINES AT VALUE FOR MONEY PRICES •

★ **3 SPEED 9 VOLT RECORD PLAYER DECK** Brand new British made decks. Plays 78, 45 and 33⅓rd. 12", 10" and 7" records. Fitted crystal Mono cartridge. Special price 60/-, p.p. 3/6.

★ STEREO HEADPHONES

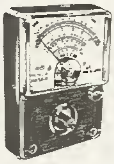
Adjustable headband. High quality 8 + 8 ohm phones with padded earpieces. Fitted jack. Suitable for 3–16 ohms. Frequency range 25c/s to 14kc/s. **DHO2S, Price 59/6.**

★ TRANSISTOR CHECKER



Complete capacity for checking all transistors *npn* and *pnp* for alpha, beta and German. Also diodes complete with leads and instructions. **ZQM-2, Price £5.19.6, p.p. 3/6.**

★ MULTIMETER



Return of a popular model. 2000 ohms/V. 0 / 10 / 50 / 500 / 1000V a.c./d.c. 0/50µA. 0/10/250mA d.c. 0 / 10 / 100kΩ / 1MΩ resistance. dB and capacitance scales. Size 5in × 3½in × 1½in. Robust and easy to use. Complete with leads, batteries and instructions. **THL33A, Price 82/6.** Leather Case, Price 22/6.

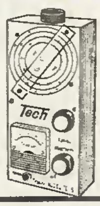
★ SPECIAL OFFER OF EMI TWEETERS

● 2½in units 6/8W, 5kc/s to 15kc/s, 8 ohms (suitable for 3–8 ohms). **Price 12/6**, p.p. 1/6.
● 3in units 10/12W, 3kc/s to 20kc/s. For 3 to 8 ohms—**Price 15/–**, p.p. 2/–. For 12 to 16 ohms—**Price 20/–**, p.p. 2/–.

★ SPRING REVERBERATION UNITS

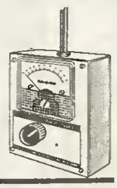
16 ohms input, 10kΩ output. Twin spring units. **Model HR42**, 9½in overall, 25–30msec delay, **Price 55/–. Model HR162**, 16½in overall, 35–40msec delay, **Price £6.10.0.**

★ GRID DIP METER



All transistor grid dip meter, absorption wavemeter and osc. detector. Frequency range 440kc/s to 280Mc/s in 6 coils. Uses 3 transistors plus diode with 500µA meter. Internal battery. **TE15, Price £11.10.0.**

★ FIELD STRENGTH METER



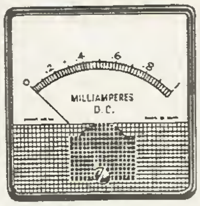
Covers 1–250Mc/s. Switches for model control and any application requiring peaking of transmitters and oscillators. 100µA meter. Complete with aerial. **FS1, Price 45/–.**

★ SIGNAL INJECTOR

New model for checking all audio and RF up to VHF. Simple to use. Battery operated. Output approx. 1kc/s, 1·4V pp. Harmonics up to VHF. **SE250B, Price 35/–.**

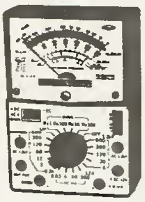
TO3 'SCOPE £35, p.p. 10/-.

★ QUALITY PANEL METERS (D.C. RANGES)

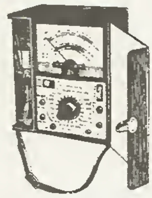


38 Series. Face size 42 × 42mm (1⅝in × 1⅝in). 50µA, **37/6**; 100µA, **35/–**; 200µA, **32/6**; 500µA, **27/6**; 1mA, 5mA, 10mA, 50mA, 100mA, 500mA, **25/–** each; 10V, 20V, 50V, 100V, 300V and 500V, **25/–** each; 1A and 5A, **25/–** each. "S" meter, 1mA, **29/6**. VAm meter, **37/6**.
65 Series. Face size 86 × 78mm (3⅜ × 3⅛in). 50µA, **62/6**; 100µA, **52/6**; 200µA, **47/6**; 500µA, **45/–**; 1mA, 5mA, 10mA, 500mA, **37/6** each. "S" meter, 1mA, **42/6**. Other ranges and sizes available.
Complete list on request.

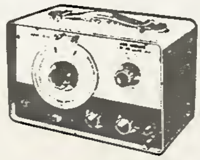
★ 50,000 OHMS PER VOLT MULTIMETER



Recommended quality instrument with mirror scale and overload protection. 0/0·3/3/12/60/120/300/600/1200V d.c. 50kΩ/V; 0/6/30/120/300/600/1200V a.c. 10kΩ/V; 0/30µA/6/60/300mA, 0/12A; resistance 0/10kΩ/1/10/100MΩ. Meter movement 20µA, Polarity reversing switch. Complete with batteries, leads and instructions.
AF105, Price £8.10.0, p.p. 2/6; **Leather case 28/6.**

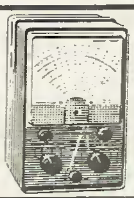


★ SINE/SQUARE WAVE AUDIO GENERATOR



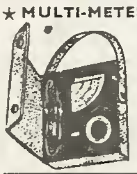
Provides audio output on 4 bands. Sine wave 20c/s to 200kc/s, output up to 7V; square wave 60c/s to 30kc/s, 7V p-p. Distortion under 2%. Output impedance 1kΩ. Variable output amplitude control. Supplied with leads and instructions. A.C. mains operated.
TE22, Price £16.10.0, carriage, etc., 10/–.

★ VACUUM TUBE VOLT METER

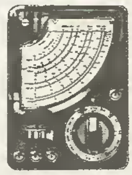


Features low price for such an instrument. Large 6in full view scaled meter. 28 ranges. **D.C. volts:** 0/1½/5/15/50/150/500/1500. **A.C. volts:** 0/1½/5/15/50/150/500/1500 r.m.s.; 0/1·4/4/14/40/140/400/1400/4000 p-p. **Resistance:** R × 10–100–1k–10k–100k–1m–10m. Range 0·2 ohm to 1000MΩ. **dB scales:** –10 to +65dB. Complete with instructions and leads. H.V. Probe, **50/–**. R.F. Probe, **42/6**.
Model TE65, Price £17.10.0, p.p. 7/6.

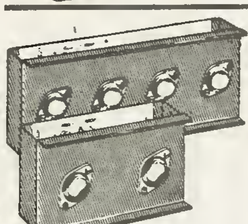
★ MULTI-METER 20kΩ/V



Popular model but with extra scale. Range 20,000 ohms per volt. 0/5/25/50/250/500/2500V d.c., 0/10/50/100/500/1000V a.c., 0/50µA, 0/2½/250mA. Resistance 0–6kΩ and 6MΩ. Also dB scales or capacitance.
200H, Price 77/6. Leather case, Price 15/–.



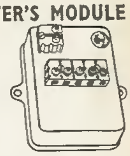
★ TRANSISTOR POWER AMPLIFIERS



12W, 3 ohm, 100mV input, 24V supply. **Model MPA12/3, £4.10.0**, p.p. 3/–.
12W, 12–16 ohm, 100mV input, 40V supply. **Model MPA12/15, £5.5.0**, p.p. 3/–.
25W, 8–16 ohm, 180mV input, 50/60V supply. **Model MPA25, £7.10.0**, p.p. 4/6. **Power supplies:** 24–40V, 90/–, p.p. 3/6; 50–60V, 97/6, p.p. 4/–.
Model PA7 7W amplifier, 3 ohms O/P, 7mV input, operates 12–18V. **Price 72/6**, p.p. 2/-.

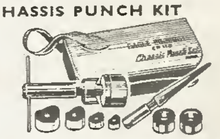
● **Henry's 320 page Catalogue has over 6,500 stock items. If you read this magazine and have not obtained one, you should—it will save you a lot of money as Henry's stock most things you require in components and equipment at low prices.**

★ EXPERIMENTER'S MODULE



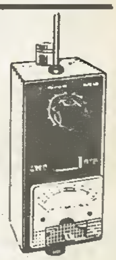
Terrific offer of brand new STC time delay electronic units. Adjustable 3–15 recs. 9–12V operated. Supplied complete with suggested used circuits. **STC Module Price 35/–.**

★ CHASSIS PUNCH KIT



Complete kit with punches ½in, ⅝in, ¾in, 1in, 1⅛in for metal, plastics, etc., up to 16 gauge. **Price 50/–**, p.p. 4/6.

★ SWR ALIGNMENT METER



Ideal for all transmitter alignment. Built-in field strength meter 100µA. Complete. Ready to use. SWR 1:1 to 1:3.

SWR-3, Price 69/6, p.p. 2/6.

★ TRANSISTORISED INTERCOMMS

2-station, **£3.10.0**; 3-station, **£5.15.0**; 4-station, **£6.12.6**. Mains operated, 2-station, uses no wires **£11.19.6**. Front Door Intercom **90/-**.

Did you know we stock over 1,000 Transistors and Devices? Ask for Latest FREE List (No. 36).

★ MAKE YOUR OWN PRINTED CIRCUITS

Supplied complete with copper boards. Templates for shapes, all necessary fluids and pastes. Easy to use. Box forms dishes. **Price 17/6**, p.p. 2/–.

★ BUILD THIS MW/LW TUNER

Complete high quality superhet tuner. Built-in ferrite rod. Battery operated. Will feed any amplifier. Printed circuit construction, 3 transistors plus diode. **To Build, 79/6**, p.p. 2/6.

CATALOGUE
320 pages with 10/– Discount Vouchers. Price 7/6, p.p. 2/–

● **SALES ASSISTANTS WANTED —APPLY TO '303'**

HENRY'S RADIO LTD.

303 & 309 Edgware Road, London, W.2
Phones: "303" 01-723 1008/9. "309" 01-723 6963
Open Mon. to Sat. 9a.m.—6p.m. Thurs. 1p.m (All Mail orders to "303")

FOLLOW THE LEADERS

KING SIZE
QUALITY-TESTED PAKS

2	Drift Trans. 2N1225 Germ. PNP 100 Mc/s.	10/-
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	OC140 Trans. NPN Switching	10/-
1	12 A SCR 100 PIV	10/-
3	Sil. Trans. 2S303 PNP	10/-
4	Zener Diodes 250mW 3-12V	10/-
3	200Mc/s. Sil. Trans. NPN BSY26/27	10/-
3	Zener Diodes 400mW 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 Mullard Type	10/-
1	Power Trans. OC20 100V	10/-
10	OA202 Sil. Diodes Sub-min. Marked	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/-
5	GT41/45 Germ. Trans. PNP	10/-
3	GT31 LF Low Noise PNP Trans.	10/-
6	IN914 Sil. Diodes 75 PIV 75mA	10/-
8	OA95 Germ. Diodes Sub-min. IN69	10/-
3	NPN Germ. Trans. NKT773	10/-
2	OC22 Power Trans. Germ.	10/-
2	OC25 Power Trans. Germ.	10/-
4	OC72 Trans.	10/-
4	AC128 Trans. PNP High Gain	10/-
2	AC127/128 Comp. pair PNP/NPN	10/-
3	2N1307 PNP Switching Trans.	10/-
10	CG62H Germ. Diodes Eqvt. OA71	10/-
3	AF116 Trans	10/-

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

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 NPN	10/-
3	12V Zener 400mW	10/-
2	10A 600 PIV Sil. Reacts. IS45R	10/-
3	BC108 Sil. NPN High Gain Trans.	10/-
1	2N910 NPN Sil. Trans. VCB100	10/-
2	1000 PIV Sil. Rect. 1·5A R53310 AF.	10/-
3	BSY95A Sil. Trans. NPN 200Mc/s.	10/-
3	OC200 Sil. Trans.	10/-
2	Sil. Power Rects. BYZ13	10/-
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	Sil. Planar Trans. NPN 100Mc/s. BSY25	15/-
1	Unijunction Trans. 2N2160 TO-5	15/-
2	Sil. Rects. 5A 500 PIV Stud Type	15/-
2	Germ Power Trans. OC28/29	15/-
1	10A Sil. Stud React. 800 PIV	15/-
1	Tunnel Diode AEY11 1050Mc/s.	15/-
2	2N2712 Sil. Epoxy Planar HFE225	15/-
8	BY 100 Type Sil. Rects.	20/-
25	Sil. and Germ. Trans. Mixed, all marked, New	30/-
2	GET880 Low Noise Germ. Trans.	10/-
1	AF139 PNP High Freq. Trans.	10/-
3	NPN Trans. 1 ST141 & 2 ST140	10/-
4	Madt's 2 MAT100 & 2 MAT120	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/-

CADMIUM CELLS

ORP60 ORP61	8/- each
ORP12	8/6 each

MANY NEW PAK ITEMS

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. Please state voltage required. Full range eqvt. to OAZ Mullard Type Z. Range of STC. I.R. Texas and IN types.

TRANSISTOR EQVT. BOOK
52 pages of cross references for trans. and diodes, types include British, European, American and Japanese. Specially imported by BI-PAK 10/- each

ANOTHER CROWNING SUCCESS—

2N2060 NPN. SIL. DUAL TRANSISTOR CODE D1699 TEXAS. OUR PRICE 5s. EACH.

GERN. RECTIFIER SINGLE-PHASE BRIDGE MULLARD TYPE GEX541—BIPI, OUTPUT VLTS 48V, OUTPUT I.C. 5A. LIST PRICE 58s. OUR PRICE 12/6d. EACH.

SILICON NPN 120V Nixie DRIVER TRANS. SIM. C407, BSX21 and 2N1893, TO-5 CAN. OUR PRICE 3/6d. EACH, 25 OFF 3s. EACH.

SILICON UNILATERAL SWITCH. A Silicon Planer monolithic integrated circuit having thyristor electrical characteristics with an anode gate and a built in Zener between gate and cathode. Type D13D1 10s. each. Full data and application circuits available.

NPN DIFFUSED SILICON PHOTO-DUO-DIODE TYPE IS701 (2N2175) for Tape Readout, high switching and measurement indicators, 50V, 250mW. OUR PRICE. 10s. EACH, 50 OR OVER 8/6d. 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 1000V	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/-
U12	12 Silicon Rectifiers EPOXY BY126/127	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 IN914 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 CRSI/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 Vlts. 3-18	10/-
U33	15 Plastic case 1 amp silicon rectifiers 1N4000 series	10/-

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

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

NEW SILICON RECTIFIERS TESTED

PIV	400mA	750mA	1·5A	3A	10A	30A
50	10d	1/-	1/6	2/9	4/3	9/6
100	1/-	1/3	2/6	3/3	4/6	15/-
200	1/3	1/9	2/6	4/-	4/9	20/-
300	—	2/3	3/9	4/6	6/6	22/-
400	2/-	2/6	4/-	5/6	7/6	25/-
500	—	3/-	—	6/-	8/6	30/-
600	2/9	3/3	4/3	6/9	9/-	37/-
800	—	3/6	4/9	7/6	11/-	40/-
1,000	—	5/-	6/-	9/3	12/6	50/-
1,200	—	6/6	7/6	11/6	15/-	—

SCR's
LOWEST PRICE LARGEST RANGE

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/-	—

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/-

INTEGRATED CIRCUITS
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.

FAIRCHILD EPOXY TO-5 8 Lead

μL900 Buffer	10/6
μL914 Dual Gate	10/6
μL923 J.K.Flip-Flop	14/-
I.C. Data Circuits, etc.	1/6

MULLARD I.C. AMPLIFIERS

TAA243 ORP. Amp.	70/-
TAA263 Min AF Amp	16/-
TAA293 G.P. Amp	21/-
RCA CA3020 Audio Amp.	30/-

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.

FULL LOW COST LIST OF ALL SEMICONDUCTORS REQD. FOR P.E. ORGAN AVAILABLE ON REQUEST

SIL. G.P. DIODES

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

Ideal for Organ Builders.

VALUE ALL THE WAY

BI-PAK Semiconductors

500 CHESHAM HOUSE
150 REGENT STREET
LONDON, W.1

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

EXPERIMENTS WITH THE OPERATIONAL AMPLIFIER

By G. K. FAIRFIELD

Part 2 Measuring small currents and voltages, waveform generators

Last month's article discussed the theory of the operational amplifier and suggested a few uses of the device concerned with the measurement of component values. Due to its very high input impedance the operational amplifier can also be adapted for the measurement of very small currents and voltages.

MICROVOLT/MICROAMP D.C. METER

The d.c. measuring circuit is given in Fig. 2.1. For high accuracy the two resistors R1 and R2 should be high stability types having an accuracy of ± 1 per cent.

With input circuit A the instrument behaves as a millivolt meter having a full scale sensitivity of ± 3mV The sensitivity can be decreased by a suitable setting of potentiometer VR1.

Since a standing d.c. is often superimposed on small changes of voltages we require to measure then a backing-off potentiometer VR3 is included. This allows a very small current $\pm i$ to be applied to the summing junction of the amplifier via a high resistance R3 which will be sufficient to back off any small d.c. present at the input terminals.

Where the operational amplifier used is itself subject to a small voltage offset, or d.c. drift, then the adjustment of VR3 will enable this to be compensated. The positive and negative supplies (which are not at all critical) can be obtained from the operational amplifier power supply.

For use as a microammeter, input circuit B is used. This permits full-scale measurements of 0–30mμA at its maximum sensitivity. This circuit requires rather more components than those discussed last month, but its construction is considerably quicker than its conventional counterpart for this order of sensitivity.

Of course, when measuring such small electrical values it is necessary to avoid 50Hz mains pick-up at the input. Consequently screened leads are recommended up to the input of the amplifier including the leads to the input attenuators.

OSCILLOSCOPE ACCESSORIES

Accurate mixing of several signals can be made using an operational amplifier with several input resistors as shown in Fig. 2.2. This technique is useful to determine the time coincidence of two waveforms, such as the incidence of a repetitive fault in the television scanning circuit, and to show its relationship with its synchronising waveform.

The identification of the separate waveforms, when they are added together in this way, is facilitated if one of these is made negative so that the output of the operational amplifier represents the difference and not the sum of the two waveforms.

With triggered oscilloscopes it is often required to commence the scan at a time when a waveform reaches a pre-determined voltage value. Assuming that the

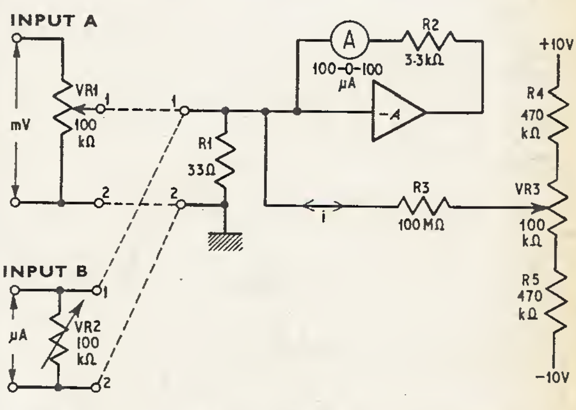


Fig. 2.1. D.C. meter for measuring microvolts and microamps

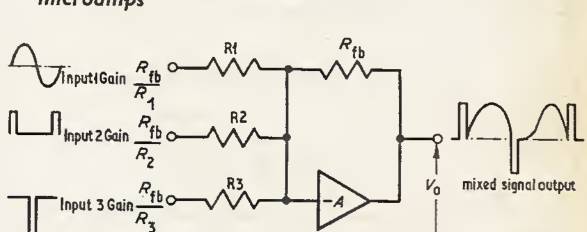


Fig. 2.2. Oscilloscope mixer amplifier circuit

oscilloscope needs a positive trigger pulse (which is generally the case) then the circuit to achieve this is given in Fig. 2.3.

As long as V_1 is very much greater than V_2 then the output of the operational amplifier is negative and the 'scope is not triggered. As soon as the trigger voltage V_2 reaches the value set by V_1 then a positive output level is obtained.

By using an operational amplifier with no feedback resistance as shown then its high gain will cause a very sharp transition between negative and positive output voltages to be obtained. This will provide a very definite triggering level for the oscilloscope.

TIMING DELAY CIRCUIT

A time delay circuit is often required in electronic equipment—a common example is a photographic process timer to fix the period of exposure during the printing process. Once again an operational amplifier can be made very quickly into a time delay circuit. In addition to the amplifier, a fixed resistor, a capacitor, a potentiometer, a low current relay and a starting switch (which may be included in the photographic or other equipment are required). The very simple circuit is shown in Fig. 2.4.

The potentiometer VR1 is set at the delay value required. Switch S1 is then opened and the capacitor C1 is charged from the operational amplifier power supply at a rate determined by the value of R_1C_1 and the setting of potentiometer VR1. After a given time t the

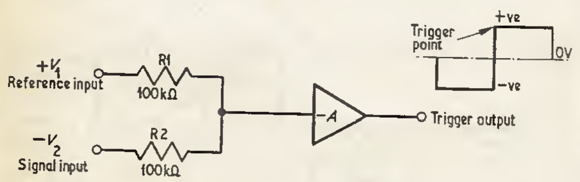


Fig. 2.3. Oscilloscope trigger circuit

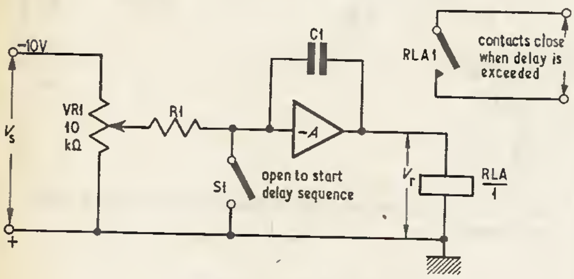


Fig. 2.4. Time delay circuit

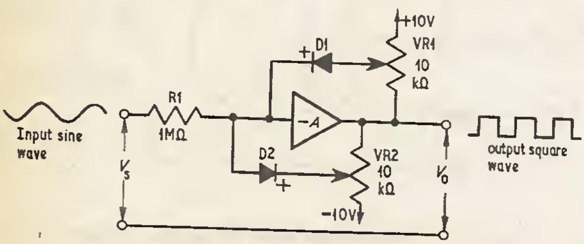


Fig. 2.5. Waveform squaring circuit

operating voltage for the relay is reached and its contacts are closed to control the desired apparatus. The time delay is given by

$$t = R_1C_1\frac{V_r}{V_s}\text{ seconds}$$

In order to obtain some practical delay figures, let us assume that a 50V relay is available. The actual voltage is not important providing the current it draws does not impose too great a load on the operational amplifier. Generally the amplifier will be able to supply a current of about 10 to 20mA.

With C1 fixed at 1μF (paper) and R1 1MΩ, then the rate of rise of voltage across the relay will be 10V per second with the potentiometer set at maximum. Therefore the minimum delay will be 50/10 = 5 seconds.

As the setting of VR1 is reduced then the delay is lengthened up to a maximum of about 250 seconds. The longest delay obtainable will depend on the stability of the amplifier and the leakage of the capacitor. Table 2.1 shows how the time delay range varies with the time constant (R_1C_1 value).

Table 2.1: TIME DELAY VALUES

Delay range (seconds)	R1	C1
0·5– 25	100kΩ	1μF
5 – 250	1MΩ	1μF
50 –2,500	1MΩ	10μF

Mathematically we can describe this circuit as an integrator.

Again assuming

$$i_i = 0$$

then

$$i_s = V_s/R_1 \quad \text{(see Part 1).}$$

The output voltage developed across C1 as a result o its charge Q is:

$$V_0 = \frac{Q}{C_1} = \frac{1}{C}\, i_s \mathrm{d}t$$

Substituting for i_s we obtain

$$V_0 = \frac{1}{R_1C_1}\, V_s \mathrm{d}t$$

Differentiating

$$\frac{\mathrm{d}V_0}{\mathrm{d}t} = \frac{V_s}{R_1C_1}$$

Thus the delay t, for a given relay voltage V_0 is

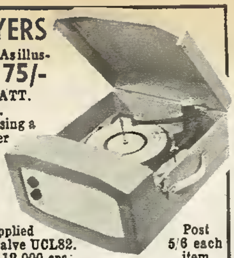
$$t = \frac{V_0}{V_s/R_1C_1}$$

SQUARER

The operational amplifier can permit a number of interesting waveform generators to be constructed which are useful for triggering or experimental work.

Let us consider first the squaring of the output of a sine wave oscillator. For this we need two germanium or silicon diodes, a fixed resistor, two potentiometers and the operational amplifier. The circuit is given in Fig. 2.5.

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 chassis with knobs. Supplied with loudspeaker and valve UCL82. 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	UA70 Transcription	£13.19.6
		Garrard	£12.19.6

All fitted LP/78 stylii and pickup cartridge complete. Stereo/mono pickups 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/-**

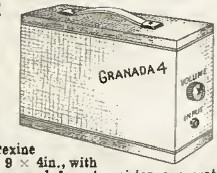
DE LUXE STEREO GRAM CHASSIS V.H.F. MW, SW 19-50m. SW 60-180m. Magic eye, push buttons. 6 valve plus rect. Size 15 × 7½ × 6in. high. British Made. Details S.A.E. **£22.10**

PICK-UP ARM Complete with ACOS LP-78 GP67 Stylii 29/6; XTAL GP67 17/6; Stereo Ceramic 35/-. Powerpoint 56 15/-

CRYSTAL MIKE INSERTS

1½" dia. 6/6; ACOS 1⅞" dia. 9/6. BM3, 1" dia. 9/6
MOVING COIL MIKE with Remote Control Switch 19/6

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 × ⅜in. 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 **1/6** yd.

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

WIRE-WOUND 3-WATT STANDARD SIZE POTS. LONG SPINDLE 50 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 $\frac{1}{16}$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
⅜in. 16/- ⅝in. 17/6 1⅛in. 19/6 1⅜in. 24/- 2$\frac{3}{32}$in. 44/3
⅞in. 16/- 1in. 19/6 1¼in. 20/6 1½in. 29/- 2½in. 57/3
⅞in. 16/9 1$\frac{1}{16}$in. 19/6 1¾in. 21/6 2in. 39/- 1in. sq. 36/6

"SONOCOLOR" CINE RECORDING TAPE

5" reel, 900' with LP strobe markings, also cine light deflector-mirror for synchronisation. 14/- each.
UNIVERSAL TAPE CASSETTES C60. THREE FOR 30/-.

Tape Spools 2/6. Tape Splicer 5/-. Leader Tape 4/6.
Reuter Tape Heads for Collaro models 2 track 21/- pair.

"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 8½ 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	32+32/250V	3/6
32/450V ..	3/9	8+16/450V	3/9	50+50/350V	7/-
25/25V ..	1/9	16+16/450V	4/3	60+100/350V	11/6
50/50V ..	2/-	32+32/350V	4/6	32+32+32/350v.	8/6

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. Discs 1/-.
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. Twin 10/6.
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.

250V RECTIFIERS. Selenium ½ wave 100mA 5/-; BY100 10/-.
CONTACT COOLED ½ wave 60mA 7/6; 85mA 9/6.
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. ½ w., ¼ w., 1 w., 20% 3d.; 1½ w. 3d.; 2 w. 1/-; ½ w. 10% 6d.
HIGH STABILITY. ½ w. 1% 10 ohms to 10 meg., 2/-. Ditto 5%. Preferred values 10 ohms to 22 meg., 9d.
5 watt } 0.5 to 8.2 ohm 3 w. 2/-
10 watt } WIRE-WOUND RESISTORS 2/-
15 watt } 10 ohms to 6,800 ohms 2/-
10K, 15K, 20K, 25K, 68K, 10W. 3/-

FULL WAVE BRIDGE CHARGER RECTIFIERS: 6 or 12v. outputs. 1½ amp. 8/9; 2a., 11/3; 4a., 17/6.
CHARGER TRANSFORMERS. P. & P. 5/-. Input 200/250v. for 6 or 12v., 1½ amps., 17/6; 2 amps., 21/-; 4 amps., 30/-

VALVE HOLDERS, 9d.; CERAMIC 1/-; CANS 1/-.

BRAND NEW TRANSISTORS 6/- each

OC71, OC72, OC81, OC44, OC45, OC171, OC170, AF117.
REPANCO TRANSISTOR TRANSFORMERS.
MAT 100 7/9; MAT 101 8/6; MAT 120 7/9; MAT 121 8/6.
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 45/-.

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 × 1½in. Snap terminals 32/6
9 volt 500mA. TRANSFORMER ONLY. 2½ × 1½ × 1¾in. 10/6
BENCH POWER PACK 230-250v. A.C. with Meter. Supplies 6-9-12v. lamp 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. 2⅝ × 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. 175/-.	

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/-.

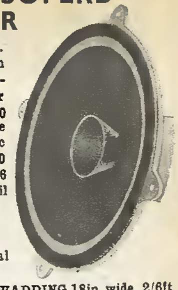
WAVE-CHANGE SWITCHES WITH LONG SPINDLES.
2 p. 2-way, or 2 p. 6-way, or 3 p. 4-way 4/6 each.
1 p. 12-way, or 4 p. 2-way, or 4 p. 3-way, 4/6 each.
Wavechange "MAKITS" 1 p. 12-way, 2 p. 6-way, 3 p. 4-way, 4 p. 3-way, 6 p. 2-way. 1 wafer 12/-, 2 wafer 17/-. 3 wafer 22/-
Additional wafers 5/- each up to 12 max.
TOGGLE SWITCHES, sp. 2/6; sp. dt. 3/6; dp. 3/6; dp. dt. 4/6

MINI-MODULE LOUDSPEAKER KIT

10 WATT **55/-** CARR. 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. 17½ × 10½ × 7½ in. Specially designed for Mini-Module above. **£5.10.0** extra

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

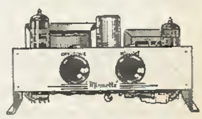
BAKER "GROUP SOUND" SPEAKERS—POST FREE
'Group 25' 12in 25 watt **6gns.** 'Group 35' 12in 35 watt **8½gns.** 'Group 50' 15in 50 watt **18gns.**
ALL MODELS "BAKER SPEAKERS" IN STOCK

Super Cone Tweeter 2½in square, 3-17kc/s. 10W 17/6.
Quality Horn Tweeters 2-18kc/s, 10W 29/6. Crossover 16/6.
LOUDSPEAKERS P.M. 3 OHMS. 2½in, 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/- or with twin tweeters, X/over and ceramic magnet 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, 10 × 2½in., 7 × 4in.
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 FRET VARIOUS TYGAN SAMPLES. Send S.A.E.

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

MINETTE AMPLIFIER



A.c. Mains Transformer. Chassis size 7 × 3½ × 4in high. Valves ECL82, EZ80. Quality output 3 ohm. With engraved fascia, valves, knobs, volume and tone controls, wired and tested. 12 month guarantee. Post 5/6 **69/6**

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**

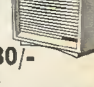
★ RADIO BOOKS ★ (Postage 9d.)

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/-
Practical Radio Inside Out	4/6
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/-
Valves, Transistors, Diodes equivalents manual	10/6
Receive foreign T.V. programmes by simple modifications	5/-
Transistor Circuits Radio-Controlled Models	7/6

MANUFACTURERS SURPLUS! **25/-**
TAPE RECORDER CASE. Red/Cream 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**

DIOTRAN SALES

P.O. BOX 5
WARE, HERTS
TEL.: WARE 3442

EX-COMPUTER PANELS I.B.M. Size 2in. × 4in. with TRANSISTORS, DIODES, RESISTORS, CAPACITORS, etc. Over ½ million already Sold out to the Trade. 70,000 only left at our Ridiculous Price of £3 per 100 panels or £28 per 1,000 panels. Plus carriage 6/- per 100 panels.

Post and Packing costs are continually rising. Please add 1/- towards same. **CASH WITH ORDER PLEASE**

OVERSEAS QUOTATIONS BY RETURN SHIPMENTS TO ANYWHERE IN THE WORLD

OVER 3 MILLION SILICON ALLOY & GERM. TRANSISTORS AVAILABLE FOR IMMEDIATE DELIVERY

TRANSISTORS Type and Construction		Qty. Price 100	Qty. Price 500	Qty. Price 1,000	Qty. Price 10,000
A 1 Germ. A.F. NPN T0-1	=AC127, NKT773, AC157, ASY86	£3.10	£15	£25	£200
A 2 Germ. A.F. PNP T0-5	=ACY17-21, NKT237-245	£1	£3	£5	£40
A 3 Germ. A.F. PNP T0-1	=AC128, NKT271, 2G381	£1	£3	£5	£40
A 4 Germ. R.F. PNP T0-1	=OC44-45, NKT72/125, ASY54	£1.10	£4.10	£7.10	£60
A 5 Germ. R.F. PNP T0-5	=2N1303, NKT164-7, 2G301-3	£1.10	£4.10	£7.10	£60
A 6 Germ. V.H.F. PNP T0-1	=AF116-7, KNT667, 2G417	£3.10	£15	£25	£200
A 7 Assorted Germ. A.F.-R.F. PNP mixed cans, general purpose		15s.	£2.10	£4	£32
A 8 Germ. A.F. S0-2 PNP	=2G371-89, ACY27-31, OC71-75	£2	£7.10	£12.10	£100
A 9 Sil. Alloy PNP T0-5	=2S301-5, BCY17-29, BCY30-34	£2	£7.10	£12.10	£100
A10 Sil. Alloy PNP S0-2.	=2S321-325, OC200-205	£2	£7.10	£12.10	£100

A1 to A7 Guaranteed 80% Good usable Transistors ideal for low cost production work and experimental use. A8 to A10 are all perfect devices, factory tested, no open or short circuit Transistors in these lots.

BRAND NEW FULLY TESTED EPOXY CASE UNIJUNCTION TRANSISTORS. Type TIS43 and BEN 3000 and replacement for 2N2646. Full data available. LOWEST PRICE AVAILABLE ANYWHERE. 100 off 4/- each = **£20**; 500 off **3/6** each = **£87.10**; 1,000 off 3/- each = **£150.** Sample devices 7/- each on request.

HIGH QUALITY SILICON PLANAR DIODES. SUB-MINIATURE DO-7 Glass Type, suitable replacements for OA200, OA202, BAY38, 1S130, 1S940. 200,000 to clear at **£4** per 1,000 pieces. GUARANTEED 80% GOOD.

SILICON PLANAR PLASTIC TRANSISTORS. 2N3708A VcB30 Hfe 20-60. All marked, fully tested and guaranteed. 1 off 1/6 each; 100 off **10d.** each; 500 off **9d.** each; 1,000 off **7½d.** each.

TO-18 METAL CAN SILICON PLANAR TRANSISTORS. VERY HIGH QUALITY 99% good. Type 2N706 BSY27 **£7.10** per 500 pieces; **£12.10** per 1,000 pieces.

FULLY TESTED DEVICES AND QUALITY GUARANTEED—SURPLUS TO REQUIREMENTS

OA202 Silicon Diode. Fully Coded.
150 PIV 250mA Qty. Price **£30** per 1,000 pieces.
ORP12 Cadmium Sulphide Cell.
1-24 **9/-** each; 25-99 **7/-** each; 100-999 **6/-** each; 1,000 up **5/6** each. Made in Holland.
BY100 SIL. RECT'S 800 PIV 550mA.
1-49 **2/6** each; 50-99 **2/3** each; 100-999 **2/-** each; 1,000 up **1/10** each. Fully Coded. 1st Qlty.

TTL IC's 4/- EACH

DUAL INLINE 14-16 PIN PLUG IN PACKAGE.
MANUFACTURERS' OUT OF SPECIFICATION FALL OUTS, BUT ALL GOOD FUNCTIONAL UNITS.
DATA AVAILABLE.

Part No.
SN7400N—Quadruple 2-input Positive NAND Gate
SN7491N—Quadruple 2-input NAND Gate with free collector outputs
SN7410N—Triple 3-input Positive NAND Gate
SN7420N—Dual 4-input Positive NAND Gate
SN7430N—8-input Positive NAND Gate
SN7440N—Dual 4-input Positive NAND "Power" Gate
SN7450N—Dual EXCLUSIVE-OR Gate with Expander Inputs
SN7451N—Dual EXCLUSIVE-OR Gate
SN7472N—Master-slave J-K Flip-flop
SN7473N—Dual Master-slave J-K Flip-flop
SN7474N—Dual Latch
SN7483N—Quad high speed full adder
SN7490N—Decode counter

ORDER AS CODE No. SHOWN ABOVE ALL ONE PRICE 4/- EACH.

1/- each TESTED TRANSISTORS 1/- each

ONE PRICE ONLY PNP. NPN. SILICON PLANAR 1/- EACH

BC108	2N696	2N1132	2N2220	2S733
BC109	2N697	2N1613	2N3707	2N3391
BFY50	2N706	2N1711	2N3711	TIS44
BFY51	2N708	2N2904	2S102	2N2906
BFX84	2N929	2N2905	2S103	2N2907
BFX86	2N930	2N2924	2S104	2N2696
BFX88	2N1131	2N2926	2S732	2N3702
				2N3703

From Manufacturers' Over-runs—Unmarked Plastic and Metal cases. Devices similar to above Nos.

GERM. PNP AND NPN TRANSISTORS FULLY TESTED, UNMARKED SIMILAR TO 1/6 EACH

AC125	ACY22	ACY36	NKT677	OC81	2G381
AC126	ACY27	NKT141	NKT713	OC82	2G382
AC127	ACY28	NKT142	NKT773	2G301	2G399A
AC128	ACY29	NKT212	OC44	2G302	
AC130	ACY30	NKT213	OC45	2G303	
ACY19	ACY31	NKT214	OC71	2G308	1/6
ACY20	ACY34	NKT215	OC72	2G371	each
ACY21	ACY35	NKT271	OC75	2G374	

POWER TRANSISTORS

OC25	OC35	NKT403	ASZ17	
OC26	AD130	NKT404	T13027	5/-
OC28	AD140	NKT405	T13028	each
OC29	AD149	NKT452	T13029	

Manufacturers' Surplus Germ. A.F. All similar to above.

TRANSISTOR EQVT. BOOK

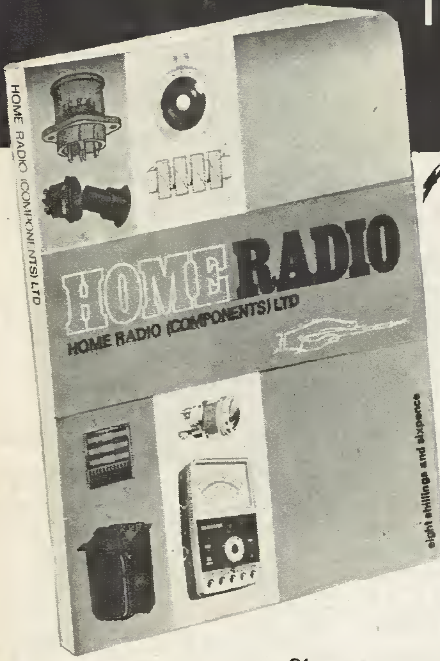
2,500 cross references of transistors—British, European, American and Japanese. A must for every transistor user. Exclusively distributed by DIOTRAN SALES. 15/- EACH.

Sub-Min. Plastic 1 Amp Sil. Rect.

Type No.	PIV	Each
1N4001	50	.. 1/3
1N4002	100	.. 1/6
1N4003	200	.. 2/-
1N4004	400	.. 2/9
1N4005	600	.. 3/3
1N4006	800	.. 3/9
1N4007	1,000	.. 4/9

Vast mixed lot of subminiature glass diodes. Comprising of Silicon, Germ., Point Contact and Gold Bonded types plus some Zeners. 500,000 available at Lowest of Low Price. 1,000 pieces **£3.0.0.** 5,000 pieces **£13.10.0.** 10,000 pieces **£23.**

THE ELECTRONIC COMPONENTS CATALOGUE THAT SETS THE STANDARD



Used and acclaimed by:-

SCIENTISTS
ENGINEERS
TECHNICIANS
TEACHERS &
STUDENTS

This edition of the Home Radio Catalogue is the result of eleven years of careful selecting, compiling and indexing. It is the finest, most comprehensive we have ever produced—it has 330 pages, over 8,000 items listed and over 1,500 illustrations. It is a must for anyone interested in radio and electronics. With each catalogue we supply a 30-page Price Supplement, a Book Mark giving Electronic Abbreviations, an Order Form, and 6 vouchers each worth 1/- when used as directed. All this for only 8/6 plus 3/6 post, packing and insurance. Send the attached coupon today, with your cheque or P.O. for 12/-.

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

Of course no catalogue is ever really finalised. As soon as we have one edition off the press, our researchers get busy finding out what is the latest in the world of Radio and Electronics—ready for the next printing.

Please write Name and Address in block capitals

NAME ....

ADDRESS ....

....

Home Radio (Components) Ltd., Dept. PE, 234-240 London Rd., Mitcham, Surrey, CR4 3HD

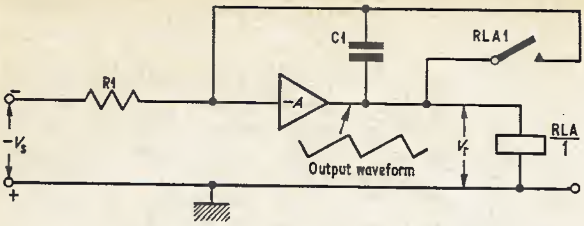


Fig. 2.6. Sawtooth waveform generator

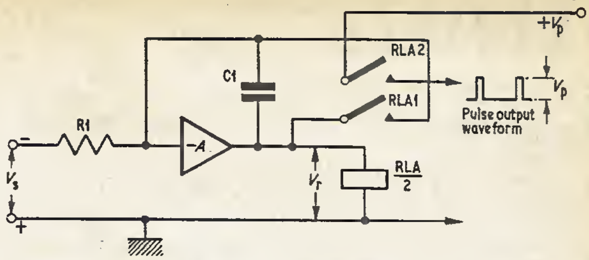


Fig. 2.7. Pulse generator

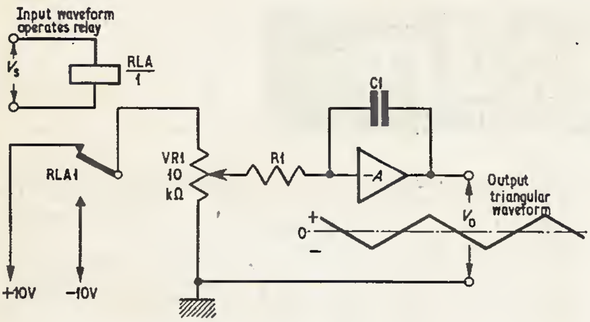


Fig. 2.8. Triangular waveform generator

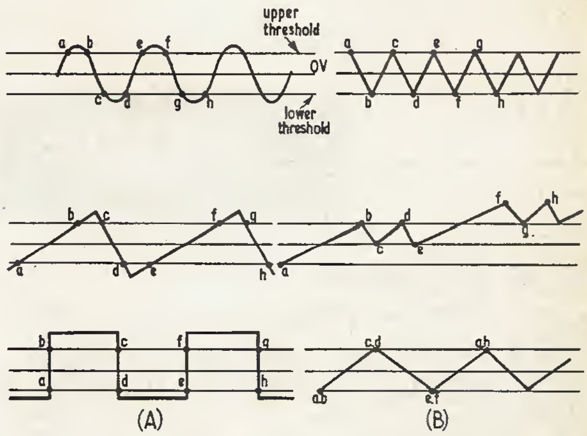


Fig. 2.9. Input and output waveform for the circuit in Fig. 2.8. Input waveform is shown left (A), and output waveform from amplifier is shown right (B)

The two potentiometers are set to give the required amplitude of the square waveform. The input sinusoidal waveform must have an amplitude greater than this.

The action of the diodes effectively prevents the output from becoming greater in amplitude than the setting of the potentiometers, since when either diode conducts, a low feedback resistance (actually the forward impedance of the diode) is shunted across the operational amplifier. As shown by the equation for gain derived in Part 1, the overall gain falls to a very low value indeed.

If a symmetrical waveform is not required it is easy to arrange either a positive or negative going square wave to be produced by setting one of the potentiometers to zero.

This same circuit could also be used to clamp a given incoming signal to a particular level set by VR1 or VR2.

SAWTOOTH WAVEFORM

To generate a free-running sawtooth waveform a capacitor, resistor, and a low current relay can be connected to the operational amplifier to form the circuit given in Fig. 2.6.

The operational amplifier with its feedback forms an integrator circuit and the value of the time constant determines the frequency of the sawtooth waveform, given by

$$f = \frac{V_r}{V_s\, C_1\, R_1} \text{ Hz}$$

where R_1 is in megohms, C_1 in microfarads, and the input V_s and relay V_r voltages are in volts.

When a negative voltage V_s is applied to the input of the circuit, capacitor C_1 begins to charge through the input resistance R_1. As it does so the voltage across the capacitor begins to increase and the feedback action works to slow down the rate of charge.

Consequently, instead of a non-linear (strictly speaking, an exponential) voltage change appearing across the capacitor, and hence the amplifier output, a very linear rise of voltage is obtained. This is because the reduction of charging current exactly cancels out the non-linearity.

When the output voltage reaches the relay operating voltage then the capacitor is short-circuited by the action of the relay contacts and the cycle repeats once more, when the voltage across the capacitor becomes zero again.

The highest frequency of operation is limited, of course, by the speed of response of the relay. Modern relays are capable of operating in as little as one millisecond so that frequencies of several hundred hertz can be generated in this way.

PULSE CIRCUIT

This sawtooth generator circuit is very adaptable and with the additional pair of contacts on the relay the same circuit can be made to provide a series of narrow pulses, one each time the relay is momentarily operated, and of amplitude V_p volts, at the output (see Fig. 2.7). The fixed d.c. supply is switched by contacts RLA2.

TRIANGULAR WAVEFORM

The integrator circuit can be used to provide a triangular output waveform from almost any shape of input signal. The circuit is given in Fig. 2.8.

The input signal is applied to a low current relay shown in the diagram. This relay will be operated when the input signal exceeds the operating voltage of the relay.

A changeover pair of contacts are required to change the input voltage to the integrator from positive to negative whenever the relay is energised. Consequently the capacitor is alternatively charged in opposite directions as the relay changes. This results in a linear rise and a linear fall of voltage at the output as described in the previous section.

If the input signal is twice the amplitude of the relay operating voltage then a symmetrical triangular waveform is generated as shown in Fig. 2.8. The amplitude of the triangle is set by potentiometer VR1 since this controls the rate of rise of the charge applied to the capacitor.

The waveform of the signal input voltage operating the relay is unimportant as long as it is able to exceed the relay operating voltage during some part of its voltage excursion. A 50Hz signal from the mains would be quite adequate and result in a triangular waveform of this frequency. A number of different input waveforms are shown in Fig. 2.9 with their resulting triangular output waveforms.

Next month: Further applications and operational amplifier circuit design.

NEWS BRIEFS

The Late John Clarricoats, O.B.E., G6CL

A WELL-KNOWN personality in the radio amateur world, John Clarricoats, joined the Radio Society of Great Britain in 1925, was elected honorary secretary in 1930 and became the full-time secretary in 1932, a post which he held until his retirement in 1963. He died March 1969.

During his term as secretary "Clarry", as he was known by his many friends, was greatly in demand as a guest speaker at local RSGB group functions. He also did much to explain the purpose of the amateur radio movement to the general public and served on numerous bodies including the IARU. He was awarded the O.B.E. in 1955 and was elected an honorary member of the RSGB in 1963.

Mains Colour Code Changes

ON July 1 the colour coding of three-core mains cables is to be changed to comply with the new International Standard. The present coding of green for earth, black for neutral, and red for live on a.c. mains will become:

LIVE—Brown
NEUTRAL—Blue
EARTH—Yellow and green stripes

In spite of what many consider to be an illogical move, there are reasons for the new choice. The new earth colours can be picked out easily in poor light or by the colour blind; the other two are sufficiently separated in the colour spectrum for one to be lighter than the other.

It is also claimed that blue and brown are the only colours which do not fade when impregnated in p.v.c. and are also cheap.

It is expected that by Spring 1970 it will be illegal to sell appliances with the old colour coded cables, although this has yet to be established.

Computer Controlled Telephone Exchange

A COMPUTER-CONTROLLED telephone exchange system, believed to be unique anywhere in the world, is being developed by Plessey Telecommunications Group under a multi-million pound programme spread over the next few years.

Other computerised or stored programme control (SPC) systems under development are based on a massive centralised processor—similar to a computer—which signals instructions to the telephone switching equipment. This method can increase costs substantially when, in order to guard against breakdown, a second or even a third standby processor needs to be installed.

Plessey plans to overcome these problems by introducing a system incorporating a plurality of smaller processors which will not only reduce capital cost but will also make the system more flexible and easier to extend.

Radar Systems

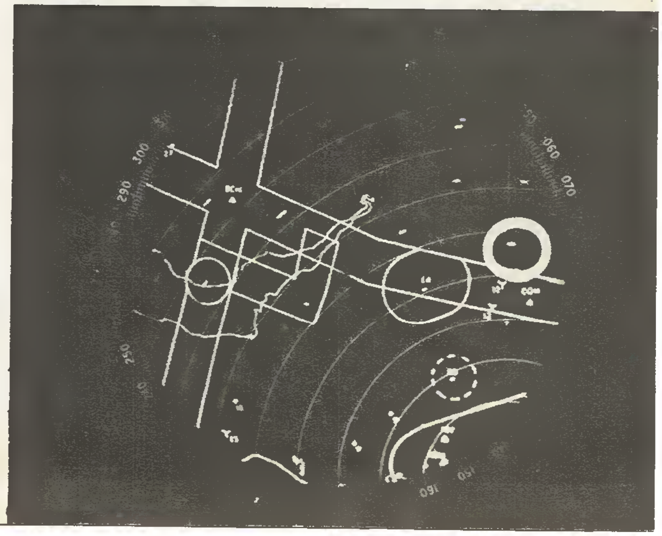
TWO NEW Plessey radar systems have been introduced recently. They are the WF44—an advanced meteorological radar—and the AR-5—a 23cm air surveillance system.

Orders for the type WF44 have been placed by the Australian Department of Supply for use by the Commonwealth Bureau of Meteorology, Melbourne.

The new radar is designed to operate in both windfinding and weather-watching roles.

Two type AR-5 radars have been ordered by the Board of Trade for installation at Burrington, Devon, the key West Country station in the chain providing en route cover for the UK's national air traffic control system.

The AR-5 can provide range cover of 200 nautical miles or more and height cover up to 80,000 feet. Shown below is a photograph taken from the screen of the prototype AR-5 installed at Plessey Radar's test and demonstration site at Cowes, Isle of Wight. The white circle encloses Concorde 002 during its maiden flight.



THE CHROMATONE

BY M. J. HUGHES M.A.

A mains powered sound operated lighting effects unit, that can provide up to 2kW of light power

A RECENT series in this magazine (**Sound Light and Colour*) described several lighting effects that can be used in conjunction with music either to intensify or complement the listeners' enjoyment. One such system used audio signals from the music to control the intensity of coloured lamps mounted on a display panel.

The Chromatone works on exactly the same principle but instead of using transistors to drive low voltage bulbs, thyristors are used to operate mains driven bulbs allowing up to 750 watts of light power on each colour channel. The unit to be described has three colour channels thus, when loaded to capacity, can deliver more than 2 kilowatts of light power—more than sufficient to light even the largest domestic room and many medium sized clubs.

The unit is highly compact and portable as well as being versatile on its input requirements; it will operate effectively from small transistor radios, hi-fi record players, commercial tape recorders, electric guitars and electronic organs. Being portable it is admirably suited to "pop" groups who wish to augment their music with constantly changing floodlights.

OVERALL SYSTEM

Fig. 1 shows the full circuitry of the equipment which is most logically divided into three sections:

(1) A matching preamplifier having a low impedance input which allows the unit to operate from any extension speaker terminals from 3 to 15 ohms without applying load to the existing speakers in circuit.

(2) A simple *RC* tone separator circuit roughly splitting the input signal into three channels—low, middle and high frequencies.

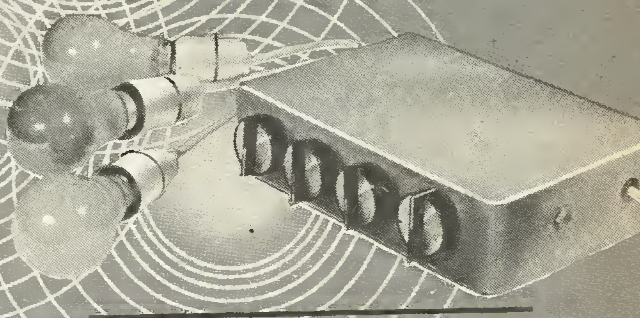
(3) Three identical but separate integrators and thyristor firing circuits.

The thyristors specified have peak voltage ratings of 400 volts and can supply up to 3 amps each. They are used to drive conventional tungsten filament bulbs and, as the circuit stands, are not suited to running fluorescent lamps. As the controlled lamps are constantly switching on and off it is suggested that normal domestic bulbs be used and special purpose high power lamps such as photo-floods or quartz iodine bulbs avoided. Any number of lamps can be wired in parallel on each channel provided the total power does not exceed 750 watts per channel.

CIRCUIT DESCRIPTION

The circuitry used is rather unconventional and for this reason it is important that the constructor reads this section carefully before embarking on any work (by so doing he will probably save himself much time and trouble).

In order to fire the thyristors it is necessary for the whole of the tone separator, integrator and firing circuits to be strapped to the "neutral" side of the mains. At the same time it is absolutely essential that the input circuit be isolated and capable of being earthed for safety reasons. Isolation is provided by a conventional 3 ohm valve output transformer (T2) con-



*The series on *Sound Light and Colour* appeared in the August to November 1968 issues; unfortunately these issues are now unobtainable.

nected so that its 3 ohm winding forms the collector load of TR1 (Fig. 1). As the common emitter line of the firing circuit cannot be connected to the earth line of the preamplifier, two separate power supplies *must* be used.

The power requirements for the preamplifier are comparatively crude and are provided by T3—a 6·3V heater transformer—through a low voltage silicon diode D2. First order smoothing is provided by C1. The input signal from an extension speaker socket is applied to the base of TR1 through a 25 ohm gain control. By normal audio standards this stage produces considerable distortion but this is of no detriment to the final effect, therefore it was decided to keep this stage as simple as possible. *To ensure safety in operation it is essential to earth the emitter line of the preamplifier.*

Tone separation is obtained very simply by three separate gain controls each of which has a crude filter circuit. The controls adjust the amount of signal applied to each filter which provide top cut (for bass), top cut and middle pass (for the mid-audio frequencies) and top pass for the higher frequencies. Accurate frequency separation is not possible with this simple layout and there is considerable overlap between the channels, but in order to keep the size, weight and cost low it was felt desirable to omit inductive tuning.

Experimenters might like to substitute their own tone circuits which could be of the *LC* type described in the *Sound Light and Colour* series. If *LC* tuning is attempted it should be pointed out that the inductance of the isolating transformer will significantly alter the characteristics of subsequent filters. In practice the overlap of frequencies did not prove as great a disadvantage as one might imagine owing to the fact that each channel's sensitivity can be set independently by VR2, 3, and 4, thus compensating to a large extent for this defect.

The output from each filter is applied to the base of a transistor (TR2, 3 and 4 respectively) in each of three thyristor firing circuits shown in Fig. 1.

INTEGRATOR CIRCUIT

It is worth describing the circuit of the integrator in a little more detail because the transistors are used in a rather unconventional fashion. Fig. 2 shows a single integrator connected to the trigger of a thyristor (SCR1).

To make a thyristor fire, the trigger electrode must be driven approximately 3 volts positive with respect to the

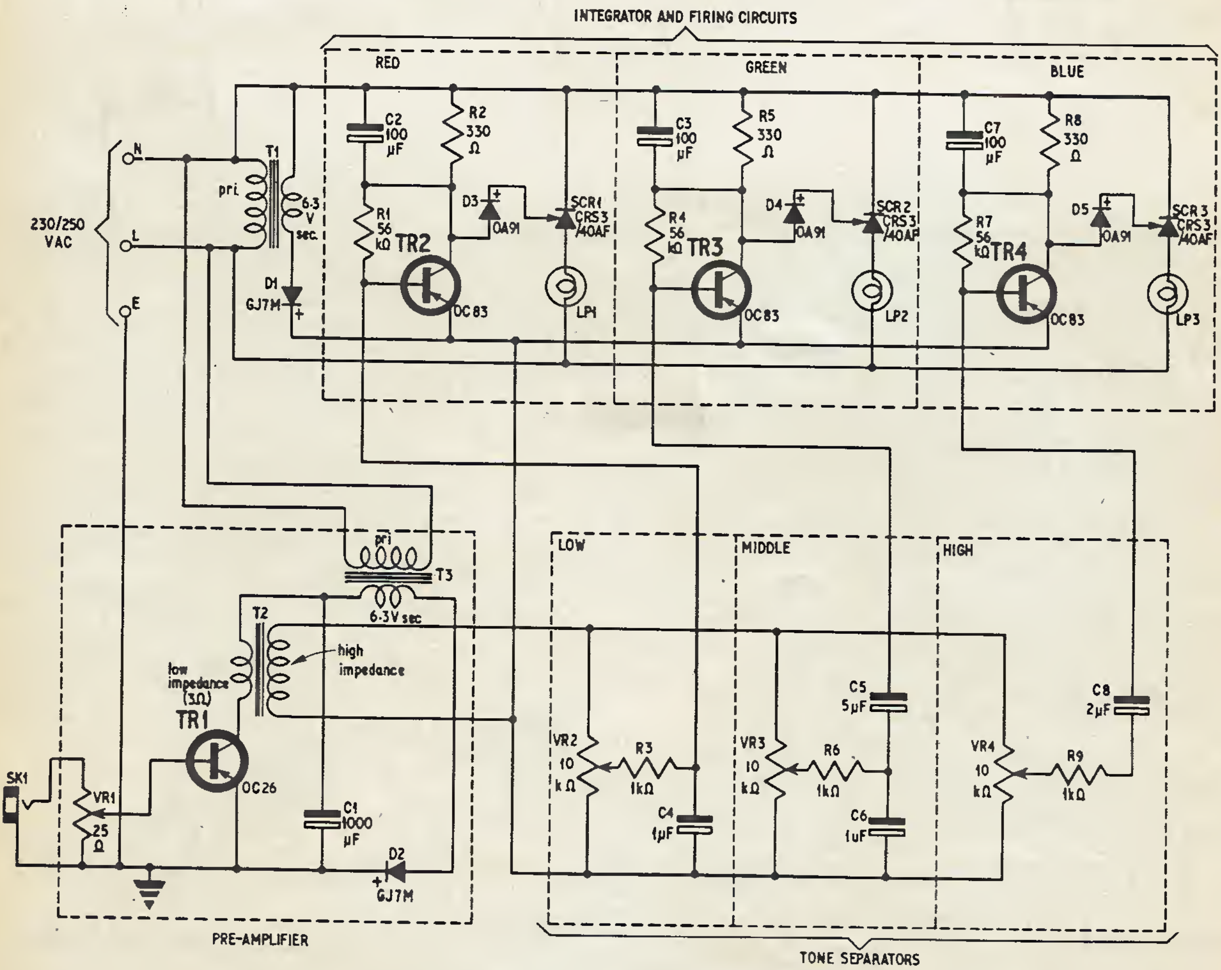


Fig. 1. The complete circuit diagram of the Chromatone

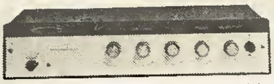
LIND·AIR OPTRONICS LTD

See our vast range of Electronic Components at our new Component Centre 25 Tottenham Court Road

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

STEREO AMPLIFIERS

DULCI STEREO AMPLIFIER MODEL 207



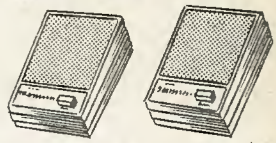
8 watts per channel. Integrated high fidelity transistor Stereo amplifier. An attractive free standing unit with provision for mounting in equipment cabinet. Finish Dark Grey vinyl simulated leather grain. Front panel satin alloy. Specification: Sensitivity, Radio/Tape 100mV into 1Mohm. Phono 100mV into 1Mohm. 3 position selector on front panel. Frequency response: 40c/s to 61Kc/s ±2dB. Separate bass and treble controls with boost and cut, balance control, Mono/Stereo Function switch (both channels work in parallel). Normally £23.2.0. LIND-AIR PRICE £18½ gns. Plus P. & P. 9/-.

Battery Eliminator. Enables transistor equipment to be operated from AC mains. 6/9/12V output selector switch and on/off switch. Case size 4 × 2¾ × 2in. complete with mains lead, connecting leads and instructions. 59/6. P. & P. 3/6.

NEW 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.

MODEL MAKER'S MOTOR No. 15RN. Voltage 11·5V. Current 400mA. Torque 12g.cm. Body size 1⅜" × long × ⅞" dia. Shaft 1/16" long × 1/16" dia. Ideal for small models and toys. 5/6 each. P. & P. 1/3. 3 for 15/-. P. & P. 2/6.

COMPACT 2-WAY INTERCOMS



For table or wall mounting. Smart two tone grey cases size 3½ × 1¼ × 2¼in. Complete with lead, staples and 9V battery. 55/-. 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/-.

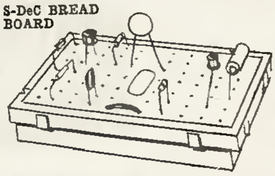
SPECIAL PURCHASE!

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.

S-DeC BREAD BOARD

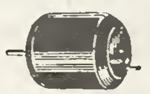


Solderless breadboard panels, for fast reliable component connections. Single DeCs. One S-DeC with Control Panel, Jig and Accessories for solderless connections to controls, etc., with booklet "Projects on S-DeC" giving construction details for a variety of circuits. 29/6. P. & P. 2/6.

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.

MOTOR BARGAINS

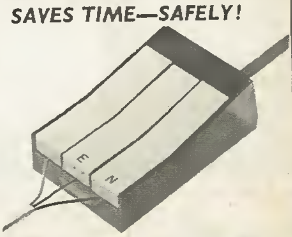
Ideal for model makers, record players, tape decks, etc.



6.3 d.c. Motor. 10,900 r.p.m. at 230mA. 1¼in × 1in dia. Shaft ⅛in long × 3/64in dia. 9/6. P. & P. 2/6.

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/-.

"HI-TEN" LOUDSPEAKER. British made full range 10in. unit handles up to 10 watts. Ceramic magnet. Freq. response: 40–10,000cps. Imp: 15Ω. Flux density: 10,000 lines. 49/6. P.&P.4/6.

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 4½ × 3¾ × 1in. 85/-. P. & P. 3/6.

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

NEW TRANSISTOR MODULES

E.1311. PHONO PRE-AMPLIFIER. Size 2 × 1 × ⅞in. Built-in R.I.A.A. characteristics enabling low output magnetic pick-up cartridges to be amplified up to 1 volt. Input 100Kohm: Gain 28dB: Max. output 3V: Max. input 50mV. Distortion 0·15% (at 1V level). Power supply 9–12V. 29/6. P. & P. 2/-.

E 1313. MICROPHONE PRE-AMPLIFIER. Enables a low output microphone to be used with an amplifier or radio. Input imp. 100Kohms: Gain 28dB: Max. output 3V: Max. input 50mV: Distortion 0·15% (at 1V level): Freq. response 10Hz–50KHz. Power supply 9–12V. 29/6. P. & P. 2/-.

E.1318. DUAL LAMP FLASHER. A switch module for electronically alternating two miniature bulbs, 6V, 100–200mV. Ideal for models, toy boats and planes, displays, warning and security devices, communication signals, etc. Flasher time ½ sec: Power supply 6V DC: Current 150mA: Lamp 6V 150mA. 25/-. P. & P. 2/-.

E.1315. ELECTRONIC ORGAN TONE OSCILLATOR. Used in conjunction with an organ keyboard, variable resistances and a 9 volt power supply, this module acts as the oscillator unit for an electronic organ. Tone Frequency: 200–1,000Hz: Output 80mW: Current 15mA. 25/-. P. & P. 2/-.

E.1314. POWER AMPLIFIER. When used in conjunction with E.1311, E.1312 and E.1313 units this amplifier module produces about 300mW output for speaker connection (8–16 ohms), without necessity for an output transformer. Input imp. 1,000 ohms: Gain 20dB: Output 300mW: Distortion 3% (at 200mW output level). Freq. res. 50Hz–10KHz. Power supply 9V. Current 20mA at no signal, 80mA at max. output. 29/6. P. & P. 2/-.

E.1317. MINIATURE MORSE TRANSMITTER. Will transmit to any adjacent AM Receiver, also makes a useful oscillator for trouble shooting. Audio tone 400c/s. Radio frequency range 400c/s to 30Mc/s. Power supply 9V DC. Current 35mA. 25/-. P. & P. 2/-.

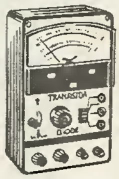
E.1312. TAPE PRE-AMPLIFIER. Incorporating N.A.R.T.B. curve characteristics, this amplifies tape head signals up to 1 volt within the frequency range of 30Hz–15KHz. Input imp. 100 Kohm: Gain 25dB: Max. output 2V: Max. input 50mV: Distortion 0·15% (at 1V level): Power supply 9–12 volts. 29/6. P. & P. 2/-.

E.1316. MORSE CODE OSCILLATOR. A transistorised morse code oscillator (buzzer) to be used in conjunction with an operating key. Suitable for direct connection to a loudspeaker. Tone freq. 400Hz: Power output 80mW: Power supply 3–9V: Current 45mA. 25/-. P. & P. 2/-.

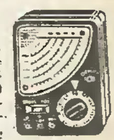
SOLDERING GUN. Comfortable grip with trigger control, "U" shaped 3¼in. bit to minimise wear. Light beam is automatically directed on to end of bit when ON/OFF trigger is in use. 230–250 volts. 85 watt element. 49/6. P. & P. 3/6.

"ADASTRA" SOLDERING IRON. 30 watt. Employs its protective cover as a handle. AC 230/250V. With 4ft lead. 12/6. P. & P. 2/6.

NEW—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 18¼in. × 7 section telescopic aerial. Size 4 × 2¾ × 1¼in. 79/6. P. & P. 3/6.



NEW TRANSISTOR CHECKER. For measuring alpha, beta and Ico. factors of transistors also for checking germanium and silicon diodes. Internal 9V battery. Wide reading scale. Moulded case size 7 × 4½ × 3¼in. Ranges: Alpha 0·7–0·9967; Beta 0–300; Ico 0–50–5,000A. Diode test: forward and reverse internal resistance. Resistances: 200 ohm–1 megohm. Complete with connectors and instruction booklet. £7.19.6. P. & P. 3/6.



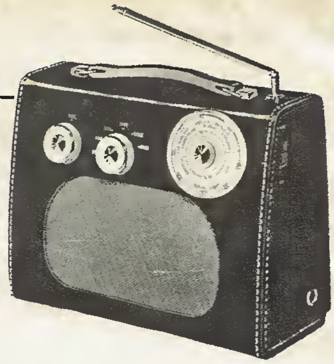
SHIRA 62D MULTI-TESTER 20,000 o.p.v. DC voltage: 5-25-50-250-500-2·5K (20,000 ohms per volt). AC Voltage: 10-50-100-500 1000 volts (10,000 ohms per volt). DC Current: 0-50μA, 0-2·5mA, 0-250mA. Resistance: 0-6K, 0-6Mg (300 ohm and 30K at centre scale). Capacitance: 10pf. to ·001 mfd, ·001μf to ·1μF. Decibels: —20 to +22dB. Size 4½ × 3¼ × 1in. Complete with case 77/-. P. & P. 3/6.

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 769 54a Tottenham Court Road, London, W.1

BUILD YOURSELF A QUALITY TRANSISTOR RADIO—FULL AFTER SALES SERVICE!



THE MAGNIFICENT **ROAMER 7** MK IV

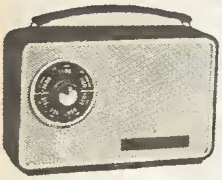
SEVEN WAVEBAND PORTABLE

7 FULLY TUNABLE WAVE BANDS—MW1, MW2, LW, SW1, SW2, SW3 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.

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

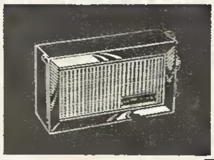
Parts price list and easy build plans 3/- (FREE with parts).

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



"NEW LOOK" MELODY SIX
MED. AND LONG WAVES. WITH SPEAKER AND EARPIECE
6 transistors and 2 diodes. Push-pull output, tuning condenser, high "Q" ferrite rod aerial, 3½in speaker, and personal earpiece with switched socket for private listening. 6¼ × 4 × 2in. **Total Building Costs 69/6.** P. & P. 4/3.

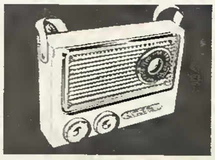
Plans and parts list 2/- (free with parts).



POCKET FIVE
MED. and LONG WAVES AND TRAWLER BAND to approx. 50 metres. ***WITH SPEAKER AND EARPIECE.*** 5 transistors and 2 diodes, ferrite rod aerial, tuning condenser, moving coil speaker, etc. 5½ × 1¾ × 3½in. **Total Building Costs 44/6.** P. & P. 3/6. Plans and Parts list 1/6 (free with parts).

ROAMER SIX
6 WAVEBANDS — MW1, MW2, SW1, SW2, LW AND TRAWLER BAND. 6 transistors and 2 diodes. Ferrite rod and telescopic aerials. 3in speaker. Top grade components. Size 7½ × 5½ × 1½in. **Total Building Costs 79/6.** P. & P. 4/6. Plans and parts list 2/- (free with parts).

TRANSONA FIVE
MED. AND LONG AND TRAWLER BAND to approx. 50 metres ***WITH SPEAKER AND EARPIECE.*** 5 transistors and 2 diodes, ferrite rod aerial, tuning condenser, volume control, moving coil speaker. 6½ × 4½ × 1½in. **Total Building Costs 47/6.** P. & P. 3/9. Plans and Parts list 1/6 (free with parts).



SUPER SEVEN
MED. LONG AND TRAWLER BAND. 7 transistors and 2 diodes. 3in speaker, 2 R.F. stages, push-pull output, etc. 7½ × 5½ × 1½in. **Total Building Costs 69/6.** P. & P. 4/6. Plans and parts list 2/- (free with parts). Personal Earpiece with switched socket for private listening, 5/- extra.

RADIO EXCHANGE LTD

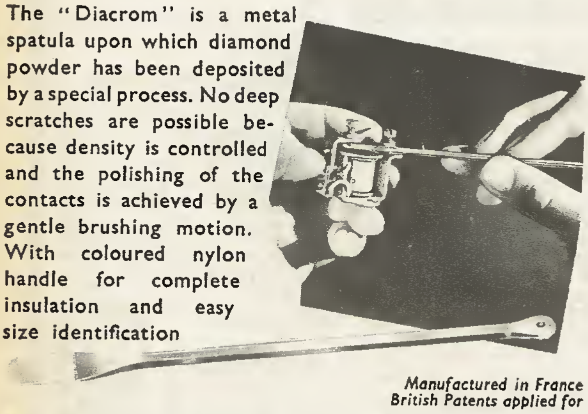
DEPT. PE7, 61a HIGH STREET, BEDFORD. 0234 52367

Callers side entrance Stylo Shoe Shop. Open 10-1, 2.30-4.30 Monday - Friday 9-12.30 Saturday

---

Keep those Contacts CLEAN
by using a
DIACROM SPATULA

The "Diacrom" is a metal spatula upon which diamond powder has been deposited by a special process. No deep scratches are possible because density is controlled and the polishing of the contacts is achieved by a gentle brushing motion. With coloured nylon handle for complete insulation and easy size identification



Manufactured in France
British Patents applied for

- Grain size 200, thickness 55/100 mm., both faces diamonded. For quick cleaning of industrial relays and switching equipment, etc.
- Grain size 300, thickness 55/100 mm., both faces diamonded. For smaller equipments, like telephone relays, computer relays, etc.
- Grain size 400, thickness 25/100 mm., one face diamonded. For sensitive relays and tiny contacts. Two close contacts facing each other can be individually cleaned, because only one face of the spatula is abrasive.

Sole Distributors for the United Kingdom

SPECIAL PRODUCTS (DISTRIBUTORS) LTD.

81 Piccadilly, London, W.1. Phone: (01) 629 9556

As supplied to the War Office, U.K.A.E.A., Electricity Generating Boards, British Railways and other public authorities; also to leading electronic and industrial users throughout the United Kingdom.

MINIATURE IRON (Half Size)

VARI-STAT
THERMOSTATIC
SOLDERING IRON

HIGH PRODUCTION MINIATURE MODEL D. 50 WATT

Weight ..	2 oz.
Heating time	50 seconds
Bit Sizes ..	1/16", 3/32", 1/8", 3/16", 1/4"
Nickel or Iron	Plated
Voltage ..	250 to 12 volts
Price	60/6

HIGH PRODUCTION INSTRUMENT MODEL H. 150 WATT

Weight ..	6 oz.
Heating time	1 min. 45 sec.
Bit Sizes ..	3/16", 1/4", 3/8", 7/16"
Nickel or Iron	Plated
Voltage ..	250 to 24 volts
Price	87/6

OTHER VARI-STAT IRONS:

Miniature Model M 50 watt Push-in Bits 1/32", 1/16", 3/32"
Instrument Model B 70 watt Bit Size 11/64"
Industrial Model I 500 watt Bit Size 5/8"

CARDROSS ENGINEERING CO. LTD.
Woodyard Road, Dumbarton
Phone: Dumbarton 2655

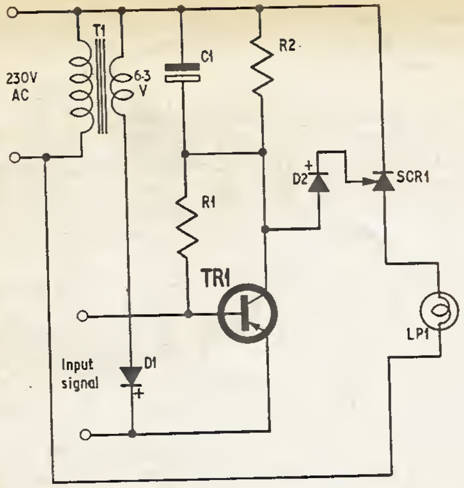


Fig. 2. Circuit of a single integrator connected to the trigger of a thyristor

anode, and the driving source must be capable of delivering at least 20mA into the trigger. Once triggered the thyristor will continue to conduct as long as it is passing a current in excess of its holding current (about 25mA) between its anode and cathode. As soon as this holding current falls below the threshold the thyristor will turn off and will not conduct again unless the triggering condition is repeated.

When operating on 50Hz mains the applied voltage passes through zero 100 times a second, and hence, to keep the thyristor conducting, it is necessary to re-trigger for every cycle (if we were using a full wave bridge it would be necessary to trigger every half cycle). Triggering therefore has to occur in synchronism with the applied voltage and in normal lamp dimmer circuits this is carried out by applying a small proportion of the applied voltage to the trigger.

Conventional dimming is obtained by changing the phase of the trigger voltage relative to the applied voltage so that the thyristor will fire during a comparatively short period of the half cycle. Phase shift is obtained in a manually operated lamp dimmer by adjusting the value of a resistor in an *RC* circuit.

Referring now to Fig. 2, we have replaced the variable resistor in the manual system with a transistor (TR1). Because the trigger of the thyristor must receive a synchronous 50Hz pulse, it is necessary to power the transistor with single wave rectified un-smoothed a.c. supplied by T1 through D1. Although the circuit is live to mains, the voltages across the circuit never exceed the 6·3V supplied by T1.

The voltage across R1 and collector/emitter of TR1 oscillates between 0 and 6·3V in exact phase relationship with the full 230V across the thyristor and the lamp. This phase relationship can only be obtained if the correct end of the secondary winding of T1 is linked to the live mains line—if the link was made to the wrong end the power to the drive circuit would be 180 degrees out of phase.

With no signal applied to the base of TR1 the transistor is effectively a very high resistance and the potential difference across R1 at any part of a half cycle is zero, thus the trigger to anode voltage of the thyristor is also zero. If a negative going signal is applied to the base the collector/emitter resistance of TR1 falls roughly in proportion to the amplitude of the applied signal and C1 starts to charge through TR1 towards the voltage set by the potential divider formed by TR1 and R2. It will take a finite time for C1 to charge and this is again dependent on the instantaneous resistance of TR1 and on the value of the capacitor.

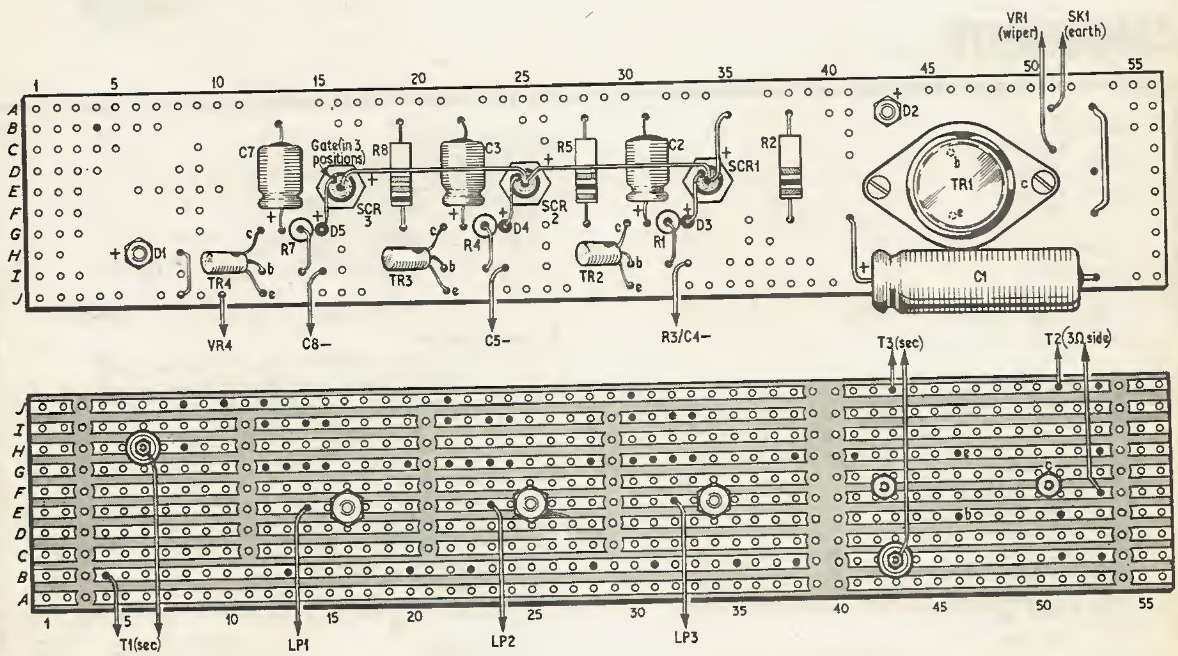


Fig. 3. Circuit board layout and wiring details

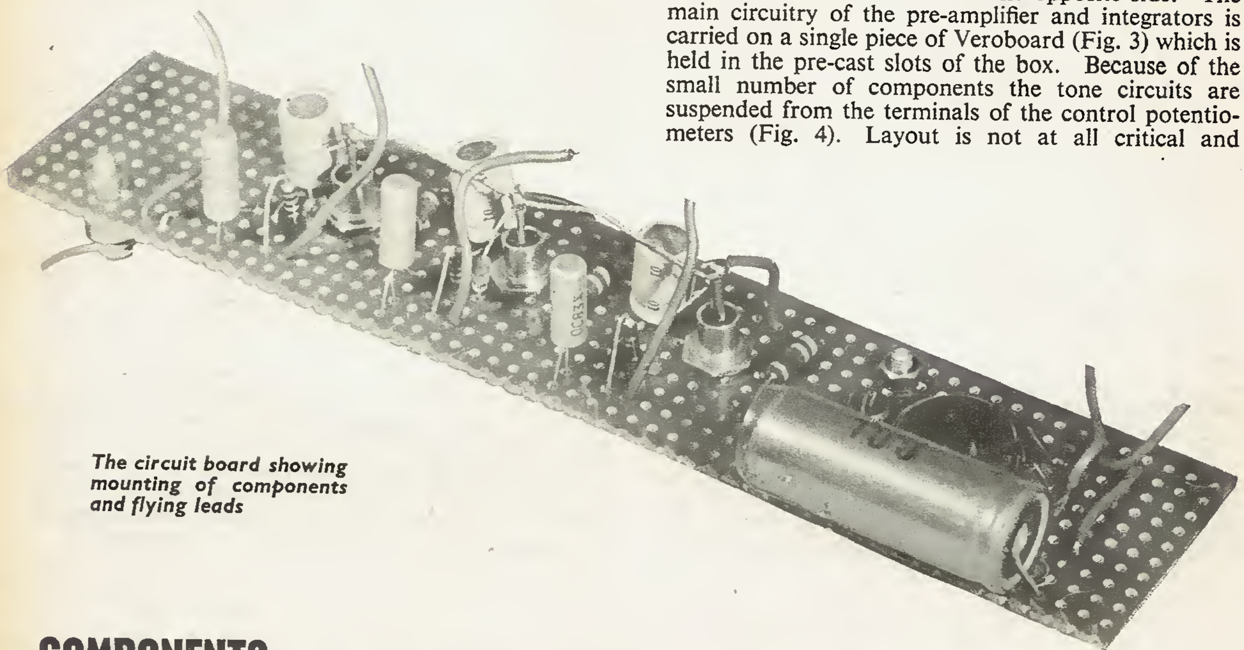
The values of C1 and R1 have been chosen so that the average integration time for the capacitor to charge to 3 volts is approximately 5 milliseconds. This naturally has considerable dependence on the input signal and has been taken into account, so that, with the master gain control (VR1) set midway, an input signal from a medium volume loudspeaker will operate the unit correctly.

With an average integration time set for 5ms, C1 will reach 3V approximately half way through a half cycle; when this moment is reached the thyristor fires thus lighting the lamp for the remainder of that half cycle. If the input signal increases in amplitude the integration time becomes less, and the thyristor will fire earlier thus passing more energy to the lamp and effectively increasing its brightness; for lower level audio signals the converse happens.

CONSTRUCTIONAL DETAILS

All components are readily available, and there are no critical values. The power transformers are conventional 6·3V heater types. The only point to watch is that the isolating transformer T2 will really isolate; hence it is best to use one that has been designed for use in valve circuits.

The unit is housed in a die cast box measuring $8\frac{3}{4}$in × $5\frac{3}{4}$in × $2\frac{3}{16}$in. The transformers used conveniently mount along one side of the box and all four gain controls are mounted on the opposite side. The main circuitry of the pre-amplifier and integrators is carried on a single piece of Veroboard (Fig. 3) which is held in the pre-cast slots of the box. Because of the small number of components the tone circuits are suspended from the terminals of the control potentiometers (Fig. 4). Layout is not at all critical and



The circuit board showing mounting of components and flying leads

COMPONENTS . . .

Resistors
R1 56kΩ
R2 330Ω
R3 1kΩ
R4 56kΩ
R5 330Ω
R6 1kΩ
R7 56kΩ
R8 330Ω
R9 1kΩ
All ±10%, ½W carbon

Potentiometers
VR1 25Ω, 3W wirewound
VR2, 3, 4 10kΩ log (3 off)

Capacitors
C1 1,000μF elect. 15V
C2 100μF elect. 15V
C3 100μF elect. 15V
C4 1μF elect. 15V
C5 5μF elect. 15V
C6 1μF elect. 15V
C7 100μF elect. 15V
C8 2μF elect. 15V

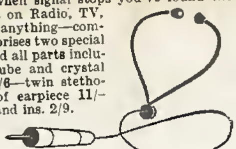
Semiconductors
D1, 2 GJ7M (or any 15 p.i.v., 1A silicon rectifier) (2 off)
D3, 4, 5 OA91 (3 off)
TR1 OC26
TR2, 3, 4 OC83 (3 off)
SCR1, 2, 3 CRS3/40AF (3A, 400 p.i.v.) (3 off)

Transformers
T1, 3 Mains transformer, sec 6·3V at 1A (2 off)
T2 Midget choke type (Radiospares) or any 3Ω valve output transformer

Miscellaneous
SK1 jack socket
Die cast box ($8\frac{3}{4}$in × $5\frac{3}{4}$in × $2\frac{3}{16}$in)
Bayonet bulb holders (3 off)
Control knobs (4 off)
Veroboard
Mains lead
Grommets
4B.A. fixings

RADIO STETHOSCOPE

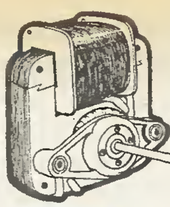
Easiest way to find fault—traces signal from aerial to speaker—when signal stops you've found the fault. Use it on Radio, TV, amplifier, anything—complete kit comprises two special transistors and all parts including probe tube and crystal earpiece. **29/6**—twin stethoset instead of earpiece 11/- extra—post and ins. 2/9.



ELECTRIC TIME SWITCH

Made by Smiths these are AC 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.

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.

NICAD RECHARGEABLE CELLS

3·6V 500mA size 1½ × 1⅞in. 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**. 5 cell 6V **29/6**. 9 cell 10·8V **47/6**.

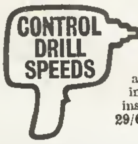
MINIATURE WAFER SWITCHES

2 pole, 2 way—4 pole, 2 way—3 pole, 3 way—4 pole, 3 way—2 pole, 4 way—3 pole, 4 way—2 pole, 6 way—1 pole, 12 way. All at **3/6** each. **36/-** dozen, your assortment.

WATERPROOF HEATING ELEMENT

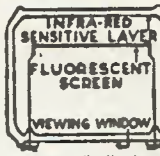
26 yards length 70W. Self-regulating temperature control. **10/-** post free.

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.

SNIPERSCOPE



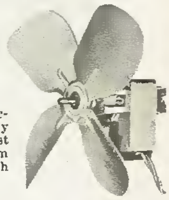
Famous war-time "cat's eye" used for seeing in the dark. This is an infra-red image converter cell with a silver caesium screen which lights up (like a cathode ray tube) when the electrons released by the infra-red strike it. A golden opportunity for some interesting experiments. **7/6** each, post **2/6**. Data will be supplied with cells, if requested.

THIS MONTH'S SNIP

DEAC RECHARGEABLE BATTERY

1·2V–2000 mA/hr. type (2000DKZ). Size 2in. dia. × ⅜in. thick approx. Tremendously powerful, will deliver 4 amp for ½ hour. Regular price over £2 each. Snip price **25/-** each. NEW AND UNUSED.

A C FAN



Small but very powerful mains motor with 6½in. blades. Ideal for cooling equipment or as extractor. Silent but very efficient. **17/6**, post 4/6. Mounts from back or front with 4BA screws

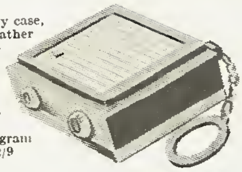
BATTERY CHARGER FOR NICADS

This is in plastic case, size 5 × 4 × 3in. approx. All wired up with 3 core output lead and 3 core mains input lead. Contains mains transformer with 40v. 250mA secondary and standard 200/240 primary. Also contains full wave bridge rectifier, neon indicator, wired up with resistors to charge 2 Nicad batteries simultaneously. Charge rates of 50mA and 25mA respectively. Batteries up to 30 volts may be charged. Price **39/6** each, plus 3/6 postage and insurance.

REPAIRABLE RADIOS

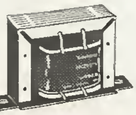
7 transistor Key chain Radio in very pretty case, size 2¾ × 2½ × 1¼in.—complete with soft leather zipped bag. Specification:—Circuit: 7 transistor superheterodyne. Frequency range: 530 to 1600 Kc/s. Sensitivity: 5 mv/m. Intermediate frequency: 465 Kc/s, or 455 Kc/s. Power output: 40mW. Antenna: ferrite rod. Loudspeaker: Permanent magnet type.

These radios require attention. Circuit diagram is not available. Price only **17/6** each plus 2/9 post and insurance. 4 radios **£3** post free.



MAINS TRANSFORMER SNIP

Making a power pack for amplifier or other equipment? These transformers have normal mains primaries (230/40v.) and isolated secondaries two types (1) 12v. 500mA at **8/6**; (2) 15v. 500mA at **8/6**.



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 as the new "Grolux" tubes for fish tanks and indoor plants. Chokes are super-silent, mostly resin filled. Kit A—15-20w. **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 MF 13/6 on first kit then 3/6 on each two kits ordered.

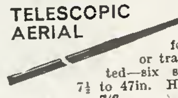
PP3 ELIMINATOR. Play your pocket radio from the mains! Save £s. Complete component kit comprises 4 rectifiers—mains dropper resistances, smoothing condenser and instructions, only **6/6** plus 1/- post.

LAST CHANCE FOR THIS BARGAIN

CASSETTE LOADED DICTATING MACHINE for only 99/6

Battery operated and with all accessories. Really fantastic offer a British made £31 outfit for only **£4.19.6**, brilliantly designed for speed and efficiency—casette takes normal spools, drops in and out for easy loading—all normal functions — accessories include: stethoscopic earpiece — crystal microphone has on/off switch—telephone pick-up—DON'T MISS THIS UNREPEATABLE OFFER—SEND TODAY **£4.19.6** plus 7/6 post and insurance. Foot switch 18/6 extra. Spare Cassettes at **4/6** each, three for **10/-**.

TELESCOPIC AERIAL



for portable, car radio or transmitter. Chrome plated—six sections, extends from 7½ to 47in. Hole in bottom for 6BA screw. **7/6**.

WIDE ANGLE LENS FOR CLOSED CIRCUIT TV

16mm. Made by the Swiss company, Kern Paillard. Yvar 1:2·8 f=75mm. Brand new in leather case **£39**, which is less than half current list price.

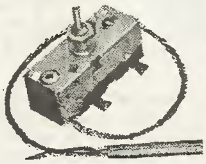
TIMED SWITCH OR MEMORY JOGGER

If you are the forgetful type this can save you embarrassment. Pre-settable up to 12 hours, operated by clockwork motor so can be used in car or anywhere independently of the mains. Switch rated at 15A, 250V can control any type of alarm, **29/6d.** less than half the current list price. Brand new and unused.

MOVING COIL METER BARGAIN

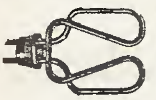
Panel meters are always being needed and they are jolly costly when you have to buy them in a hurry—so you should take advantage of this offer: 2in. moving coil flush mounting meters only **9/6**. These are actually R.F. meters and cost about **£3** each but if you don't want them for R.F. then all you have to do is to remove the thermocouple and you will have a 2–3 mA meter which you can make into almost anything by adding shunts or series resistor. New and unused.

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 others means not controllable by the switch. Made by the famous Teddington Co., we offer these at **12/6** each. Postage and insurance 2/9.

KETTLE ELEMENT



230/240V 1500 watt. Made by Best for kettles with 1⅛ in. dia. hole including: Best, Besco, Chalfont, Davidson, Dimplex, Grafton, Hawkins, Jurymaid, Mirroware, Monogram, Pifco, Revo, Towen, Swan. Normally 32/6. Our price **15/-** plus 2/6 post.

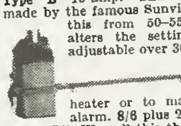
MINIATURE RELAY

American make—630 ohm coil 20–30 volt operation—2 pole change over **4/6** each, **48/-** doz.

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.



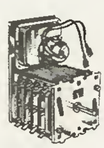
Type "D". We call this the Ice-stat as it cuts in and out at around freezing point, 2/3 amps. Has many uses one of which would be to keep the loft pipes from freezing, if a length of our blanket wire (16 yds. 10/-) is wound round the pipes. **7/6**. P. & P. 1/-.

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.

MOTORISED CAM SWITCH

Made by the famous meter company Chamberlain and Hookham, these have a normal mains 200–240V motor which drives a ratchet mechanism so geared to give one ratchet action per minute on a wheel with 60 teeth thus a complete revolution of the cam takes place in one hour. The cam operates 8 switches (6 changeover and 2 on/off thus 480 circuit changes per hour are possible). Contacts, rated at 15 amps have been set for certain switch combinations but can, no doubt, be altered to suit a special job. Also other switch wafers or devices can be attached to the shaft which extends approximately one inch. **47/6**. p. & ins. 4/6.



QUICK CUPPA

Mini Immersion Heater, 350w. 200/240v. Boils full cup in about two minutes. Use any socket or lamp holder. Have at bedside for tea, baby's food, etc. **19/6**, post and insurance 1/6. **12v. car model also available.**

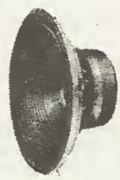
MAINS TRANSISTOR POWER PACK

Designed to operate transistor sets and amplifiers. Adjustable output 6v., 9v., 12 volts for up to 500mA (Class B working). Takes the place of any of the following batteries: PP1, PP3, PP4, PP6, PP7, PP9, and others. Kit comprises: mains transformer rectifier, smoothing and load resistor, condensers and instructions. Real snip at only **16/6**, plus 3/6 postage.

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—Main 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 £7.19.6.**



16 RPM GEARED MOTOR

Made by Smith's Electrics, these are almost silent running, but are very powerful. They operate from normal to 240V. mains and the final shaft speed is 16 r.p.m. **15/-**. Post & ins. 2/9.

REED SWITCH

Suitable for dozens of different applications, such as burglar alarms, conveyor belt switching, These are simply glass encased switches which can be operated by a passing permanent magnet coil. A special buy enables us to offer these at **2/6** each, or **24/-** a dozen. Suitable magnets are **1/-** each.

Where postage is not stated then orders over £3 are post free. Below £3 add 2/9. Semi-conductors 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

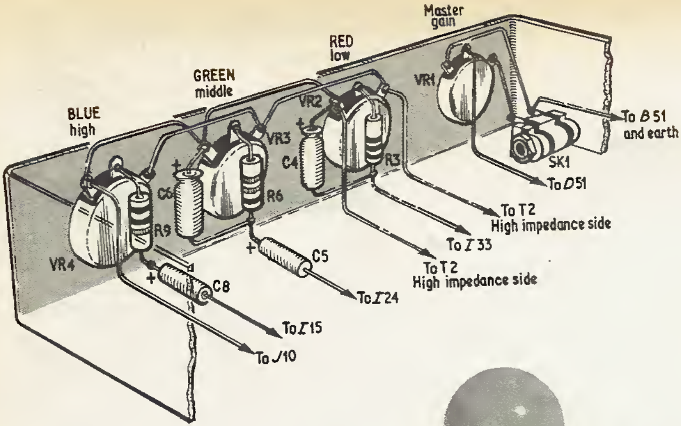
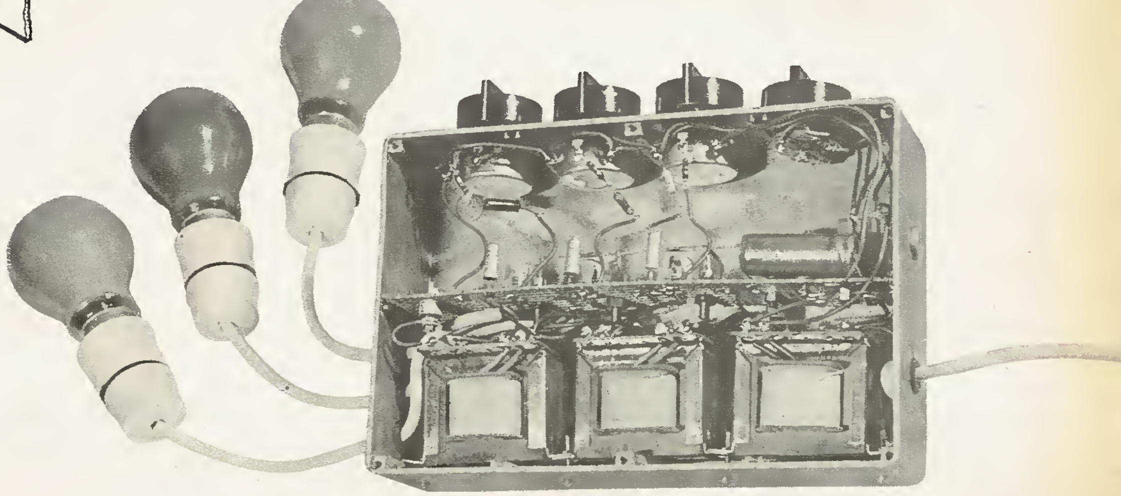


Fig. 4. Layout and wiring details of the four gain controls and filter circuits

The complete Chromatone showing the layout and wiring of all components



readers could use any type of enclosure provided it can be adequately earthed or similarly protected in case the insulation of T2 should break down.

Output connections to the three lamp channels are provided by flying leads terminated with standard bayonet bulb sockets. Panel mounting sockets could be used if desired, but should be capable of carrying 230V at 3A. The prototype was designed to run from a fused 13A plug, and therefore an integral fuse was omitted; for safety's sake a built-in fuse must be fitted if the unit is to be used without a fused plug.

No details of fixing holes are given as these will vary according to the types of component used by the constructor. Work should begin by drilling all holes in the box, and grommets inserted in all those holes carrying inlet or outlet leads. All components should then be wired in to the Veroboard as shown in Fig. 3. The final stage of assembly is to wire up the transformers and gain controls to the Veroboard (Figs. 4 and 5). When connecting the transformers, try to ensure that the linked ends of primary and secondary of T1 are both "starts"; this will ensure that phasing is correct.

OPERATION

When the wiring is complete, connect the input jack socket (SK1) to the extension speaker terminals of a record player or radio, plug three different coloured lamps into the bayonet sockets (it is suggested that red be used with the low frequency circuit, green for the middle, and blue for the high). Turn all gain controls to minimum and plug the unit into the mains. None of the lamps should light under this condition. Next set

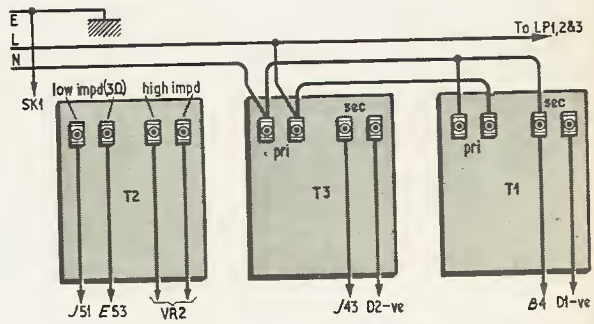


Fig. 5. Wiring details of transformers showing mains input lead

the volume of the record player to a comfortable listening level and turn VR2, 3 and 4 to midway positions. Slowly turn up VR1 and if all is correct one or all of the lamps should begin to light up in time with the music. If on advancing all controls to maximum none of the lamps light, and the circuit has been checked for errors, it is more than probable that the phasing is wrong. This is simply remedied by reversing the connections from the secondary of T1.

When the lamps are working satisfactorily the overall sensitivity of the unit can be set by VR1 and any personal choice of light balance can be set by adjusting the tone gain controls relative to each other. ★

Readout—
A SELECTION FROM OUR POSTBAG

correspondents wishing a reply must enclose a stamped addressed envelope

I.C.'s for the public

Sir—As suppliers of integrated circuits advertising in PRACTICAL ELECTRONICS, we were somewhat disconcerted to read the letter from Mr Robson (*Readout*, May 1969) expressing his opinion that i.c.'s are not for the public at large. We note that Mr Robson offers no reasons for his "down" on i.c.'s and we would be interested to read his other letter to which he refers.

It has been our experience that i.c.'s are indeed for the public as evidenced by the fact that we find people who have bought them frequently come back for more. Surely, from the experimenter's point of view, the i.c. is no more nor less than just another semiconductor, but admittedly a much more sophisticated one than a single transistor for example.

Most manufacturers produce comprehensive data sheets which include a circuit diagram of the device, and often examples of applications, giving the average enthusiast all the information he needs for many hours of experimenting.

D. E. Johnston,
Director,
Kinver Electronics Ltd.,
Stourbridge.

Cost of i.c.'s

Sir—I was surprised to find in the May edition of PRACTICAL ELECTRONICS two letters objecting to integrated circuits. Labelling the letter concerning the radio repairing a problem relating to "I.C." even if the latter was in inverted commas is a bit unfair. The use of the word module in the letter suggests that either a hybrid circuit was used or simply normal circuitry enclosed in some impregnable material such as Araldite. As an engineer working on the circuit development of integrated circuits, I can say that to the best of my knowledge the average cost of an integrated circuit for a radio is certainly not in the region of pounds trade price. Such a circuit contains all the circuit functions of a radio, bar the decoupling capacitors and passive tuning components. I.C.'s for the domestic market, like present transistors, are almost certain to be plastics or ceramic encapsulated by all manufacturers; the most likely configuration is the dual in line package, which should be easily removable with the help of a specially shaped soldering bit—a matter of half a minute's work?

I would be interested to see Mr James Robson's objections to i.c.'s. All i.c. circuits can of course be implemented in ordinary discrete circuitry, but i.c.'s I would think are far easier to use and make the whole system much neater. I have for instance just made a system that produces a 1·5 volt "ramp" formed of 512 discrete steps. This required only three, ten lead TO5 cans and about 20 resistors. Each TO5 can is the equivalent of three clockable flip-flops plus an AND gate. I admit that at the present time it is probably cheaper for the amateur to build such a system of discrete components, but I would suggest that within the next few years, i.c.'s will make it possible for the ambitious person to build himself a desk top calculator (probably to be used more by his children for homework) a project a little daunting in discrete components.

. . . and electronic dice

I also have a suggestion for Mr Brian Dellow regarding an electronic dice. The difficulty here as I see it is the production of a random sequence. A pseudo-random sequence could be produced entirely digitally, but the system would be rather complex in order to beat people with exceptionally good memories. An alternative would be to use an analogue source of noise, such as a noisy transistor, amplify the noise, filter it and feed the filtered signal onto the input of a squaring stage to produce a pulse output. The output could then be decoded serially to produce a decimal number from a binary sequence, or perhaps three filters of different values could be used to produce a parallel output. The outputs could be decoded with a simple diode matrix and fed to six bulbs via amplifiers.

P. Cranswick,
Swindon,
Wilts.

Electronics instructor!

Sir—Our Youth Club is most interested to make contact with amateur electronics clubs and enthusiasts in this area in order to form a section within the Club.

Our members have recently indicated a great deal of interest in forming their own group to build radio and electronic systems but, of course, they desire to receive instruction from a person who has experience and knowledge of this sort of interest.

I would be most grateful if you were able to give me contacts who would be able to help us in this present situation.

Brian Gouldman,
Youth Leader,
Liverpool Jewish Youth Centre,
Harold House,
Dunbabin Road,
Liverpool L15 6XL.

Electronic club wanted

Sir—I have been asked for names and addresses of any local clubs or societies concerned with do-it-yourself electronics. I shall be grateful for any help you can give.

Ealing Borough Librarian,
Technical Library,
Acton Library,
High Street,
London, W.3.

— NOTICE —

ARSENIDE DIODES GO UP

With reference to an editorial note in *Readout* last April, Messrs Proops Bros. inform us that the current price of the gallium arsenide light source type MGA100 is 35s. This is an increase of 6s 6d on the advertised price prior to December last and which we unsuspectingly quoted. We are also asked to state that the MGA100 is a new production item.

Thus dashed for the moment, it seems, is the earnest hope expressed on that occasion for an early downward trend in the cost of infra-red devices.—Ed.

OLRUS ELECTRONICS LTD

As we have had a number of complaints concerning the service provided by this Company, readers are asked to get in touch with me before dealing with it.

EDITOR.

These HEATHKIT Test-Twins are really Going Places !

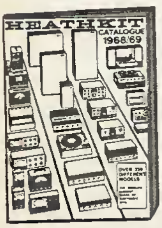
IM-17

Portable In-Circuit Transistor Tester IT-18
Has all the facilities needed for fast in-circuit transistor/diode testing and it costs just a fraction of many other brands.
Rugged polypropylene case and lead storage compartment.

Portable Solid-State VVM, IM-17
4 AC, DC voltage ranges. 4 ohm ranges.
Rugged case with lead storage compartment.
Battery powered to work anywhere. A must for the engineer, hobbyist, etc.

KIT PRICE ONLY £12-18-0 EACH *Carr. 6/- extra.*

IT-18



MANY MORE MODELS, TEST INSTRUMENTS, HI-FI, RADIOS, ETC., in the FREE CATALOGUE.

Send for your copy today . . .

HEATHKIT

DAYSTROM LTD.,
Dept. PE-7, GLOUCESTER GL2 6EE. Telex 43216
Please send me further information without obligation to:

Name ....

Address ....

....

Bargain—Car Radios. Our Price **9 gns.** Negative or positive earth (switched) fully transistorised (12V) medium and long waves. Speaker and fitting kit supplied at no extra cost. P/P 5/-.

Sonotone 9TA and 9TA/HC. Diamond Cartridge brand new, boxed in manufacturers' carton **49/6** plus 2/6 p/p. **Acos** GP 91-1 and GP 91-3 stereo compatible cartridges, new in sealed manufacturers' cartons **22/6** plus 2/6 p/p.

BASF TAPE 25% OFF

5in	600ft. **14/-**	900ft. **19/-**	1200ft. **30/-**
5¾in	900ft. **19/-**	1200ft. **24/-**	1800ft. **39/-**
7in	1200ft. **24/-**	1800ft **35/-**	2400ft. **57/-**

P/P 2/- per reel—over £5 FREE

HI-FI SPEAKER
K12TC—12in 12 watt
Offers an exceptionally smooth and extended response, with very low level of distortion from the specially designed twin diaphragms.
Frequency Response: 30–16,000Hz.
Impedance: 15-160Hm
OUR SPECIAL PRICE 97/6
PLUS P/P 6/6

● **BARGAIN — Speakers, Hi-Fi — The Baker Selhurst Stalwart.** 12in round, 15 watt rating, 12,000 lines gauss, 15 ohms, response 45-13,000c/s. Bass resonance 40-50c/s, solid aluminium chassis. **Our price £5.9.6. p/p 6/6**

DULCI HI-FI UNITS
The Dulci range of tuners and amplifiers offer exceptional quality at a sensible price.
Amplifiers: 207 and 207M. **Tuners:** FMT7 and FMT7s.
SEND NOW FOR FULL DETAILS

TRIO Stereo Moving Magnet Cartridge Model AD76K. Diamond Stereo LP Stylus. Frequency response 20-20,000c/s output. 7mV tracking pressure 2 grammes ± 0·5 grm. Fully guaranteed. Price **85/-** p/p free.

● **Bargain—Changer decks at lowest prices ever**

	GARRARD	
Beautiful teak plinth and perspex cover to suit these units **5 Gns. P/P** Free	1025	**£8.0.0**
	2025	**£8.10.6**
	AT60 Mk. 11	**£12.19.6**
	SP25 Mk. 11	**£12.0.0**
	3500 with Son 9TA.HC diam. cart.	**£10.19.6**

Add 10/- p/p for each Garrard unit

SPEAKER ENCLOSURES
Type: INFINITE BAFFLE
Model 8: 8in plus 3 in tweeter
Model 138: 13in × 8in EMI
Both **£4.19.6** each
Model 1012: 10in or 12in, plus 4in tweeter **£7.19.6**
All enclosures are in oiled teak, fully built.
Please add 8/- p/p on each enclosure

● **BARGAIN — Speakers, Hi-Fi — The Baker Selhurst** Guitar Group 25, 12in round, 25 watt rating, 12,000 gauss, 15 ohms, response 30-10,000c/s, solid aluminium chassis, heavy duty cone. **Our price £5.9.6. p/p 6/6**

The greatest HI-FI Budget system today — can't be beaten—price or quality anywhere —look at these great features—then compare.

	£	s.	d.
Teleton F2000 tuner amp. AM-FM with multiplex decoder and A.F.C.—2 x 5W channels R.M.S. Bass Volume Treble Balance controls, a truly outstanding unit	43	1	0
Garrard SP 25 Mk II Transcription deck	15	11	11
Teleton SA 1003 matching speaker enclosures	9	5	0
Sonotone 9 TA Diamond Cartridge	4	2	0
Plinth and Perspex cover	7	0	0
	£78	**19**	**11**

Exclusively offered by WALDON at the remarkably low price of 63 gns.

E.M.I. HI-FI SPEAKERS
SET 450: 13 × 8 with two built-in tweeters and cross-over unit. **Our Price 69/6.** 3 or 15 ohm, 10W, 40-13,000Hz.
SET 850: 6½in bass plus 3¾in tweeter and cross-over unit. 8 ohm, 10W, 65-20,000Hz. **79/6.**
SET 250: 5in heavy duty bass plus 3in tweeter and cross-over unit. 8 ohm, 6W, 80-20,000Hz. **65/-**
Add 5/6 p/p for each speaker set

WALDON ELECTRONICS, Atlas House, Chorley Old Rd., Bolton. Bolton 45628

Practical Electronics Classified Advertisements

SERVICE SHEETS

RADIO TELEVISION, over 8,000 Models. JOHN GILBERT TELEVISION, 1b Shepherds Bush Rd., London, W.6. SHE 8441.

SERVICE SHEETS, Radio, TV, 5,000 models. List **1/6.** S.A.E. enquiries. TELRAY, 11 Maudland Bank, Preston.

LARGE SUPPLIER OF SERVICE SHEETS
T.V., RADIO, TRANSISTORS, TAPES, ETC.
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.

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.

LOUDSPEAKERS, 3" Elac, 15 ohms, **12/6** post free. CROWBOROUGH ELECTRONICS, 3 Rotherhill Road, Crowborough, Sussex.

DOUBLE BEAM OSCILLOSCOPE Telequipment D43, two Type A plug-in amplifiers—**£80** o.n.o.
OSCILLATOR Venner TSA625/2, 1MHz Sine and Square—**£25** o.n.o.
POWER SUPPLY International Electronics, 0–50V, 0·5A protected—**£20** o.n.o.
All in excellent condition. Write or phone—SALMON, Old Rectory, Fittleworth, Pulborough, Sussex (Fittleworth 306).

SOLARTRON CD513 Oscilloscope. Plus handbook. In perfect working order. **£45** or near offer. Phone 01-883 3295.

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

MISCELLANEOUS

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.

RATES : 1/3 per word (minimum 12 words). Box No. 1/6 extra.
Advertisements must be prepaida nd addressed to Advertisement Manager, "Practical Electronics"
IPC MAGAZINES LTD., Fleetway House, Farringdon Street, London, E.C.4

MISCELLANEOUS *(continued)*

4 WATT GRAM AMPS.
Volume and tone controls, mains operation, 3Ω output, new and boxed **65/-** POST PAID
BIG BARGAIN PARCELS OF COMPONENTS ONLY **10/-** POST PAID
SALOP ELECTRONICS
23 Wyle Cop
Shrewsbury, Shropshire *S.A.E. for lists*

4 BISTABLES—10/-, 1% RESISTORS—8d. each. Semicondtctors, Condensers, etc. S.A.E. Lists and circuits. C. L. BROOKER, 262 Hornsey Road, Holloway, London, N.7.

ROBOTS
Synthetic Animals with "BRAINS" of their own. The NEW 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 a machine which "recognizes" itself, and an electronic dog whistle, etc., etc. HOSTS OF EASY-TO-CONSTRUCT projects, for anyone with a basic knowledge of Electronics.
SEND 2/6 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.

ETCHED PRINTED CIRCUIT BOARD KITS. Full instructions. **19/6,** c.w.o. CIRCUITETCH, 12 Cambridge Rd., St. Albans, Herts.

MAKING AN ORGAN
We can save you £ £ £s
We have acquired the bulk organ stores from a leading British manufacturer. Stocks too numerous to list in full. Examples:

PLAIN STOP TABS	1/6
ENGRAVED STOP TABS from	2/6
GENERATOR P.C. BOARDS from	5/-
AMPLIFIER P.C. BOARDS from	5/-
RESISTORS from	1d.

SPEAKERS, KEYBOARDS, CABINETS, PEDALS, FOOTSWITCHES, MOTORS, TRANSFORMERS, CAPACITORS, ETC., ETC.
Everything you want to build : organs, amplifiers, "Leslie" cabinets...
S.A.E. for full price list.
E.M.C. (Dept. P.E.1), 104 ASHLEY ROAD, PARKSTONE, POOLE, DORSET
TRADE ENQUIRIES INVITED

MISCELLANEOUS *(continued)*

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.

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.

UFO DETECTOR CIRCUITS, data. 10s. (refundable). Paraphysical Laboratory (UFO Observatory), Downton, Wilts.

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

GOVT. SURPLUS WIRELESS EQUIPMENT HANDBOOK
This useful Handbook gives detailed information and circuit diagrams for British and American Government Surplus Receivers, Transmitters and Test Equipment, etc.; also contained are some suggested modification details and improvements for the equipment. Incorporated in this revised edition is a surplus/commercial cross referenced valve and transistor guide. This book is invaluable to radio enthusiasts, radio clubs, universities and laboratories. The latest edition, Third Edition, at 45/- per volume, plus 5/- P. & P., C.O.D. a pleasure, is obtainable from us at
GILTEXT (LEEDS) LTD
Dept. P.E., 24 Stansfield Chambers
Gt. George Street, Leeds 1
S.A.E. with all enquiries, please. Extra postage for all foreign orders. Individual circuits and information on most surplus equipment now available.

EDUCATIONAL

STUDY RADIO, TELEVISION AND ELECTRONICS with the world's largest home study organisation. City & Guilds; R.T.E.B., etc. Also practical courses with equipment. No books to buy. Write for FREE Prospectus to ICS (Dept. 577), Intertext House, Stewarts Road, London, S.W.8.

EDUCATIONAL *(continued)*

LEC

RADIO & TELEVISION SERVICING
RADAR THEORY & MAINTENANCE
TELECOMMUNICATIONS

This private College provides efficient theoretical and practical training in the above subjects. One-year day courses are available for beginners and shortened courses for men who have had previous training. Write for details to:—
The Secretary, London Electronics College, 20 Penywern Road, Earls Court, London, S.W.5. **Tel. 01-373 8721**

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.

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.

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.

SITUATIONS VACANT

RADIO TECHNICIANS
VACANCIES TO BE FILLED BY OCTOBER 1969

A number of suitably qualified candidates are required for unestablished posts, leading to permanent and pensionable employment (in Cheltenham and other parts of the UK, including London). There are also opportunities for service abroad.

Applicants must be 19 or over and be familiar with the use of Test Gear, and have had practical Radio/Electronic workshop experience. Preference will be given to such candidates who can also offer "O" Level GCE passes in English Language, Maths and/or Physics, or hold the City and Guilds Telecommunications Technician Intermediate Certificate or equivalent technical qualifications. A knowledge of electro-mechanical equipment will be an advantage.

Pay according to age, e.g. at 19 — £869 at 25 — £1,130 (highest age pay on entry) rising by four annual increments to £1,304.

Prospects of promotion to grades in salary range £1,217-£2,038. There are a few posts carrying higher salaries.

Annual Leave allowance of 3 weeks 3 days rising to 4 weeks 2 days. Normal Civil Service sick leave regulations apply.

Application forms available from:

Recruitment Officer (RT/54)
Government Communications Headquarters
Oakley, Priors Road
Cheltenham, Glos. GL52 5AJ

RECEIVERS AND COMPONENTS

TRANSISTORISED REVERBERATION

Six transistor circuit, all components £7.10.0. post free. (Case 34/- extra, P. & P. 2/6). Circuit and construction details 1/- (free with kit).

TRANSISTORISED SIGNAL INJECTOR 19/6 P. & P. 1/6. Catalogue of components etc. 1/-. Wilsic Electronics Ltd, 6 Copley Road, Doncaster, Yorks.

CARBON FILM RESISTORS, 13/- per 100. S.a.e. for component catalogue. SRY ELECTRONICS, 11 Rosedene Ave., Croydon, CR0 3DN. 01-684 0402.

SITUATIONS VACANT *(continued)*

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.

RECEIVERS AND COMPONENTS *(continued)*

R & R RADIO

51 Burnley Road, Rawtenstall
Rossendale, Lancs
Tel.: Rossendale 3152

VALVES BOXED, TESTED & GUARANTEED

BF80	3/-	EBC41	4/6	PY33	5/-
EBF89	3/6	PCC84	3/-	PY81	3/6
ECC82	3/-	PCF80	3/-	PY82	3/-
ECL80	3/-	PCF82	3/6	U191	4/6
EF80	1/6	PCL82	4/-	6F23	5/-
EF85	3/-	PCL83	4/-	30F5	2/6
EY86	4/-	PL36	5/-	30L15	5/-
EL41	5/-	PL81	4/-	30P12	4/6
EZ40	4/6	PL83	4/-	30C15	5/-

POST. ONE VALVE 9d. TWO TO SIX 6d.
OVER SIX POST PAID.

ULTRASONIC TRANSDUCERS. Ideal remote control door alarms, etc. Operating frequency 40 ± 1Kc/s beam width @ 3dB Points 60°. 2 for 55/- or 30/- each. Post free. Circuit diagram available if required. THE DIAMOND STYLUS CO. LTD., Colwyn Bay, North Wales.

BRAND NEW ELECTROLYTICS. 15 Volt, 0·5, 1, 2, 5, 6, 8, 10, 15, 20, 30, 40, 50, 100, 200 mfds. 7/6 dozen, postage 1/-. THE C. R. SUPPLY CO., 127 Chesterfield Road, Sheffield S8 0RN.

SILICON PLANAR TRANSISTORS. 100% tested and full spec. 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.

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, multi-meter 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 ....

....

.... 7/69

RECEIVERS AND COMPONENTS
(continued)

COMPONENTS

Samples from our catalogue:— Geared motors 300rpm-1r/24H from 7/6, 15v. 300mw. Zeners 3/-, 10K + 10K 2% 3" ganged pots 20/-, 220 ohm 200 watt resistors 7/6, 6d. stamp for catalogue.

F. HOLFORD & CO.
6 Imperial Square, Cheltenham

TAPE HEADS

BSR BRAD. 2 TRACK 39/6 pair
MICHIGAN REC./PLAY MED. IMP. 4-TRACK 45/-
BSR MARR 4 TRACK 39/6 pair
BOGEN ERASE UL218/6 4-TRACK 27/6
REUTER — COLLARO ERASE 4-TRACK 15/-
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 or 3 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 23⅜ × 13⅜ × 9⅞", contemp. 12" legs for Tape Recorder and Tuner **99/6**
RELAYS 4 pole changeover, ideal for models. 1⅛ × 1⅛ × ⅝", 700 ohm 9-24v. **10/-**

TWEETER 3" 16 ohm, 10W CR/0.3k Ω, 18,000 c/s **25/-**
Horn type Hi-Fi

CROSSOVER NETWORK **14/-**
3kc/s, 16 or 3 ohm

REFLEX CONE TYPE WATERPROOF SPKR.
5 watt, 3 ohm. 300-16,000c/s PA & Music Relay **£3.10.0**
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**
AD140 8/6 BC108 3/6 NKT226 5/6 OC200 5/6
AF186 11/6 NKT213 5/6 OC45 3/- OA91 1/6
GET103-113-116-118-119-887-889-890-896-7-8 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. **£4.15.0**
P/P on Decks, Plinth and Cover 7/6

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

RECEIVERS AND COMPONENTS
(continued)

RECEIVER PANELS MW/LW. Size 8 × 3in. Six transistors, OC44, OC45 (2 off), OC81D, OC81 (2 off), ½ watt output, contains all resistors, capacitors, I.F. transformers, osc. coil and transistors *but will require* ferrite aerial, tuning capacitor, wavechange switch, and volume control, supplied with connecting data, as brand new, made by famous British manufacturer, ONLY 32/6 post paid.

TUNING CAPACITORS (Brand new and boxed). 345pF + 165pF with two 20pF sections for F.M. tuner, size 2½ × 2 × 1⅛in. ONLY 4/6 each or 8/- for two. 325pF + 375pF with two 20pF sections for F.M. tuner, size 2½ × 1½ × 1⅛in. ONLY 4/6 each or 8/- for two.

VOLUME CONTROLS. 5k log. with S.P. switch, ¼in dia. spindle. 2/- each (new).

DISC CERAMIC CAPACITORS. 0·02mF 500v.w. wire ended, 1,800pF 1,000v.w. wire ended, 0·047mF 30v.w. P.C. type, all 3/- doz.

Thyristors. 400 P.I.V. at 5 amp. ideal for drill speed controls. 12/6 each.

TRANSISTORS. GT45B equiv. to OC45, OC71, etc. (BRAND NEW marked). 1/3 each, 12/- doz.

TRANSFORMERS. 250V a.c. input, 22 volts at 1 amp. output. 11/- post paid.

TAG STRIPS. 4½in long with 9 insulated tags and 2 earth tags. 4d. each, 3/- doz.

MIXED BAG. Silver mica and ceramic capacitors, approx. 150 items 10/- bag. Approx. 250 for 15/-.

SX633 SILICON DIODES. Unmarked 300 P.I.V. at ½ amp. tested 9d. each, 5/- doz.

ELECTROLYTICS. 32 + 32mF 250 v.w. 2/- each.

TRANSISTOR. Single tuned 470Kc/s I.F. transformers, 1/6 each, 4 for 5/-.

VALVE. 465Kc/s I.F. transformers ⅞sq., 1½in high, some 2in high, 2/- each.

HUNTS. ·25mF. 350v.w. ½ × ⅜in, brand new, wire ended, 6d. each, 4/- doz.

TELEVISION mains dropper resistors—send for list. 12·7 Mc/s and 13·125 Mc/s HC6/U xtals. tested, ex-equipment, 4/6 each.

ALL ITEMS PLUS 1/6 POSTAGE UNLESS STATED. MAIL ORDER ONLY
S.A.E. FOR LISTS

A. J. H. ELECTRONICS
59 WAVERLEY ROAD, THE KENT
RUGBY, WARWICKSHIRE
RUGBY 71066

WE ARE BREAKING UP COMPUTERS

EX COMPUTER PRINTED CIRCUIT PANELS 2in × 4in packed with semiconductors 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. 6/6. With a guaranteed minimum of 350 transistors.

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 +other components. 100 Ω, 500 Ω, 15K., 20K. State requirements. 5 boards 10/-. P. & P. 2/-.

NPN GERMANIUM TO5I WATT POWER TRANSISTORS on small heat sink, on 2in × 4in panel. 5 for 10/-. P. & P. 2/-.

POWER TRANSISTORS sim. to 2N174 ex eqpt., 4 for 10/-. P. & P. 2/-.

ABOVE on Finned Heat Sink (10D). 4 for £1. P. & P. 5/-.

ORGAN BUILDERS' SPECIAL 300 TO18 TRANSISTORS +200 Si DIODE GATES on panels. £4. P. & P. 6/-.

OVERLOAD CUT OUTS. Panel mounting in the following values . . . 5/- each. 2, 3, 4, 7, 10 amp. P. & P. 1/-.

MINIATURE GLASS NEONS, 12/6 doz. P. & P. 1/-.

Ex-Computer **"MEMORY" FERRITE CORE STORES.** 4,000 bits per plane. 25/- +3/- P. & P.

PAPST FANS. Powerful Extractor/Blower fans. 230/250V. 100c.f.m., 2,800 r.p.m. 35/- +5/6 P. & P. each.

LARGE CAPACITY ELECTROLYTICS
4½in, 2in diam. Screw terminals.
All at 6/- each +1/6 each P. & P.

4,000mF	72V d.c. wkg.
10,000mF	25V d.c. wkg.
6,600mF	45V d.c. wkg.
16,000mF	25V d.c. wkg.
25,000mF	12V d.c. wkg.

KEYTRONICS, 52 Earls Court Road London, W.8. Mail order only

RECEIVERS AND COMPONENTS
(continued)

TRANSISTOR PANELS

INTEGRATED CCT'S TAKEN FROM PANELS
A — Quad 2 I/P Gate 5/-
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/-
With Circuit and Pin Connections. Post Paid

EX GOVMT. RECEIVER R.209 covering 1—20 mc/s 12V D.C. Input **£15** 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
4—OC36 + 8—GET103 + 4—ZS31A .. 25/-
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—OC44 .... 5/-
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/-.

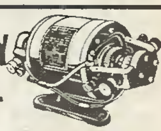
BRAND NEW BOXED CHASSIS containing 2—OC35, 2—OC29 12 WW resistors 25/-. Postage 1/6 **NEW CROSS RADIO**
6 OLDHAM ROAD, MANCHESTER 4

TAPE RECORDERS

TAPES TO DISC—using finest professional equipment—45 r.p.m. 22/-. S.A.E. leaflet, DEROY, High Bank, Hawk Street, Carnforth. Lancs.

ELECTRICAL

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

AIRCRAFT— PLUS GENERAL V.H.F. TELECOMMUNICATIONS BAND REC.

Listen to the thrills of Aircraft, Pilots, and Airports at work. Also Civil Depts., Fire and Ambulance services. Gas and Electricity Depts. Ideal for receiving 2 metre amateurs. Gives super reception within the range of all transmissions. A fully transistorised receiver covering 97–147m/s VHF broadcasts. Robust attractive 2-tone finished metal cabinet size approx. 7 × 4 × 4in. Operates from a 9 volt internal battery. Speaker or earphone output plus chrome telescopic aerial. Only £8.19.6. Carr. and insurance 10/6. CWO or COD.

SURPLUS BARGAINS
HEAVY DUTY ACCUMULATORS
Type 1 (6 volt) 40AH. In metal cabinet. Size approx. 10 × 9 × 5in. Complete with output socket, carrying strap. Brand new and unused. Worth £10 each. Our Price 55/–, carriage and insurance 15/–.
Type 2 (6 volt) 16AH. In sturdy wooden cabinet with carrying strap. Worth £7 each. Brand new and boxed, only 32/6 each, p. & p. 12/6.

FIELD TELEPHONES
Type F. Housed in a portable wooden case. Ideal for indoor/outdoor communication up to 10 miles. Absolutely brand new. Price only £5.19.6 per pair, carriage and insurance 15/–.
19 Set Headphones and Mike. Not new but in working order. Only 7/6 per set. p. & p. 4/6.
Tannoy Mikes. Moving coil. As new, 9/6 each, p. & p. 3/6 (heavy duty, ideal for P.A. work).
High Quality moving coil headphones and hand microphone. Brand new, only 25/–, p. & p. 5/–. Suitable for most applications (cost approx. £3 per pair).

AIR/SEA RESCUE TRANS/REC.

Compact VHF Trans./Rec. Fits in the pocket. Consists of Mike/Speaker, amplifier, aerial, transmitter and receiver. Were made to operate up to 100 miles depending on terrain. Operates from dry batteries. Completely self-contained. Cost Govt. over £50 each. Regulations state must not be operated in UK so please mention "For Dismantling purposes only" when ordering. Price £2.10.0 each, p. & p. 10/–. Two sets for £5.0.0, post free. Four sets £8, carriage free. Bulk sale of 10 sets £15, carriage £1. Export enquiries invited.

PRECISION PANEL METERS
Brand new, boxed and fully guaranteed. With fixing nuts and bolts. Size approx. 3¼in square. 0–500 volts FSD. As used by leading laboratories. Ex-stock, only 35/–, p. & p. 5/–. Two for £3, post free.

HEAVY DUTY POWER SUPPLY UNITS
Bulk Purchase. Famous manufacture. Must have cost nearly £40 each. Input 200/250 volts 50c/s a.c. Output 250 volts d.c. at approx. 175m.a. 6·3/12 volts at approx. 4 amps a.c. Robust metal rack mounting cabinet, size approx. 19 × 15 × 8in. Price only 85/–, carriage and insurance 15/–. All units are fully fused and metered.

SMOOTHING UNITS (cure your hum problems)
Beautifully made pieces of equipment. 12 volts or 24 volts d.c. input gives a fully smoothed fully regulated d.c. output. Worth £30 each. Robust metal cabinet with provision for standby battery. Brand new in maker's cartons. Price 65/–, p. & p. 15/–.

New walk-round scientific store now open at 38 Bridgend, Meadow Lane, Leeds 1. Open weekdays 9 a.m.–6 p.m. Plus all day Saturday. All items available for inspection and demonstration.

SCOOP PURCHASE TRANSFORMER SALE

Bulk purchase enables us to offer the following transformers at these ridiculously low prices. Made by a famous manufacturer and fully tested and guaranteed. **Charger Transformers.** 0–9–15V 2A. 9/6 each, p. & p. 2/6. Two for 17/6 postfree. **Transistor Power Pack Types.** 6·3V at 2A, 7/6 each, p. & p. 2/6. 12V at 2A, 12/6 each, p. & p. 2/6.

GLOBE SCIENTIFIC LTD
DEPT. P.E., 24 CAWOODS YARD, MILL STREET, MARSH LANE, LEEDS 9
Callers welcome for a demonstration

TRANSISTOR SUBSTITUTION HANDBOOK

AMERICAN, JAPANESE, BRITISH, ETC. NEW 9th EDITION. 16/-. P. & P. 1/6

49 EASY TRANSISTOR PROJECTS by Brown. 16/-. P. & P. 1/3.

F.E.T. PRINCIPLES AND PROJECTS by Noll. 42/-. P. & P. 1/6.

INDUSTRIAL TRANSISTOR CIRCUITS by Lytel. 24/-. P. & P. 1/6.

101 EASY AUDIO PROJECTS by Brown. 28/-. P. & P. 1/6.

ELECTRONIC MUSICAL INSTRUMENT MANUAL by Douglas. 55/-. P. & P. 2/-.

PRINCIPLES OF TRANSISTOR CIRCUITS new 4th ed. by Amos. 25/-. P. & P. 1/6.

R.C.A. HOBBY CIRCUITS MANUAL. 17/6. P. & P. 1/6.

SILICON CONTROLLED RECTIFIERS by Lytel. 21/-. P. & P. 1/6.

AUDIO AMPLIFIERS by Data. 10/6. P. & P. 1/-.

ELECTRONIC NOVELTY DESIGNS by Kampel. 8/6. P. & P. 1/-.

TRANSISTOR CIRCUITS FOR RADIO CONTROLLED MODELS by Boys. 7/6. P. & P. 1/-.

UNIVERSAL BOOK CO.
12 LITTLE NEWPORT ST., LONDON, W.C.2
(Leicester Square Tube Station)

CRESCENT RADIO LTD.

(electronic component specialists)
For all regular components try
40 Mayes Road, Wood Green, N.22
For surplus components and equipment try
11 Mayes Road, Wood Green, N.22

Printed circuit board, 8 × 6in	2/– each
Zener diode 8·2 volt, 400mW	2/6 each

BARGAIN BOARDS
Transistors, diodes, resistors, capacitors and various components all mounted on computer board, 2/– each, 3 for 5/–, 7 for 10/– and 15 for 20/–

MODEL MOTOR

12 volt, 9,000r.p.m., 400mA	4/6 each

TRANSISTORS & DIODES

AC127	4/6 each
OC19	5/– each
2N2926	3/6 each
BC147	4/6 each
BYZ12	7/6 each
OA47	1/– each
AA120	2/6 each
OA6	1/6 each
M3	1/– each

BARGAIN PACK

50 unmarked and untested transistors	10/6 per pack

SILICON DIODE RECTIFIERS

750mA, 800p.i.v.	3/3 each

COMPONENT BARGAINS

D.P. rotary ON/OFF mains switches	2/– each
Car fuseholders complete with lead and tages	1/3 each
Low impedance transistor earpiece	1/6 each
Slab aerial transistor type	2/9 each
LA3 type pot core 45mh	4/6 each
2¼in. transistor loudspeaker 80 ohm	5/6 each
Rev counters (tape recorder type)	5/– each

CASSETTES

C60	12/6 each
C90	18/6 each

With our new premises in Mayes Road we can now offer an even wider selection of components for the home constructor and enthusiast.

POSTAGE WITH ORDER PLEASE; P.S. Our new catalogue is now available at 1/6 per copy

4-STATION INTERCOM

£7/15/0

Solve your communication problems with this **4-Station Transistor Intercom** system (1 master and 3 Subs), in de-luxe plastic cabinets for desk or wall mounting. Call/talk/listen from **Master** to **Subs** and **Subs** to **Master**. Ideally suitable for Business, Surgery, Schools, Hospital, Office and Home. Operates on one 9V battery. On/off switch. Volume control. Complete with 3 connecting wires each 66ft. and other accessories. P. & P. 7/6.

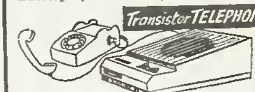
MAINS INTERCOM
No batteries—no wires. Just plug in the mains for instant two-way, loud and clear communication. On/off switch and volume control. Price 12 gns. P. & P. 9/6 extra.

INTERCOM/BABY ALARM

65/-

Same as 4-Station Intercom for two-way instant communication. Ideal as Baby Alarm and Door Phone. Complete with 66ft. connecting wire. Battery 2/6. P. & P. 4/6.

Transistor TELEPHONE AMPLIFIER



59/6

Why not boost business efficiency with this incredible De-Luxe **Telephone Amplifier**. Take down long telephone messages or converse without holding the handset. A useful office aid. On/off switch. Volume control. Battery 2/6 extra. P. & P. 3/6. Full price refunded if not satisfied in 7 days.

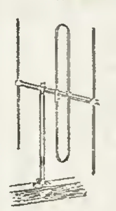
WEST LONDON DIRECT SUPPLIES (PE/3)
169 KENSINGTON HIGH STREET, LONDON, W.8

NEW RANGE BBC 2 AERIALS

All U.H.F. aerials now fitted with tilting bracket and 4 element grid reflectors.

Loft Mounting Arrays, 7 element, 37/6. 11 element, 45/-. 14 element, 52/6. 18 element, 60/-. **Wall Mounting with Cranked Arm,** 7 element, 60/-. 11 element, 67/-. 14 element, 75/-. 18 element, 82/6. **Mast Mounting** with 2in. clamp. 7 element, 42/6; 11 element, 55/-; 14 element, 62/-; 18 element, 70/-. **Chimney Mounting Arrays, Complete,** 7 element, 72/6; 11 element, 80/-; 14 element, 87/6; 18 element, 95/-. Complete assembly instructions with every unit. **Low Loss Cable, 1/6 yd. U.H.F. Pre-amps** from 75/-. State clearly channel number required on all orders.

BBC · ITV AERIALS



BBC (Band 1). Telescopic loft, 25/-. External S/D, 30/-. "H", £2.15.0.

ITV (Band 3). 3 element loft array, 30/-. 5 element, 40/-. 7 element, 50/-. Wall mounting, 3 element, 47/6. 5 element, 52/6.

Combined BBC/ITV. Loft 1+3, 40/-; 1+5, 50/-; 1+7, 60/-; Wall mounting 1+3, 57/6; 1+5, 67/6; Chimney 1+3, 67/6; 1+5, 75/-.

VHF transistor pre-amps, 75/-.

COMBINED BBC1—ITV—BBC2 AERIALS 1+3+9, 70/. 1+5+9, 80-/. 1+5+14, 90/-. 1+7+14, 100/-. Loft mounting only. Special leaflet available.

F.M. (Band 2). Loft S/D, 15/-, "H", 32/6, 3 element, 55/-. External units available. Co-ax. cable, 8d. yd. Co-ax. plugs, 1/4. Outlet boxes, 5/-. Diplexer Crossover Boxes, 13/6. C.W.O. or C.O.D. P. & P. 6/-. Send 6d. stamps for illustrated lists.

CALLERS WELCOME
OPEN ALL DAY SATURDAY

K.V.A. ELECTRONICS (Dept. P.E.)
40-41 Monarch Parade
London Road, Mitcham, Surrey
01-648 4884

Published about the 15th of the month by IPC Magazines Ltd., Tower House, Southampton Street, London, W.C.2, at the recommended maximum price shown on the cover. Printed in England by THE CHAPEL RIVER PRESS, Andover, Hants. Sole Agents—Australia and New Zealand: GORDON & GOTCH (A/sia) Ltd.; South Africa and Rhodesia: CENTRAL NEWS AGENCY LTD.; East Africa: STATIONERY & 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

for complete listening satisfaction choose either the—

MA66 6 WATTS MONO OR 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.

MA7 MONO **£8.10.0** — OR STEREO POST PACKING 5/- EITHER MODEL — MA66 **£16.10.0** — OPTIONAL MAINS UNIT PS20 £2 6d pp 4 -

Illustrated leaflets 12 and 14 FREE on request

ELECTRONIC ORGANS KITS TO BUILD YOURSELF AND COMPLETE UNITS

The MAYFAIR *Acclaimed by everyone*

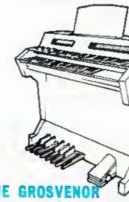
A completely new development in portable electronic musical instruments and a new field for the home constructor. The 'MAYFAIR' produces a multitude of the most pleasing sounds with a wide range of tone colours suitable for classic or popular music. **The organ is fully polyphonic, that is full cords can be played over the entire keyboard.** Supplied as a kit of parts which includes 165 transistors, printed circuit panels, special fully sprung and depth of touch adjusted keyboard, attractive vynair covered cabinet with carry handle.

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 MAYFAIR 99 GNS
BROCHURE 9

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

★ The GROSVENOR



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 PAIR 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	R.F. Generator	21 0 0	—
29x	Xtal R.F. Generator	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.

MULLARD 1 WATT AMPLIFIER

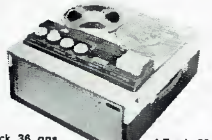
PORTABLE TRANSISTOR UNIT with volume control
Many uses. Intercoms, Baby Alarms, Guitar Practice, Telephone or Record Player Amplifier.
Optional Rexine covered Wood cabinet 12 x 9 x 4, 12/6.
7 x 4 in. speaker, 17/6
Uses PP9 battery.

45/- pp. 3/6d.

Ask 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.**



2 Track 36 gns. — 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.
ASK FOR BROCHURE 6.
Today's Value £80.

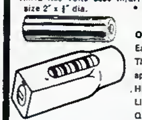
VHF FM SUPERHET TUNER MKII

. 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 *real sound*. Excellent stability, economically priced.
PARTS TOTAL COST £6.19.6.
DECODER £5.19.6.
(CABINET 20/-) ASK FOR LEAFLET 3.

NEW—MALLORY LONG LIFE MERCURY BATTERIES 50% OFF LIST PRICES

*RM12 1.35 volts 3600 m/aH **OUR PRICE 5/- each**
size 2" x ⅝" dia.



* **RM625 10.35 volts 350 m/aH Pack of 8. Size 2⅛ x ⅝ 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.

GARRARD RECORD DECKS

ALL BRAND NEW at huge savings

	£	s.	d.
2025 Mono/Stereo GKS 25	8	8	0
3000 LM Mono/Stereo 9 TAHC	9	19	6
SP25 Mk II	11	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	6	19	6
B.S.R. MA65	9	19	6
B.S.R. MA70	12	12	0
B.S.R. MA75	16	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*

TRANSISTORS

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 Extn 4.

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/-

HI-FI equipment to suit EVERY POCKET

VISIT OUR NEW HI-FI CENTRE at 309 EDGWARE ROAD AND SAVE UP TO £25 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**