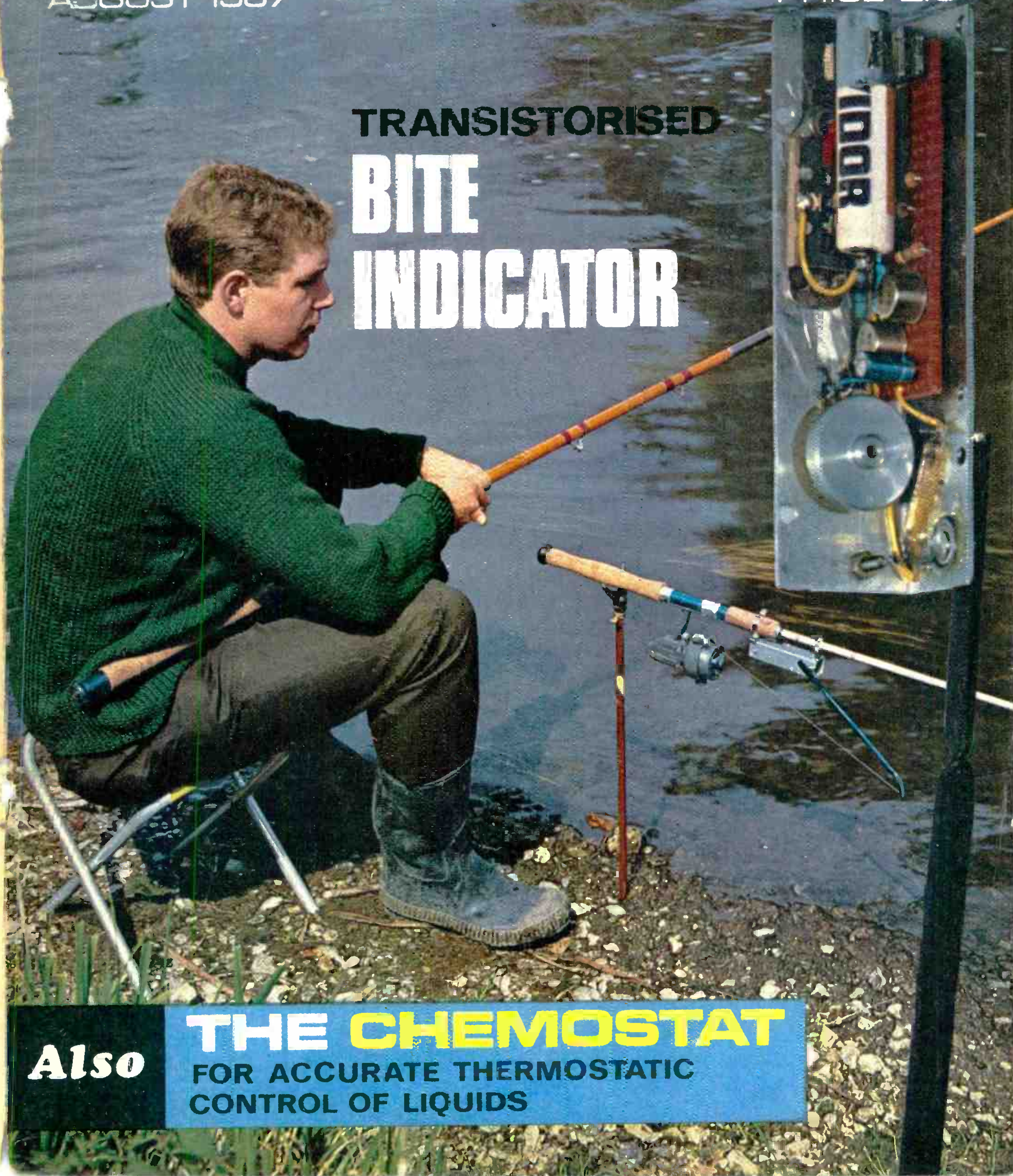
PRACTICAL ELECTRONICS

AUGUST 1967

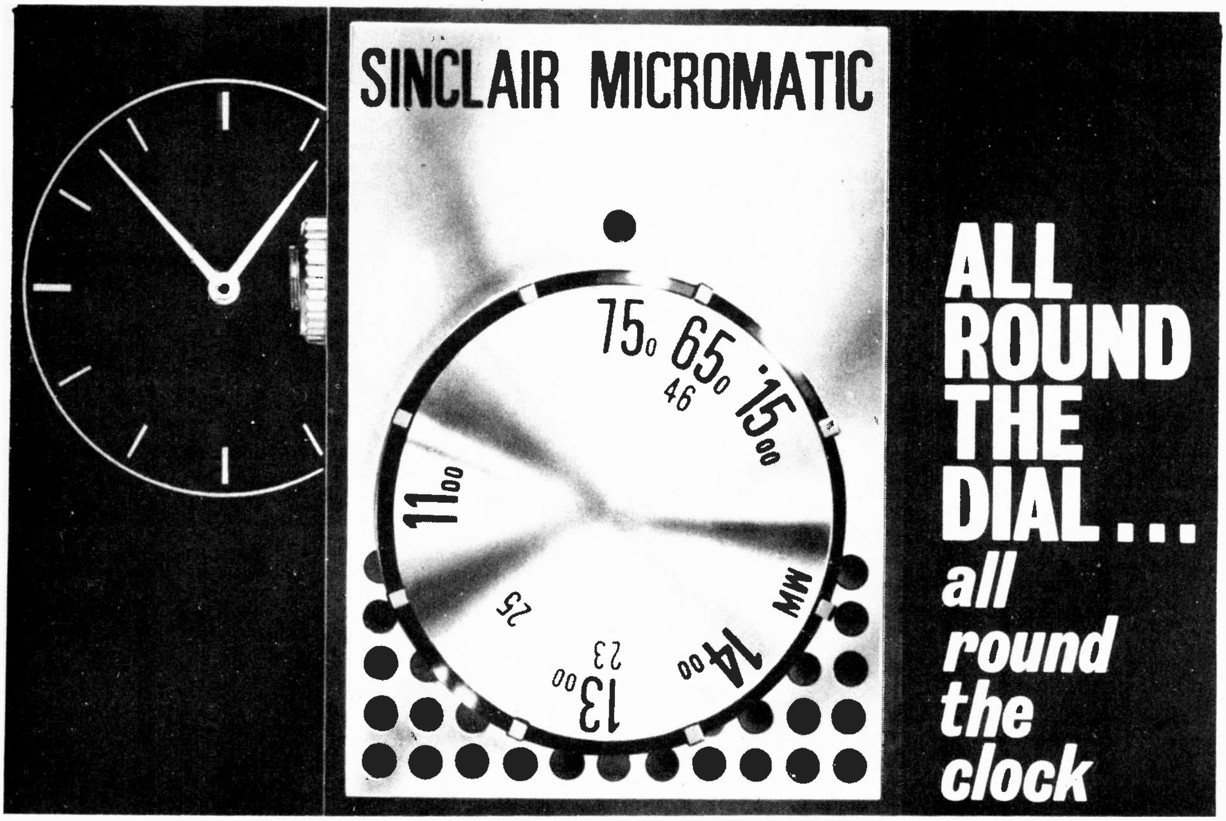
PRICE 2/6

TRANSISTORISED BITE INDICATOR



Also THE CHEMOSTAT

FOR ACCURATE THERMOSTATIC CONTROL OF LIQUIDS


SINCLAIR MICROMATIC
ALL ROUND THE DIAL...
all round the clock

FULLY GUARANTEED INDIVIDUALLY PACKED VALVES

AC/HL	6/-
ACP4	6/-
AC6PEN	5/-
AL60	5/-
AR8	5/-
ARP3	3/-
ARP12	2/6
ATP4	2/3
ATP7	5/6
AU7	55/-
AZ31	9/-
B6H	15/-
BD78	40/-
BL63	10/-
BS4	8/-
BS5	20/-
BS84	47/6
BY214	7/6
B2134	16/-
CC3L	2/-
CY31	6/6
D1	1/6
D41	3/3
D61	6/-
D77	3/-
DA30	12/6
DA100	120/-
DAF96	6/-
DD41	4/-
DF73	5/-
DF91	3/-
DF92	3/-
DF96	6/6
DK96	5/6
DL63	8/-
DL92	4/-
DL93	4/-
DL94	5/9
DL96	7/-
DL810	8/-
DY86	7/6
E80F	23/-
E88CC	12/-
E90CC	10/-
EA50	1/-
EA73	7/-
EABC80	5/9
EAC91	3/6
EAF42	8/-
EB34	1/6
EB91	3/-
EBC33	6/-
EBC41	8/6

EBC80	5/-
EBF80	6/6
EBF83	7/6
EBF89	6/9
EBL31	20/-
EC52	4/-
EC53	12/6
EC70	4/-
EC90	6/-
EC91	3/-
ECC32	4/-
ECC33	10/-
ECC81	4/-
ECC82	5/-
ECC83	6/-
ECC84	5/6
ECC85	6/6
ECC91	4/-
ECC189	9/6
ECF80	7/-
ECF82	7/-
ECH35	12/6
ECH42	9/-
ECH81	5/-
ECH83	7/6
ECL80	6/-
ECL82	6/3
ECL83	10/-
ECL86	9/-
EF36	3/6
EF37A	7/-
EF40	8/-
EF41	6/-
EF50	2/6
EF52	6/-
EF55	8/-
EF71	7/6
EF72	5/-
EF73	5/-
EF74	4/-
EF80	5/-
EF85	4/6
EF86	6/6
EF89	5/-
EF91	3/6
EF92	2/-
EF95	5/-
EF95	5/-
EF183	6/6
EF184	6/6
EH90	7/6
EL31	15/-
EL32	3/9

EL34	10/-
EL35	5/-
EL37	16/-
EL38	17/6
EL41	8/-
EL42	8/-
EL50	8/-
EL81	8/-
EL83	6/3
EL84	4/3
EL85	7/6
EL91	4/6
EL95	5/-
EM31	5/-
EM80	6/-
EM81	7/-
EM84	6/3
ESU74	80/-
ESU208	6/-
EY51	5/6
EY86	6/6
EY91	3/-
EZ40	6/6
EZ41	6/6
EZ80	5/6
EZ81	4/6
F/6057	5/-
F/6061	5/-
F/6063	4/-
FW4/500	6/6
FW4800	8/6
G50/2G	5/-
GM4	45/-
GZ32	10/-
GZ34	10/-
H30	3/6
HK54	22/6
HL2K	2/6
HL23	6/-
HL23DD	5/-
HL41	4/-
HVR2	9/-
K3A	30/-
KT32	8/-
KT33C	6/-
KT44	5/9
KT63	4/-
KT66	16/-
KT67	25/-
KT71	5/-
KT76	8/6
KT88	22/-
KTZ41	6/-

KTZ63	5 -
MH4	5/-
ML6	6/-
N34.	8/-
N78	15/-
NE17	7/-
OA2	5/9
OB2	6/-
OB3	7/-
OC3	5/-
OD3	5/-
OZ4A	5/-
P41	4/-
PC86	9/-
PC88	9/-
PC97	7/6
PC900	12/-
PCC84	5/6
PCC89	10/-
PCF80	6/3
PCF82	6/6
PCF84	6/-
PCF86	8/-
PCF801	8/6
PCF802	9/6
PCF805	11/-
PCL81	9/-
PCL82	7/-
PCL83	8/6
PCL84	7/-
PCL85	8/6
PCL86	8/-
PEN25	4/6
PEN46	3/-
PFL200	17/6
PL36	9/-
PL38	16/-
PL81	7/-
PL82	6/6
PL83	6/-
PL84	6/6
PL500	13/6
PM24A	5/-
PT15	13/-
PX4	14/-
PX25	12/6
PY33	8/6
PY80	5/6
PY81	5/6
PY82	5/6
PY83	6/-
PY800	7/-
PZ1-35	14/-
PZ1-75	12/-
QP21	6/-
QP25	5/-
QP230	5/-
QS95/10	5/6
QS1202	8/-
QV04/7	8/-

RS	8/-
RK72	6/-
S11E12	10/-
SP2	8/6
SP41	1/6
SP61	4/-
SP210	3/6
T41	12/6
TP22	5/-
TP25	15/-
TT15	35/-
TTR31	45/-
TZ20	16/-
TZ40	40/-
U81	8/-
U12/14	8/-
U17	5/-

UF89	6/-
UL41	7/6
UL84	5/6
UU5	7/-
UU9	8/6
UY21	7/6
UY85	5/-
VP23	2/6
VP133	9/-
VR99	7/6
VR105/30	5/-
VR150/30	5/-
VU33A	4/-
VU39	8/-
VX3208	5/-

1B22	30/-
IC5GT	6/-
1D8GT	6/-
1E7G	7/6
IF2	3/-
1G6GT	6/-
1L4	2/6
1LA6	6/-
1LC6	7/-
1LH4	4/-
IN21	3/6
1N21B	5/-
1N43	4/-
1N70	4/-
1R4	5/-
1S4	5/-
1S5	4/6

3Q5GT	7/6
3S4	4/-
3V4	5/9
4C27	35/-
4D1	4/-
5A173G	5/-
5A174G	5/-
5B/251M	40/-
5B/253M	15/-
5B/254M	40/-
5B/255M	35/-
5R4GY	9/-
5TR	7/-

TRANSISTORS

OC16	20/-	OC81	5/-	OC201	15/-	XC141	10/-
OC22	15/-	OC81D	3/6	OC202	13/-	XC142	15/-
OC25	9/6	OC81M	5/-	OC203	10/6	XC155	12/6
OC35	12/6	OC82	8/-	OC204	15/-	XC156	15/-
OC44	4/6	OC82DM	3/6	OC206	15/-	2N247	9/6
OC45	3/6	OC83	5/-	AAZ12	6/-	2N412	7/6
OC71	4/6	OC122	5/-	AC/28	4/6	2N502	19/6
OC72	5/-	OC170	5/6	BCZ11	7/6	2N585	7/6
OC73	8/6	OC200	7/6	BY38	7/6	2N1090	20/6
						2N1091	9/6

U18	6/-
U25	13/-
U26	13/-
U27	8/-
U52	4/6
U191	11/6
U801	17/-
UABC80	6/-
UAF42	9/-
UBC41	6/-
UBF80	5/6
UCC85	6/6
UCH42	8/-
UCH81	6/-
UCL82	8/-
UCL83	9/-
UF41	8/6

W21	5/-
W118	8/-
W119	9/-
X66	7/6
X81M	18/-
X118	8/-
X145	8/-
YF	1/-
Y63	5/-
Y65	4/-
Y66	8/-
Z246A/1K	190/-
Z800U	20/-
Z801U	10/-
1A3	3/-
1A5GT	5/-

1T4	3/-
2A3	5/-
2B26	8/-
2C26	5/-
2C26A	7/-
2C34	7/-
2C45	22/6
2C46	30/-
2C51	12/-
2D21	5/-
2X2	3/-
3A4	4/-
3B7	5/-
3B24	9/-
3D6	4/-
3E29	50/-
3Q4	6/-

5U4G	4/6
5V4G	8/-
5X4G	8/6
5Y3GT	5/-
5Y3WGTB	9/-
5Z4G	6/6
6AB7	4/-
6AC7	3/-
6AG5	2/6
6AG7	6/-
6AH6	10/-
6AJ7	3/-
6AK5	5/-
6AK6	6/-
6AK7	6/-
6AK8	5/9

P.C. RADIO LTD
170 GOLDHAWK ROAD, W.12
Shepherds Bush 4946
Open 9-5.30 p.m. *Thursday* 9-1 p.m.

6AL5	3/-
6AL5W	7/-
6AM5	2/6
6AM6	4/-
6AQ5	7/-
6AQ5W	9/-
6AS6	4/-
6AS7G	15/-
6AT6	4/-
6AU6	6/-
6AX4	8/-
6B4G	17/-
6B7	6/-
6B8G	2/6
6BA6	5/-
6BA7	5/-
6BE6	4/6
6BJ6	7/6
6BJ7	7/-
6BN6	8/-
6BR7	9/-
6BR8	5/-
6BW6	7/-
6BW7	10/-
6C4	6/-
6C5G	2/6
6C5GT	6/-
6C6	4/-
6C8G	3/-
6CH6	4/6
6CL6	9/-
6CW4	12/-
6D6	3/-
6F5G	5/3
6F5GT	8/-
6F6G	4/-
6F7	6/-
6F17	5/-
6F8G	6/6
6F12	4/6
6F13	5/-
6F32	4/-
6F33	20/-
6G6G	2/6
6H6GT	1/9
6H6M	2/-
6J4WA	10/-
6J5	6/-
6J5G	2/-
6J6	3/6
6J6W	6/-
6J7G	5/-
6J7M	8/-
6K6GT	5/6
6K7G	2/-

6K7GT	4/9
6K8G	3/-
6K8GT	8/3
6K8M	8/6
6L5G	6/-
6L6GA	7/6
6L7G	4/-
6L34	3/-
6LD20	5/9
6N7G	5/9
6P25	12/-
6R7	5/6
6SA7	7/-
6SA7GT	6/6
6SK7GT	4/-
6SC7	7/-
6SC7GT	5/-
6SF5GT	5/6
6SH7	3/6
6SJ7	7/-
67J7G	6/6
6SJ7Y	8/-
6SK7	5/6
6SL7GT	5/6
6SN7	3/6
6SQ7GT	6/-
6SS7	2/-
6V6G	5/-
6V6GT	7/6
6V6M	8/-
6X4	3/6
6X5G	5/-
6Y6G	8/-
6X5GT	5/3
6-30L2	8/6
6Z4	5/-
7B7	7/6
7C5	10/-
7C6	7/-
7C7	6/-
7F8W	12/6
7H7	7/3
7Q7	7/-
7V7	5/-
7Y4	8/-
7Z4	4/6
8D2	2/6
9D2	3/-
9D6	2/-
10F9	9/-
11EZ	15/-
12A6	2/6
12AH7	5/-
12AT6	5/-
12AT7	4/-

12AT7WA	5/6
12AU7	5/-
12AV6	5/6
12AX7	6/-
12AY7	10/-
12BA6	5/6
12BE6	7/-
12BH7	7/-
12C8	3/-
12H6	2/-
12J5GT	2/6
12J7GT	6/6
12K7GT	7/-
12K8M	10/-
12Q7GT	5/-
12SC7	4/-
12SG7	3/-
12SH7	3/-
12SJ7	5/-
12SK7	5/-
12SN7GT	5/9
12SR7	5/-
12Y4	2/-
14L7	7/-
14S7	18/-
15D2	6/-
19AQ5	5/-
20P4	12/6
21B6	7/-
25L6GT	5/6
25Y5	6/-
25Z4G	6/6
25Z5	7/6
25Z6GT	8/6
28D7	6/-
30C15	10/-
30C18	11/-
30F5	8/6
30FL1	10/6
30FL12	19/-
30FL13	6/-
30FL14	13/-
30L15	15/-
30P12	9/-
30P19	13/-
30PL1	15/-
30PL13	15/-
35L6GT	7/-
35T	17/6
35W4	5/-
35Z3	10/-
35Z4GT	6/-
35Z5GT	6/-
37	4/-

38	4/-
50CD6G	27/6
50L6GT	8/-
53A	7/6
57	6/-
58	6/-
59	6/-
75	5/6
76	5/-
77	6/6
78	5/-
80	5/6
81	9/-
82	8/-
84	5/-
85A2	8/-
307A	5/6
313C	25/-
350B	8/-
357A	70/-
368AS	30/-
393A	27/6
446A	8/-
6080	22/-
6146	25/-
703A	30/-
705A	10/-
715B	60/-
717A	3/-
757	18/-
803	22/6
807	8/-
808	8/-
813	75/-
815	35/-
829B	50/-
832	15/-
832A	45/-
866A	14/-
884	10/-
954	4/6
955	2/6
956	2/-
957	5/-
958A	4/-
C.R. Tubes	
09J	75/-
VCR97	28/-
VCR517	50/-
VCR517B	55/-
VCR517C	60/-
3FP7	45/-
5CP1	30/-
5FP7	25/-
88D	80/-

MANY OTHERS IN STOCK include Cathode Ray Tubes and Special Valves. U.K. Orders up to 10/-, P. & P. 1/-; 10/- to £1, P. & P. 2/-; over £1, P. & P. 2/- in the £; over £3, post free. C.O.D. 4/- extra.

NESTLÉS

HAVE VACANCIES FOR

STAFF INSTRUMENT MECHANICS

(ELECTRONIC/PNEUMATIC)

AND

STAFF ELECTRICIANS

Average salary: Weekly **£27.13.6**
Annual **£1,439**

To work on the installation and maintenance of highly automated Process plant and machinery.

Applicants should have preferably served a recognised apprenticeship.

INSTRUMENT MECHANICS

Should be fully conversant with electronic instrumentation and control circuits, and/or pneumatic control systems.

ELECTRICIANS

Should have had installation and maintenance experience of motors, hand and automatic control gear and associated circuits, rated from fractional to 150 H.P.

Successful applicants would be required to work on a 3 Shift System — Average 42½ hour week.

Holiday arrangement will be honoured.

First-class conditions include: Superannuation Fund, Social Club, Canteen and Medical Facilities.

STAFF VACANCIES EXIST FOR OTHER ENGINEERING TRADES

Please apply to the: **PERSONNEL OFFICER**

THE NESTLÉ COMPANY LIMITED
HAYES, MIDDLESEX

SAMSON'S ELECTRONICS LTD.

9-10 CHAPEL STREET
LONDON, N.W.1
Tel.: PAD 7851 Tel.: AMB 5125

SOLARTRON POWER SUPPLY SUB-UNIT TYPE A5955/2

A.C. input 100-125v. and 200-240v. Stabilised D.C. output continuously variable between 100 and 200v. at 200 mA. Also two 6·3v. A.C. at 6 amps. and one at 2 amps. Supplied BRAND NEW with instruction manual. Manual sent on a returnable deposit of 10/-. £9.19.6 and Case 10/-.

SPECIAL OFFER, BRAND NEW WESTINGHOUSE L.T. SUPPLY UNITS

A.C. input tapped 200, 220, 240va D.C. output 25·5v. 8 amps. and 5 tapped A.C. output of 6·5-7-7·5-8-8·-9-9·5-10-10·5v. 17 amps. Totally enclosed in wall mounting metal case size 16 × 10 × 8 ins. £13.10.0, carr. 10/-

SURPLUS L.T. TRANSFORMERS ALL BY FAMOUS MAKERS

A. Pri. 200-240v. Sec. (1) Tapped 38v., 40v. 10A Sec. (2), 6.2, 6.8, 7.3, 7.9, 8.5, 9, 9.5, 10, 10.6v. 18 amps. **£7/10/-**, Carr. 10/-.
B. Pri. 240v. Sec. Tapped 53.6, 55.2v. 6 amps. "C" Core, **72/6**, Carr. 7/6.
C. Pri. 200-240v. E.S. Sec. Tapped 32, 34, 38, 40, 44, 46v. 7 amps. **75/-**, Carr. 7/6.
D. Pri. 200-240v. Sec. 8v. 6 amps. **19/6**, P.P. 4/6.
E. Pri. 200-250v. Sec. Tapped 8-15-25-28-30-33-35v. 15 amps. **£6.9.6.** Carr. 10/-.
F. Pri. 240v. Sec. 50v. 4 amps. and 18-0-18v. 1 amp. **49/6**, P.P. 6/6.
G. Pri. 200-240v. Sec. Tapped 15-30v. 1½ amps. **19/6**, P.P. 4/6.

WODEN "C" CORE H.T. TRANSFORMER

Pri. 200-250v. Sec. 315-0-315v. 110 M/A, 175-0-175v. 25 M/A, 6·3v. C.T. 4 amps., 6·3v. C.T. 2 amps., 6·3v. 3 amps., 6·3v. 1 amp., 5v. 1·9 amps. **49/6**, P.P. 6/6.

PARMEKO JUPITER SERIES CHOKES

34H 60 M/A D.C., 70H 35 M/A D.C., 2·5 kv. D.C. Totally enclosed **25/-**, P.P. 5/-.

MULTI-TAPPED TRANSFORMERS

MOST TYPES, FULLY SHROUDED AND TERMINAL BLOCK CONNECTIONS.
ALL PRIMARIES 220-240 VOLTS
*** Denotes Unshrouded Types**

TYPE	SEC. TAPS	AMPS.	PRICE			CARR.
1A	25-33-40-50	15	£7	19	6	9/-
1B	25-33-40-50	10	£5	19	6	7/6
1C	25-33-40-50	6	£4	19	6	7/6
1D	25-33-40-50	3	£2	19	6	6/-
2A	4-16-24-32	12	£5	7	6	7/6
2B	4-16-24-32	8	£4	2	6	7/6
2C	4-16-24-32	4	£2	12	6	6/-
2D	4-16-24-32	2	£1	15	0	5/-
3A*	25-30-35	40	£12	15	0	15/-
3B*	25-30-35	20	£7	19	6	9/6
3C	25-30-35	10	£5	10	0	7/6
3D	25-30-35	5	£3	5	0	6/-
3E	25-30-35	2	£2	7	6	4/6
4A*	12-20-24	30	£9	15	0	10/-
4B	12-20-24	20	£5	19	6	8/6
4C	12-20-24	10	£3	19	6	7/6
4D	12-20-24	5	£2	15	0	6/-
5A	3-12-18	30	£7	5	0	7/6
5B	3-12-18	20	£5	9	6	7/6
5C	3-12-18	10	£3	5	0	6/-
5D	3-12-18	5	£2	5	0	5/-
6A	48-56-60	2	£2	17	6	4/6
6B	48-56-60	1	£1	19	6	4/6
7A*	6-12	50	£7	15	0	9/6
7B	6-12	20	£4	10	0	7/6
7C	6-12	10	£2	19	6	6/6
7D	6-12	5	£2	2	6	5/-
9A	15-30	1½		19	6	4/6
10A	1-15	2		19	6	4/6
11A	6-3	15	£1	17	6	5/6

Note: By using the Intermediate Taps many other voltages can be obtained. Example:

Range One 7-8-10-15-17-25-33-40-50 v.
Range Two 4-8-12-16-20-24-32 v.
Range Five 3-6-9-12-15-18 v.

A.C. 200-240v. RELAYS

15 amps. make contact overall size 2½ × 1½ × 1½ ins. 10/6, P.P. 2/6.

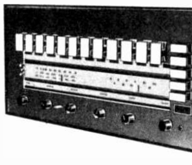
STONEBRIDGE RESETTABLE COUNTERS

4 digits. 48v. D.C. 27/6, P.P. 2/6.

Lasky's Radio

SPECIAL INTEREST ITEMS!

EXCLUSIVE LASKY'S BARGAIN—SOLID STATE MULTIPLEX STEREO AM/FM TUNER/AMPLIFIER CHASSIS



Model T10E—made for U.K. use by famous North American manufacturer and originally installed in De Luxe Hi-Fi consoles costing several hundred pounds. The chassis is of outstanding appearance and quality and offers many unique features plus an extremely comprehensive specification.

Features ● Separate transistorised AM and FM tuners ● 3 AM wavebands—LW, MW and Continental T.R. band ● full FM cover with 5 push button preselected stations (sep. tuning controls for AM and FM ranges) ● built in multiplex decoder with unique FMX feature which provides automatic switching from mono to stereo when stereo signal is received and vice versa ● unique split amplifier facility for simultaneous play of radio plus any other source ● channel reverse ● switched inputs for tape and auxiliaries (sep. sockets for tape in and out) ● switched extension speaker outlet ● thermal safety trip ● socket for stereo headphones.

Tech. spec.: Output 10 watts RMS per channel; output imp. 8 Ω p.c.; sensitivity 50mV for 8W output at 1 Kc.; input imp. 100 K Ω p.c.; 12 unique tumbler type function controls, 8 push button wavechange and station selection controls, vol., bass, treble and balance controls, push button contour (loudness) control; illuminated tuning scale; AM ranges: MW 520-1640 Kc/s, LW 140-290 Kc/s, Continental TR 170-345 Kc/s; FM range 88-108 Mc/s with switched AFC. Operates on 200/250V A.C., 50 or 60 c/s. Size 17¾ × 8 × 12in.

LASKY'S PRICE 59 Gns. Post & Packing 20/-

A range of high quality Hi-Fi Console Cabinets by the same famous manufacturer is also available at almost ⅓ list price and may be seen at our Hi-Fi Audio Centres.

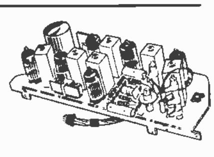
UHF T.V. TUNERS

Well known British makers' surplus stocks. Now available for the first time to the Home Constructor. Add 2/6 Post and Packing on each.

VALVE UHF MODEL

In metal case size 4 × 6 × 1½in. Fully tunable—complete with PCC86 and PCC88 valves. **LASKY'S PRICE 29/6.** Without valves **7/6**

TELEVISION IF AMPLIFIERS



38 Mc/s. Contains a large number of components, IF transformers, resistors, capacitors, etc., and the following valves: 2xPCF80, 1xEB91, EF80, EF183 and EF184. Overall size 11¼" × 3¾" × 4" deep. Ideal for servicemen and experimenters. This IF amp. when used with the Valve model UHF Tuner (above) provides a suitable conversion for B.B.C.2. Circuit supplied.

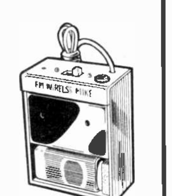
LASKY'S PRICE 29/6 Post 2/6

SPECIAL PACKAGE OFFER

Free standing table cabinet, size 17½ × 9 × 5¼in., finished in medium Mahogany. Scale marked 21 to 68 (UHF band). Designed to accept the above IF Amplifier with space for a Valve UHF Tuner **Cabinet only 27/6.** Post 3/6.

Special Package Offer IF Amplifier, UHF Tuner with valves and Table Cabinet. **PACKAGE PRICE 59/6** Post 6/-

EXPORT TTC B4002 FM WIRELESS MIC.



Highly sensitive — suitable for either static or mobile use. Signal can be picked up by any FM radio or tuner which receives frequencies between 96-104 Mc/s. over several hundred yards. Size only 3 × 2¼ × 1in. (in leather case). Operates on one PP3 type battery. Complete with neck cord, clip-on dynamic extension mike (¼ × ⅞ × 5/16 in.) and battery.

LASKY'S EXPORT PRICE 10 Gns. Post Free. Anywhere in the World.

TTC 13/500. More powerful version of above—size 7¼ × 1¾ × ¾in. Operates on one PP3 type battery. **LASKY'S PRICE 12 Gns.** Post Free. Anywhere in the World.

These cannot be operated in the U.K. owing to G.P.O. regulations.

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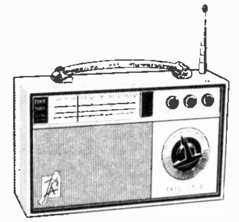
CONSTRUCTORS BARGAINS

THE SKYROVER De Luxe



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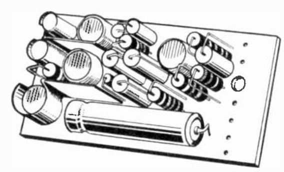
LASKY'S MINIATURE TRANSISTOR AMPLIFIER MODULES



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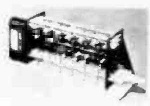

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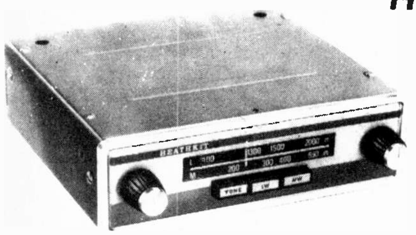

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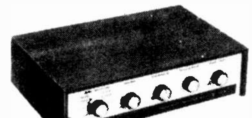

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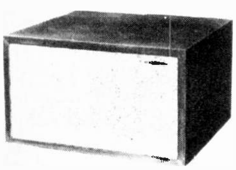

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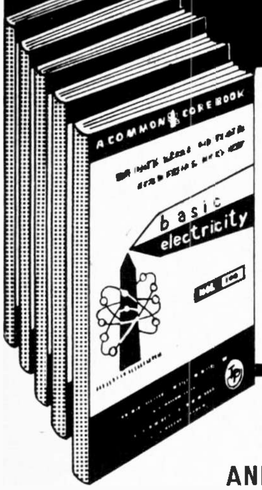

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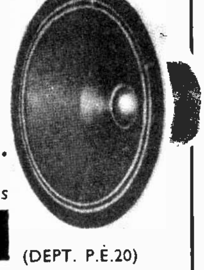

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SPECIAL OFFER: I can plus optional transferable snap-on trigger handle (value 5/-) for 18/11, carriage paid. Choice of 13 selfspray plain colours and primer (Motor car quality) also available.

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Please enclose cheque or P.O. for total amount to:
YUKAN, Dept. PE8 307a Edgware Rd., London W.2.
Open all day Saturday. Closed Thursday afternoons.

ZENER DIODES

Comprehensive range 3V to 50V in three power ratings all 5% tol. 350mW 3/6 each. 1·5W 5/- each. 7W 7/6 each.

SCR's (THYRISTORS)

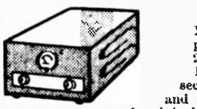
Piv	50V	100V	300V	400V
1 amp	6/6	7/6	12/6	15/-
3 amp	7/6	8/6	14/6	17/-
25 amp	30/-	35/-	47/6	60/-

SEMI-CONDUCTOR BARGAINS

Type No.	Price	Type No.	Price	Type No.	Price
2N1727	15/-	MAT101	8/6	OC71	3/6
2N1728	10/-	MAT120	7/9	OC72	5/-
2N1742	25/-	MAT121	8/6	OC75	6/-
2N1747	25/-	OA5	5/-	OC76	5/-
2N1748	10/-	OA10	6/-	OC77	7/-
AC107	9/-	OA47	3/-	OC78	5/-
AC127	9/-	OA70	2/-	OC78D	5/-
ACY17	8/6	OA79	2/6	OC81	5/-
ACY18	5/6	OA81	2/6	OC81D	5/-
ACY19	6/6	OA85	2/6	OC82	5/-
ACY20	5/6	OA90	2/6	OC83	5/-
ACY21	6/-	OA91	2/6	OC84	6/-
ACY22	4/6	OA200	3/3	OC139	8/6
AF114	7/-	OA202	4/3	OC140	12/6
AF115	6/6	OC22	10/-	OC170	5/-
AF116	7/-	OC23	17/6	OC171	6/-
AF117	5/-	OC24	15/-	OC200	9/-
AF118	10/-	OC26	7/6	OC201	12/6
AF139	12/6	OC28	15/-	OC202	13/6
AF186	17/6	OC29	17/6	OC203	12/6
AFZ12	15/-	OC35	12/6	OCP71	15/-
ASZ21	15/-	OC36	15/-	ORP12	8/6
BC107	14/6	OC42	6/6	ORP60	10/-
BY100	4/6	OC44	4/-	SB078	6/6
BYZ13	7/6	OC45	3/6	SB305	6/6
MAT100	7/9	OC70	4/-	SB251	10/-

MINIATURE RELAYS with removable covers. Very sensitive (will close on only 20 mA). Coil resistance 10,000 ohms—contacts are three sets: triple set for change over pair to open circuit and the third pair to close circuit—perfect order unused (removed from equipment), 7/6 each.
Vacuum Cleaner Flex. Non-kinkable ribbed rubber, most pliable but very tough. 24/36 Cores. Normally 1/9 per yard, offered at £3 per 100 yard coil, post and insurance 8/6.
Sub-Miniature Silicon Diodes. General purpose type with gold-plated, leads, 1/- each, 10/- per doz.
Silicon Rectifier, equiv. BY100. 750 m.a. 400v., new, perfect. 6 for £1, post free.
MAINS TRANSFORMER. Upright mounting with primary tapped 200, 220, 240 V. H.T. secondary is 250–0–250 V at 100 mA. and it has two L.T. secondaries of 6·3 V 1½ amp.—unused (removed from equipment), 15/- plus 3/6 post and insurance.
"C" CORE POTTED OUTPUT TRANSFORMER. Made by the famous "Parmeko" company these are the best money can buy, we can offer a bargain 15 watt rating, centre tapped primary with secondary for 3 ohm speaker. Potted and in black stove enamelled case for upright mounting these will make your amplifier or rig look perfect at only 12/6 plus 3/6 carriage and insurance—hurry for these.
½ MEG. POTS. By Erie, standard ¼in. spindle, 1in. long, 7d. each in doz. lots, otherwise 10d.
½ MEG. POTS WITH D.P. SWITCH. Again by Erie. Standard size spindle 1in. length. 10d. each in doz. lots, otherwise 1/3 each.
MINIATURE PICK-UP. For pop records—this is made by Cosmocord—has a crystal cartridge and long play sapphire stylus—offered for less than the wholesale price of the stylus only—namely 3/9 each or 36/- doz.

BUILDING SOMETHING?



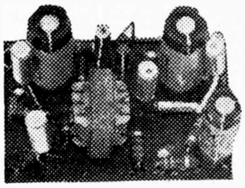
Most useful power pack with 250-0-250 V 100 mA. H.T. plus 2 × 6·3V secondary windings and standard primary fused is housed in louvred metal cabinet, size approximately 10in. × 10in. × 7in., on the front is a 2in. flush moving coil meter. Also five preset controls. Within the unit is a power pack, a lot of clear space for anything you want to fit. Below is an assortment of tag panels and components. All unused. 29/6 plus 10/- carriage and insurance.

STUPENDOUS OFFER—£11 for £2

Only recently sold for £10.9.6. Note these features: ● Long & Medium Wave ● Long dial ● Push pull output ● A.V.C and feed back ● Ferrite aerial ● Six transistors ● Cabinet size 4¾in × 3in × 1½in with carrying strap. You get everything you need and instructions. 39/6 plus 3/6 P. & P. Battery 1/9 extra. Data separately 2/6.

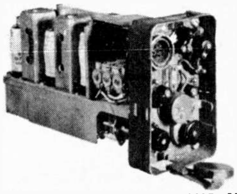
DRILL CONTROLLER

Electronically changes speed from approximately 10 revs. to max. Full power at all speeds by fingertip control. Kit includes all parts, case, everything and full instructions. 19/6 plus 2/6 post and insurance.



750 mW TRANSISTOR AMPLIFIER

4 transistors including two in push-pull input for crystal or magnetic microphone or pick-up—feed back loops—sensitivity 5mV Price 19/6. Post and insurance 2/6. Speakers 3in. 12/6; 5in. 13/6: 6in. × 4in. 14/6.



EX-WD BARGAIN Easily rebuildable to short wave radio

This is the 46 Receiver/Transmitter. It has a range of approx. 5 miles. Operates from dry batteries. Complete with six valves and in metal case. Size approx. 12in. × 6in. × 3½in. Complete but less crystal, not tested nor guaranteed, 19/6 plus 4/6 post and insurance. Should not be operated as a transmitter in the U.K

THIS MONTH'S SNIP

An excellent opportunity to re-equip your house or workshop, or if you are a contractor to restock for future ring main jobs. We offer 12 GEC switch sockets, Bakelite flush mounting or Bakelite surface mounting—your choice. Latest ring main type listed at 6/6 each. You can have a box of 12 for 30/- only—thus showing you a saving of £2.8.0. Postage and insurance 4/6 extra.

SUPERTONE G.C.V.

Saves you work—
It's partly built
Like its predecessors this latest Companion has full fi performance—such as only a good wooden cabinet and biflux speaker can give, and due to its being partly built you will have it going in an evening. Note these features:

- All Mullard Transistors including 3 × AF117.
- Two-tone Cabinet, size 11 × 8 × 3in.
- All circuit requirements—Push-pull output—A.V.C. and feed back, etc.
- Printed circuit board all wired only connections, e.g. to Volume control—W.C. Switch and Tuning Condenser.
- Pre-aligned IF stages complete with full instructions. Price only £3.19.6 plus 6/6 post and insurance.

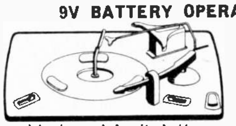
GARRARD AUTO RECORD PLAYER Model 2000

This is one of the latest products of the World's most experienced maker of fine record reproducers. Its superior features include—automatic playing of up to 8 mixed size records—stopping and starting without rejecting—manual playing—pick-up pivots to give low stylus pressure—large diameter turn-table for max. stability—adjustments include pick-up height—pick-up dropping position and stylus pressure. Size is 13½ × 1⅝in. clearance 4⅝in. above 2¼in. below—fitted with latest hi-compliance cartridge for stereo—and mono L.P. and 78. Supplied complete with mounting template and service sheet. Offered this month at the Special Snip price of £6.9.6 plus 7/6 carriage and insurance.

CASSETTE LOADED DICTATING MACHINE

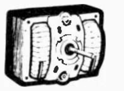
Battery operated and with all accessories. Really fantastic offer a British made £31 outfit for only £6.19.6 brilliantly designed for speed and efficiency—cassette takes normal spools drops in and out for easy loading—all normal functions—accessories include: —stethoscopic earpiece—crystal microphone has on/off switch—telephone pick-up—tape reference pad—DON'T MISS THIS UNREPEATABLE OFFER—SEND TODAY £6.19.6 plus 7/6 post and insurance. Foot-switch 18/6 extra. Spare Cassettes at 7/6 each, three for £1.

9V BATTERY OPERATED RECORD CHANGER



Made by Sanders Electronics. This provides extreme reliability under arduous conditions. Long battery life, compactness and lightness. Unit plate 10½ × 8¼in. Clearance above 3¾in., below 2⅝in. Takes Eight 7in. records, 33 or 45 r.p.m. Motor has governor giving consistant speed despite battery, voltage drop. Wow, ·4% Flutter ·2%. Heavy Zinc Turntable gives Flywheel effect with improved reproduction. Pick up is the Acos GP 79/5 Ceramic Cartridge. Frequency response 50–8000 c/s. Output 250 mV. Tracking weight 9 grams. Automatic Trip complete with mounting hardware. Leads ready for connection. 79/6 each, carriage and insurance 7/6.

MAINS MOTOR



made by Garrard for their best changers, laboratory balanced, size 2¾in. × 2¼in. Suitable for 115 V or 230/240 V working by re-arranging lead connections. 15/- each. P. & P. 4/6.

MAINS TRANSISTOR POWER PACK

Designed to operate transistor sets and amplifiers. Adjustable output 6 V, 9 V, 12 volts for up to 500 mA (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, 5,000 and 500 mfd. condensers. Zener diode and instructions. Real snip at only 14/6 plus 3/6 postage.

GANGED POTS

Standard type and size with good length of spindle—made by Morganite. List price is 10/- each but if you act quickly you can have them at 12/- doz. (or 1/6 each if less than doz.). Following values in stock. all "lin." — 10K + 10K — 100K + 100K — 500K + 500 K all new and unused. Post 2/9 on 1st doz. then 1/- per doz. 6 doz. or more post free.

TRANSISTOR SET CASE

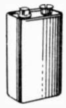
Very modern cream cabinet, size 5¼ × 3 × 1⅝in. with chrome handle, tuning knob and scale. Price 4/6 plus 2/- postage. Printed circuit board for this case TRF circuit, 2/6, superhet 3/6.

ARMCHAIR CONTROL UNIT

Remote Controller for Philips, Stella and Cossor TV sets but adaptable to most others, and to model control. Comprises 3 rock switches, two variable resistances and components including Mullard OA81—Knobs—10 way plug—11 ft. 7 way cable, etc., etc.
List price £3/3/-, yours for only 12/6 plus 2/- post and insurance.

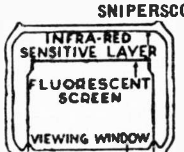
PANEL LAMP BARGAIN

An assortment of radio panel bulbs, all made by the famous Philips company. Their cost if bought retail would exceed 30/-. Offered as a parcel for 10/- post free. Parcel comprises 20 × 6·3 V, 0·3 A, 10 × 12 V, 0·1 A, 10 × 24 V, 0·05 A. All M.E.S. cap.



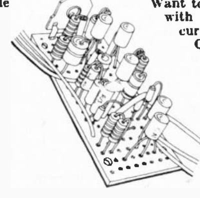
PP3 Eliminator—play your pocket radio from the mains! Save £s. Complete component kit comprises 4 rectifiers—mains dropper resistances, smoothing condenser and instructions. Only 6/6, plus 1/- post.

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.

AUDIO SWITCH



Want to open your garage door with a toot? Or close your curtains with a whistle? Or make anything obey your command? Then first you need an Audio Switch. We offer complete kit, including 5 transistors, Veroboard panel, all the resistors and condensers and the relay with diagrams, etc., for making 48/6 plus 2/6 post and insurance.

AUTOMATIC TIME SWITCH By Hurseal

12 hour, 15 A, to control heating, lighting, radio, immersion heaters, etc. Regular price £4.4.0. Limited quantity 39/6 p. & p. 3/-.

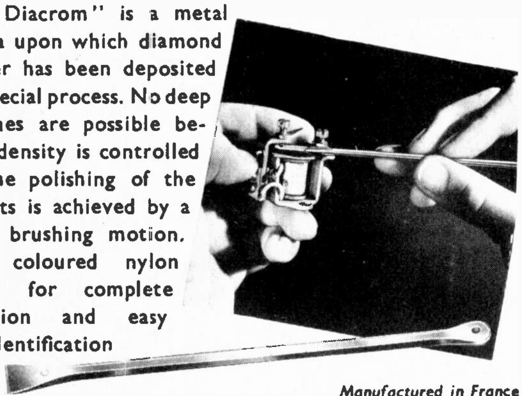
Where postage is not definitely stated as an extra then orders over £3 are post free. Below £3 add 2/9. Semi-conductors add 1/- post. Over £1 post free.

ELECTRONICS (CROYDON) LIMITED

(Dept. P.E.) 102/3 TAMWORTH RD., CROYDON, SURREY *(Opp. W. Croydon Stn.)*

also at **266 LONDON ROAD, CROYDON, SURREY**

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.

RADIOGRAM CABINETS ONLY £5.19.6

An attractive discreetly designed space saving cabinet in natural grained polyestered sapele. Press-drop flap for autochanger and record storage compartment. 10" × 5" speaker position. Complete with legs. DIM. 29½" H × 14½" D × 29" W. Carr. Ins. 25/-.

OTHER MODELS—SEND FOR LIST

17 in. TWO-YEAR GUARANTEE EX-RENTAL TELEVISIONS £11.10.0

3 star Guarantee ★ Tube ★ Valves ★ Components
Channels for all areas Insured Carriage 30/-

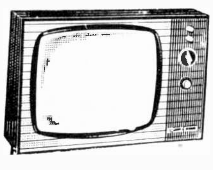
FREE ILLUSTRATED LIST

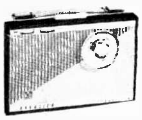
Slim line models

17" — 19" — 21" — 23"

A wide range of sizes, models and prices.

Demonstrations daily





TRANSISTOR CASES 7/6. 9½" × 6½" × 4½" P. & P. 3/6.

TRANSISTOR CASES 19/6. Cloth covered, many colours. Size 9½"×6½"×3½" P. & P. 3/6. Similar cases in plastic 7/6.

SINGLE PLAYER CABINETS 19/6. P. & P. 7/6.

T.V. TURRET TUNERS 2/6. New Less Valves. Slim Models 5/-. Press Button Models 19/6. P. & P. 4/6.

TAPE RECORDER CABINETS 49/6
Dia. 16"×12½"×7½". Red and Grey. Cut out for BSR deck. P. & P. 7/6.

DUKE & CO. (LONDON) LTD.
621/3 Romford Road, Manor Park, E.12
Phone: 01-478 6001-2-3. Stamp for Free List.

ELECTROLYTIC CONDENSERS

0·25uf.	..3V.	4uf.	..4V.	16uf.	..150V.	100uf.	..3V.
1uf.	..10V.	4uf.	..12V.	20uf.	..3V.	100uf.	..6V.
1uf.	..15V.	4uf.	..25V.	20uf.	..6V.	100uf.	..10V.
1uf.	..40V.	4uf.	..100V.	20uf.	..9V.	100uf.	..12V.
1uf.	..50V.	5uf.	..6V.	20uf.	..15V.	100uf.	..15V.
1uf.	..350V.	5uf.	..25V.	25uf.	..6V.	150uf.	..12V.
1·25uf.	..16V.	5uf.	..50V.	25uf.	..12V.	150uf.	..25V.
2uf.	..3V.	5uf.	..70V.	25uf.	..25V.	200uf.	..3V.
2uf.	..9V.	6uf.	..12V.	25uf.	..30V.	200uf.	..4V.
2uf.	..10V.	6uf.	..15V.	30uf.	..6V.	200uf.	..16V.
2uf.	..15V.	6·4uf.	..40V.	30uf.	..10V.	250uf.	..2·5V.
2uf.	..70V.	8uf.	..3V.	30uf.	..15V.	250uf.	..9V.
2uf.	..150V.	8uf.	..6V.	32uf.	..1·5V.	250uf.	..15V.
2·5uf.	..16V.	8uf.	..50V.	32uf.	..25V.	320uf.	..2·5V.
2·5uf.	..25V.	10uf.	..6V	40uf.	..3V.	500uf.	..4V.
3uf.	..3V.	10uf.	..10V.	40uf.	..6·4V.	640uf.	..2·5V.
3uf.	..12V.	10uf.	..12V.	50uf.	..6V.	750uf.	..18V.
3uf.	..25V.	10uf.	..25V.	50uf.	..9V.	1000uf.	..6V.
3·2uf.	..6V.	12·5uf.	..4V.	64uf.	..2·5V.		
3·2uf.	..6·4V.	12·5uf.	..40V.	64uf.	..9V.		
3·2uf.	..40V.	16uf.	..16V.	64uf.	..10V.		
3·2uf.	..64V.	16uf.	..30V.	64uf.	..40V.		

All at 1/- **each, 9/- per dozen.** Mixed packet (our selection) **20 for 10/-.** 200/100uf., 275V.; 200/200uf., 275V.; 125/300/50uf., 275V.; **5/- each** or **3 for 10/-.**

PAPER CONDENSERS

0·001uf.	..500V.	0·005uf.	..750V.	0·1uf.	..350V.	0·5uf.	..150V.
0·001uf.	..1000V.	0·02uf.	..600A.C.	0·1uf.	..750V.	0·5uf.	..350V.
0·002uf.	..500V.	0·02uf.	..350V.	0·25uf.	..350V.	0·5uf.	..500V.

All at **15/- per 100,** or mixed packet (our selection) **50 for 10/-.**

VERY SPECIAL VALUE! SILVER MICA, POLYSTYRENE, CERAMIC CONDENSERS
Very well assorted. Mixed types and values. **10/- per 100.**

RESISTORS
Very small ⅛ watt, 5% long leads, ideal for transistor work. **10/- for 50.**
¼ watt assorted values including printed circuit types, **10/- for 100, 55/- per 1,000.**
½ watt to 3 watt mixed values and types, **10/- for 100, 55/- per 1,000.**
TO CLEAR: 10 Meg. 1/6th watt resistors, **£1 per 1,000.**
WIRE-WOUND 3 watt, 5 watt—**6d each.**
7 watt, 10 watt—**9d. each.**
Most values, 1 Ω to 47K Ω.

TRANSISTORS
AFZ12, Screened V.H.F. oscillator transistors, **5/- each.**
OC44, 45, 81D—**2/6d each.**
OC71 equivalent, **1/- each, £3 per 100.**
Switching Transistors ASY22 (pnp) or I.B.M. (npn), **6 for 10/-.**
Car radio type Output Transistors type NKT40S, **10/- each.**
UNMARKED, UNTESTED TRANSISTORS—**50 for 10/-.**
LIGHT-SENSITIVE TRANSISTORS SIMILAR TO OCP71—**2/- each.**

TELEVISION VALVES. BRAND NEW AND BOXED
PCF80, 7/6; PL81, 7/6; PCL82, 7/6; PCL85, 7/6; PCL84, 7/6; PCC84, 6/6; PY81, 6/-; ECC82, 6/6; PL36, 9/-; EY86, 6/-; PCL83, 9/-; PY33, 9/-; ECL80, 6/6; PCC89, 9/-.

Silicon diodes. Make excellent detectors. Also suitable for keying electronic organs. **1/- each or 20 for 10/-.**
BY100 TYPE TELEVISION H.T. RECTIFIERS, SPECIAL PRICE **5/- each, 30/- dozen.**
ORP12 light sensitive resistors, **9/- each.**
TRANSISTOR BATTERY ELIMINATORS—same size as PP9, **30/-**; PP6, **20/-.**
BATTERY CHARGERS, with meter and fuse, 4 amp. 6/12V., **55/- each.**
SOLON MODEL 615 Slim Pencil-bit Soldering Irons, **25/- each.**
WELLER DUAL-HEAT SOLDERING GUN, **57/6.**
NUTS, SCREWS and WASHERS, very useful assorted packs, **6/- each.**
WALKIE-TALKIES (not for use in U.K.), **£7/10/- pair.**

SIGNAL INJECTOR, parts and circuit to make, **10/- only.**
SIGNAL TRACER, parts and circuit to make, **10/- only.**
MOTOR CAR REV. COUNTER (less 1mA meter), parts and circuit to make, **10/- only.**
TRANSISTORS, COMPONENTS AND CIRCUIT to convert 1mA meter to 0 to 10 Meg. ohm meter, **10/-.**
TRANSISTORISED RUMBLE AND SCRATCH FILTER (for improving reproduction of old records), all components and circuit, **30/-.**

SINCLAIR. All products in stock including latest version of MICRO-6—World's smallest radio—and only **59/6!**

NEEDLES FOR RECORD PLAYERS. HALF PRICE!
All types below at **3/6 each!**
TC8LP; GC2LP; GC8LP; BF40LP; GP67LP; GP37; GP59; TC8 Stereo LP; Studio O LP.
CARTRIDGES
SONOTONE MONO, **10/-**. ACOS, **15/-**. ACOS STEREO SAPPHIRE **12/6**; DIAMOND, **17/6.** All complete with needles!

LAPEL MICROPHONES, Magnetic or Crystal, **10/- each.**
TAPE RECORDER MICROPHONES, Fantastic value at **12/- each.**
ACOS MIC. 4S, **30/-.** Many others, both crystal and dynamic in stock.

THIN CONNECTING WIRE. 10yd., **1/-**; 100yd., **7/6**; 500yd., **25/-**; Post 4/6. 1,000yd., **40/-.** Post 6/-.

LOUDSPEAKERS. 12in. Richard Allen, **37/6d.** 12in. Bakers Guitar, **£5/5/-.** 3in., 4in., 5in. and 5in × 3in., all at **10/- each**; 8in. × 2¾in., **12/6**; 2in. 80 ohm, **7/6.**
EARPIECES. Magnetic or Crystal, **5/- each.**

VEROBOARD
2½in. × 5in., **3/11**; 2½in. × 3¾in., **3/3**; 3¾in. × 5in., **5/6**; 3¾in × 3¾in., **3/11.**
Terminal Pins, **50 for 3/-**; Spot Face Cutter, **7/3**; Pin Insert Tool, **9/6.**
Special Offer—Cutter and 5 boards, 2½in. × 1in., **9/9.**

ORDERS BY POST—TO G. F. MILWARD, 17 PEEL CLOSE, DRAYTON BASSETT, STAFFS.

PLEASE INCLUDE APPROPRIATE POSTAGE COSTS

No Enquiries without stamped addressed envelope

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Rock Exchanges, 231 Alum Rock Road, Birmingham 8

VOL. 3 No. 8
AUGUST 1967

PRACTICAL ELECTRONICS

NEW ROLES IN MICROELECTRONIC INDUSTRY

THE likely impact of microelectronic techniques upon future product developments has excited much attention. Complex data processing systems and control equipments for industry; desk top calculators for the office; hi fi equipment and automatic washing machines for the home—these are just some of the diverse applications where, it is said, integrated circuits are bound to have an important influence.

No one will doubt that the improved products made possible by the new techniques will bring about many profound changes in everyday life, in one way or another. What is perhaps less generally appreciated is the "revolution" the electronic industry itself faces due to this large scale movement from discrete components to integrated circuits.

There seem to be two major "domestic" problems created by the microelectronic era: one concerns the function of the manufacturers, and the other the function of their design staff.

Some companies which previously manufactured discrete components only are now producing thin film circuits or semiconductor chips. This means they are in reality assuming the role of circuit designer. Their old customers, the electronic equipment manufacturers, may therefore find themselves relegated in part to the role of assemblers of someone else's circuit blocks. In an attempt to prevent this, some equipment firms are setting up their own integrated circuit production units. It is thus obvious that the once fairly clear-cut distinction between component manufacturer and equipment manufacturer will cease to exist in the future.

The second problem we have referred to concerns the role of the design engineer.

It has been suggested by some authorities that design engineers will be eventually classified as "device" men, or "systems" men. Only one in about ten (it is suggested) will be required in the first category, which involves circuit design; the great majority will find employment as systems designers, and to them the integrated circuit will be merely a "black box". This latter role is of course comparable with that of the computer engineer.

Yes, major changes are on the way. But in this latest technological revolution the repercussions will (in their own way) be no less dramatic and far-reaching for the innovators, than for the users of the finished electronic equipment.

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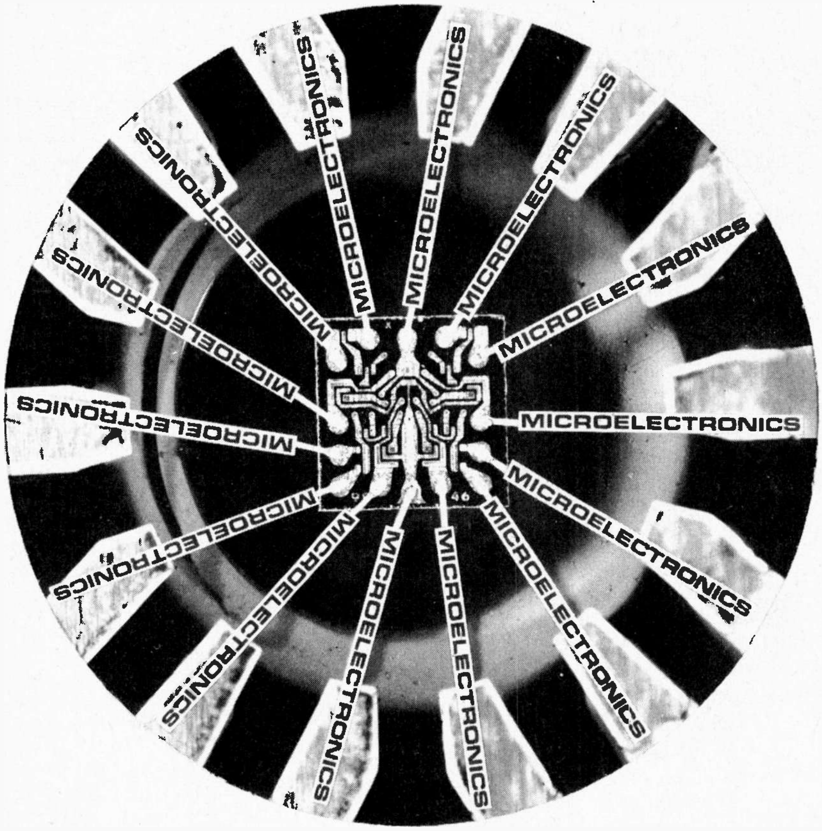


PART ONE

WITHOUT any shadow of doubt the last few years have seen a revolution with the widespread introduction of microelectronic circuits to industry. Until now very little has been seen of these devices on the amateur market largely because of their relatively high price, or availability, but the time is now with us when it is possible to buy modular, thin film integrated, and semiconductor integrated circuits for a matter of shillings—the same devices having cost as much as £50 as recently as 1960.

By M.J.HUGHES M.A.

WHY MINIATURISE?

Why is it necessary, or desirable, to aim at smaller and smaller components and circuits? The answer is not quite as simple as might appear at first sight. It is obviously desirable to have small, compact units when building vast complex electronic equipments, but this is not the end of the story.

As modern computers get faster in their speeds of operation, engineers now find that they are not so limited by switching speeds of circuits themselves, but by the distance signals have to travel down wires. (The speed at which an electrical signal passes down a wire is approximately 3×10^{10}cm per second—the speed of light.) If we were to consider the typical case of a wire 100cm in length, the time for a signal to travel from one end to the other would be approximately 3 nanoseconds.

There are already in existence circuits with switching speeds faster than this; therefore, the actual wiring length of a computer complex could be a serious limiting factor to the computer's speed of operation. The only way to overcome this problem is to keep interconnection wires as short as possible, therefore the packing density of the components must be high. A second, and more down to earth point, is that by modern techniques of manufacture—which will be described later in this article—the smaller the circuit the cheaper it is to manufacture.

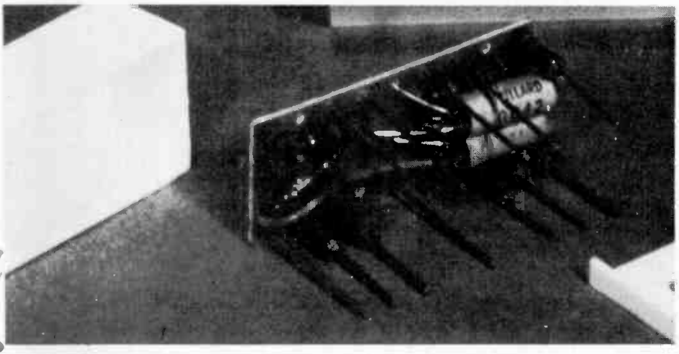
It is inevitable that whatever one gains on one hand one loses on the other, and microelectronics is no exception. Although it is quite possible to reduce the size of components to microscopic dimensions, it is not always possible to reduce such factors as power dissipation. The smaller and more dense circuits become, the more difficult it is to remove heat produced by the mundane effect of current passing through a component. This particular phenomenon has to be overcome by careful circuit design to keep dissipation to a minimum, wherever necessary by using special high thermal conductivity packaging to dissipate unwanted heat into the atmosphere.

Another problem which becomes highly relevant as size comes down is the effect of parasitic capacitance, and mutual inductance between components and this can only be prevented by the skill of the designer. There are many other associated problems, and some of these will be mentioned later.

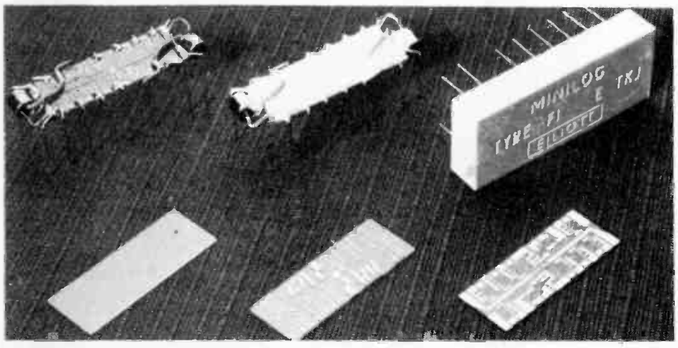
THREE MAIN LINES

As has already been implied there are three main lines towards miniaturisation; these are modular circuits which are made by high density wiring of conventional (discrete) components into encapsulated units; thin film integrated circuits which are made by depositing thin layers of metal on to glass substrates to form equivalents of resistors and capacitors on a micro scale, to which more or less conventional transistors are added.

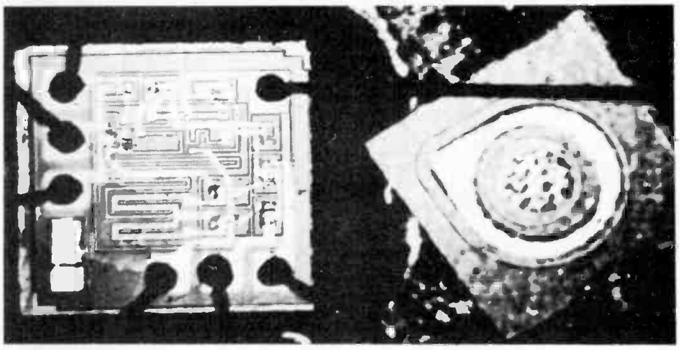
The third method, and perhaps that which is most likely to provide devices on the work bench of the amateur (from the cost point of view) is the integrated circuit—sometimes called the semiconductor integrated



A typical Elliott modular circuit with discrete components



Thin film version of an Elliott logic circuit shown in its manufacturing stages



Semiconductor integrated circuit (1½mm square) compared with a silicon planar transistor dice (right) type 2N1613 made by SGS-Fairchild

circuit, or SCIC—which as the name implies is made from semiconducting material such as silicon. In the early days of development these latter circuits were loosely referred to as "solid circuits".

MODULAR CIRCUITS

Not a great deal need be said about modular circuits; they are made by wiring conventional miniature components on to printed circuit board—sometimes highly sophisticated wiring systems are used—and when completed with suitable lead out wires, or tags the completed circuits are potted in epoxy resin such as Araldite, or Bondaglass.

It is usually impracticable to contemplate repairing such circuits, and therefore it is essential that basic designs are well within the tolerances and ratings of the individual components.

GLOSSARY

A short Glossary of terms commonly used with reference to Thin Film, and Semiconductor Integrated Circuits.

Active component—A device providing gain to a circuit, e.g. a transistor.

Angstrom (Å)—Unit of length equal to 10^{-8}cm.

Base width—The distance between the emitter and collector regions of a transistor. The narrower the base width the higher the gain of the device, but the more difficult it is to control. Base width is typically 0·5 to 1·5 micron for a planar transistor.

Bipolar—Containing *npn* or *pnp* junctions as distinct from field effect devices.

Bonding

Wire bonding—The connection of very fine gold or aluminium wires to the contact areas of circuits, thence to the lead out terminals of the package. It can be carried out by soldering in thin film circuits, but more commonly by thermal compression, or ultrasonic welding techniques.

Dice bonding—Attaching the dice, or chip, which contains the circuit, to the platform of the package which is to hold the circuit. This process is always carried out before wire bonding commences.

Bonding pads—Small areas—typically gold for thin film circuits, but aluminium for semiconductor integrated circuits—to which the fine lead-out wires can be connected by wire bonding methods.

Buried layer—A region below an epitaxially deposited growth which is heavily doped, and therefore of very low resistivity. It can be used as a basis for isolation, or more commonly as a shunt to the collector of a transistor to reduce the internal voltage drop, or saturation voltage, of the transistor.

Cermet—A combination of ceramic and metallic powders used in making thin or thick film resistors.

Charge storage—The effect whereby any *pn* junction can act as a capacitor—the depletion layer acting as a dielectric.

Chip (or dice)—A small piece of silicon, usually no more than 2mm square which contains all the elements of the circuit.

Depletion layer—The crossover region where *p* material merges into *n* material (commonly known as a junction). The region is low in holes or electrons due to the cancelling effect, and therefore is high in resistivity. This area causes the capacitance effect of *pn* junctions.

D.C. injection electroluminescence—The production of light from a junction in a semiconductor by the injection of minority carriers by a steady field.

Diffusion

Base emitter diffusion—The process of introducing an impurity or dopant into silicon by the natural migration of atoms of the dopant under the action of heat. By controlling the time and temperature of a diffusion, the depth of penetration can be very accurately controlled.

Isolation diffusion—The diffusion of channels of say *p*-type dopant into *n*-type silicon which if electrically biased in a reverse direction will isolate the silicon on both sides of the channel. This process is usually carried out in conjunction with a buried layer.

Discrete components—Conventional components with individual lead wires as opposed to integrated components.

Dopant—A material which, when added to a semi-conducting material such as silicon, will provide either free electrons or free holes (depending on whether it is an n or a *p*-type dopant). Common n-type dopants are arsenic, antimony, and phosphorus, while the most used *p*-type dopant is boron.

Dual in-line package—A very popular form of package for integrated circuits. It gets its name from the fact that there are two rows of outlet leads separated by 0·3in, and the leads in each row are in line and separated by 0·1in. (Ideal for use with 0·1in matrix perforated board.)

Epitaxial growth—The deposition of material—typically silicon—on to a substrate. Although the grown layer may differ in type or resistivity to the substrate, it follows the same crystal orientation.

Etch

Selective etching—The preferential removal of one material from a sandwich structure without affecting any other material, effected by careful selection of chemicals or acids.

Fan in—The number of inputs a logic gate can handle.

Fan out—The number of stages a logic gate can drive.

Flat pack—A very compact form of encapsulation for integrated circuits. There are various types of flat pack, but a typical example is ¼in square, and approximately $\frac{1}{16}$in thick. The lead-outs are in the same plane as the package, and are designed for welding into a circuit.

Flip chip—A piece of silicon containing perhaps a transistor, a diode, or a resistor, or any combination, which may be inverted and then bonded into a circuit (sometimes directly to printed circuit board) without any encapsulation or wire bonds. These chips usually have solder dipped bonding pads, and the chips are fixed to a well fluxed circuit board merely by the application of heat. Sometimes aluminium contacts are used, and in this case ultrasonic bonding is used.

Header—The part of a metal can to which a dice is bonded. This header usually forms part of the final package, and usually carries the lead-out wires.

Hybrid integrated circuit—A complex circuit made (in microelectronics) by the joint use of semi-conductor integrated circuits together with thin film circuits. The integrated circuits may sometimes be in the form of flip chips.

Integrated circuit (IC)—A term often referred to as a small circuit which is made up of components encapsulated in a single package. Strictly speaking, modular or thin film circuits are integrated, but the term is becoming more and more used specifically for semiconductor integrated circuits of the monolithic type.

Isolation

Dielectric isolation—The use of non-conducting materials, typically silicon dioxide, to prevent electrical conduction from one portion, or component of an integrated circuit to another.

Diode isolation—Using the high reverse resistance effect of *pn* junctions to limit conductivity between neighbouring areas of an integrated circuit.

Epitaxial isolation—This is the same as diode isolation except that the *pn* junction is formed at the boundary between the epitaxial layer and the substrate.

Resistive isolation—Making use of high resistivity (containing low dopant concentrations) silicon to limit conductivity.

Junction—The region between *p*- and *n*-type material which is deficient in current carriers (holes or electrons) and has rectifying properties.

(TO BE CONTINUED)

THIN FILM CIRCUITS

Thin film circuits are one step removed from conventional component circuits in that passive circuit components such as resistors, capacitors, interconnections, and sometimes inductors are actually fabricated in the process of making the circuit. The components are made by the process of vacuum evaporation, or sublimation of materials such as gold for conductors, nickel chromium alloy for resistors, and aluminium for the electrodes of capacitors with silicon dioxide, or monoxide as dielectric material.

VACUUM EVAPORATION

Any material has associated with it what is called a vapour pressure. This vapour pressure is caused by atoms of the material leaving the solid or liquid to go into the vapour in much the same way as "steam" can be seen over puddles on a hot day, even though the water in the puddle may not be boiling.

The number of atoms which escape from the material depend on the temperature and the pressure of the atmosphere around it; the lower the pressure the more easily atoms can escape. This effect is well known to climbers who have had the difficult experience of boiling an egg at high altitudes without the help of a pressure cooker. The water molecules in the latter case leave the liquid so easily that it is unnecessary to heat water to such a high temperature to get it boiling, and consequently the egg never cooks.

If an artificially low pressure is produced such as that in a vacuum bell jar (see Fig. 1) it is possible to boil certain metals at comparatively low temperatures. It is this principle which is used to form the thin films of metal from which thin film circuits are fabricated.

When a piece of metal such as gold is heated in a vacuum, the atoms of gold leave the heated source and move off in straight lines in all directions from the source. If the vacuum is as near perfect as possible, and there are no foreign atoms present in the space around the source, the gold atoms will travel on until they reach the cool walls of the vacuum chamber, where they condense and build up a thin layer of solid gold.

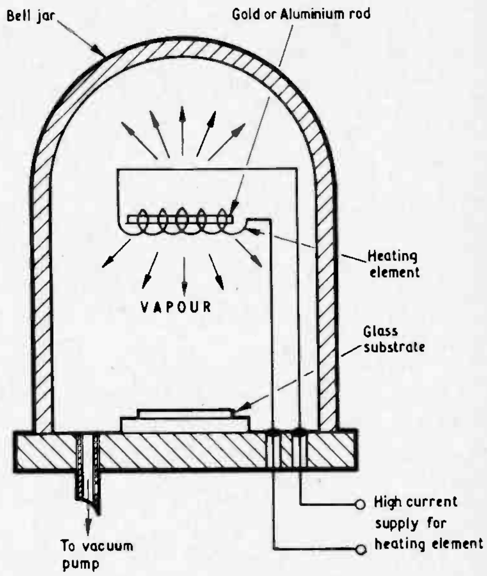
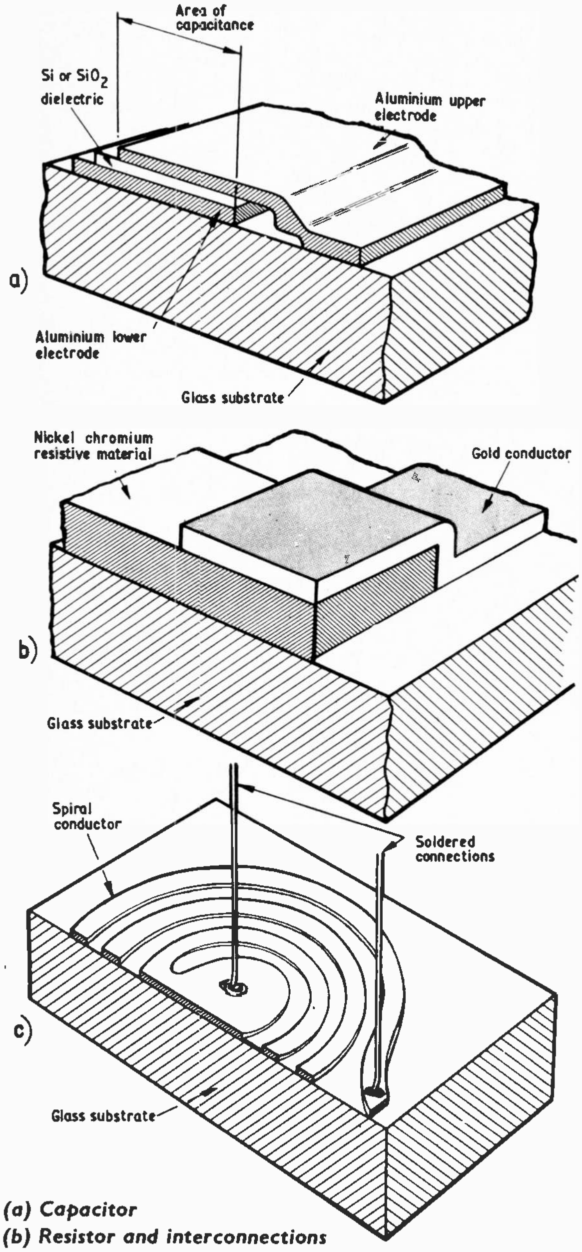


Fig. 1. Schematic diagram of an evaporation chamber

If a shaped mask is held between the source and the wall of the chamber, it will act rather like a stencil, and will reproduce its shape as a shadow pattern in the gold.

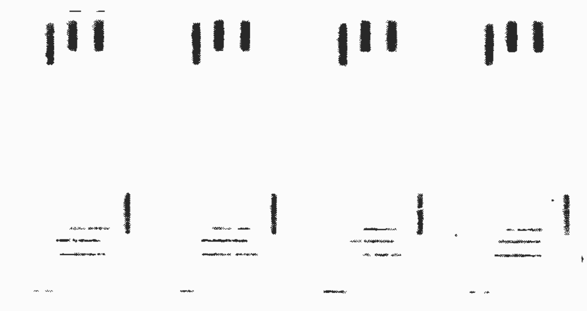
INTERCONNECTION PATTERNS

If we were to introduce a stencil with patterns cut in it to represent the connection patterns of a printed circuit, the gold would pass through the cut-out areas and faithfully reproduce this pattern either on the wall of the chamber, or better still on a "substrate" of glass or similar material, which would take the place of the insulating backing of a conventional printed circuit board. As gold is a very good conductor of electricity we would, by this method, build up a useful set of interconnection patterns.

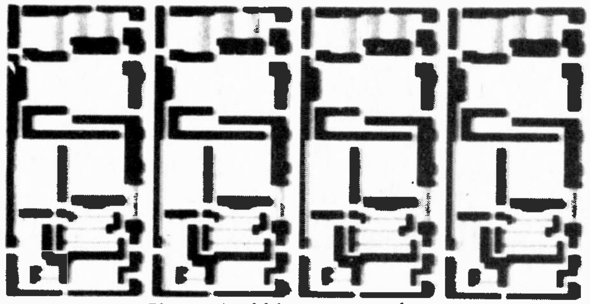


(a) Capacitor
(b) Resistor and interconnections
(c) Inductor

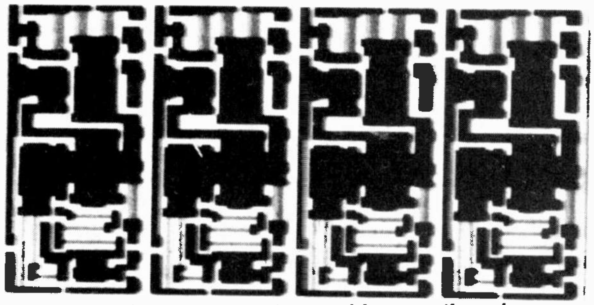
Fig. 2. Cross-section of thin film components



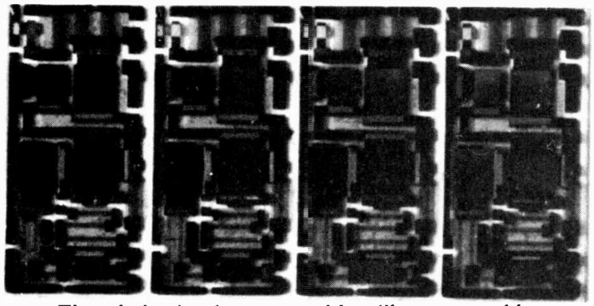
Nickel chrome resistors on glass substrate



Chrome/gold interconnections

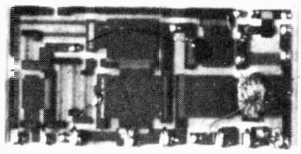


Capacitors are superimposed by stencil mask

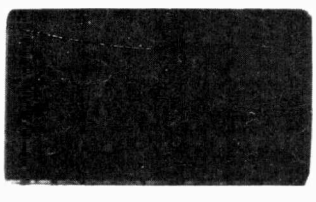


The whole circuit protected by silicon monoxide

Transistor, coil, and lead wires added to diced substrate



Finished pack (right)



These six pictures show stage-by-stage process of making an S.T.C. thin film circuit by stencil mask

In actual practice this method has to be slightly modified as gold by itself does not adhere particularly well to glass, and therefore most manufacturers carry out an intermediate process of desposíting chromium, or nickel chromium, which bonds well to glass, and will accept gold as a secondary deposit (see Fig. 2).

All materials, even gold, have certain specific resistances; these are sometimes called bulk resistivities and are constant for any particular material irrespective of its shape. This resistivity by itself does not determine the actual resistance of a piece of metal unless the dimensions of the metal are taken into account. For a given resistivity, the resistance of a material is directly proportional to its length, and inversely proportional to the area of cross section through which the current flows.

EXTREMELY THIN LAYERS

The process of vacuum deposition is capable of producing extremely thin layers of material quite often as little as 75 Ångstrom units, or $\frac{1}{100}$ of the wavelength of visible light. An Ångstrom is a unit of length used to define extremely short distances; 1 Ångstrom unit is equal to 10^{-8}cm.

The thinness of these layers limits the effective cross-sectional area, and hence the current flow path, quite considerably. By careful choice of film thickness and materials one can generate either reasonably high conductive areas, e.g. with gold, or high resistance areas with nickel chromium alloys.

Using sequential evaporation of different materials through different stencil masks it is therefore comparatively easy to build up networks of conductors and resistors. Naturally there are some limitations to the values of resistance one can produce by this method, but generally speaking short wide areas of resistive material can produce values as low as 10 ohms, and long narrow paths, which can sometimes meander or zig-zag, will give values up to 1 megohm.

As gold can be soldered very easily it is possible to attach conventional miniature components to these circuits to cover values which are not readily made by thin film methods. Although this is possible most manufacturers prefer not to adopt this practice as it is not an easy operation, and can add considerably to the cost of a circuit.

PHOTOLITHOGRAPHY

An alternative method of producing conductor and resistor patterns is by a process called photolithography. This process is used in the printing world as a method for etching patterns into metal plates from which photographs and drawings could be printed. It is now an extremely common process in the electronics industry both for making printed circuits, and perhaps more so in the production of microcircuits.

There are several plastics materials available which undergo a change called polymerisation when subjected to ultraviolet light. These materials are called photoresists. Polymerisation causes the plastics to harden, and usually tends to make it less soluble in certain solvents.

A glass substrate coated entirely in a thin layer of gold, is coated with a layer of photo-resist, either by brushing or spraying (see Fig. 3). It can then be exposed through a photographic negative of a conductor pattern, thus hardening the plastics over areas which would ultimately be the actual conductors. By using a suitable solvent—more commonly called a developer—the remaining "soft" material is removed from the rest of the substrate. With an etching solution, such as a mixture of iodine in potassium iodide, the unwanted gold areas are etched away leaving the conductor pattern.

This process is very often used to produce extremely fine patterns both for conductors and resistors and is usually called upon to produce higher values or tighter tolerances in resistors. Naturally, different etchants would be required for different materials. As the actual values and tolerances of the final resistors are directly proportional to the dimensions of the photographic image, it is very important that great care is taken in producing the negatives.

SCALED-UP PATTERN

As the types of microcircuit described here rarely exceed dimensions of 1in × ½in, all original design work is carried out many times life size, and photographic methods are used to reduce the size to the final requirements.

The designer of thin film circuits would need to calculate the dimensions of the resistors he requires knowing the resistivity, and thickness of the nickel chromium film to be used. He would then make a rough sketch (to scale) of the layout of these components and their interconnection patterns in exactly the same way as would a printed circuit designer.

When the dimensioned sketch is finished a special table, called an *x-y* co-ordinatograph is used to transfer the patterns, sometimes 20 or 30 times life size, on to a material called "cut and peel" film. This film has a tough base of transparent plastics, with a thin film of red plastics on its surface.

By using special cutters on the table it is possible to cut through the thin red film without damaging the underlying plastic base; after cutting round the required areas the unwanted red film can be stripped from the base material. The finished scaled pattern of the final circuit connections is left behind in red on a clear background.

The film is illuminated from the rear, and a special camera is used to reduce the pattern to the required size on to a high-contrast photographic plate. Sometimes the same camera can be used to step and repeat

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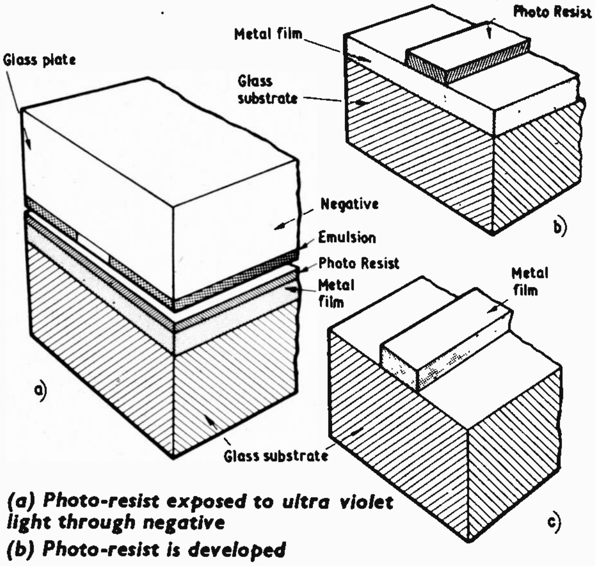

(a) Photo-resist exposed to ultra violet light through negative

(b) Photo-resist is developed

(c) After removal of photo-resist

Fig. 3. Stages in photolithography method

INVESTIGATOR OSCILLOSCOPE

Part Two

By R. Hirst

THE "Investigator" oscilloscope is simple in design and construction, so very little description is necessary. Last month the complete circuit was given with a description of each stage and its function.

Also included were drilling diagrams for the front and back panels. This month the rest of the constructional details are followed by a simple setting up procedure.

MECHANICAL ASSEMBLY

As many constructors do not possess the metal working machinery normally to be found in industrial workshops, the metal work used in this unit is kept simple. Possibly the top cover is the only piece that may prove to offer some difficulty when finally coming to the bending operation.

The main frame consists of six pieces of material: the four side struts are made from ½in square aluminium or steel each 9½in long; the end pieces form the front and rear panels (Figs. 2 and 3 last month) of the oscilloscope which are screwed to the struts. To this structure the rest of the metalwork and component board may be screwed thus forming a very rigid assembly.

The tube mounting plate again has only one simple bend and is screwed to the top struts of the main structure. This has been made adjustable by putting slots in the plate so that the plane of the tube can be orientated.

The tube is held in two places. A piece of 3in bore aluminium tubing is fixed to the front panel and is lined with foam rubber to cushion the tube screen end. The tube mounting plate is fitted with a large capacitor clip to hold the base end which is also adjustable.

The cover consists of two sections, one being the base plate which is just a simple rectangular piece of 20 s.w.g. aluminium to which is screwed a handle. This handle is not only used for carrying but also inclines the instrument on the bench so that viewing is more comfortable.

Another piece of large aluminium tubing was polished and used as a permanent viewing hood although the two pieces can be combined as one which is passed through the large hole in the front panel. This may be glued in position with Araldite. The final frame and panel assembly is shown in Fig. 4.

MAIN CHASSIS WIRING

After the main frame has been assembled with the front and rear panels, the components should be assembled on the panels and wired completely according to Figs. 5 and 6. This is possibly the longest job and great care should be taken in checking this wiring assembly before any further assembly takes place.

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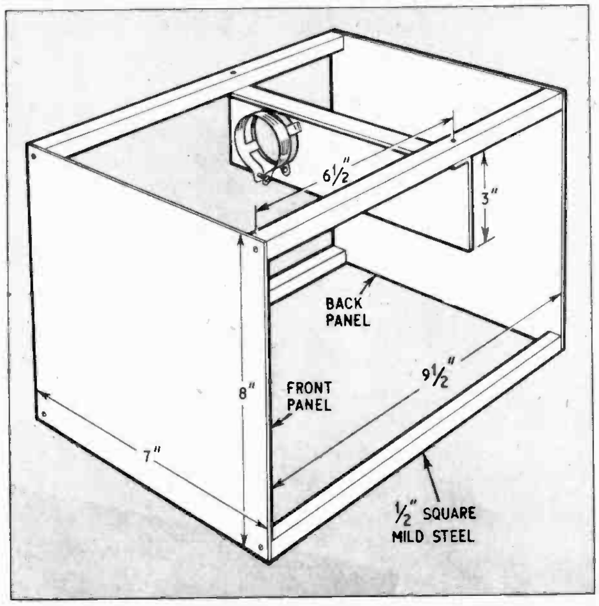


Fig. 4. Main frame with front and back panels

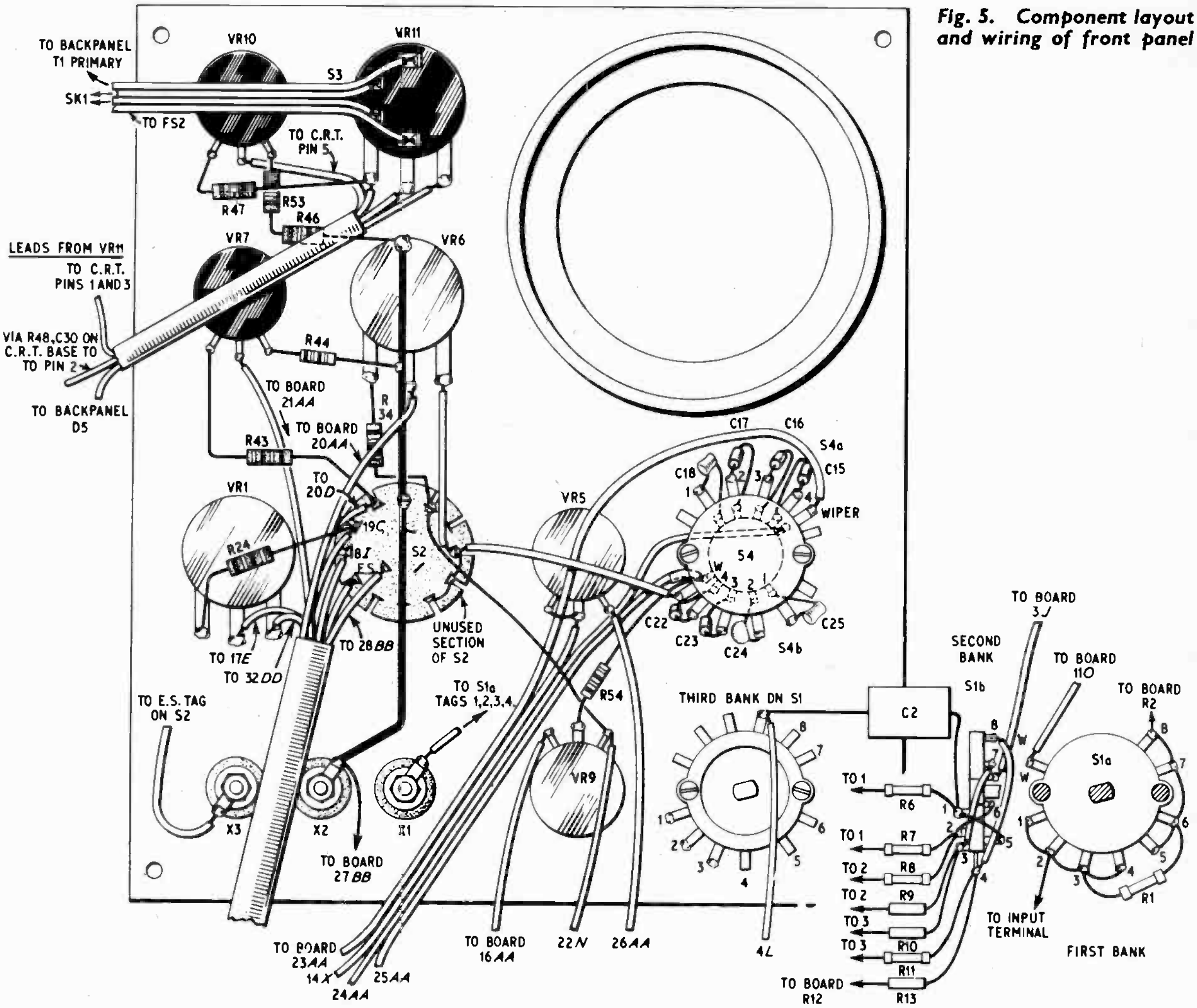
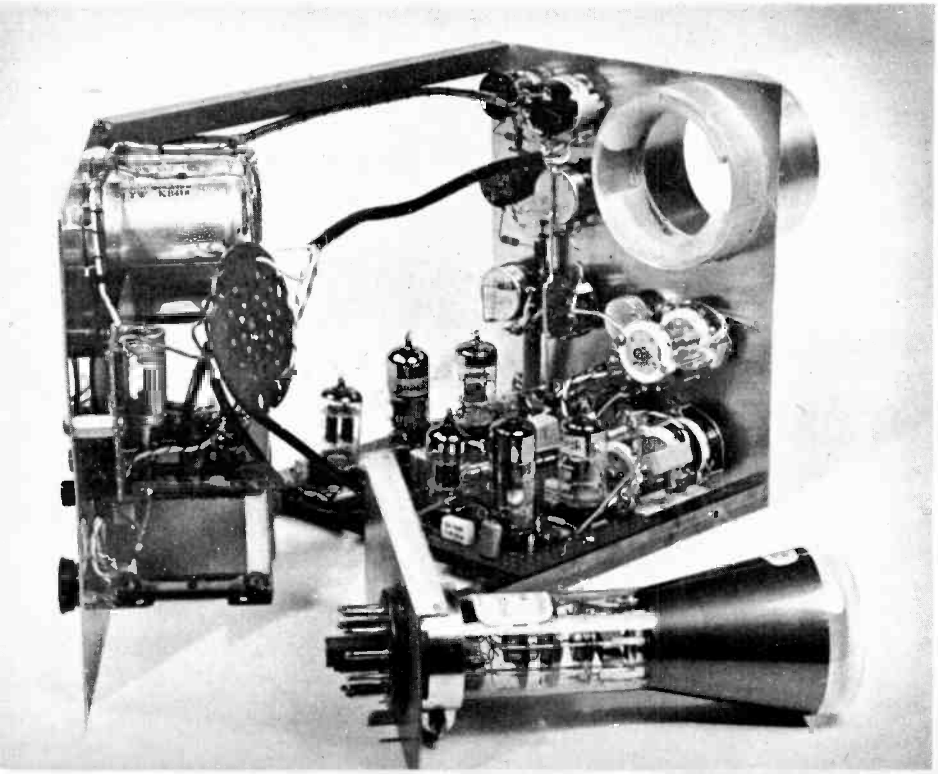


Fig. 5. Component layout and wiring of front panel



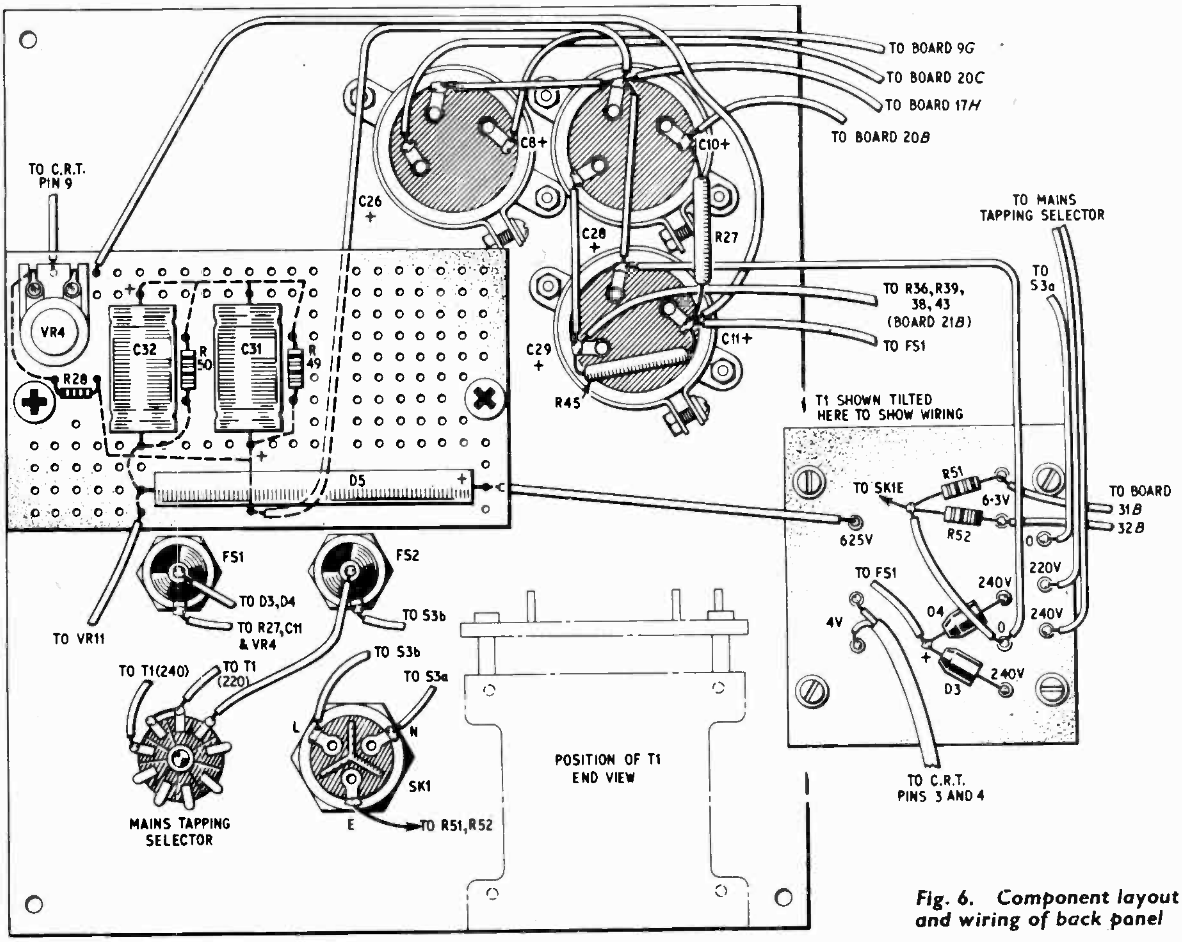


Fig. 6. Component layout and wiring of back panel

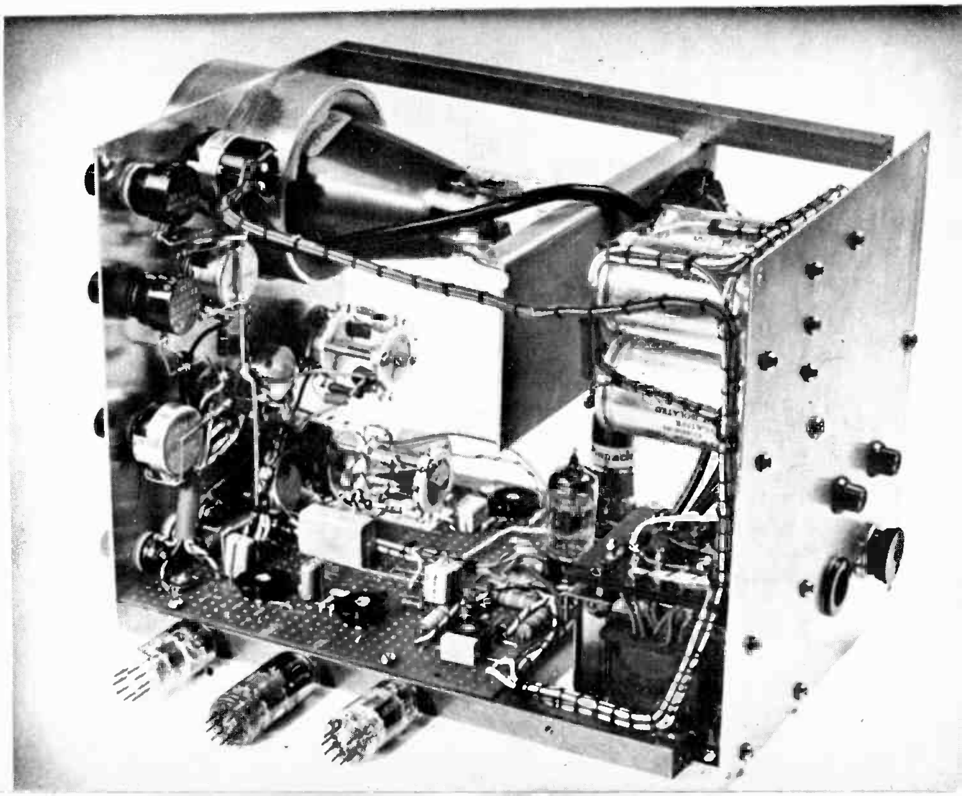
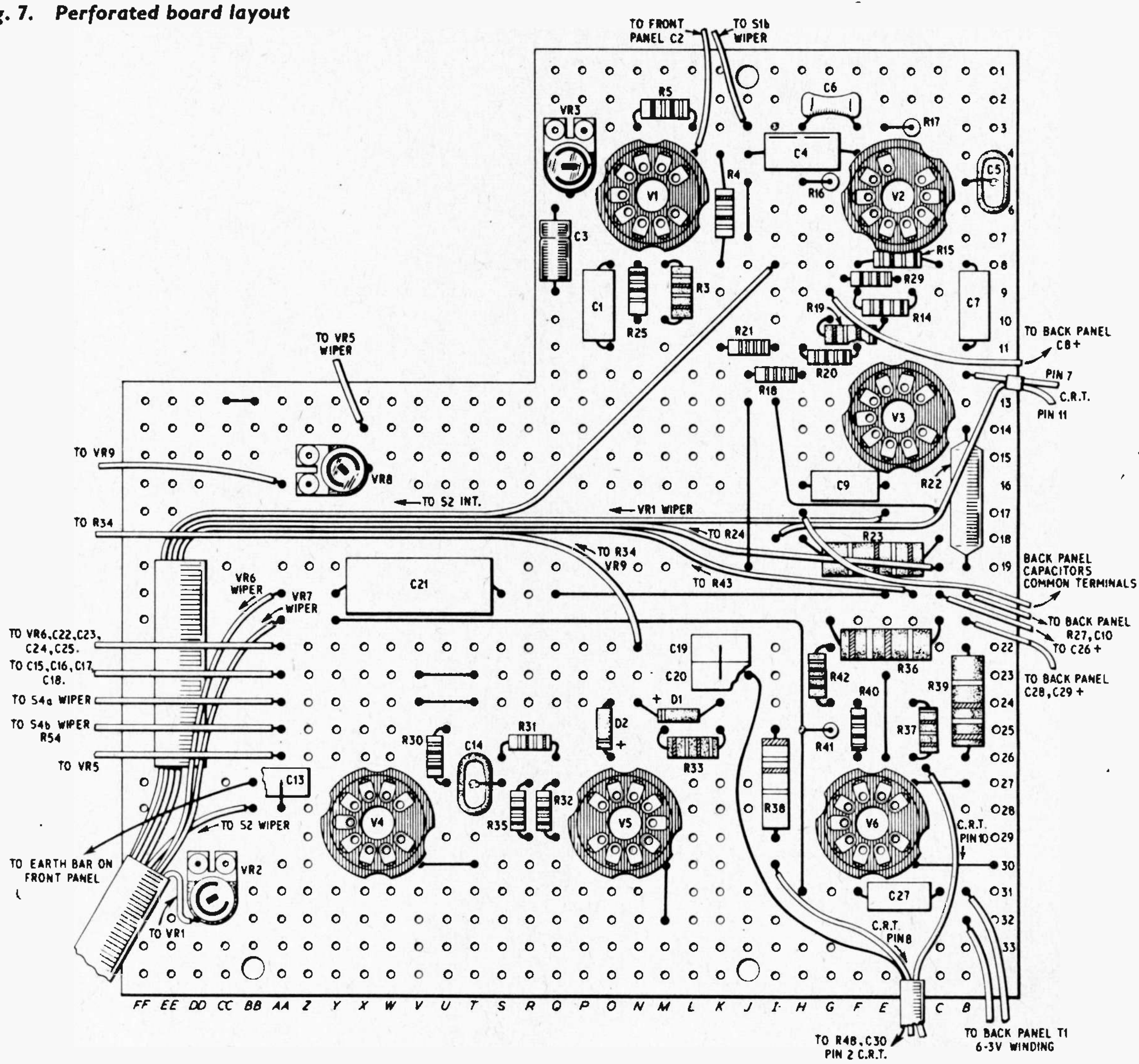


Fig. 7. Perforated board layout



In order to check wiring and voltages at a later stage, it will be an advantage to wire the respective h.t. lines in different colours to save having to trace wiring round the cable harness.

POWER BOARD

The power supply unit is simply mounted on the rear panel, being held off by two pillars and contains the e.h.t. supply components. *Great care should be taken when delving around this section after the instrument has been switched on as the voltage present is somewhere in the order of 800 V relative to chassis.* Even when the supply is switched off the capacitors C31 and C32 may still be charged to a high voltage.

The physical size of the $50 + 50\mu F$ capacitors should be kept as small as possible to clear the c.r.t. fixing bracket.

MAIN AMPLIFIER

This amplifier is fitted to the bottom struts of the oscilloscope; the base plate of the case has been made removable so that it is easy to check the underside wiring during the setting-up procedure (Figs. 7 and 8).

As this board is only held on its extreme edges, care must be taken when inserting the valves so that the board is not fractured by too much pressure in pushing the valves home.

As there are one or two adjustments to be made to potentiometers at a later stage, it may be advisable to drill through the board in the appropriate places so that adjustment may be made from the underside.

FINISHING NOTES

Great care must be taken when checking out the wiring as any error could be detrimental not only to the tube but to the valves and rectifiers, if shorts or incorrect supply voltages appear at various points. Test voltages were given on the circuit diagram (Fig. 1) last month. When clamping the tube base, too much pressure must not be brought to bear on the base itself otherwise fracturing of the tube could ensue.

The front panel was finished in a light coloured cellulose spray paint; it is best to do this and allow to dry before assembling components on it. The whole

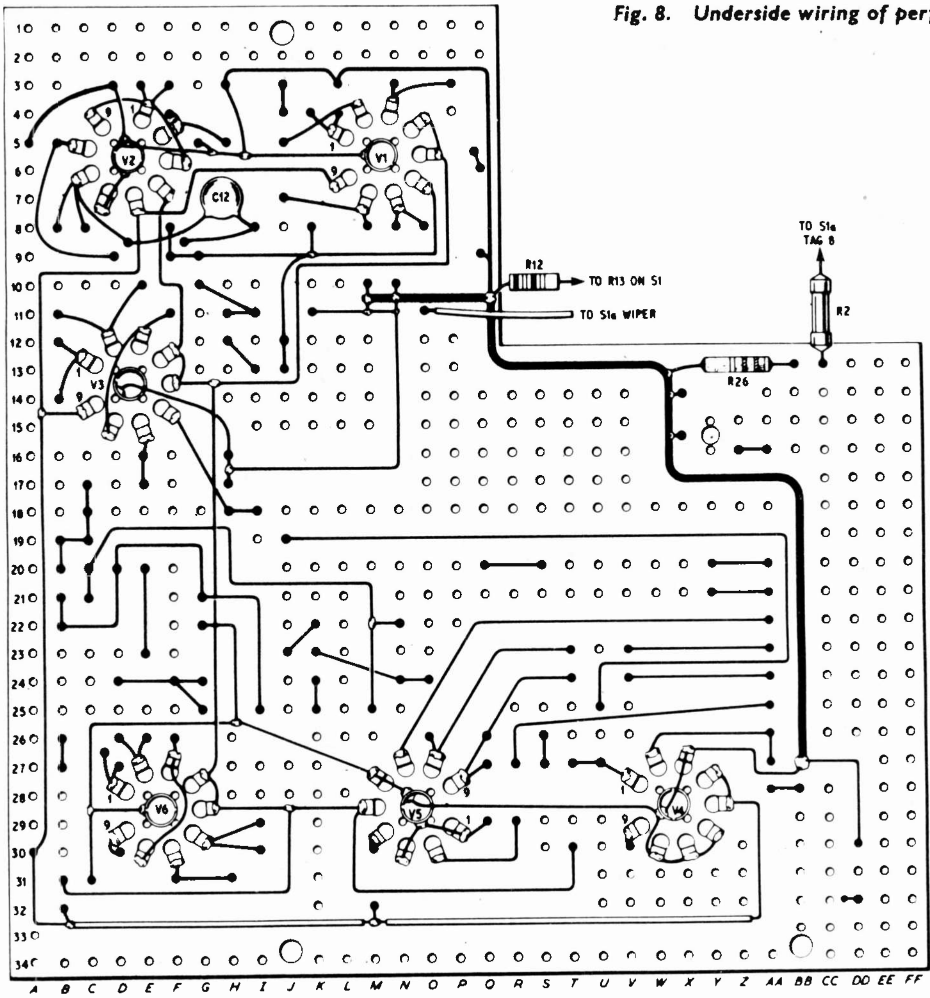


Fig. 8. Underside wiring of perforated board

of the casing can be sprayed in blue hammer finish paint obtained from Messrs. Yucan or Finnigan Speciality Paints (as advertised).

A graticule can be made to slide down the viewing hood so that instant reference may be made to this grid when measuring voltage levels. The graticule consists of a clear piece of Perspex cut to fit the hood and then scribed at accurate 1cm spacings from the centre X and Y axes.

Once a groove has been cut in the Perspex a black wax crayon is rubbed across the surface on the side that has been scribed; very clear black lines will show up when the surplus wax has been cleaned off. Intermediate millimetre markings can be similarly scribed on the centre X and Y axes.

SETTING-UP PROCEDURE

Y calibration

The oscilloscope should be switched on by advancing the brilliance control in a clockwise direction and the instrument should be given two minutes to warm up. The X gain should be in the fully clockwise condition and the X shift control in the middle of its travel.

The brilliance and focus are now adjusted to give the required trace and the function switch S4 is set into the 1 millisecond position with the Y gain switch set at 1 volt.

After the sync control has been set to INT a 1kHz signal of 355mV r.m.s. or 1V peak-to-peak is applied to the input socket and the "set gain" control VR3 is set so that the deflection on the screen is 1cm.

Now the signal is removed, Y shift (VR1) is set to mid-position, and VR2 is adjusted so that the trace centres in the Y plane.

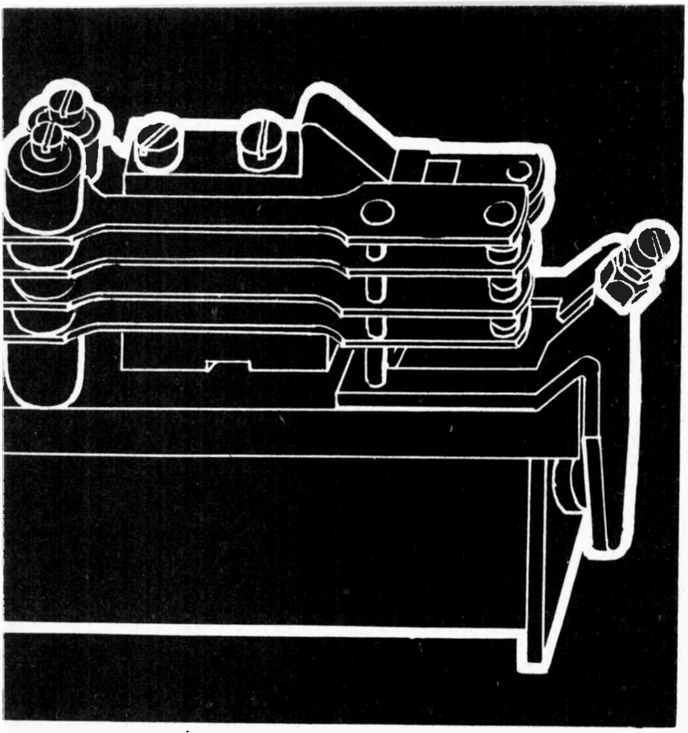
X calibration

With the controls set in the condition indicated in the previous paragraphs and the input signal at 1kHz re-applied to the input, the fine frequency control (VR9) is set in the fully counter-clockwise condition and the X gain is adjusted so that the time base scans exactly 5cm.

The trigger control (VR5) is advanced from a fully counter clockwise condition until the waveform just locks and then VR8 is adjusted so that five complete cycles are indicated on the screen. This shows that 1kHz covers one centimetre, that is to say that the time base is running at a speed of 1 millisecond.

This accuracy can be checked by switching to the 100 microsecond range and increasing the input signal frequency to 10kHz; once again five complete cycles should be seen.

If the components in the time base stage are kept to a reasonably close tolerance then it is possible to check the frequency of incoming signals quite accurately. It is essential when trying to ascertain the frequency of an incoming signal that the fine frequency control is in the fully counter-clockwise condition. ★



By A.T.J. CARRINGTON

ELECTROMAGNETIC RELAYS

PART TWO

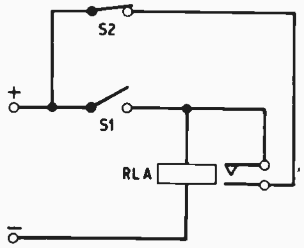


Fig. 16. Latching a relay with its own contacts

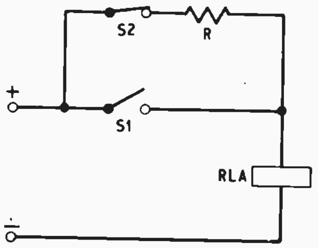


Fig. 17. Using a resistor to hold a relay in

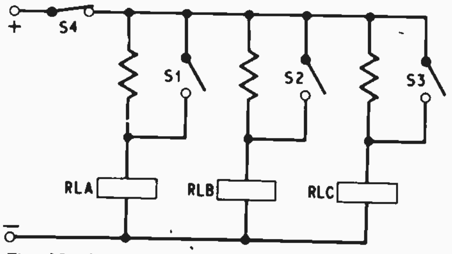


Fig. 18. Multiple latching and simultaneous unlatching

THE relay, being a two state device, can be used as a memory cell. In fact a complete computer, logic circuits, arithmetic unit, registers, etc. can be built using only relays, although their comparatively slow speed and their considerable power requirements make such a project impracticable. However, the "memory" function can be put to good use in many circuits where it is desired that the relay remains closed after the cessation of the operate pulse.

This property is known as "latching" the relay, i.e. it stays closed when the operating current ceases.

A relay may be latched in several ways. Fig. 16 shows how a pair of make contacts is used to connect the coil to the supply after the operate pulse has ceased. So closing switch S1 energises the relay, when the contacts close, the circuit is completed through S2. When S1 is opened, the relay remains energised, only becoming de-energised when S2 is opened.

LATCHING A RELAY WITHOUT USING CONTACTS

In order to avoid using a special pair of contacts just for latching, the circuit shown in Fig. 17 may be used.

Here advantage is taken of the fact that the "hold-in" current is less than the "pull-in" current.

The value of the resistor R is chosen so that insufficient current flows through R and RLA to close the relay, but sufficient to hold it in when it has been closed by S1. Again opening S2 will release RLB.

Several relays may be latched in this manner and released by a common "unlatching" switch, S4 in Fig. 18.

In this circuit the respective relay will latch by closing S1, S2, or S3, but all can be unlatched simultaneously by opening S4.

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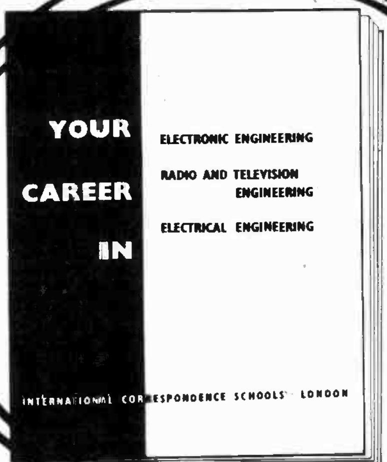

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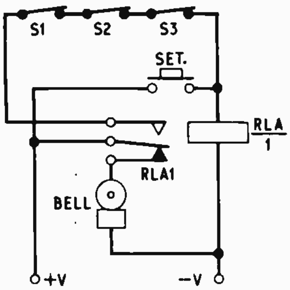


Fig. 19. Simple relay burglar alarm

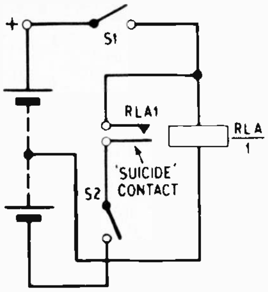


Fig. 20. "Suicide" contacts on a remanent relay

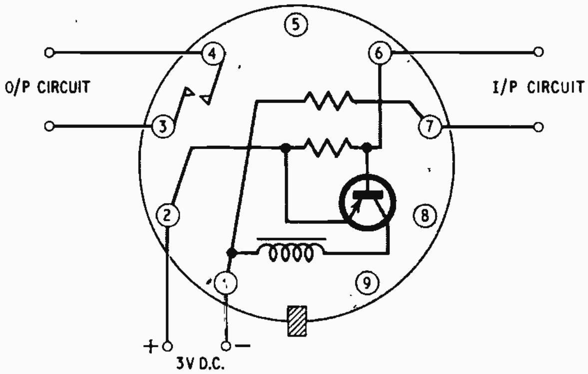


Fig. 21. A typical transistorised relay block diagram

SIMPLE BURGLAR ALARM

The burglar alarm circuit (Fig. 19) incorporates a "fail-safe" facility, i.e. if a wire is cut or a contact opened the relay will drop out and remain out. RLA is fed via a closed loop consisting of the door and window operated switches S1, S2, and S3, and a make contact on RLA. When the "set" button is pressed, RLA pulls in and holds in through the n.c. contacts of the changeover set. The relay contacts change over and hold via the switches. If the closed loop is broken momentarily the relay drops out, the bell rings, and even if the loop is closed again, the relay will not pull in until the "set" button is pressed again.

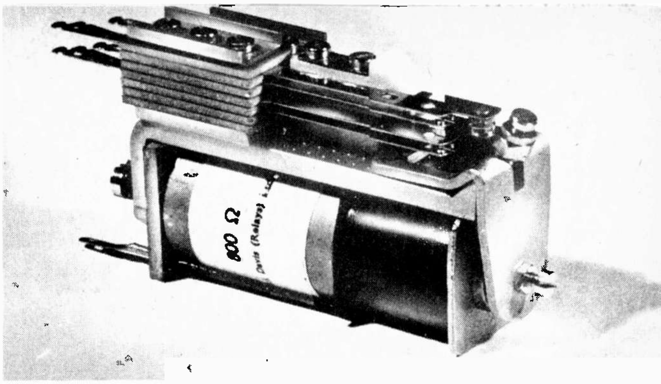
THE REMANENT RELAY

Such latching circuits have two drawbacks: they consume power all the time the relay is latched; and in the event of a supply failure, they would all unlatch. Such an event could be catastrophic if the latched relays represented a number in the memory of a computing device.

To overcome these defects the "remanent" relay is used. This has a special core of highly remanent material, that is, when the magnetising current is switched off, the core retains sufficient magnetism to hold the armature in.

To unlatch this relay, a pulse of opposite polarity to the energising pulse is applied to the coil, and the armature releases. If the pulse were too long, the armature would be attracted back again as the coil became a magnet of opposite polarity. A "suicide contact" is invariably used, to break the circuit immediately the armature is released.

This is shown in Fig. 20. When S1 is closed, the relay energises and remains latched even when S1 is opened, due to the remanent core. To release the armature S2 is closed, when a pulse of opposite polarity is applied to the coil, releasing the armature and opening the "suicide" contact; the armature thus remains released. To simplify the power supply circuits, and to extend the versatility of the remanent relay, it is also available wound with two coils, called the "operate" and "release" coils.



Permanent relay with slugged core (Jack Davis Relays)

THE TRANSISTORISED RELAY

It frequently happens that a very low power source is required to operate a relay controlling apparatus of high power. For example, a tiny contact on the pointer of a measuring instrument may have to switch in a large a.c. motor.

Normally we would have to use at least one "slave" or intermediate relay, the sensitive contact operating this "slave" relay, which in turn energises the main relay.

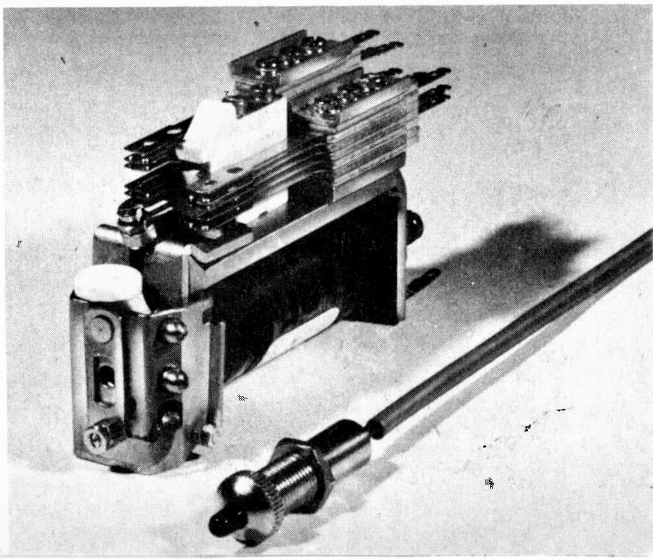
By using a relay in conjunction with a transistor, non-inductive loads of up to 5A at 30V d.c. or 250V a.c. can be switched directly by inputs of as low as 75 microwatts. This means that a robust relay can be used with consequent stability under conditions of vibration or mechanical shock.

Transistorised relays are available as integrated units in which the connections are brought out to a 9-pin valve base or multi-way plug and socket.

Fig. 21 shows the block diagram of a typical transistorised relay. The relay operates when the input circuit across pins 6 and 7 is closed, and approximately 4mA is drawn from a 3V supply.

When the input circuit is open, the current consumption is small enough to be ignored for practical purposes, rising to about 40mA when the relay is energised.

Mechanical latching on a P.O. 3000 type relay. The push button cable trigger is attached to the latching mechanism (Jack Davis Relays)



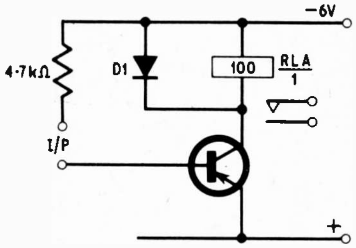


Fig. 22. Transistorised relay using an OC72

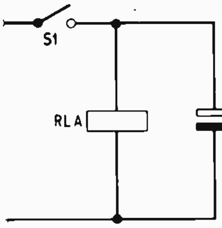


Fig. 23. Slow to release using a capacitor

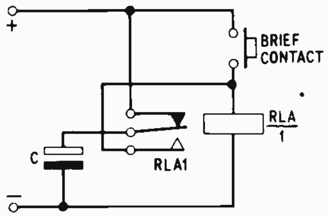


Fig. 24. Slow to release for pulse operation

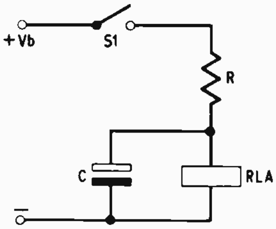


Fig. 25. Slow to operate

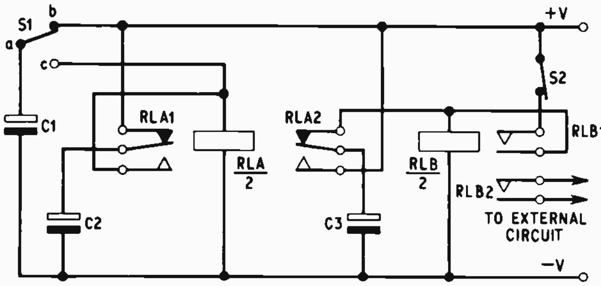


Fig. 26. Two relays used for longer operate delays

Fig. 22 shows a circuit using an OC72 transistor. Here the input is energised when the input terminals are connected together, and drops out when they are disconnected. The diode D1 is included to protect the transistor from the high peak voltages which may develop when the on/off action is very fast, giving a build-up of back e.m.f. from the relay coil.

The diode should be able to carry at least the maximum current flowing through the relay, of the order of 60mA with a 100 ohm coil, and its maximum inverse voltage rating must be much greater than the supply voltage.

DELAYING A RELAY

Because a relay depends for its action on the building up and the decaying of a magnetic field, it is possible to prolong the time for which it remains operated after the energising pulse has ceased, or conversely to delay the operation of the relay by various means.

Copper slugs inserted in the core can produce operate delays up to 150ms or release delays up to 500ms, but where larger delays of the order of 300 seconds are required, the connecting of a large capacitor in parallel with the relay coil will considerably delay the release of the armature. See Fig. 23.

When S1 is closed the full supply voltage appears across RLA, which pulls in at once. At the same time capacitor C is charged to the supply voltage. When S1 is opened, the energy stored in C will tend to keep the relay closed as the capacitor discharges through the relay coil.

The larger the capacitance, the more energy is stored and the longer the relay remains closed after S1 is opened. It will also be apparent that a relay of high resistance will take longer to discharge a given capacitor, and in general, longer delays are possible with high resistance relays.

This delayed drop out is also assisted by the fact that the magnetic field of a relay with high inductance takes a finite time to decay, and in decaying, produces a force which opposes the change to which it is due, in this case the cutting off of the supply voltage. The relay then will tend to remain closed until the magnetic field collapses.

This method of delaying a relay has a drawback if the relay is to be actuated by a short pulse. In this case the pulse may not be long enough to charge the capacitor fully, and a varying delay will be obtained. To overcome this the circuit of Fig. 24 can be used.

In this circuit, C is charged through the break sections of a changeover contact while the relay is open. A brief pulse, as long as it is of sufficient duration just to close the relay, switches the charged capacitor through the make section of the changeover contact. Thus a constant delay with varying input pulses is obtained.

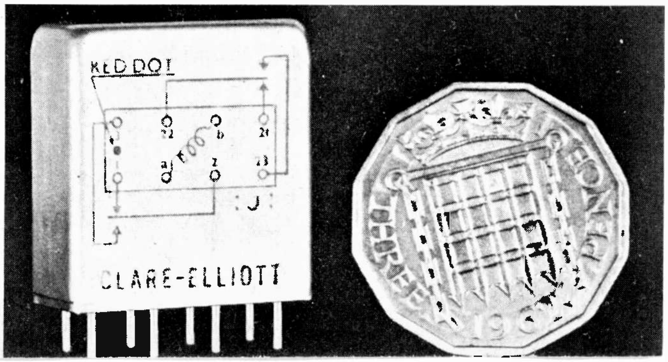
With large values of C up to 5,000μF, and high relay resistances up to 50 kilohms, delays of up to several minutes are possible.

DELAYED PULL-IN

Occasionally it may be required that a relay does not pull in immediately, but after a fixed delay. One way of doing this is shown in Fig. 25.

Unfortunately, however, it is not possible to obtain delays longer than about 1 second or so by this method without using capacitors of a prohibitively large value. Also the drop-out will be delayed more than the pull-in.

Encapsulated plug-in sub-miniature relay with two changeover contact sets. (Clare-Elliott)

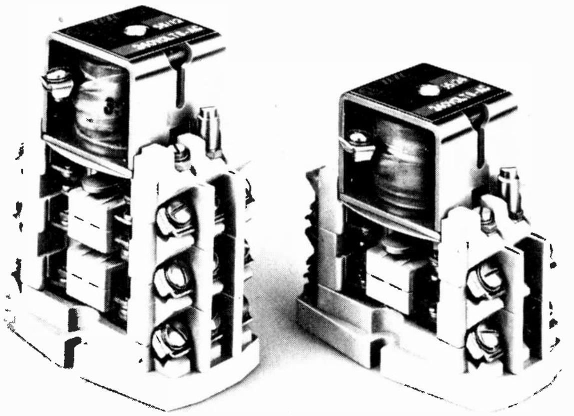


The following circuit using two relays will delay the pull-in for longer periods, up to 3 or 4 minutes (Fig. 26).

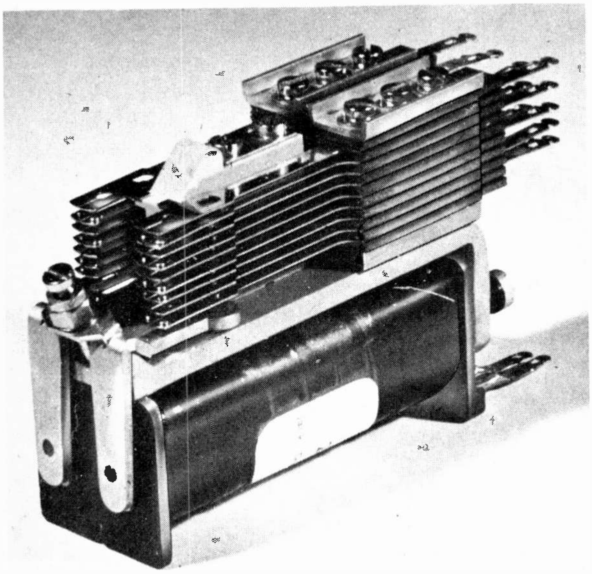
In this circuit RLB is the relay whose pull-in is to be delayed. Upon operating S1, C1 previously charged to +V through contact b, will discharge through RLA which pulls in and holds for a brief period depending on the value of C2 and the resistance of RLA. While RLA is energised, C3 charges up to +V through the make contact of RLA2. When RLA eventually drops out, RLB is pulled in by the discharge from C3, and holds in through its latching contact RLB1.

RELAY AS AN OSCILLATOR

If a relay is connected as shown (Fig. 27), it will oscillate rapidly in a similar manner to that of a bell or buzzer. The oscillatory action may be slowed down by connecting a large value capacitor in parallel with the coil. This results, however, in a very unequal mark/space ratio, because while the drop-out is delayed, the pull-in is virtually instantaneous.



Relay contactors for power stations (B & R Relays)



Double coil, double armature relay. Each bank of contacts can be individually controlled (Jack Davis Relays)

A rather more even action can be obtained by connecting two relays as shown in Fig. 28. By connecting capacitors in parallel with either or both relay coils, the mark/space ratios can be altered.

Several relays can be connected together in an oscillating circuit to enable lamps to be lit in sequence, for example, see Fig. 29.

The action is started by momentarily depressing S1. RLA pulls in and is held in for a time by the charge on C1. Meanwhile, C2 is charged up to the supply voltage. When RLA eventually drops out, C2 discharges through RLB which pulls in and holds in temporarily via C3, at the same time charging C4. When RLB drops out, RLC is operated in a similar manner, C4 then operating RLA when RLC drops out, the cycle thus recommencing. Thus the lamps will light in sequence as long as the circuit remains in action. Any number of relays may be used in this circuit, and effective displays can be made using this basic principle.

HEIGHT MEASURING DEVICE

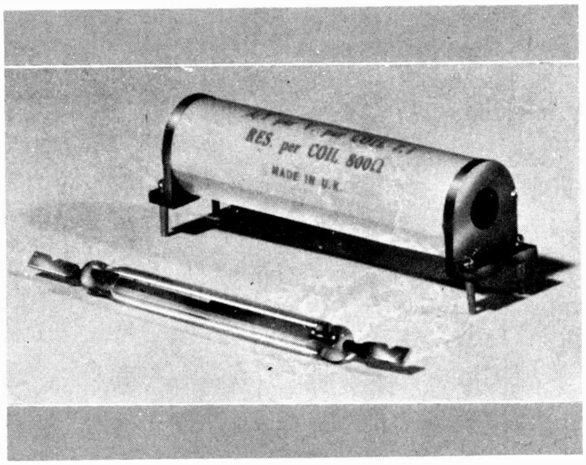
The next circuit is of an automatic coin operated height measuring device, designed for use in an amusement arcade. The machine exploits the properties of a light dependent resistor, and the principle is shown in Fig. 30.

The subject stands on platform P and inserts a penny. The belt carrying the light sensitive device then moves downwards until it reaches the lower contact which is fixed at a height lower than the lowest to be measured.

Upon closing this contact, the belt reverses its direction of travel while the ambient light is prevented from reaching the l.d.r. by the subject's body. At the position corresponding to the top of the head the l.d.r. unlatches the coin relay, stopping the belt, its position now registering the height of the subject. The basic circuit is shown in Fig. 31.

When a coin closes contacts S1, RLB pulls in and latches through its hold-on contact RLB1 via contact RLA1. RLB connects the motor via RLB2 and RLC1 to BY2 negative. RLA and RLC are so far in the non-operated condition. So the motor drives the belt carrying the l.d.r. down.

Upon reaching the lower contact S2, RLC pulls in and latches via its hold-on contact RLC2 and contact RLA1. The motor is now connected to the BY1



Reed relay coil and reed switch insert (Radiospares)

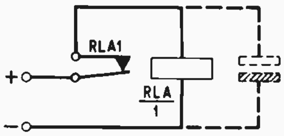


Fig. 27. Oscillating or vibrating relay

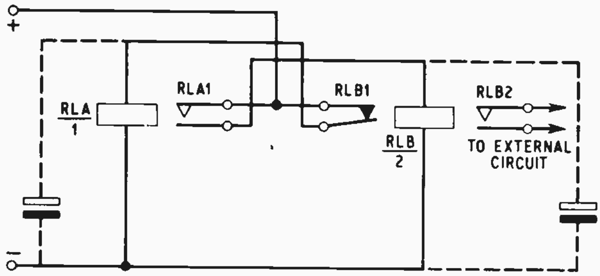


Fig. 28. Two relays for more even oscillation

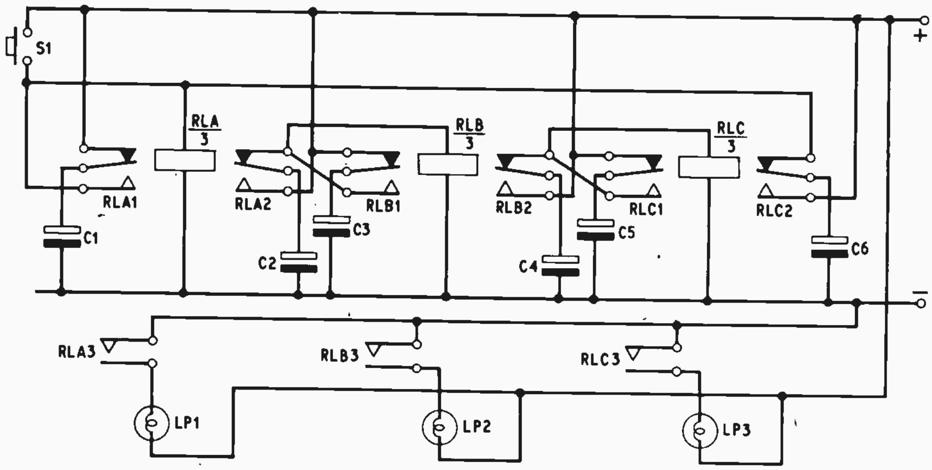


Fig. 29. Sequential switching of lamps

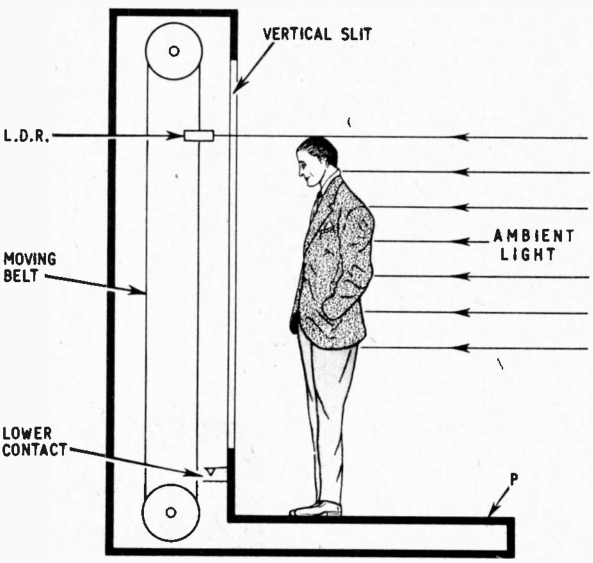


Fig. 30. Principle of height measurement using a l.d.r.

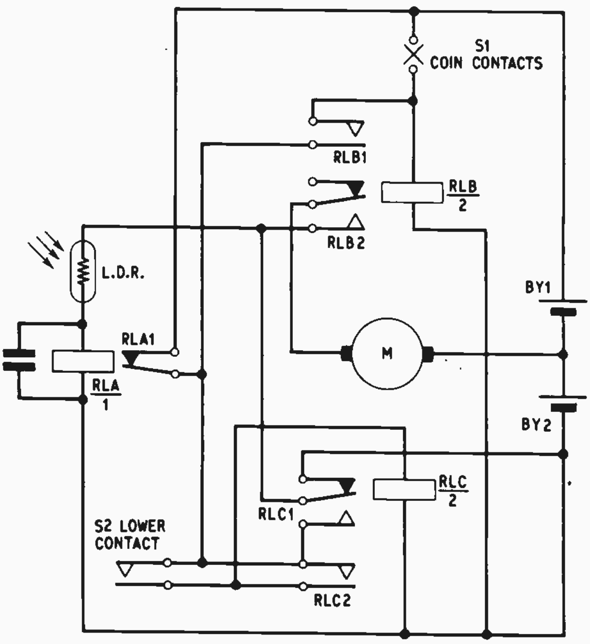


Fig. 31. Circuit diagram for height measurement device

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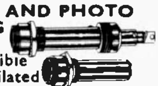

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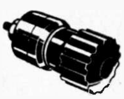

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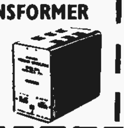

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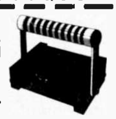

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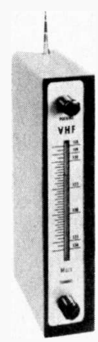

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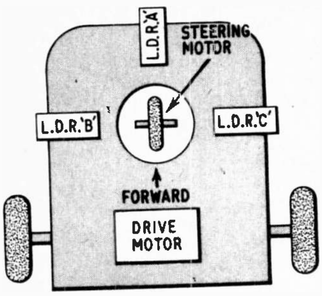
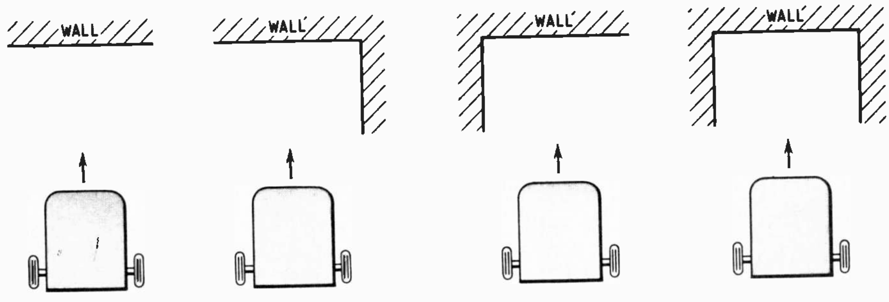


Fig. 32. Simple robot vehicle with obstacle sensors



(a) wall ahead *(b) wall ahead and right* *(c) wall ahead and left* *(d) wall ahead, left and right*

Fig. 33. Configurations of obstacle sensing

positive via RLB2, RLC1, and RLA1 so causing it to move the belt upwards. At the same time, the l.d.r. circuit, which cannot yet operate as the light is still blocked by the subject, is connected to BY1 positive via RLC1 and RLA1. The belt moves upwards until light falls on the l.d.r.

RLA then operates, and is held in by the capacitor. RLA1 opens long enough to unlatch RLB and RLC, thus stopping the motor. When the capacitor has discharged through RLA coil, RLA will revert to normal. The position of the l.d.r. now indicates the height of the subject.

Of course this is only the basic circuit; in practice other components would be needed, for example, limit switches to prevent the motor over-running, and some means of adjusting the sensitivity of the l.d.r. to suit different degrees of ambient light.

ROBOT VEHICLE

A more complex circuit is that of an automatically controlled vehicle which will take appropriate avoiding action on meeting an obstacle. Here again the obstacle is detected by means of l.d.r.s (Fig. 32).

The type of obstacle to be avoided takes the form of a vertical wall, and the machine can avoid the following configurations (see Fig. 33):

1. A single wall immediately ahead.
2. A wall ahead *and* one to the right,
3. A wall ahead *and* one to the left.
4. A wall ahead and to right and left.

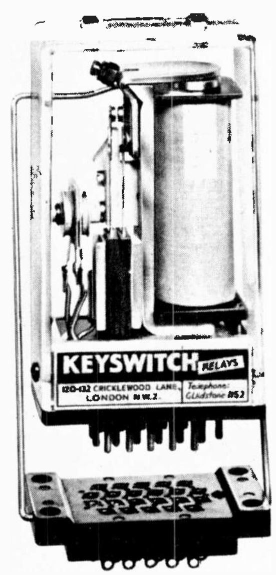
The vehicle is equipped with three l.d.r.s sensitive to ambient light, and their associated relays, normally energised, drop out when their respective l.d.r.s are a certain distance from the obstacle. The contacts are so arranged that various combinations of de-energised relays cause the machine to take the appropriate avoiding action.

If "A" is obscured, the machine turns either to the right or left; if "A" and "C" are obscured, to the left; if "A" and "B" are obscured it turns to the right; if all three, "A", "B" and "C" are obscured, then the machine goes into reverse.

Each situation produces a different combination of de-energised relays, and in order to make the machine take the appropriate action, we require a separate output for each combination.

We can simplify the requirements if, instead of giving the machine a choice of direction when it encounters obstacle 1, we make it turn always to the right, say, whenever this obstacle is encountered.

For three relays then, we have eight possible combinations, as set out in Table 1. For each combination the required functions of the drive motor and steering motor are also tabulated.



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Hermetically sealed mercury relay using a plunger in a gas filled tube
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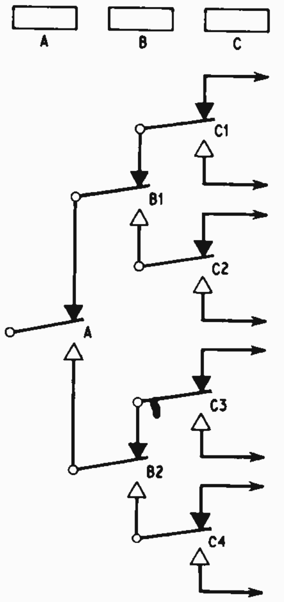


Fig. 34. Transfer tree of relay contacts for avoiding obstacles

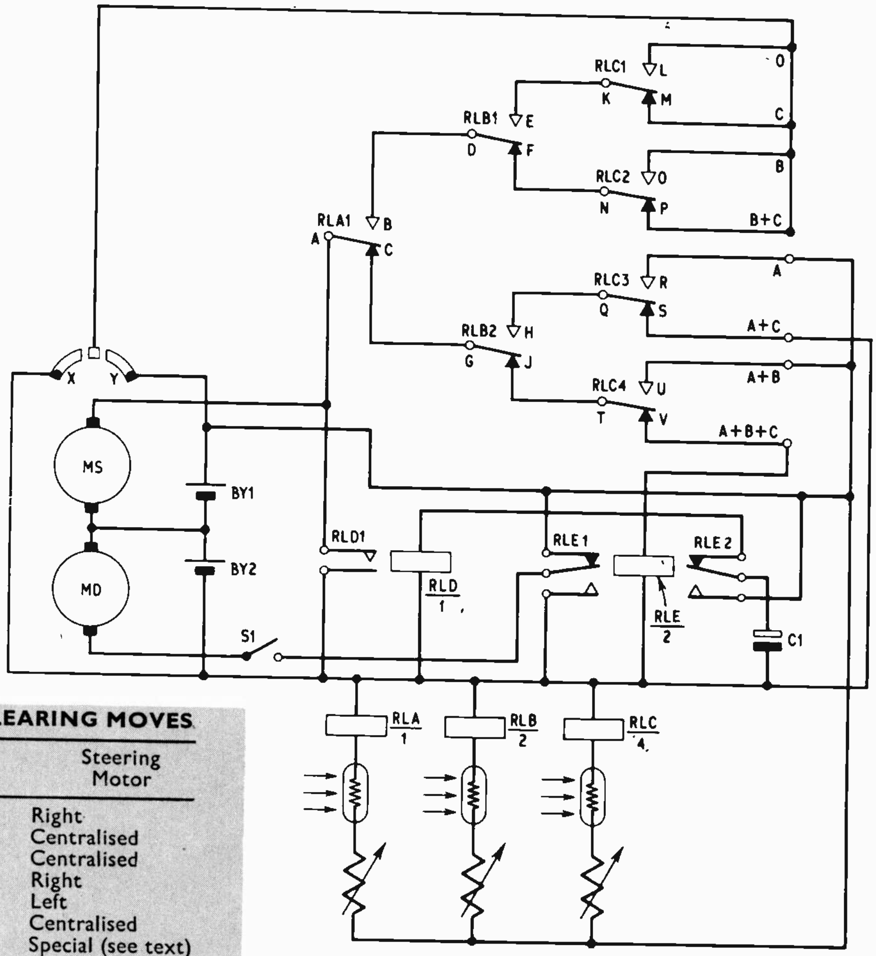


Fig. 35. Circuit diagram for avoiding obstacles

Table 1: OBSTACLE CLEARING MOVES

Relay de-energised	Drive Motor	Steering Motor
RLA	Forward	Right
RLB	Forward	Centralised
RLC	Forward	Centralised
RLA + B	Forward	Right
RLA + C	Forward	Left
RLB + C	Forward	Centralised
RLA + B + C	Reverse	Special (see text)
Nil	Forward	Centralised

To produce a separate output for every possible combination of the three relays ($2^3 = 8$) we can use the "transfer tree" method of connection (see Fig. 34) which, for any combination of relays RLA, RLB, and RLC will give one, and only one, output. It will be seen in Fig. 35 that to achieve this, relay RLA has one changeover contact, RLB has two changeovers, and RLC has four changeovers.

MS is the steering motor fitted with centralising segments, and MD is the main propulsion motor.

With S1 closed, MD runs in a forward direction, deriving its supply from the positive side of the battery BY1 via RLE1.

If all of the relays RLA, RLB, and RLC are energised, which only occurs on meeting an obstacle, the steering motor MS centralises via the contact segments "X" and "Y". The circuit follows the path L, K, E, D, B, and A, and either segment "X" or "Y", the steering motor thus running in the required direction to centralise and then stop.

If RLA now drops out, corresponding to obstacle 1 (see Fig. 33), MD remains in the forward direction, the steering motor is connected via A, C, G, H, Q, R to BY1 positive, which steers the machine to the right. As soon as the machine has turned sufficiently so that RLA energises once more, the steering motor centralises through O, N, F, D, B, and A, because RLB will now be shielded by the obstacle. Similarly if RLA and RLB are de-energised, the steering motor is fed via A, C, G, J, T, and U to BY1 positive and again the machine turns to the right until RLA re-energises, when MS centralises.

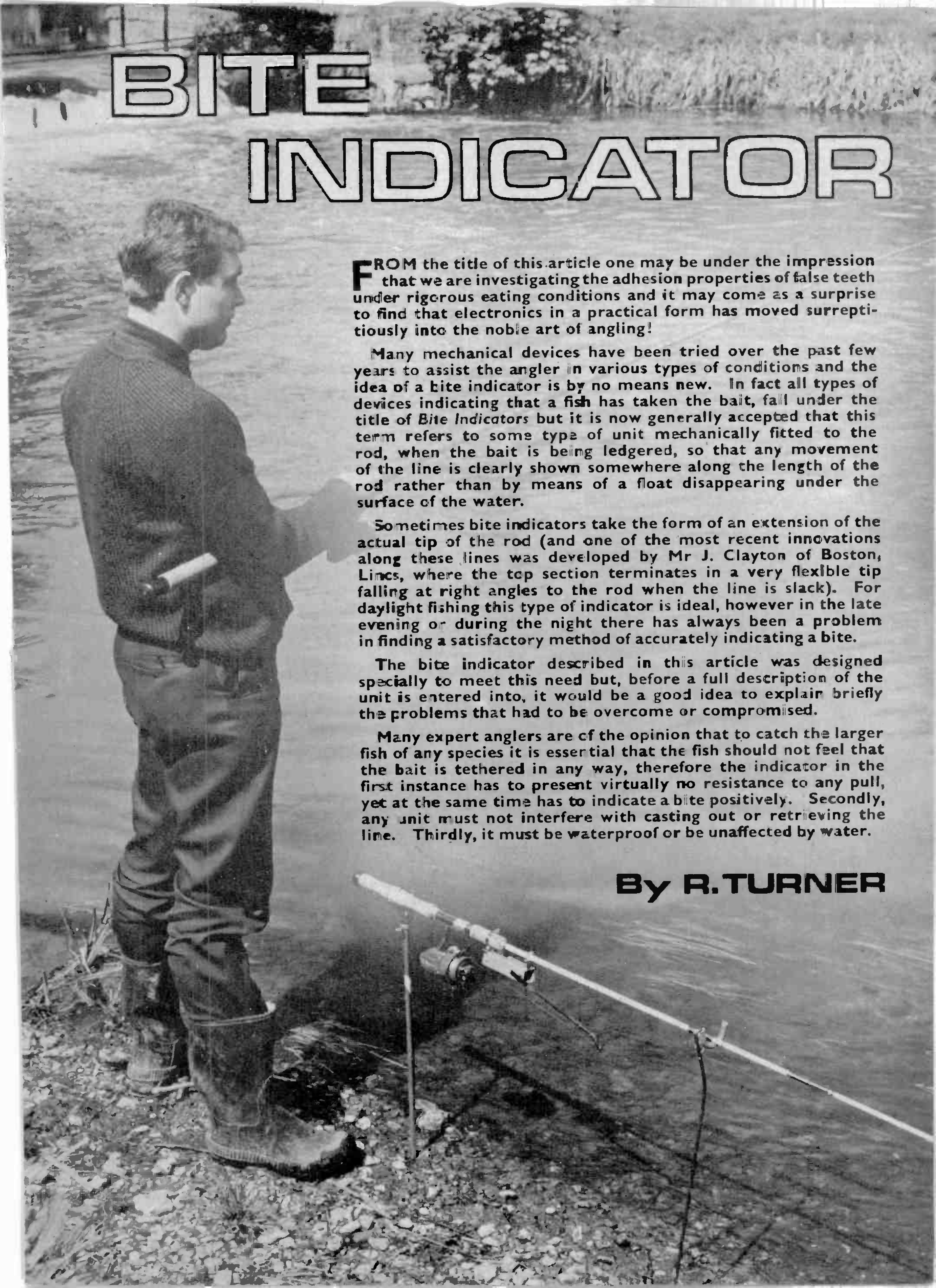
If RLA and RLC are de-energised, MS is fed via A, C, G, H, Q, and S to BY2 negative, and so the machine turns to the left, centralising as soon as RLA re-energises. If now RLA, RLB, and RLC de-energise, the circuit to the steering motor is completed via A, C, G, J, T, and V, and relay RLE. The resistance of RLE is made high enough to prevent the steering motor turning, but sufficient current (about 10mA) flows to pull it in. This reverses the polarity of MD, which drives the machine in reverse until again RLA is de-energised.

While RLE is pulled in, C1 charges up to the full supply voltage and, when it drops out, high resistance relay RLD pulls in and holds in for a time dependent on the capacitance of C1 and the resistance of RLD. This has the effect of temporarily energising the steering motor, to prevent the machine from continuously moving into and reversing out of, the obstacle.

CONCLUSION

There are many applications, some of which we have considered, where relays afford a versatile and elegant method of operation, particularly where many circuits are to be switched simultaneously, or where circuits depend on mutual interlocking for their correct operation. ★

BITE INDICATOR



FROM the title of this article one may be under the impression that we are investigating the adhesion properties of false teeth under rigorous eating conditions and it may come as a surprise to find that electronics in a practical form has moved surreptitiously into the noble art of angling!

Many mechanical devices have been tried over the past few years to assist the angler in various types of conditions and the idea of a bite indicator is by no means new. In fact all types of devices indicating that a fish has taken the bait, fall under the title of *Bite Indicators* but it is now generally accepted that this term refers to some type of unit mechanically fitted to the rod, when the bait is being ledgered, so that any movement of the line is clearly shown somewhere along the length of the rod rather than by means of a float disappearing under the surface of the water.

Sometimes bite indicators take the form of an extension of the actual tip of the rod (and one of the most recent innovations along these lines was developed by Mr J. Clayton of Boston, Lincs, where the top section terminates in a very flexible tip falling at right angles to the rod when the line is slack). For daylight fishing this type of indicator is ideal, however in the late evening or during the night there has always been a problem in finding a satisfactory method of accurately indicating a bite.

The bite indicator described in this article was designed specially to meet this need but, before a full description of the unit is entered into, it would be a good idea to explain briefly the problems that had to be overcome or compromised.

Many expert anglers are of the opinion that to catch the larger fish of any species it is essential that the fish should not feel that the bait is tethered in any way, therefore the indicator in the first instance has to present virtually no resistance to any pull, yet at the same time has to indicate a bite positively. Secondly, any unit must not interfere with casting out or retrieving the line. Thirdly, it must be waterproof or be unaffected by water.

By R. TURNER

MECHANICAL STRUCTURE

The illustrations show the mechanical structure that suited the particular rod to hand. It is not necessary to adhere to this pattern and no doubt many readers will have their own excellent ideas as to the mechanics to be adopted. The bite indicator breaks down in to three sections and each section is described separately in the following paragraphs.

ACTUATOR ARM

The actuator arm serves two purposes: (a) to connect the line to the unit and (b) to trigger off the oscillator, see Fig. 1.

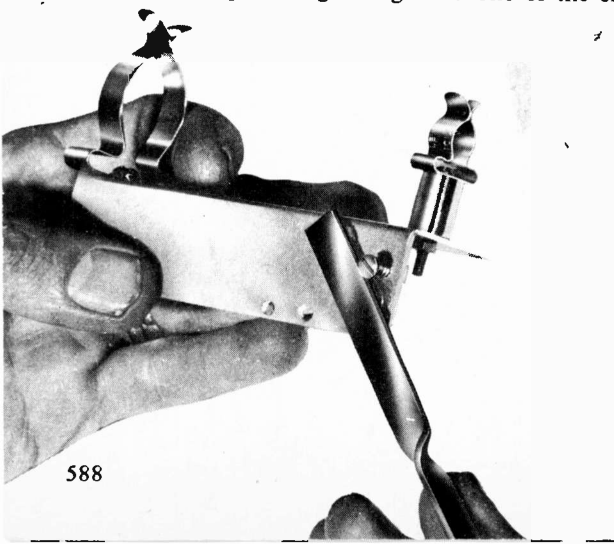
For the first requirement a hole is drilled in one end of the plastic strip and a fine slot cut into the side of this to allow for easy loading of the line and yet retain the line during actual operation. The slight bend has been made to make sure that in the arc of operation there is no binding action of the arm upon the line, and as this will differ from rod to rod it will be a matter of trial and error to determine the exact amount of bend needed.

At the other end of the strip a small piece of metal is glued onto the actuator arm—the size being determined by the ball race used—and this latter fixture acts as a shaft for the ball race. The material is twisted through 90 degrees about a quarter way along its length so that the plane of the material lends itself to carrying the line at the one end and taking the bearing shaft at the other. All these dimensions are shown in Fig. 1.

The more critical of the features of the actuator arm concern the positioning of a small magnet at the upper end of the arm so that when moved either up or down the magnet will open circuit a reed switch RLA accurately housed in the main unit. The choice of a reed switch was made to minimise the interference with the actuator arm, consequently reducing the actuating force required. It is not as difficult as it sounds to place the magnet and reed switch in a suitable position but merely a matter of common-sense. However, it must be noted that the body of the mechanical housing is made from aluminium, as steel will quash any operation of the reed switch.

MECHANICAL HOUSING

Again, the mechanical housing is a matter of choice, and the two clips that fix the unit to the butt of the rod will have to be varied to suit the varying cork thicknesses of different rods; or it may be necessary to adopt the configuration used on this unit where the butt section is not quite long enough and one of the clips



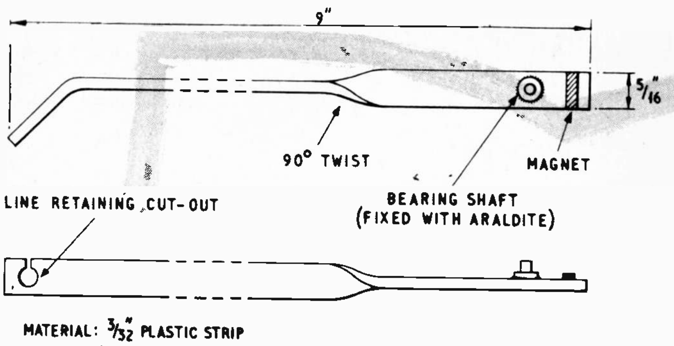
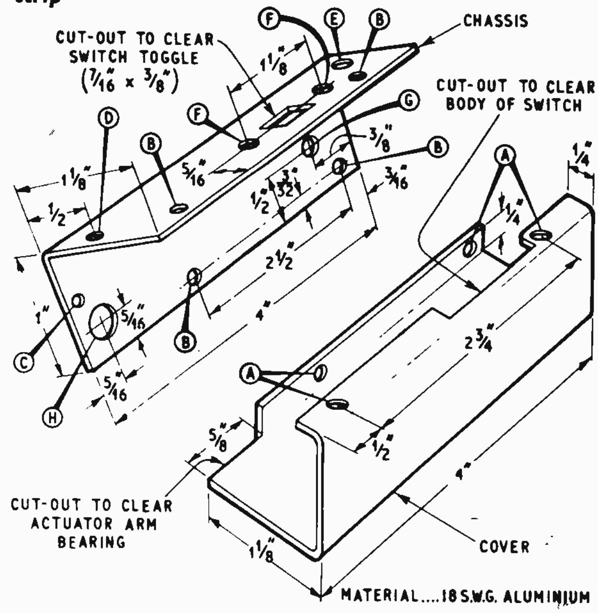


Fig. 1. Actuator arm, this is made from a piece of plastic strip



KEY TO HOLES
A.....6BA FOR SELF-TAPPING SCREWS.
B ...TO CLEAR 6BA SELF-TAPPING SCREWS.
C.....6BA FOR ACTUATOR ARM STOP SCREW.
D.....6BA FOR FIXING SMALL TERRY CLIP.
E.....4BA FOR FIXING LARGE TERRY CLIP.
F.....4BA FOR FIXING SWITCH.
G.....4BA FOR FIXING CIRCUIT BOARD
H.....3/8" DIA. FOR ACTUATOR ARM BEARING.

Fig. 2. The housing for the bite indicator. This is built up from two pieces of aluminium cut out, bent, and drilled as shown

fits onto the rod itself. The on/off switch S1 has been situated within easy reach of the left hand which is usually the one that is free.

The construction of the housing is clearly indicated in Fig. 2.

OSCILLATOR

The electronics of the bite indicator are very simple and make use of the elementary emitter coupled oscillator, see Fig. 3.

The two transistors TR1, TR2 are directly coupled and a gain figure of a relatively small quantity is required to promote oscillation. TR1 is the amplifier and is directly coupled to TR2 which acts as a matching device with the required low output impedance. The collector load of TR1 is so arranged that TR2 is correctly biased and the high input impedance of TR2 places little load on output of the preceding stage.

COMPONENTS . . .

Resistors
R1 390Ω
R2 390Ω
R3 1kΩ

Capacitors
C1 0·64μF elec.
C2 6·4μF elec. (see text)

Transistors
TR1 NKT261
TR2 NKT261

Battery
BY1 1·5V Vidor type V16

Switches
S1 S.P.C.O. Slide Switch
RLA Miniature Reed Relay with magnet

Miscellaneous
Magnetic earpiece (65Ω)
Perforated board $2\frac{3}{8}$in × $\frac{3}{4}$in
Three spring clips (see text)
Four 4 B.A. nuts, bolts and washers
Two 6 B.A. nuts and bolts
Four 6 B.A. self-tapping screws
Aluminium spacer approx. $\frac{1}{8}$in if required (see text)
Ball race
Plastic actuator arm approx. 9in (see text)
Two pieces of aluminium sheet 4in × $2\frac{1}{8}$in and 4in × $2\frac{5}{8}$in
Wire, sleeving, solder, etc.

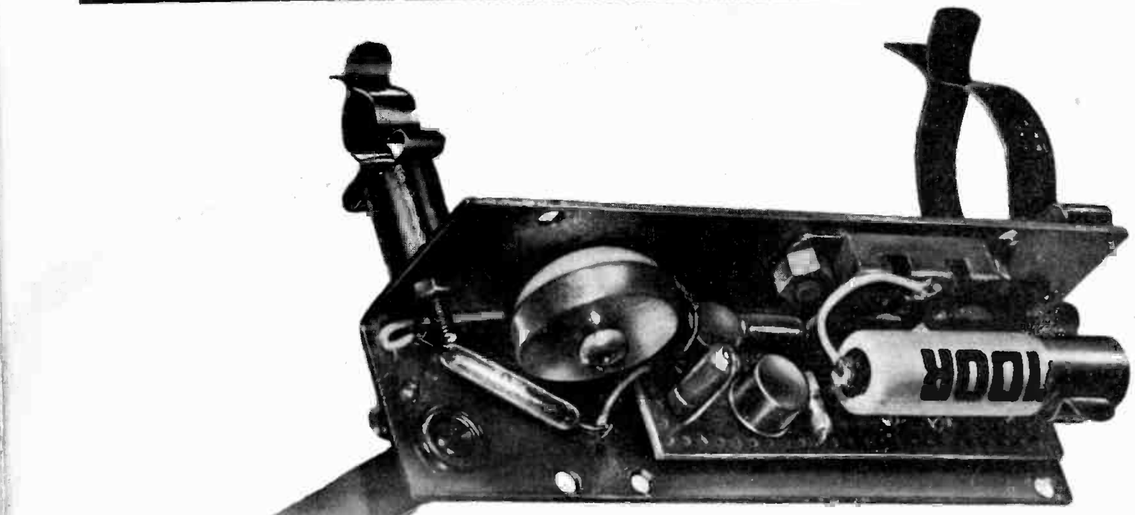


Fig. 4 (right). The electronic assembly. Most of the circuit components are mounted on the small piece of perforated board. The board is secured to the housing by the same screw which secures the battery clip; a 4 B.A. nut must be positioned on the screw, between the rear of the board and the metal housing, as a spacer.

The earpiece X1 and the ball race are secured to the housing with Araldite. The reed switch however must be secured with Evostick, this is to ensure a flexible bond and so prevent damage to the glass tube if the bite indicator is dropped or otherwise receives a blow (see Fig. 6)

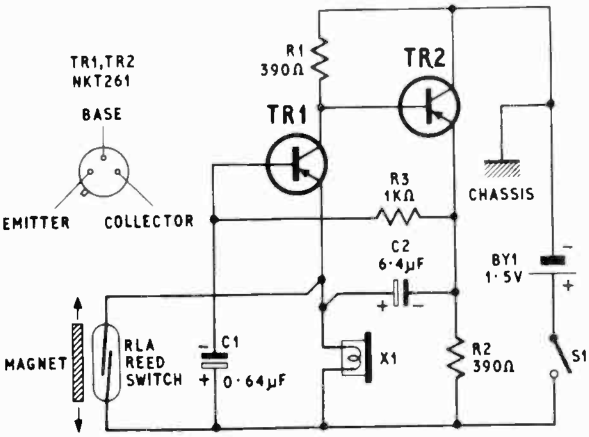
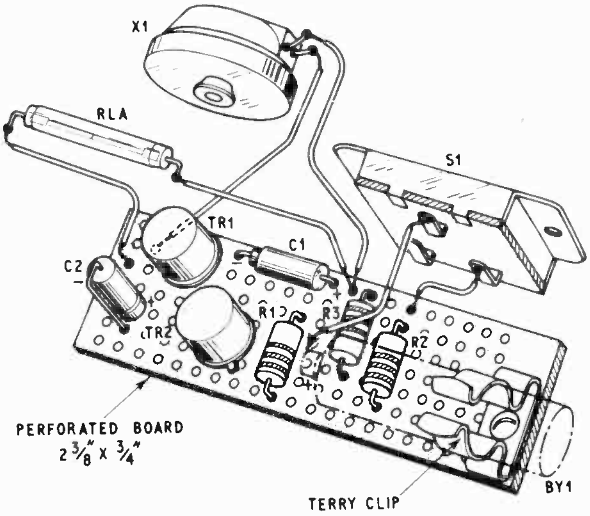
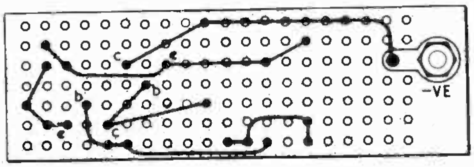
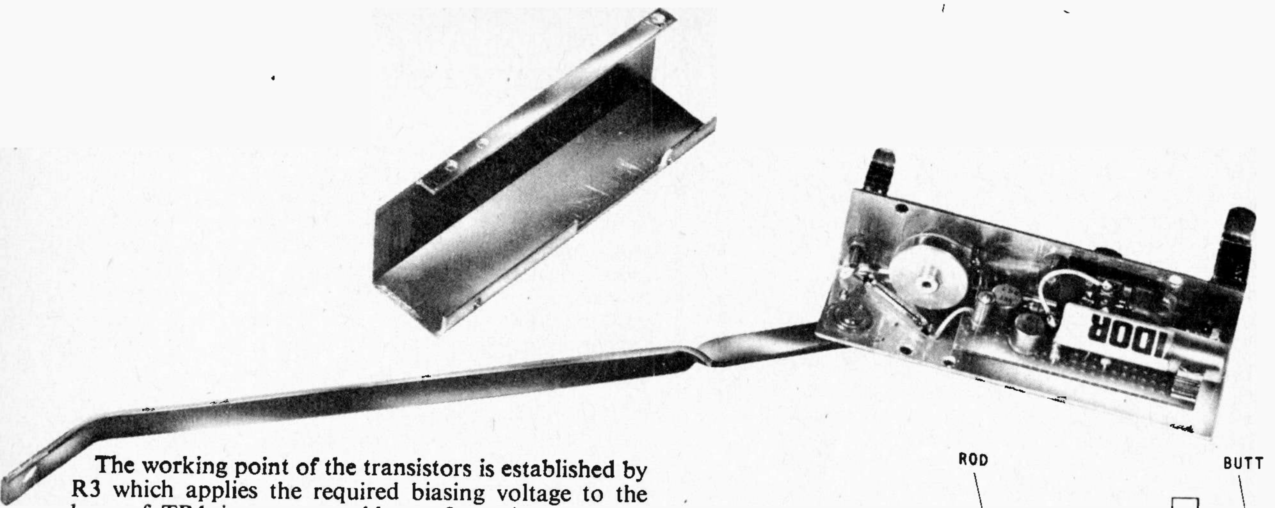


Fig. 3. Circuit diagram of the bite indicator







The working point of the transistors is established by R3 which applies the required biasing voltage to the base of TR1 in a very stable configuration. As the temperature increases so the collector voltage of TR1 becomes more positive and due to the emitter follower action of TR2 this fall in voltage is fed back to the base of TR1 via R3 and reduces the base to emitter voltage of TR1 thus returning the circuit to its original condition. Of course the action is reversed should the temperature fall.

On test the unit was found to be satisfactory between −10 degrees C and +55 degrees C which, unless the operator were fishing for seal through a hole in the ice, should prove quite adequate.

The frequency at which the circuit oscillates is governed by C1 and C2, with C2 playing the greater part. It is a little difficult to establish the exact value for C2 as this will vary depending upon the earpiece used and the tone required. The earpiece incorporated in this unit had an impedance of about 65 ohms but widely varying devices in fact performed quite successfully, although the value of C2 had to be adjusted accordingly.

FUNCTION OF REED SWITCH

The reed switch merely shorts out the earpiece X1 in the inoperative condition and when the magnet is taken away from the switch (the actuator arm moved), the switch becomes open-circuited and an audible warning is given.

The quiescent current of the unit is in the order of 2·5mA in both conditions, thus the battery gives many weeks of use.

Some query may be raised as to why the reed switch does not open circuit the supply voltage in the inoperative condition and consequently draw no current from the battery; this in fact was the way in which the first unit was made, but the problem was then to give warning of a bite where the fish had picked up the weight and caused the arm to drop instead of move in an upwards direction. This could have been solved by the inclusion of a second reed switch, but the difficulty in setting up the magnet to cope with both conditions is very awkward and it was felt that the small battery drain was worth the more accurate results thus obtained.

Details of the electronic assembly and wiring are given in Fig. 4.

The battery BY1 is held in position with a spring clip. Some of the paper surrounding the cell is removed so the casing makes contact with the negative rail via the clip.

SETTING UP PROCEDURE

As the electronics are of such a simple nature no setting up is required other than to determine the value

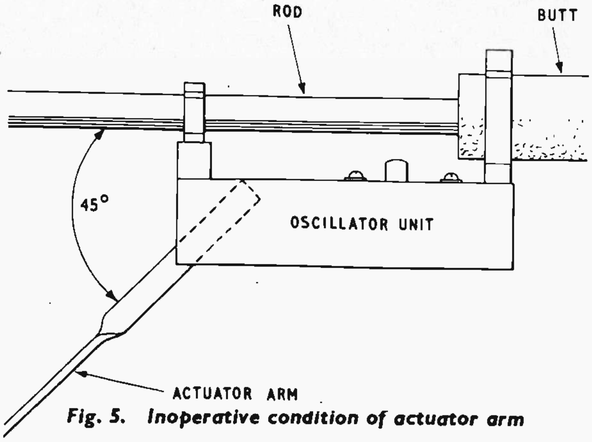


Fig. 5. Inoperative condition of actuator arm

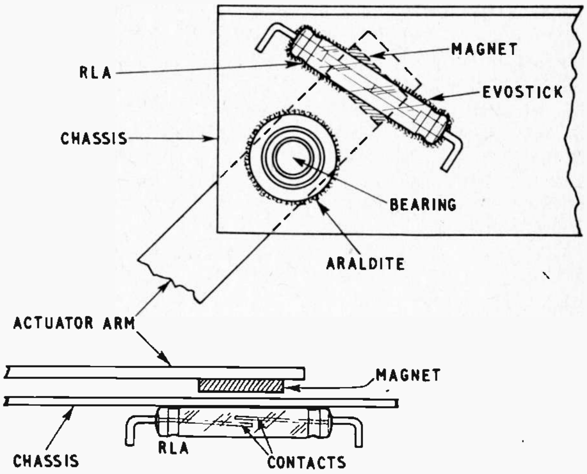


Fig. 6. Correct positioning of the reed switch RLA

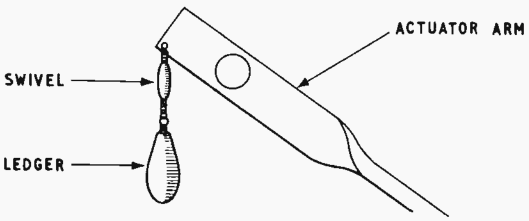


Fig. 7. Ledger weight used to reduce the actuating force required to operate the indicator

of C2 in the circuit of Fig. 3, so that the tone generated by the oscillator is satisfactory to the user.

The main adjustment will lie in the setting of the reed switch with regard to the magnet fixed to the actuator arm. It will be much more of a simple operation if this point is attended to before the oscillator or any of the wiring is installed.

The reed switch can be clearly heard to come in and out as a magnet is passed lengthwise over the reed switch, so if the magnet is fixed to the arm in the first instance and the arm correctly located in the ball race, a spot of Evostick or the like can be smeared over the underside of the reed and the reed placed in an approximate position in the housing. The arm should be at about 45 degrees to the horizontal plane of the rod when the reed is in the middle of its HELD ON condition (see Fig. 5) and it is a simple matter to move the reed about until this condition is achieved.

Once the position has been determined the reed switch should be glued into position with a rubbery type of adhesive so that the vibration encountered in casting, etc. will not fracture the glass casing of the reed.

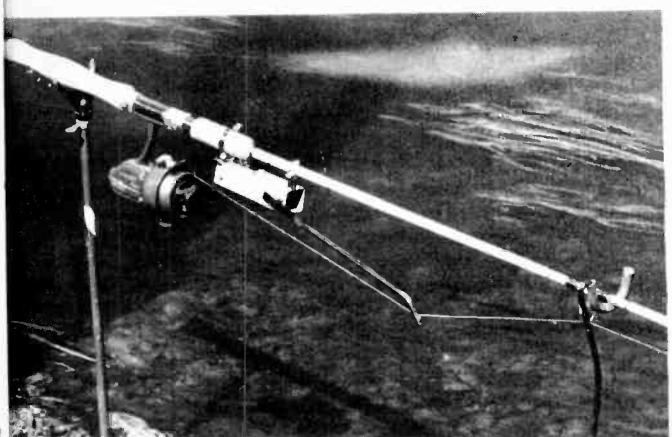
If the wires coming from the end of the reed switch have to be bent to facilitate wiring of the unit, it is essential that no bend should be made within $\frac{3}{16}$in of the glass and a pair of pliers should be used to grip the wire between the glass and the section to be bent. *If the glass is fractured, then the reed is useless.* The reed switch must be placed on the chassis so that the wider section of the internal contacts are parallel with the mounting surface, otherwise the switch will not pull in. This is indicated in Fig. 6.

SUMMARY

While the mechanics may be altered to suit individual requirements, the bite unit is primarily based upon a self contained oscillator which requires no trailing wires to a separate power supply. In order to make the actuating force even lighter a small hole can be drilled in the end of the actuator arm at the magnet end so that a small ledgerweight can be clipped on to act as a counterweight (as shown in Fig. 7). Under this type of condition a small shot hanging on the line has been found sufficient to actuate the indicator.

In practice, of course, this shot would be lying on the bed of the lake and any small alteration in the balance of the equipment would be sufficient to indicate that this condition has been disturbed.

From the other point of view where the unit is being used in fast running water, then it may be necessary to apply a weight, such as a weighted crocodile clip, to the other end of the actuator arm to counteract the drag of the flow. ★



MICROELECTRONICS

continued from page 570

the pattern several times over the same plate if several circuits are required simultaneously.

The negatives produced by this process are used for photolithographic removal of the thin film from the circuit substrate, or can also be used to produce stencil masks by etching through thin stainless steel foil. Different "cut and peel" masters have to be prepared for each type of circuit element, for instance, a circuit involving just resistors and interconnections would require two separate masters.

THIN FILM CAPACITORS

For the sake of simplicity we have kept off the subject of capacitors, but these can be produced in a similar way as resistors. The prime difference, however, is that to produce capacitance it is necessary to have a dielectric of some description sandwiched between two electrodes. A thin film capacitor is perhaps one of the most basic forms, and can be produced by several methods.

The most common way is to deposit an area of aluminium through a stencil mask as a base electrode, and on to this an insulating film of silicon monoxide through a second mask. A more sophisticated dielectric with better properties is silicon dioxide—pure quartz—but this requires a highly specialised deposition process called dielectric sputtering. (This process will not be described here as it is outside the scope of this article.) The second electrode of the capacitor is then deposited by using aluminium through a third mask.

The capacitance of such a device is proportional to the dielectric constant of the insulating material, the area of cross-over of the two electrodes, and is inversely proportional to the thickness of the dielectric. Unfortunately the working voltages of such capacitors are directly proportional to the thickness of the dielectric; therefore a compromise between capacitance value and breakdown voltage has to be determined.

Usually the maximum values of thin film capacitors are limited to about 5,000pF for these reasons. This is not such a disadvantage as this top value will meet most applications. Whenever higher values are needed, additional discrete components can be used; there are now many physically small, but high value capacitors of the solid tantalum type, with dimensions no more than 3mm × 3mm × 1mm, which can give capacitance values as high as 25μF.

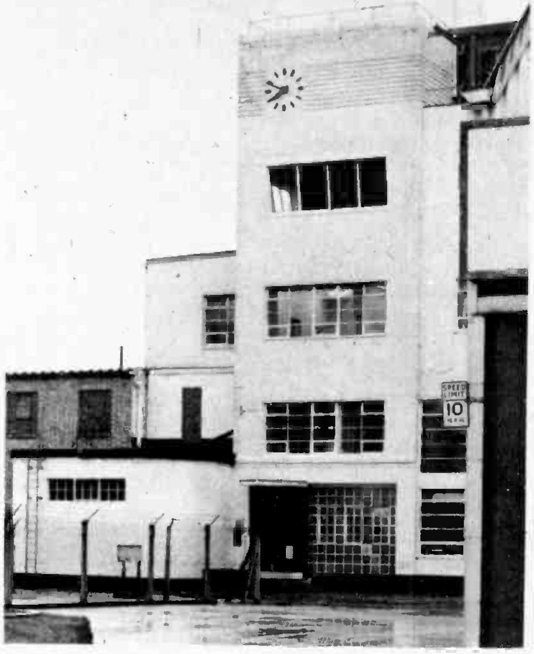
THIN FILM INDUCTORS

Inductors can be made by thin film techniques, but as the circuits can only be made in a single plane, it is impossible to make multiturn, pile wound coils. The nearest approximation to a coil is produced by depositing a spiral of conductive material. Inductance values for these tend to be very low, and also the areas occupied by the spirals tend to be large.

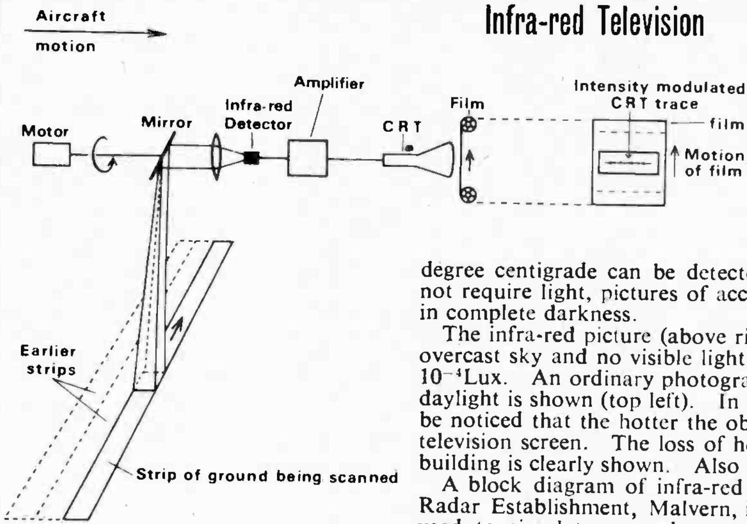
When all the deposition stages are completed, active devices such as transistors and diodes can be wired into the circuit by careful soldering. Naturally the transistors used have to be as small as possible, and there are many special types of encapsulations for transistors designed specifically for thin film circuits. The final stages in the manufacture of a circuit are to solder on the lead out wires, and to encapsulate the whole circuit—usually in an epoxy resin.

Next month: Semiconductor integrated circuits

ELECTRORAMA



Infra-red Television

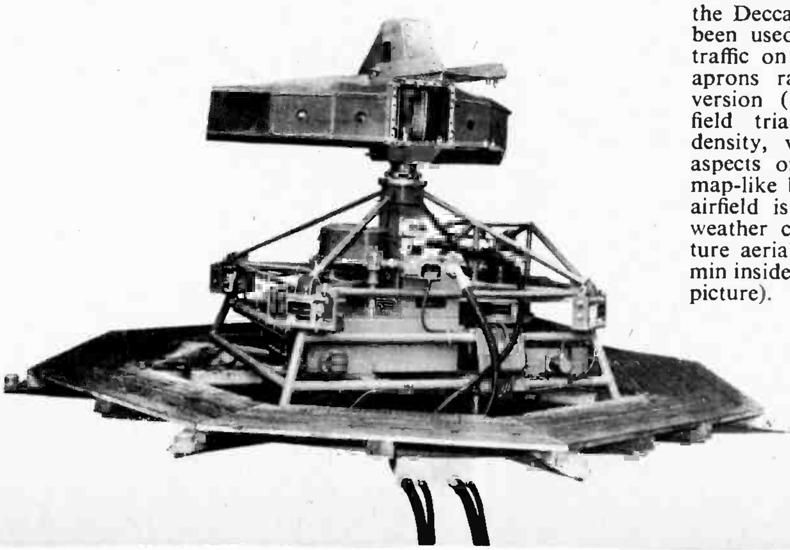


EMI ELECTRONICS is currently engaged in developing scanning equipment to produce infra-red television pictures. Whereas a normal television system utilises the reflection of light, the infra-red television uses the heat or infra-red radiation emitted by an object. With the EMI system, temperature variations of a few hundredths of a degree centigrade can be detected and, since the method does not require light, pictures of acceptable quality can be obtained in complete darkness.

The infra-red picture (above right) was taken at night with an overcast sky and no visible light; a light level of approximately 10^{-4}Lux. An ordinary photograph of the same subject taken in daylight is shown (top left). In the infra-red photograph, it will be noticed that the hotter the object, the whiter it shows on the television screen. The loss of heat through the windows of the building is clearly shown. Also the turret top (right) is revealed.

A block diagram of infra-red equipment in use at the Royal Radar Establishment, Malvern, is shown left. Here it is being used to simulate ground reconnaissance systems likely to be used in aircraft.

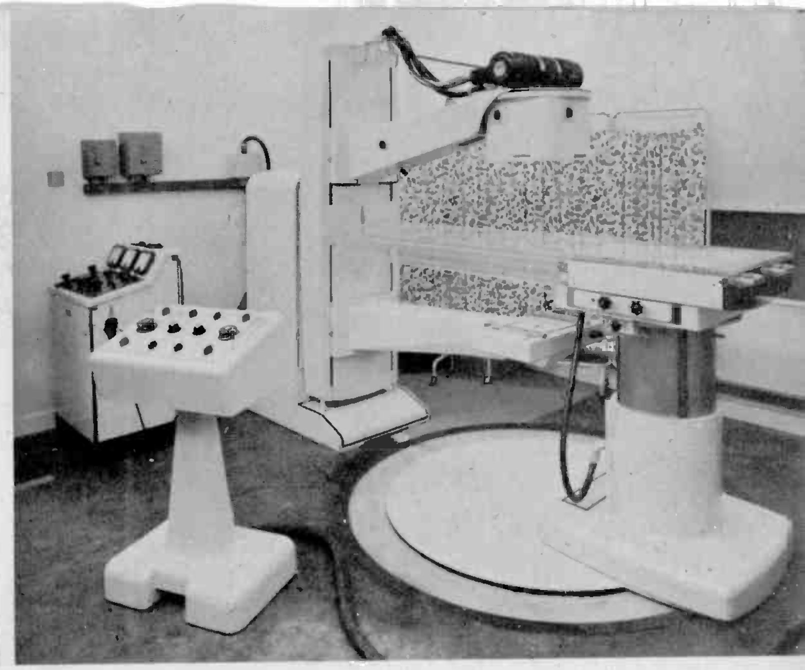
Airport Movements Watched by Radar

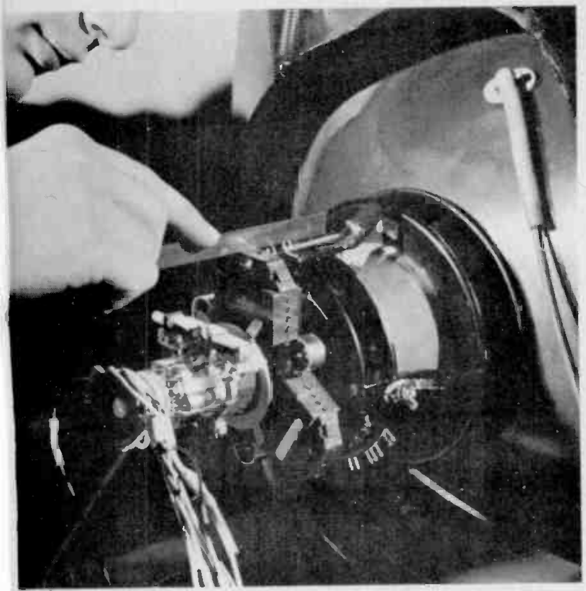


As an aid to efficient manoeuvring within a tight schedule of aircraft and vehicles at London Airport' the Decca ASMI A-band radar has been used for 12 years. But with traffic on the airfield runways and aprons rapidly increasing, a new version (Mark III) is undergoing field trials to overcome vehicle density, visibility and long range aspects of user interpretation. A map-like background picture of the airfield is displayed, even in poor weather conditions. The 6ft aperture aerial (left) rotates at 750 rev/min inside a radome (removed in this picture).

Simulator for Cobalt Treatment

A HIGHER ratio of patients is expected to be treated by cobalt and other high energy teletherapy equipments by setting up a preliminary simulator to the required position and dosage. The time the patient has to remain under the cobalt source will be significantly reduced by ensuring that accurate readings are obtained when the patient is finally placed under the isotopic source—shown in the photograph (right) as the overhead source head. The patients' treatment bed can be raised and lowered, and rotated through 360 degrees to locate the treatment area, by using the control consoles. Shown by Fairey Engineering at the Hospital Equipment and Medical Services Exhibition at Olympia, this simulator is expected to contribute to treatment of cancer.





Lined up for Colour

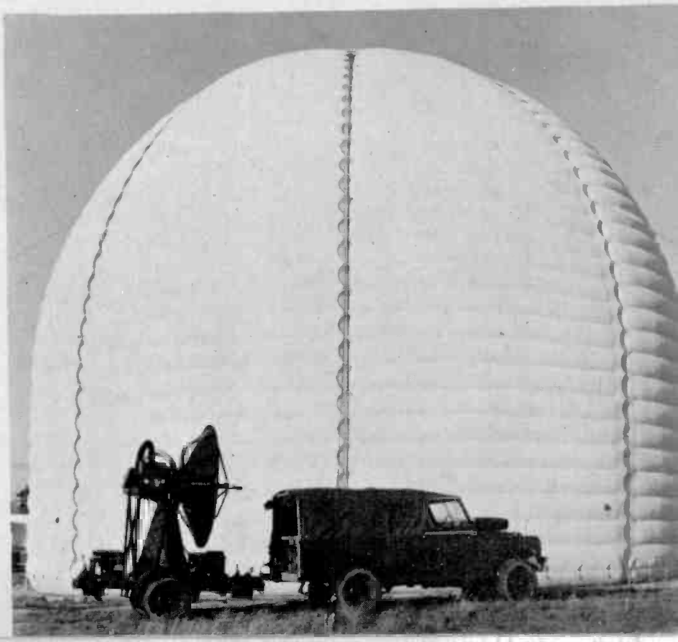
ONE of the important tests which have to be carried out on colour television receivers is to make sure that the scanning coils mounted on the neck of the tube are correctly positioned. Our photograph (left) shows the tube neck; the range of colour purity is adjusted on a prototype Plessey scan coil and convergence assembly. Here the technician checks the adjustment.

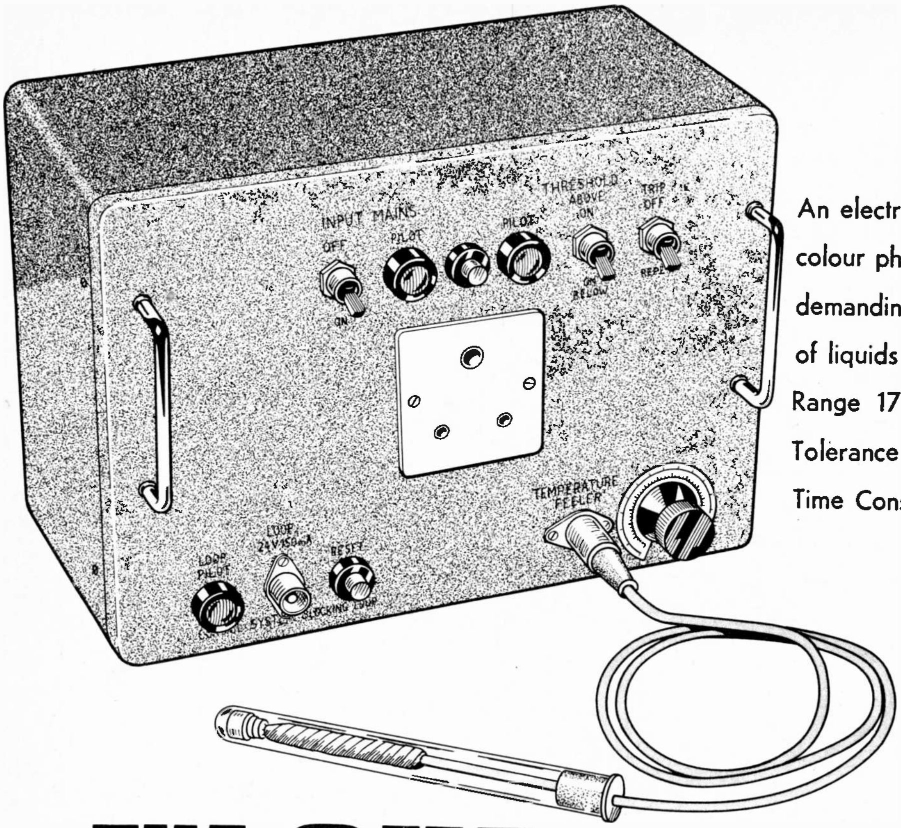
Mobile Satellite Communication

THE day may arrive when we have Field Days for "hams" who may communicate by satellite—if one can afford it.

The Signals Research and Development Establishment near Christchurch, Hampshire, have found that successful communication via satellite is not necessarily restricted by the size of dish. Their latest set-up, built for experimental use only, is this 6ft diameter dish with teleprinter equipment in the truck. The only restrictions are the number of channels that it will handle and the time allocated for transmission.

The operating frequency is 8GHz from a 1kW air cooled klystron. The equipment can be set up (below left) almost anywhere on location in less than half an hour by using a compass for direction finding. Below right, we show the 6ft dish on tow compared in size with a large SCAT station radome in which is housed a 40ft Marconi dish with transmitter, parametric amplifiers, and receiver.





An electronic remote thermostat for colour photography and other processes demanding accurate temperature control of liquids

Range 17°C to 40°C (63°F to 105°F)

Tolerance $\pm 0{\cdot}1$°C

Time Constant (in liquids) 100 seconds

THE CHEMOSTAT

By M. L. Michaelis M.A.

THE CHEMOSTAT is a mains power switching device controlled by a remote temperature feeler, which may be connected via any convenient length of three-way screened cable to the main unit. The circuit will switch any type of mains appliance (room heaters, immersion heaters, refrigeration units, water pumps, etc.) up to 2kW rating. The feeler temperature at which the circuit switches is continuously variable between 17 degrees C and 40 degrees C (scale 63 degrees F to 105 degrees F is also fitted) and may be set to any desired value within this range, with the help of a manual control on the front panel.

This temperature range is primarily suited for colour and monochrome photographic processing and for preparing various kinds of solutions for photographic baths. However, the Chemostat is equally suitable for use in conjunction with any chemical process requiring accurate thermostatic control of liquids—for example medical and physiological incubation experiments. The upper limit of the temperature control range covers normal body temperature and moderate fever simulation. It is very easy to extend the range up to still higher temperatures.

The Chemostat may also be used for controlling room air temperature, and for raising flowing cold water to a mean temperature suitable for washing photographic prints.

SWITCHING FUNCTIONS

A switch S1 on the front panel permits choice of "power on" either *above* or *below* the selected switching temperature. This provides maximum versatility of types of external appliances which can be controlled. For example, refrigeration units require power to be on above the switching temperature, but heating systems require power to be on below the switching temperature.

A second switch S2 on the front panel selects the alternative functions of "trip off" or "repeat". The "repeat" function is for normal thermostatic control, power being switched on and off repeatedly according to the state of the switching amplifier. The "trip off" function is required, for example, when using the Chemostat to warm large volumes of water to a predetermined temperature (usually between 30 degrees C and 40 degrees C) to make up solutions for photographic processing tanks. For this application, an immersion heater powered via the Chemostat, a stirring motor and the Chemostat temperature feeler are mounted such that they all dip into the water vessel. When the desired temperature has been reached, the heater will be switched off automatically and remains off.

The "trip off" function is also required when using the Chemostat feeler inside experimental electronic equipment. The switching temperature is thereby set

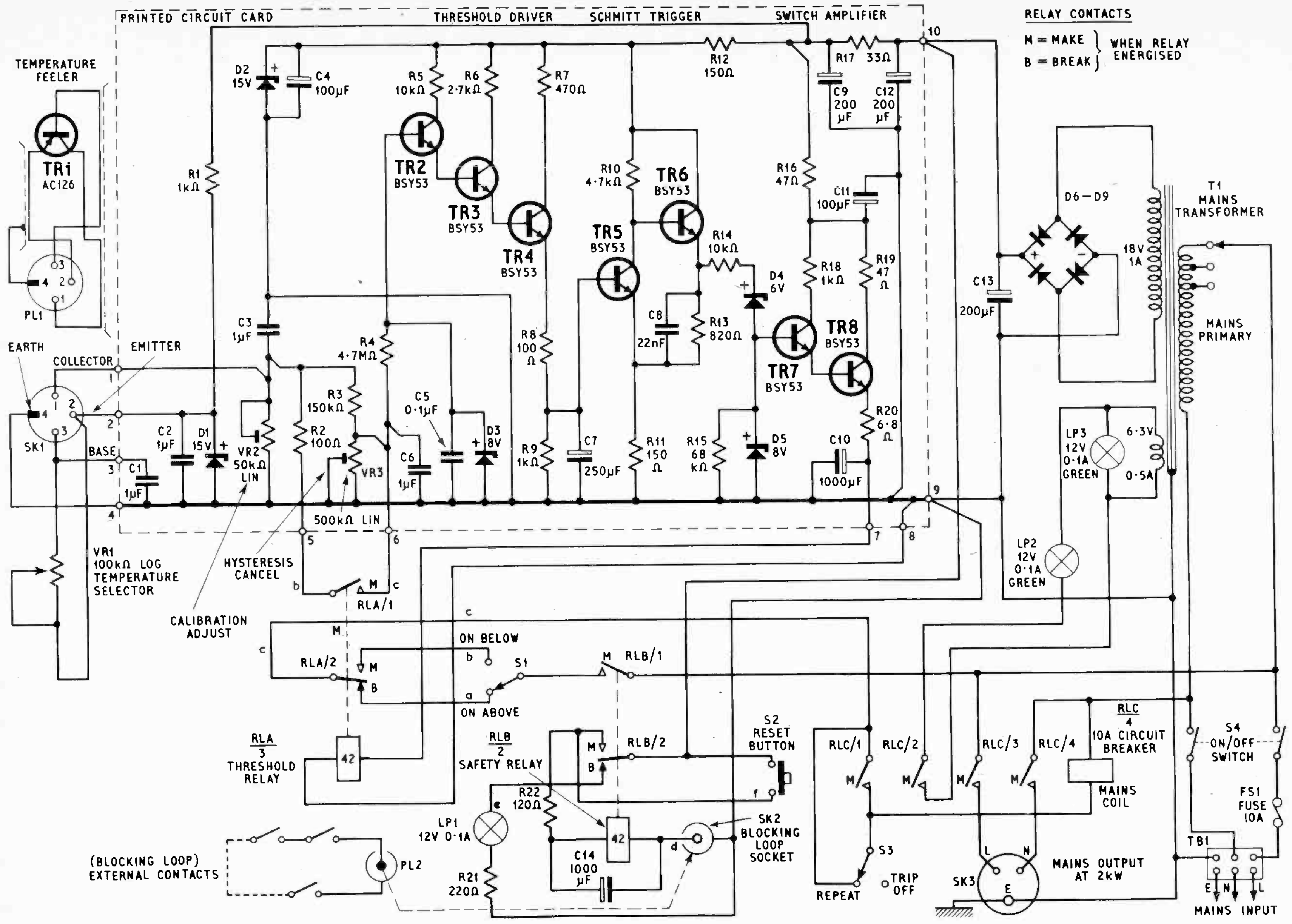


Fig. 1. Circuit diagram of the Chemostat and Temperature Feeler

to the maximum safe temperature and the equipment is powered via the Chemostat. If the experimental equipment develops excessive temperature, power to it is automatically switched off and remains off.

BLOCKING LOOP

Electrical installation regulations often demand the provision of a blocking loop in power control equipment. A blocking loop is an override circuit containing a number of low-voltage contacts which must all be closed before power can be switched on, regardless of the other prevailing states and conditions. Such a blocking loop is an important safety device, and it should be incorporated even if regulations do not expressly stipulate it.

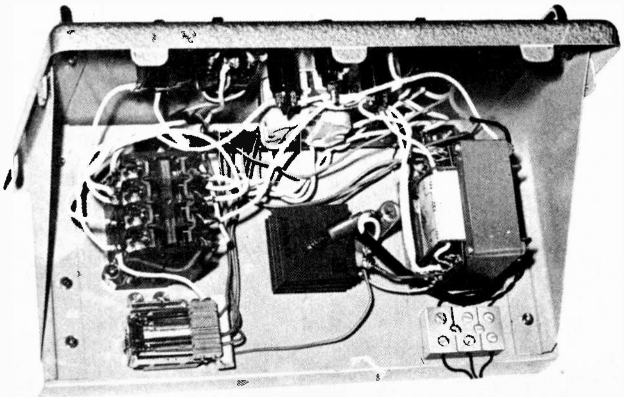
For example, if the temperature feeler of the Chemostat is inadvertently left disconnected, or if it develops a faulty plug or cable contact, the power to the immersion heater will not be switched off in the normal manner when the intended temperature has been reached. The blocking loop must therefore contain a simple bimetal strip contact in a glass test tube close to the immersion heater and set to open at a still safe temperature above the highest normally intended temperature. High accuracy is not necessary.

When using water jacket systems for adjusting the temperatures of photographic baths (see next month's instalment), trouble would again arise if the water flow ceases for any reason, such as inadvertent pinching of a rubber tube in the darkroom, or even forgetting to turn the water tap on. A simple flow contact can be included in the blocking loop for such applications.

Any reasonable number of contacts may be included in the blocking loop as required. All contacts must be connected *in series*, in any convenient order. If any one contact opens, power is tripped off in an overriding manner and *remains off* until reset manually by pressing the reset button on the front panel. Pressing the reset button has no effect if the blocking loop is still open circuit at any contact. Power can be restored manually only when the blocking loop is closed. The function of the blocking loop is quite independent of whether the control switching circuit happened to be on or off, or set to trip or repeat. It always blocks power switching until the faulty condition has been rectified and the blocking loop relay re-energised by manual actuation of the reset button.

VISUAL INDICATORS

Three pilot lamps on the front panel of the Chemostat meet all requirements of visual indication. Two *green* lamps indicate normal running conditions. One of these (LP3) is lit continuously, indicating the presence of mains input power to the Chemostat. The other green lamp (LP2) is on when the output power is switched on, and off when the output power is off. The third lamp (LP1) is a *red* one and announces abnormal conditions (blocking loop open or still not set) when it comes on.



Continuous visual indication of the actual temperature would involve unnecessary circuit complication and additional expense. Once the system has reached the selected nominal temperature, fluctuations of the feeler temperature do not exceed about $\pm 0{\cdot}1$ degrees C, and fluctuations of the bath solution temperature do not exceed about $\pm 0{\cdot}5$ degrees C. Discrepancies smaller than these are of little interest, at least not for photographic work. The second green lamp thus suffices as a combined temperature and power indicator. In a heating control system, the temperature is on the low side when this green lamp is lit, and vice versa.

TEMPERATURE FEELER

We require a very sensitive temperature feeler, in order to obtain a satisfactory change of its electrical output for 0·2 degree C change of temperature. The collector leakage current of a transistor is a notoriously temperature-dependent parameter. It was therefore decided to aggravate this effect to the maximum obtainable slope in designing a transistor feeler for the Chemostat.

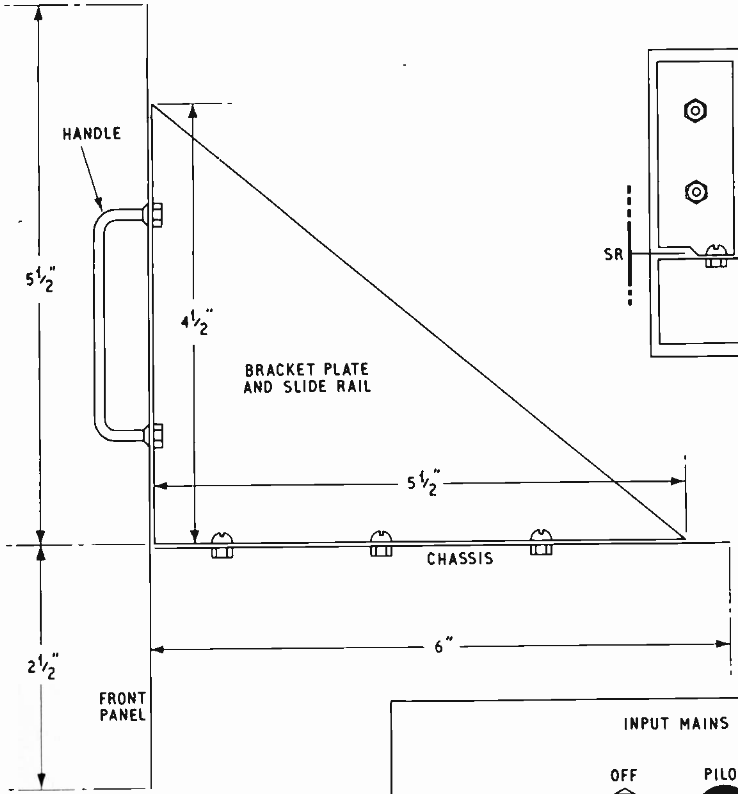
All transistors, including silicon types, manifest collector leakage currents with a very large positive temperature coefficient, but the absolute magnitudes in the temperature range of interest for the Chemostat are satisfactory only with germanium transistors. High current gain is also required. A Mullard AC126 meets these requirements and is very readily obtainable.

To maximise temperature-dependent collector current, no base current should be injected apart from that due to internal thermal leakage. To obtain the greatest possible slope, the emitter must be taken straight to the positive supply voltage without interposing any resistor. Furthermore, the operating point must be chosen such that the current gain is rising with collector current. This calls for a constant operating point, which then logically corresponds to the trip-over point of the already mentioned trigger circuit.

The thermal resistance of an AC126 is about 0·3 degree C/mW, so that the operating point must not dissipate more than about 2mW in the transistor, to keep the junction temperature change within the ambient tolerance limit. The constant operating point enables the junction temperature difference correction to be included in the calibration, so that to a first order of approximation it is then effectively zero.

TEMPERATURE SELECTOR

The manual temperature selection control (VR1) takes the form of a variable resistor between the base and emitter of the temperature feeler transistor. It shorts out an adjustable fraction of the thermal leakage current injected internally from collector to base. The nominal collector current is then reached at correspondingly higher temperatures, the smaller the base-to-emitter resistance is made. It was found possible to achieve a slope of nearly one volt per degree centrigrade with an AC126 at an operating point satisfying all essential conditions. This means that the hysteresis of the trigger stage must be reduced to 0·2V or less, which was found to be readily possible in



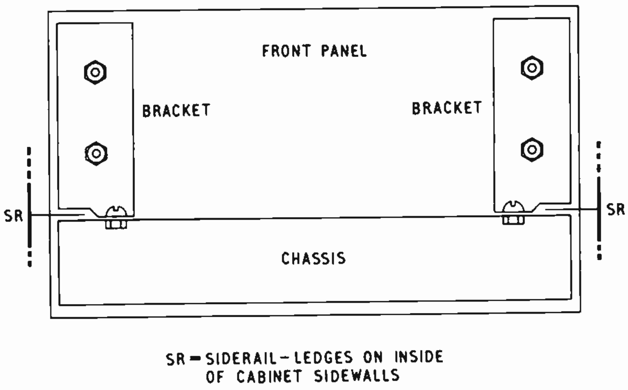


Fig. 2. Chassis and front panel assembly

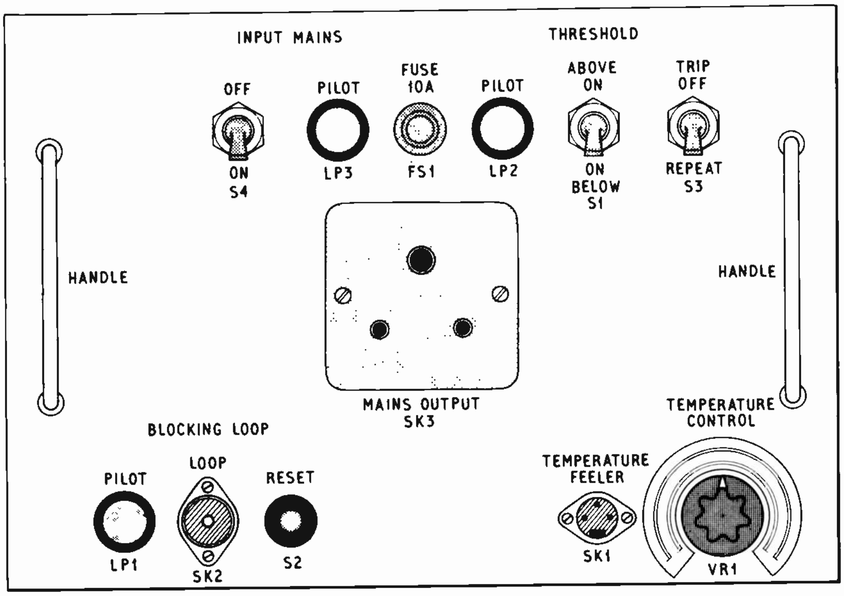


Fig. 3. Front panel layout and engraving

the adopted circuit. The slope of the transistor temperature feeler is equivalent to halving its effective impedance for about 5 degree C rise of temperature, which is nearly twice as steep as the steepest standard-range n.t.c. resistor. Thus, the transistor feeler is an improvement on an ordinary n.t.c. resistor.

INPUT AMPLIFIER

C1, C2, C4, and C14 provide a.c. shorts to chassis for all leads of the temperature feeler, so that it is quite insensitive to mains hum or other inductive interference. Screened cable is not absolutely essential, but advisable, for the temperature feeler. The collector current of the temperature feeler transistor TR1 develops 5·2V across VR2 at the nominal operating point. This is the voltage input to the linear current amplifier TR2–TR4 at which trip-over of the trigger stage TR5, TR6 takes place.

Below this threshold level, relay RLA is energised, so that one of its contacts is shorting-out R3 and thus the full 5·2V appear across VR3 and are applied via R4 to the base of the first transistor TR2 in the current amplifier. The trigger stage thus trips-over as soon as C5 has charged to 5·2V via R5. This causes relay RLA to drop off and remove the short across R3, causing the amplifier input voltage to drop to a fraction of that across VR2. Suitable adjustment of VR3 thus makes the trigger stage revert to just above its trip-back level (3·5V) as soon as it has tripped over.

A very small feeler temperature drop then reduces the input voltage sufficiently for trip-back, whereupon RLA

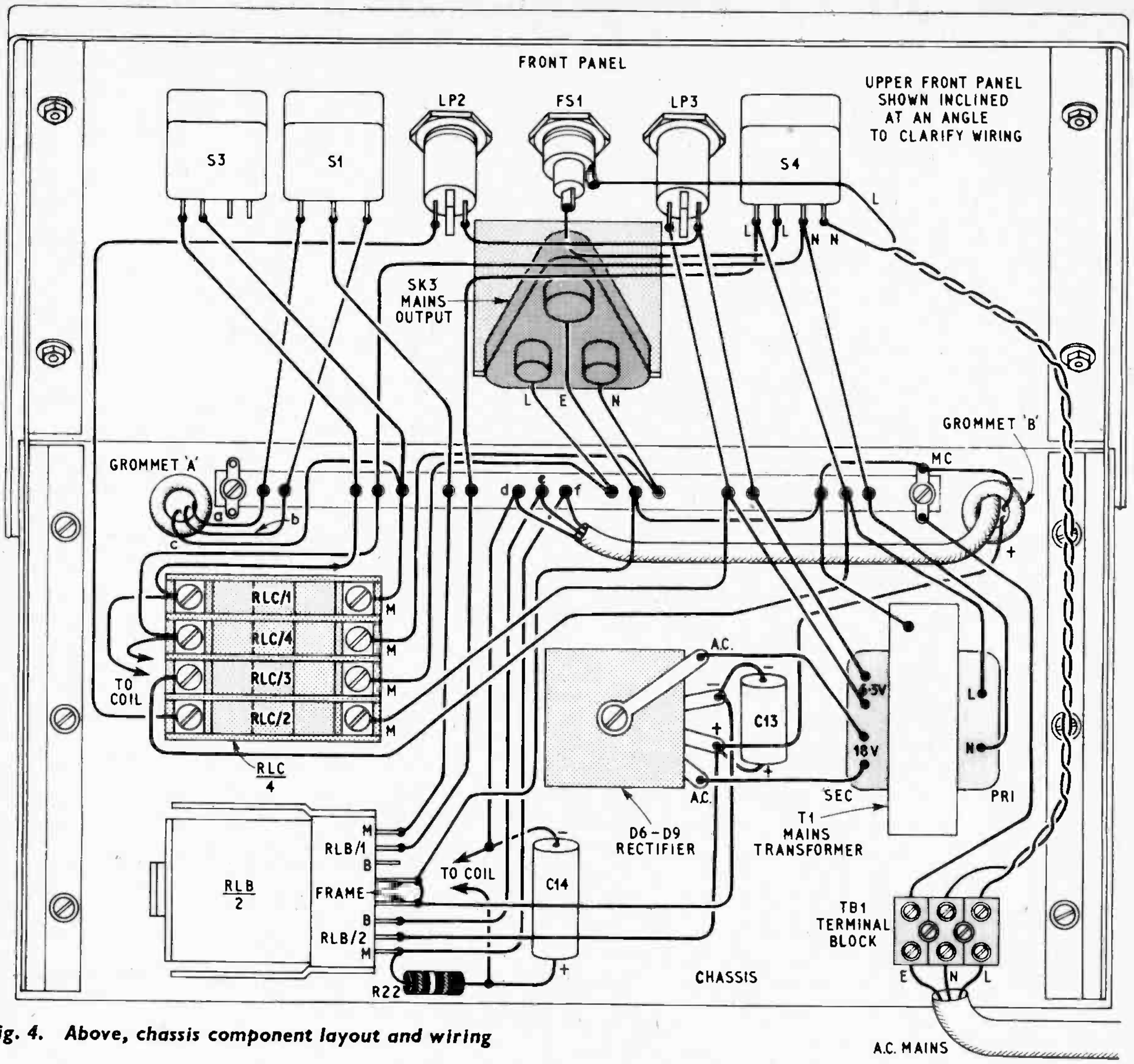


Fig. 4. Above, chassis component layout and wiring

energises and immediately shorts-out R3 again, lifting the trigger stage back to the verge of trip-over. R2 prevents instantaneous charge transfer between C6 and C3, avoiding relay contact spitting.

D3 is a small Zener diode to limit the input voltage to the current amplifier to a safe value if VR1 happens to be set to a temperature much smaller than the actual feeler temperature.

The input amplifier TR2–TR4 is necessary because the hysteresis-cancellation and time-delay circuits at its input lead to a very high impedance from which it is not possible to drive the trigger stage directly. The amplifier is a simple three-stage cascaded emitter follower with a current gain of about fifty thousand. R8 ensures a safe minimum output load for TR4, whilst R9 and C7 develop the low-impedance drive voltage for the trigger stage and hold it constant during switching transients.

SCHMITT TRIGGER STAGE

With no voltage, or only a small voltage, applied to the base of TR5, this transistor remains cut off. Its high collector voltage saturates TR6, whose resulting heavy current also flows through R11 and there produces the voltage drop holding TR5 cut off. Once the input voltage is sufficient to lift TR5 to cut-on, cumulative feedback via C8 causes TR5 to saturate immediately and the resulting low collector voltage reduces the current through TR6 to a very low value.

The Zener diode potential divider D4, D5 ensures that the input voltage to the output amplifier TR7, TR8 is zero in this state and 8V in the former state. This ensures either nominal voltage or zero voltage across the relay RLA at the output.

SWITCH AMPLIFIER

The switch amplifier TR7, TR8 is similar to TR2–TR4 and is required because the output impedance of the trigger stage is too high to supply RLA directly.

R20 ensures a safe minimum load for TR8 and C10 removes inductive transients otherwise produced when current through the relay coil is suddenly interrupted. C10 at the same time delays relay drop-off for a fraction of a second, preventing any possibility of chatter. R19 is very important. Its purpose is to reduce the collector voltage of TR8 in the switched-on state, such that the power dissipation in TR8 definitely remains below 500mW.

STABILISED SUPPLIES

Stabilised supply voltages are essential for the temperature feeler, input amplifier, and trigger stage,

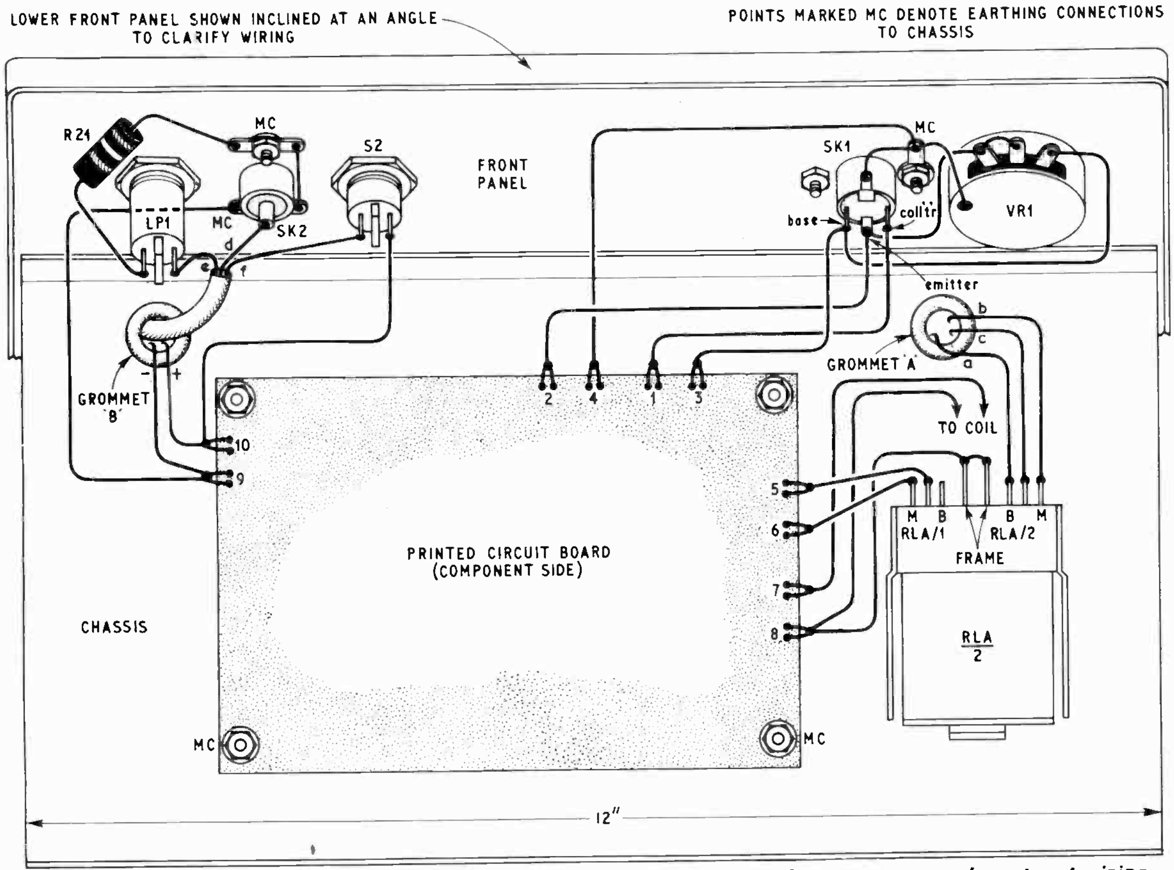


Fig. 5. Under-chassis component layout and wiring

COMPONENTS . . .

Resistors

R1	1kΩ	R9	1kΩ	R16	47Ω 1W
R2	100Ω	R10	4·7kΩ	R17	33Ω 1 W
R3	150kΩ 1W	R11	150Ω	R18	1kΩ
R4	4·7MΩ 1W	R12	150Ω 1W	R19	47Ω 1W
R5	10kΩ	R13	820Ω 1W	R20	6·8Ω 1W
R6	2·7kΩ	R14	10kΩ	R21	220Ω 5W ww
R7	470Ω	R15	68kΩ	R22	120Ω 5W ww
R8	100Ω				

All ±10%, ½W carbon unless otherwise stated

Potentiometers

VR1 100kΩ carbon, log.
VR2 50kΩ carbon, lin. } miniature skeleton
VR3 500kΩ carbon, lin.

Capacitors

C1	1μF microfoil	C8	22μF microfoil
C2	1μF microfoil	C9	220μF elect. 30V
C3	1μF microfoil	C10	1,000μF elect. 6V
C4	100μF elect. 30V	C11	100μF elect. 30V
C5	0·1μF microfoil	C12	200μF elect. 30V
C6	1μF microfoil	C13	200μF elect. 30V
C7	250μF elect.	C14	1,000μF elect. 12V

Transistors

TR1 AC126 (Mullard)
TR2–TR8 BSY53 (S.T.C.) (7 off)

Relays

RLA, B 42Ω coil, 6V d.c. Two c/o contacts. (Trls 152a/TBV63040/63d. Siemens) (2 off)
RLC Mains energised contactor. Three 10A contacts and one 6A c/o (B & R Relays type K10)

Diodes

D1 ZX15
D2 ZX15
D3 Z8 } Intermetall Zener Diodes (S.T.C.)
D4 Z6
D5 Z8
D6–D9 Silicon l.t. rectifiers ½A, 100V p.i.v. (4 off or Selenium Bridge 18 or 24V a.c. ½A d.c. (FSL2497A S.T.C.)

Switches

S1 S.P.D.T. mains, 2A, toggle
S2 1 maker press button
S3 S.P.S.T. mains, 2A, toggle
S4 D.P. mains, 10A, toggle

Plugs and Sockets

PL1 3 pole Continental type plug
SK1 3 pole Continental type socket
SK2 Coaxial socket
SK3 3 pole wall socket, 13A or 15A
TB1 3 way terminal block

Lamps

LP1 Red, 12V 0·1A
LP2 Green, 12V 0·1A
LP3 Green, 12V 0·1A
(NOT 6V, since too bright for darkroom!)

Fuse

FS1 10A panel mounting fuse

Miscellaneous

Material for chassis, front panel, etc. Pair of handles. Copper clad laminated plastics board. Pointer type control knob.

to avoid temperature calibration errors due to mains voltage fluctuations. D2 stabilises the supply for the input amplifier and trigger stage, whilst D1 stabilises the supply for the temperature feeler. These separate stabilisers are necessary to avoid residual switching transient interactions which would impair the stability of hysteresis cancellation.

A bridge connected rectifier D6–D9 fed from an 18V winding on the mains transformer T1 provides the direct current for the electronic circuits and coils of relays RLA and RLB.

A.C. POWER CIRCUITS

Power is switched on an off on both poles of a single-phase mains supply, using two contacts of a standard three-phase 10 amp circuit breaker with mains-energised solenoid (RLC).

Two make contacts are used to switch the output power circuit to the outlet socket SK3, a third to switch the power indicator pilot lamp LP3 and the fourth contact is used as a self-latching contact for the mains energised solenoid in the "trip-off" function. For the "repeat" function, S2 simply shorts-out this latching contact.

The mains feed to the circuit breaker solenoid is also taken via contacts of RLA and RLB. S1 selects either a maker or a breaker contact of RLA for this purpose, to provide the optional power-on above or below the threshold temperature.

RLB is associated with the blocking loop and completes the circuit for the solenoid of RLC only when RLB is energised, which is possible only when the blocking loop is closed at SK2. RLB is energised via the blocking loop and its own latching contact, so that it drops off and remains off if the blocking loop is temporarily interrupted. C14 prevents RLB unlatching on brief mains kicks. The third contact of RLB switches-on the red fault indicator lamp LP1 whenever RLB is not energised, i.e. when power control is blocked off. It is important to use 12V bulbs in LP1 to LP3, although the running voltage is only about 6V: six volt bulbs would be far too bright for the photographic darkroom.

CONSTRUCTIONAL DETAILS

A front panel and a simple U-shaped chassis bolted together with the aid of two angle brackets form the main structure for the Chemostat. Dimensions and assembly details are given in Fig. 2.

The electronic circuitry enclosed within the dotted line in Fig. 1 is built up on a printed circuit board, see Fig. 6 and Fig. 7. This board is secured to the underside of the chassis. The disposition of all other components and wiring is clearly shown in the diagrams, Figs. 3, 4, and 5.

Make sure that the mains wiring is carried out with substantially insulated wire and that connections are secure—especially all earthing connections. The conductor side of the printed circuit board must be coated with approved insulating varnish to prevent spurious leakage due to dust accumulation.

The main assembly should be enclosed in a suitable sized metal cabinet. To minimise dust entry, use a cabinet with only very small ventilation slits at the rear. The entire circuit develops negligible heat, so that efficient ventilation is not necessary.

Next month's article will include diagrams for the printed circuit board and the temperature feeler; also instructions for calibrating and using the Chemostat.

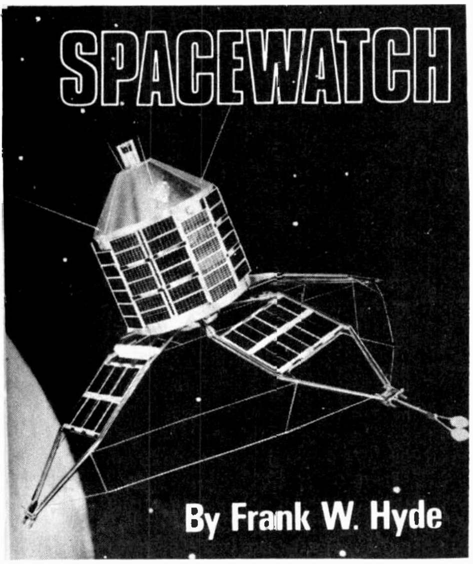
The opening article of this new feature is mainly devoted to the first all-British spacecraft.

FIRST ALL-BRITISH SPACECRAFT

The contributions to space research from the United Kingdom have been considerable, though, perhaps, they have not received the same degree of publicity as those from other countries. With the successful launching of satellite *UK3*, the first all-British built spacecraft, there is indeed something to shout about.

At the end of its first pass in a correct orbit the space craft, in accordance with custom, changed its designation to *ARIEL 3*.

There are five experimental packages aboard the vehicle and the integration of these electronic-wise presented some problems which have now been proved to be fully mastered



SPACEWATCH

By Frank W. Hyde

A commentary on space exploration activities

New developments in radio astronomy and spacecraft with emphasis on the electronic techniques and equipment employed

V.L.F. EXPERIMENT

A study being carried out for Sheffield University is directed to the spatial and temporal characteristics of very low frequency radiation above the ionosphere. The data from this experiment will extend the studies in this field which have already been made by the *Alouette* and *Injun* satellites.

The observations are being made at various frequencies at a number of earth based stations simultaneously with those of the satellite. The frequencies chosen are 3·2, 9·6, and 16kHz. The aerial is a 14 turn loop and the receiver is housed in a box measuring 8in × 6in × 6in into which are crammed some 183 transistors and 800 other components, with a total power consumption of 250 milliwatts.

The ground-based stations are at Sheffield University, at Halley Bay, in the Faroes operated by an amateur Martin Haasen, and at Winkfield, Johannesburg, Quito and Santiago.

SURVEY OF THE IONOSPHERE

Birmingham University have designed their experiment to investigate the density of ionisation and the temperature at various points along the satellite's path. The density of the ionisation is being measured by using an r.f. plasma probe developed by the University. The measurement of temperature is made by a new probe which is in the form of a pair of matched spheres which draw current from the environment occupied by the satellite. The data will be telemetered and also stored and then read out once every orbit.

NOISE RESEARCH

The Nuffield Radio Astronomy Laboratory, University of Manchester at Jodrell Bank, has an experiment which is designed to map out large scale noise sources in the Galaxy. The emission of noise or sky brightness, if made with sufficient angular resolution, will provide information on the ionospheric refraction and its effect on the distribution radiation across the sky.

A special technique used in this study takes advantage of the focusing effect of the ionosphere. The receiver is made to sweep slowly across a spectrum of 2 to 5MHz. When the frequency coincides with the cut-off frequency prevailing locally there occurs a focusing effect which gives a finite width of beam of about 20 degrees at 5MHz and 20 degrees at 2MHz.

METEOROLOGICAL OFFICE

The amount of molecular oxygen present between the satellite and the Sun in the upper atmosphere is being investigated by a Meteorological Office experiment.

A detector which is sensitive only to a specified wavelength in the ultra violet region is used for this work. There are four ion chambers which look sideways from the top of the satellite. The chambers are sensitive to a wavelength of 1,450 Ångstroms. The outputs are amplified by means of a very sensitive (d.c.) amplifier developed by the Meteorological Office.

TERRESTRIAL NOISE

An experiment which is being carried on behalf of the Radio and Space Research Station seeks to discover the amount of h.f. noise received and the distribution of the noise sources. These sources include lighting and the aim is to deduce the distribution over the surface of the earth at different times of the day and at different seasons.

ARTIFICIAL SATELLITE ARIEL 3 (1967—42 A)

Injected into orbit 1967, May 5.
Weight 89·9kg, length 0·91 metres, diameter 0·76 metres.
Orbital elements:

Perigee height 497km.	Apogee height 608km
Inclination 80°. 2	Period 95m·7
Eccentricity 0·008	Daily change −4·5 min
Interval +97·5 min.	Beacon on 136·56MHz

The average voltage is measured and its envelope divided into three pairs of narrow-band channels at 5, 10, and 15kHz. The number of amplitudes over a certain threshold is measured.

The aerial system consists of two orthogonal screened loop aerials. Each has an effective area of 0·12 sq. metre. Noise data is recorded after filtering by a low speed encoder at intervals of 27·92 seconds and stored in the recorder. There are outputs every 1·745 seconds for direct telemetry.

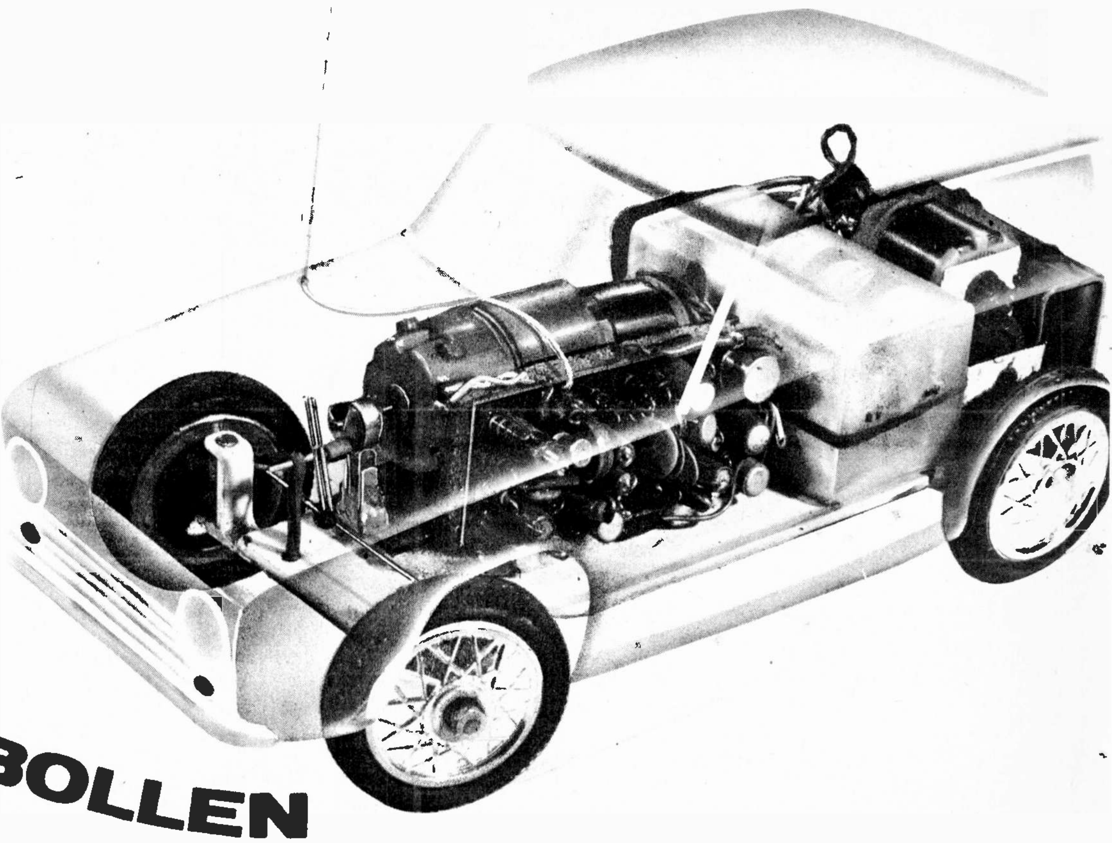
SOLAR POWER

Power for several electronic units in *Aerial 3* is provided by over 6,000 Ferranti solar cells. The printed circuits in these solar cells have been manufactured by Turner Electrical Instruments from copper-clad Bakelite laminated.

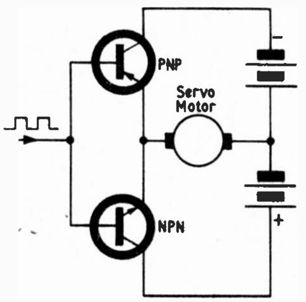
SOUND WAVES IN THE IONOSPHERE

The mirror in the sky, the elevated region of the atmosphere where free electrons and ions modify, reflect, and refract radio waves has been assumed to consist of layers. These layers at varying heights and with varying degrees of reflectivity are subject to a number of influences. Some of the effects have been explained by making the assumption that very low frequency waves existed in the atmosphere. Information is now available that these infrasonic waves have been observed.

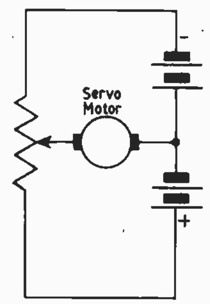
At the Physics Dept. of the University of Queensland, K. L. Shrestha has analysed a disturbance which occurred over a large part of Australia on August 12, 1965. A regular variation of 10 to 25 seconds was observed at ·3·84MHz and a longer period of up to 50 seconds at a frequency of 5·8MHz using the normal methods of ionospheric sounding. The variations are shown to be the effect of infrasonic waves moving upwards through the atmosphere. The velocity of these waves was of the order of 650 metres per second. The origin of these waves however is still not known. At the time of the occurrence no unusual effects were observed on the barometric or magnetic records.



By D. BOLLEN



Relayless Output for pulsed tone



Equivalent circuit

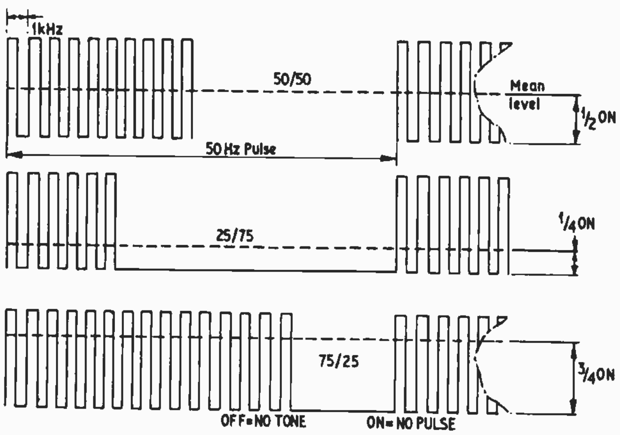


Fig. 14. Pulsed tone

It is worth considering briefly the various "states" given by control systems, in terms of elementary logic. There is first of all the single channel sequence binary state, made more versatile by further mechanical binary division in the escapement itself. For progressive steering three states are required, corresponding to going right, going left, and steering fixed. With two channels, four states are theoretically possible, no tone, tone one, tone two, and both tones.

Although the last mentioned state—simultaneous tones—can be achieved with two separate audio oscillators in the transmitter, and a special relayless switch, this is a considerable complication just for one extra state. As far as model control is concerned, the more states there are the better, so long as this does not involve a build-up of component density in the model. However, even though very small models exclude the use of many channels, circuits can be devised which, by careful blending of internal switching with available states, will accomplish a great deal.

Taking the simple single-tone transmitter with its two states, and a single-channel receiver, if the tone is chopped by a 50 : 50 mark/space square wave, a new condition will be created which, for want of a better term, may be described as the "half-on state". Rearrangement of the relayless output switch will permit this new state to be usefully employed as a zero datum so that "no tone" corresponds to, say, a negative signal, and "full tone" a positive signal. Furthermore, the mark/space ratio can be continuously varied by a potentiometer at the transmitter to give signals such as "quarter on" or "two-thirds on"; in fact, anything between full on and full off. Therefore, pulsed tone can give the counterpart of "three-state" two-tone working with fewer components and the added advantage of an analogue function.

MODEL CONTROL INSTALLATIONS

Part Three PULSED TONE

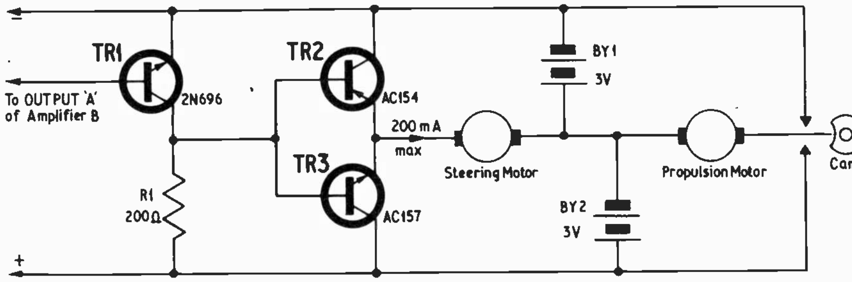


Fig. 15. Circuit diagram of "one-stick" single channel control system

"ONE STICK" PROGRESSIVE SYSTEM

Relayless output and servo details for a pulsed control system are shown in Fig. 15. The propulsion motor is switched by modified limit contacts on the servo to achieve six "states", so that the model will be fully steered while going forward or in reverse, and the propulsion motor can also be stopped. Control is accomplished by a single potentiometer mounted on the transmitter. In the model, a 1kHz version of Amplifier "B", relayless output, servo, and low consumption propulsion motor are all powered by a single centre-tapped battery of four pen-cells.

Although this system has been tested to the limits of range in a fast model aeroplane, with an engine speed servo in place of the propulsion motor, it is best restricted to slower speed models which work in two dimensions only, unless the operator has an ultra-fast reaction time and very good nerves. The simplicity of the system commends it particularly to electrically powered small model boats and cars. There is ample servo crank power to overcome the heaviest model car steering loads.

In Fig. 15, additional amplification is provided by TR1, to ensure that TR2 and TR3 are switched hard on in the emitter follower mode. With this output circuit, TR2 and TR3 are both off when the mutual base voltage is close to the battery centre-tap voltage.

Of course, since TR2 and TR3 are alternately switching hard on in response to the mark and space of the pulse, they will never both be off at the same time, but the servo motor interprets a 50 : 50 mark/space ratio as a zero d.c. voltage across its brushes.

Although smoothing could be applied, to convert the mean pulse level to steady d.c., it is an advantage to allow this large ripple voltage to remain as it helps to overcome servo motor inertia and frictional forces, and gives a much smoother response.

Depending on pulse repetition rate, and servo gearbox ratio, a slight jitter of the steering cam will be evident, together with a loud hum from the motor when stationary, but this does not affect the model.

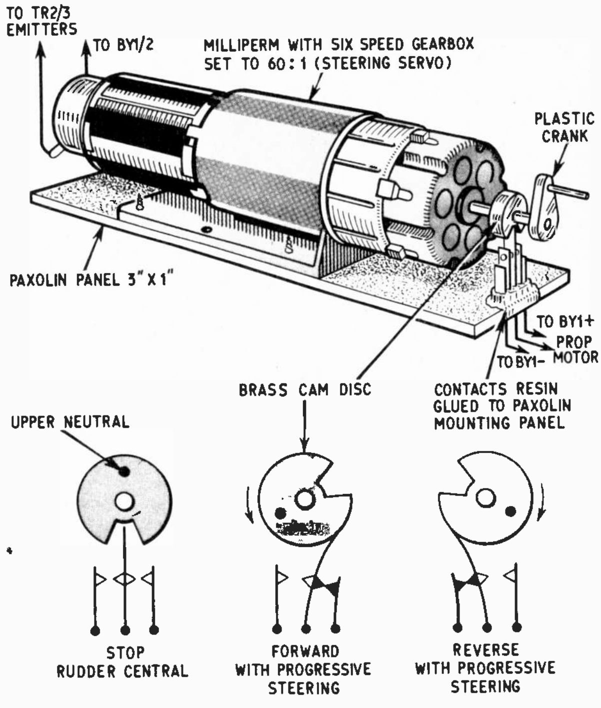


Fig. 16. Servo system details for the circuit in Fig. 15

Propulsion motor switching, by means of the cam and changeover contacts depicted in Fig. 16, is as follows. Starting with the cut-away portion of the cam in line with the moving contact, the contacts are biased open, steering is at neutral, and the propulsion motor is stopped. Also, the control stick attached to the transmitter potentiometer will be upright and central.

By advancing the stick slightly to the right the servo will be made to creep slowly, say, counter clockwise,

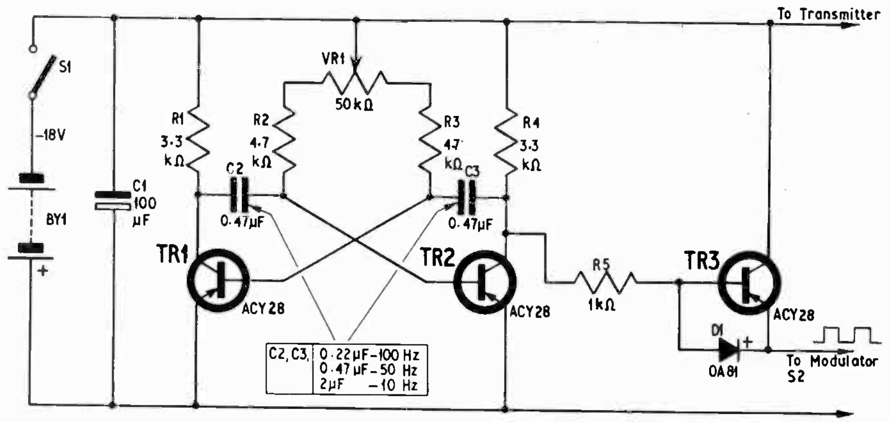


Fig. 17. Circuit diagram of a pulser

thus the moving contact will be pushed by the cam to the right and the propulsion motor will start.

Left steering is momentarily applied while the crank moves to the lower neutral position. When the crank reaches lower neutral, the control stick is returned to the upright position, whereupon the model will be going forward in a straight line. If now the model is steered to the left, with the cam going clockwise, the servo contacts will *not* switch back, so full right and left steering commands may be given without affecting the forward motion of the model.

If the model is required to go in reverse, the transmitter stick is pushed to the left. The speed of servo response is determined by how far the stick is displaced from centre. The stick is held until the cut-away in the cam again comes into line with the moving contact. Servo rotation is continued in a clockwise direction and the moving contact will this time be pushed to the left, reversing the propulsion motor, while allowing steering to be carried out as before.

To stop the model at any time it is only necessary to push the stick hard over until the cut-away lines up with the moving contact, and hold it with the stick central.

Although the procedure may be difficult to grasp when explained, it is fairly simple to master when a model is being controlled. The important point to

COMPONENTS . . .

PULSER CIRCUIT

Resistors

R1 3·3kΩ
R2 4·7kΩ
R3 4·7kΩ
R4 3·3kΩ
R5 1kΩ
All 10% $\frac{1}{10}$ watt carbon

Potentiometer

VR1 50kΩ linear miniature carbon

Capacitors

C1 100µF elect. 25V
C2, C3 Miniature paper 60V (see Fig. 17 text)

Transistors

TR1, TR2, TR3 ACY28 (S.T.C.) or OC81 (3 off)

Diode

D1 OA81

Switch

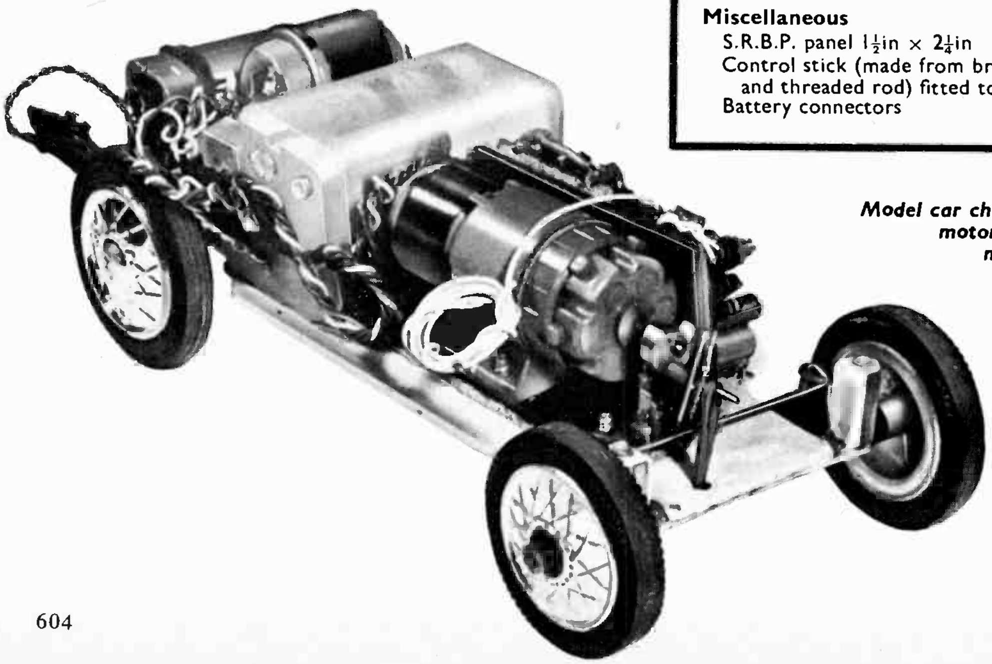
S1 Single pole or double pole, on/off, miniature slide switch

Batteries

BY1, BY2 9V type PP7 (2 off)

Miscellaneous

S.R.B.P. panel 1½in × 2¼in
Control stick (made from brass control knob insert and threaded rod) fitted to VR1 spindle
Battery connectors



Model car chassis showing the steering motor, gearbox, and track rod mechanism. The receiver aerial wire (coiled on the gearbox) would be connected to a whip aerial

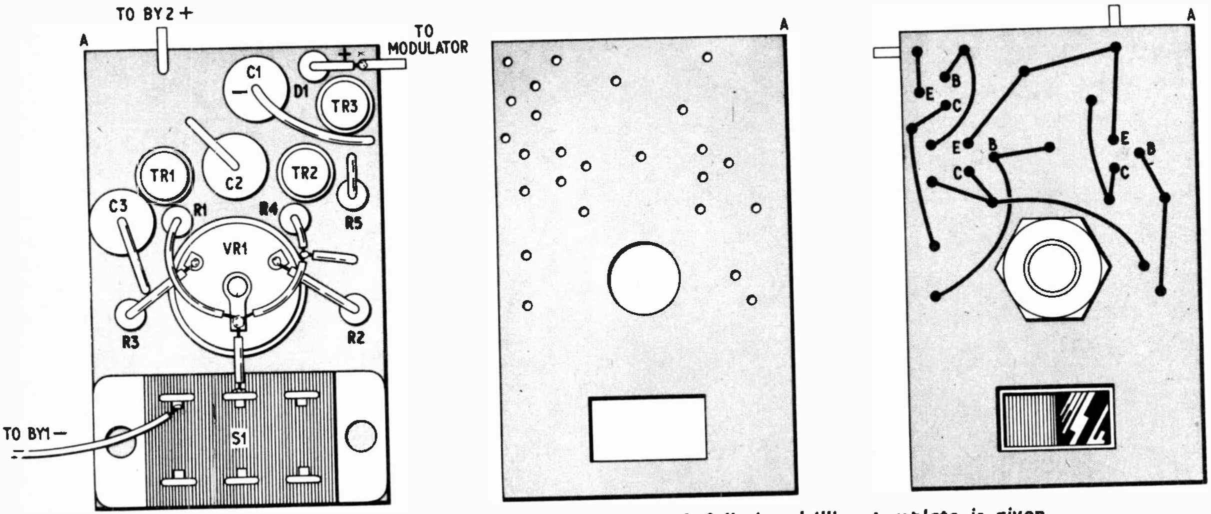


Fig. 18. Component layout of the pulser circuit. A full size drilling template is given

realise is that the propulsion motor contacts are arranged to switch off or over only when the cut-away in the cam is presented to them. Normal steering motion is confined to the upper 180 degrees of the crank, with the cut-away remote from the contacts.

Fig. 16 shows the essential constructional points of the servo. The moving contact should be of springy material which will retain its shape despite the bending forces of the cam. Crank, cam, and contacts are resin glued.

PULSER CIRCUIT

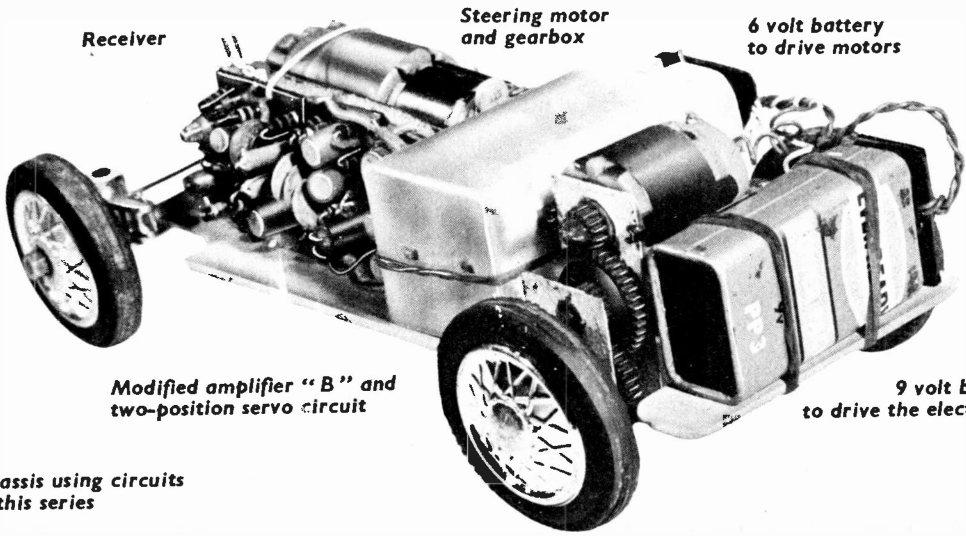
The pulser circuit is in Fig. 17, and component placement panel details are in Fig. 18. The output from the pulser is taken to the R1/S2 connection in the transmitter modulator (see transmitter circuit), and S2 can be removed from this circuit.

The prototype pulser was fitted into a larger transmitter case, alongside the transmitter panel, with two PP7 batteries. It was decided to retain the tone push button, for use with sequence equipment when required. Pulser panel construction follows closely the method employed with previous units, and is quite straightforward.

If it is found that the control stick action is reversed relative to the steering in the model, track connections to VR1 should be interchanged.

The 18V transmitter rail voltage is in excess of the maximum collector rating of many transistors in common use. If transistors of a different type to those specified—or of uncertain origin—are substituted, check that the maximum ratings are not exceeded. Where a doubt remains, and if the full range capabilities of the transmitter are not required, the supply voltage may be reduced to 9V or 12V.

In Fig. 17, alternative values are given for C2 and C3, so that the pulse frequency can be adjusted; 50Hz–100Hz will suit most progressive steering servos. Simple pulse-proportional has not been mentioned, because its low crank power and steering linkage oscillation renders it unsuitable for use in model cars. However, the 10kHz pulser frequency is included for those who wish to experiment with simple proportional control of model boats. The servo of Fig. 16 can be quickly adapted for pulse-proportional by attaching a rubber band to the crank, to bias the steering in the lower neutral position; that is with cam cut-away 180 degrees



Model car chassis using circuits described in this series removed from the contacts. The gearbox should be set to give a 6 : 1 or a 12 : 1 reduction ratio. No other modifications are required.

RECEIVER COILS

Several readers have requested details of the series *Miniature Model Control* on which this current series of articles is based. We regret that neither these back numbers nor reprints from them are available, but details of the individual circuits originally used are reproduced in this current series.

The circuits for the receiver and amplifiers "A" and "C" were reproduced in the June 1967 issue. Details of the receiver coils are as follows:

L1 is a wave-wound r.f. choke on a small carbon resistor and is a purchased item. The winding terminations are secured to the pi winding with small spots of glue. The resistor is then carefully removed, leaving the winding intact. Although the precise inductance of the original was not known, the choke had a self resonance at 2MHz; the estimated inductance was 1mH.

L2 is made by winding 30 turns of 32 s.w.g. enamelled wire close wound on a $\frac{3}{16}$in coil former. The winding is secured in place with a layer of tape or wax. It can be wound on a former taken from a television tuner "biscuit", obtainable from television repair shops. After winding, the former is cut down to an overall length of $\frac{9}{16}$in.

The capacitor C6, across the collector and emitter of TR1, is made by twisting together a pair of 32 s.w.g. enamelled wires each $1\frac{1}{2}$in long. The two wires must not be in electrical contact with each other and must not be untwisted.

The circuits for the transmitter and amplifier "B" were reproduced last month; coil details were included. ★

POINTS ARISING

THE ELECTRONIC ORGAN

Our introductory series of articles on the electronic organ was concluded in the June issue. We would remind readers that detailed information and instructions for building the specially designed P.E. Organ will be presented in a new series. An announcement concerning publication date will be made shortly.

COMPUTER EVOLUTION

This current series will be resumed next month, with Part Four.

C.R.O. TRACE DOUBLER *(June 1967)*

The resistors used on the model shown were $\frac{1}{2}$ watt 10 per cent types. It is not essential to use those types quoted in the Components List.

DIAL-A-NAME GAME *(June 1967)*

Under the side heading "CODE COUNTING", read: the initial letter of the surname on the *centre* dial scale is dialled against each letter of each christian name on the *outer* scale. In the example, dial B on the *centre* scale against J on the *outer* scale, and so on throughout.

ROYAL AIRCRAFT ESTABLISHMENT

The Royal Aircraft Establishment is concerned with almost every aspect of the work of the aircraft and aircraft equipment industries. Ground and airborne avionics are a very important part of the varied activities undertaken at the R.A.E. headquarters at Farnborough.

Open Days (the first for six years) held last June provided the opportunity for visitors to explore the extensive site and to inspect the work of all departments.

A star attraction was the forward section of the Concord fuselage installed on the special test frame in the newly built site. A multiplicity of cables run from the fuselage to the adjacent Control Centre building where the signals from various transducers will be fed into KDF7 computers. Tests will cover all significant loading actions experienced by the aircraft on the ground and in flight.

An example of a piece of airborne test gear (essentially electronic) is the Counting Accelerometer. This instrument automatically counts the number of times given levels of acceleration are exceeded due to rough air conditions. The counters are photographed at intervals together with instrument readings of height, speed and time. This kind of instrument has been flown in passenger aircraft and the data collected and analysed. The results assist aircraft designers in allowing for metal fatique.

INSTRUMENT LANDING SYSTEMS

Much work is being undertaken in instrument landing systems (ILS). A comprehensive study of a hybrid navigation system for future long range transport aircraft is being made. Such a system would be pilot operated, with world wide coverage. It would employ a digital computer, an inertial navigator for controlling the autopilot in azimuth, and an externally based system such as a radar aid for gross error checking.

Study is being made into a new approach guidance system for helicopters. This will be computer controlled, and will use microwave interferometers.

The R.A.E.'s interest in advanced electronic technology is illustrated by current work on semiconductor materials—particularly the development of light emitting junction devices for incorporation in display panels, and in light controlled contactless switches and variable controls for electronic equipment.

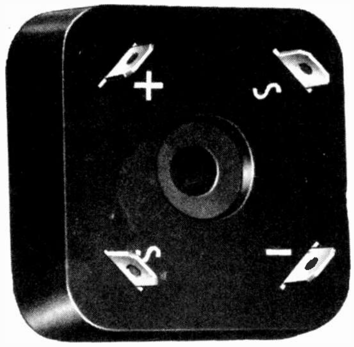
The use of a digital computer to aid the circuit designer was demonstrated. This in no way replaces creative talents of the designer, but provides him with a rigorous analysis of the circuit characteristics, allowing a deeper insight in circuit performance; the result is a reduction in development time and cost.

LOAD MEASURING SANDALS

Work undertaken at the R.A.E. is not limited exclusively to aeronautical applications. One department has been helping the medical staff at the Royal Orthopaedic Hospital in connection with the treatment of arthritic patients. Load measuring sandals have been devised to give the medical authorities a graphic record of the load imposed on the sole and heel of the foot as the patient walks. These sandals embody a capacitive transducer in the sole which modulates the carrier frequency of the tiny transmitter housed inside the hollow heel. Signals are radiated at 100 and 150kHz (right and left foot respectively) and picked up by an inductive loop system. The two outputs from the receiving equipment are voltages proportional to foot load, and these can be displayed on a double trace c.r.t., and also used to operate a pen recorder.

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 be made direct to the firm concerned.



50 watt voltage regulator and 2·5A bridge rectifier assembly from Lucas Semiconductor Division

SHOW REPORT

It follows, that this month's *Market Place* should devote its pages to the R.E.C.M.F. Components Exhibition.

Held once every two years, this exhibition is the Electronic Industries' largest "market place", showing British Manufactured Components and typical British skill to the World.

This year's main theme throughout the exhibition was one of quality coupled with reliability; and this being Quality and Reliability Year was reflected very successfully at practically every "stall" visited.

To those companies not mentioned and all concerned with this year's show, it is sufficient to mention that the attendance figures were up by 10 per cent and at least £25 million of deals were transacted to gauge the amount of effort and hard work that went into the show to make it so successful—indeed, praise to all concerned.

One subject that was prominent throughout the show was the vast strides taken by British firms in the field of microminiaturisation. This reflects the courage and resources of British Industry, using their own money and brains, in this highly competitive field, until recently dominated by American firms backed by Government subsidies. This strangle-hold seems to be finally broken.

Early applications of microelectronics was confined to the computer, missile and aircraft applications. Now they are edging their way into the consumer field. Typical of these firms is **Mullard** who are producing microcircuits and modules for domestic radio and audio equipment.

Now down to business and to mention just some of the many varied and some new components unveiled at the show for the first time.

SEMICONDUCTORS AND TUBES

Recently honoured for their technical achievements the **Semiconductor Division of Joseph Lucas (Electrical) Ltd.** are now producing a new range of "flangeless" high voltage rectifiers, potted rectifier assemblies and voltage regulators.

The 50 watt Voltage Regulators are available in 12, 13, 15, 16, 18 and 20 volt versions, with 5 per cent tolerance, but this range will be extended later in the year.

Of interest to designers is a new service being offered by **SGS-Fairchild Ltd.**, Planar House, Walton Street, Aylesbury, Bucks., whereby variants of their basic range of silicon planar semiconductors can be specified to meet individual requirements.

Emihus Microcomponents Ltd., have added a new range of double-heat sink diodes to their Hughes DO7 range. The new type HDS is particularly suitable for low current switching applications.

From **Electrautom Ltd.**, there is a large range of silicon rectifier modules. All units are available with controlled avalanche or high transient voltage limits and are ideally suitable for general applications.

All the large companies introduced new ranges of silicon planar transistors and all claimed greater versatility and closer operating tolerances, due to better manufacturing techniques.

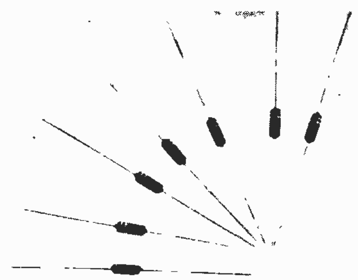
With less than four months to the start of colour television programmes it was inevitable that firms should introduce components for use in sets suitable for receiving this new service.

Mullard introduced their 19in and 25in "Colourscreen" picture tubes. They are rectangular 90 degree types that do not need any protective shield and include four integral mounting lugs. The tubes need no more scanning power that earlier tubes and a new unipotential electron gun enables the neck diameter to be narrowed to only 36mm.

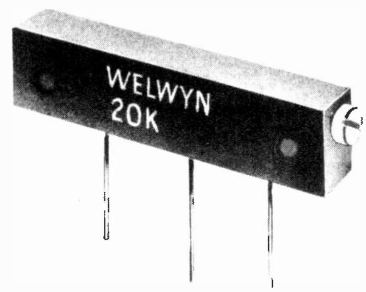
As no protective shield is required in front of the screen the tube is able to project beyond the front cabinet, saving costs of masks and escutcheons, and enabling new cabinet styles to be tried. Another point worth mentioning is that the 25in tubes are covered by a one year guarantee and at the time of purchasing his receiver the customer has the option of extending the guarantee for a further three years for a recommended premium of £8 0s 0d.

RESISTORS AND CAPACITORS

Electrosil Ltd. announced two new ranges of glass-tin-oxide resistors. The first is an improved TR5 triple rated range offering a lower temperature coefficient of 100 p.p.m. and better colour code legibility. The second is the NC range with 50 p.p.m. temperature coefficient.



TR5 Glass-Tin-Oxide resistors from Electrosil



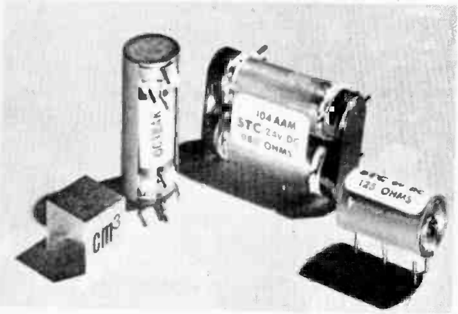
Welwyn "Trimultimate" potentiometer

MARKET PLACE

Morganite Resistors Ltd. and **Welwyn Electric Ltd.** were amongst a large number of companies who announced new types of potentiometers.

The new Welwyn potentiometer is called the "Trimultimate" and is rated at 1 watt at 70 degrees centigrade. The ohmic values vary from 10 ohms to 20 kilohms in standard values at ± 5 per cent.

Silver-mica capacitors were featured by both the **London Electrical Manufacturing Co. Ltd.,** and **Erie Resistor Ltd.** The main points being their small size and low voltage types, but with a good range of capacitance and stability.



STC subminiature diaphragm relays

RELAYS AND SWITCHES

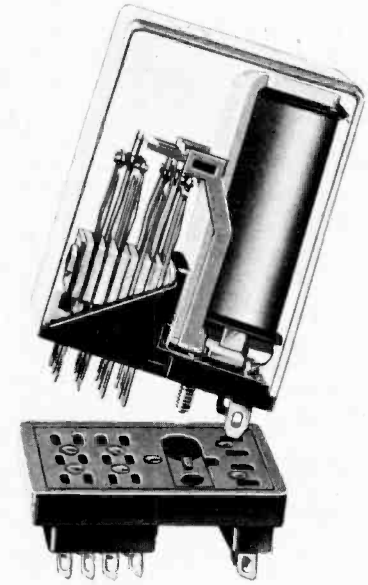
This section was probably the largest and the final choice is left to personal taste and the type of delivery and after sales service obtainable. Although this is very difficult as practically all firms recognise this important facility and make every effort to meet any requirements.

The B16 miniature relay from **B & R Relays Ltd.,** Temple Fields, Harlow, Essex, is a new component which can be interchanged with the older B14 type and can also be used in printed circuits. The B16 has nominal power ratings of 0·1 watt, and current rating of lamp at 250 volts a.c.

Oliver Pell Control Ltd., introduce two additions to the Varley miniature plug-in relay range. Supplied to operate from 6V to 250V, the contact arrangement can vary from two, four or six makes and breaks. Contact ratings can be 1 amp, 1 amp twin or 5 amp for most models.

The same firm's a.c. solenoid switches have improved performance figures and the AT 2 L/S model, which originally had a pull of $6\frac{1}{2}$lb at $\frac{5}{16}$in, now has a pull of 8lb at $\frac{3}{8}$in.

A special feature of the reed relays from **Allen Taylor Transformers Ltd.,** Munster Park Works, Gowan Avenue, S.W.6, is that choice of gold, tungsten, mercury, rhodium or silver contacts are available. The contacts are enclosed in hermetically sealed glass tubes filled with a protective gas and situated inside the coil. The relays are available with one to six contacts, either normally open and/or changeover types.



Varley plug-in relay produced by Oliver Pell Control

There were many other firms exhibiting reed switches similar to those mentioned above.

A new approach in relay design was shown by the **Electro-Mechanical Division of Standard Telephones & Cables Ltd.** Called "Diaphragm Sub-miniature Relays", they make use of a flexible metallic diaphragm as the moving contact in a simple "make" action. When the coil is energised, the diaphragm is attracted to the fixed contact and makes firm contact. To ensure reliable contact the surfaces are coated with gold, typical contact resistance being 30 milliohms.

The relays are designed for printed circuit use, connections being made by soldering pins. The maximum current and voltage ratings are 0·5A and 150V d.c. or 250V a.c. Operating time is approximately 1·5ms including point bounce; release time is about 500μs.

The diaphragm relay is produced in multiple forms and, like the reed relay, the contacts are hermetically sealed in a non-oxidising gas.

The reliability, performance and small size should make the diaphragm relay a strong competitor to the reed relay, particularly in applications where the reed, due to its fragile nature, requires protection.

SOLDERING

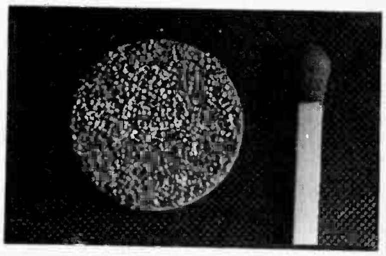
Here many interesting developments were evident. **Multicore Solders Ltd.,** have produced a five-core solder in the Ersin range which is so thin it can be threaded through the eye of a needle. This should be ideal for fine printed circuit work where large deposits of solder are not wanted.

Another item from the above firm was the introduction of solder pellets. These pellets are primarily intended for industry, but no doubt many "go-ahead" retailers will be stocking them in the future and readers will

Aerosol Freezer marketed by Electrolube

soon find various conditions where there use solves the particular problem at hand.

A product that seems to be "tailor" made for the amateur market is the Electrolube Freezer from **Electrolube Ltd.,** in aerosol form. Many applications are recommended besides its primary function of tracing faults in circuits.



Solder Pellets from Multicore

BUILD YOURSELF A QUALITY TRANSISTOR RADIO—GUARANTEED RESULTS BACKED BY OUR SUPER AFTER SALES SERVICE!

THE MAGNIFICENT ROAMER 7 MK IV

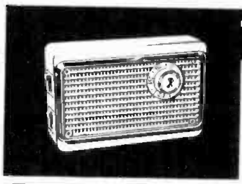
Seven waveband portable and car Radio with a super specification giving outstanding performance!

- 7 fully tunable wavebands—MW1, MW2, LW, SW1, SW2, SW3 and Trawler Band.
- Extra Medium waveband provides easier tuning of "pop" stations.
- Built in ferrite rod aerial for Medium and Long Waves.
- 5 Section 22 in. 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 Philco Micro-Alloy R.F. Transistors.
- Famous make 7×4 in. P.M. speaker, rich-toned volume.
- Air spaced ganged tuning condenser.
- Separate on/off switch, volume control, wave change switches and tuning control.
- Attractive leather look case with hand and shoulder straps. Size 9×7×4 in. approx.
- First grade components.
- Easy to follow instructions and diagrams make the Roamer 7 a pleasure to build with guaranteed results.

Total building costs £5.19.6. P. & P. 5/6

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

TRANSONA FIVE

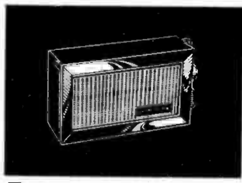


MEDIUM WAVE, LONG WAVE AND TRAWLER BAND PORTABLE

Attractive case with red speaker grille. Size 6½ x 4½ × 1¼in. Fully tunable. 7 stages—5 transistors and 2 diodes—ferrite rod aerial, tuning condenser, volume control, fine tone super dynamic speaker, all first grade components. Easy build plans and parts price list 1/6 (FREE with kit).
Medium Wave, Short Wave and Trawler Band version can be supplied if preferred.

Total building costs 42/6 P. & P. 3/6

POCKET FIVE

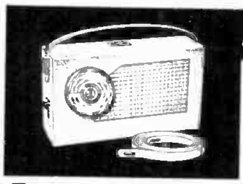


TWO WAVEBAND PORTABLE WITH 3in. SPEAKER

Attractive black and gold case. Size 5½ × 1½ × 3½in. Fully tunable over both Medium and Long Waves with extended M.W. band for easier tuning of "pop" stations. All first grade components, 7 stages—5 transistors and 2 diodes—super-sensitive ferrite rod aerial, fine tone 3in. moving coil speaker, etc. Easy build plans and parts price list. 1/6 (FREE with kit).
POCKET FIVE Medium and Long Wave version with miniature speaker ONLY 29/6. P. & P. 3/6.

Total building costs 42/6 P. & P. 3/6

MELODY SIX

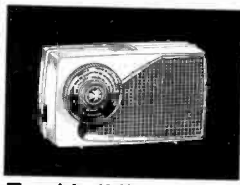


TWO WAVEBAND PORTABLE WITH 3in. SPEAKER

Handsome leather-look case, size 6¾ × 3¾ × 1¾in. with gilt trim and hand and shoulder straps. Fully tunable over both Medium and Long Waves. Incorporates pre-tagged circuit board, 8 stages—6 transistors and 2 diodes—ferrite rod aerial, push-pull output, wave change slide switch, tuning condenser, volume control, 3in. moving coil speaker, etc. Easy build plans and parts price list 2/- (FREE with kit).

Total building costs 59/6 P. & P. 3/6

MELODY MAKER 6

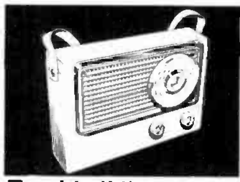


THREE WAVEBAND PORTABLE WITH 3in. SPEAKER

Smart pocket size case, 6½ × 3¾ × 1¼in. with gilt fittings. Fully tunable over both Medium and Long Waves with extra M.W. band for easier tuning of "pop" stations. 8 stages—6 transistors and 2 diodes—top grade 3in. speaker, 2 R.F. stages for extra boost, high "Q" ferrite rod aerial. Easy build plans and parts price list 2/- (FREE with kit).

Total building costs 69/6 P. & P. 3/6

ROAMER SIX

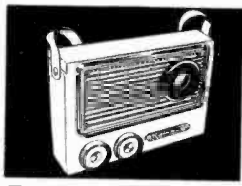


SIX WAVEBAND PORTABLE WITH 3in. SPEAKER

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

Total building costs 79/6 P. & P. 3/6

SUPER SEVEN



THREE WAVEBAND PORTABLE WITH 3in. SPEAKER

Attractive case size 7½ × 5½ × 1½in. with gilt fittings and carrying strap. The ideal radio for home, car or outdoors. Covers Medium and Long Waves and Trawler Band. Special circuit incorporating 2 R.F. stages, push-pull output, ferrite rod aerial, 7 transistors and 2 diodes, 3in. speaker (will drive larger speaker) and all first grade components. Price list 2/- (FREE with kit).

Total building costs 79/6 P. & P. 3/6

RADIO EXCHANGE Ltd

61a HIGH STREET, BEDFORD

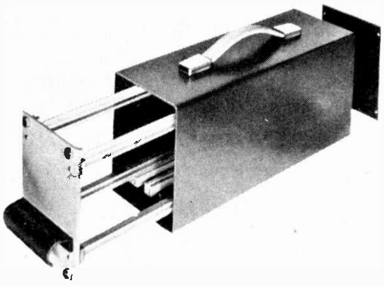
Telephone: Bedford 52367

Callers side entrance Barratt's Shoe Shop. Open 9-5 p.m. Saturday 9-12.30 p.m.

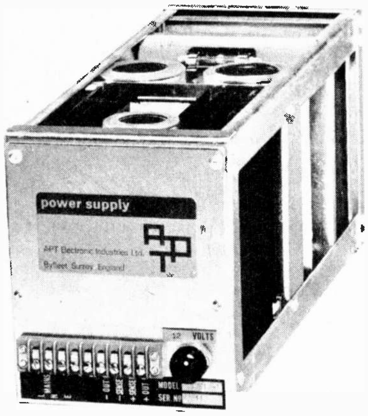
MARKET PLACE

When discontinuity, instability, intermittence or drift occurs in a circuit, it is often the result of a temperature rise in some thermally sensitive component such as a transistor, capacitor or resistor. By applying the Freezer to suspect components one at a time whilst the circuit is operating, the nature of the fault will change, once the faulty component is sprayed, due to the rapid temperature drop. Similarly if a dry joint or faulty connection is suspected the symptoms will again change.

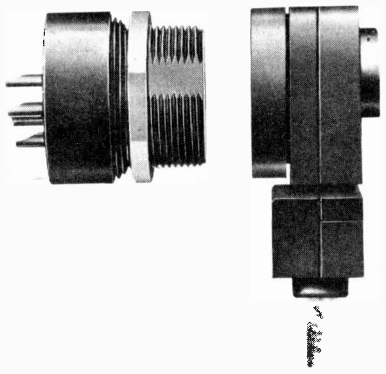
It is obvious that one of the most common mistakes or faults that occurs when building apparatus is the damage caused by excessive heat from the amateur's soldering iron, caused by conductance of heat through the component leads. Transistors, diodes, pick-up cartridges, etc. are typical devices in this class. But by applying the Freezer before soldering ensures adequate protection for the components.



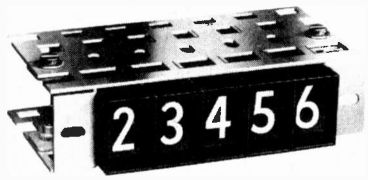
Chilworth portable cabinet from Vero Electronics



Type SCV31B-1 power supply from A.P.T. Electronic Industries



Thorn-Bendix Stumpi connector



Miniature display from Counting Instruments

ROUND-UP

Many firms had new ranges of cabinets on show and **West Hyde Developments Ltd.**, demonstrated their standard printed circuit board and the ease with which they can be installed in their Contil instrument cases. **Vero Electronics Ltd.** also produce portable cases. Called the "Chilworth" they are designed to house standard 7¼in and 10¼in boards.

Bulgin had their usual large assortment of control knobs as well as their Security Alarm System on display.

There were many new power supplies and just one of these was the Series 30 units from **A.P.T. Electronic Industries Ltd.**, Chertsey Road, Byfleet, Surrey. The Series 30 models cover any preset output between 0 and 500V at various current ratings up to 10A at low voltages, and 100mA above 350V. They can also be supplied as variable voltage units.

Both **Sifam Electrical Instrument Co. Ltd.**, and **Taylor Electrical Instruments** showed new meters, as did many other firms.

The "Liliput" series of transformers from **Gardeners Transformers Ltd.**, Somerford, Christchurch, Hampshire, are designed for use with semiconductor circuits at low voltages (normally below 100V peak). An exception to this is the SCR Trigger Transform Series where higher secondary voltages are required. Typical circuit uses are: converter/inverter circuits; output stages; a.f. and wide band communication a.f. drivers; a.f. smoothing and pulse circuits.

In addition to metal film, high stability carbon and wirewound resistors, **Painton & Co. Ltd.**, Kingsthorpe, Northampton, displayed new moulded subminiature r.f. chokes. Type C30M is rated at 0·17 watt at 90 degrees centigrade up to 120μH and 0·15 watt over 120μH. The inductances available being from 0·15 microhenries to 1,000 microhenries.

Wolsey Electronics gave details of their new v.h.f./u.h.f. set-top aerials, designed to cover all television channels in bands 1, 3, 4 and 5.

Two new miniature d.c. motors, type AB.100 and AB.2000 were shown by **A.B. Metal Products Ltd.**, 119/127, Marylebone Road, London, N.W.1.

The 3-pole ungoverned AB.1000 produces 4 to 10 watts output at 3,500 r.p.m. approximately. The operation voltage is 13·5V nominal at 250mA.

The AB.2000 is similar to the AB.1000 but the rated speed is 5,000 r.p.m. The operating current is 1·8A.

EMI Sound Products Ltd., Components Division, Blyth Road, Hayes, Middlesex, are another firm who produce a vast variety of small electric motors.

The motors from both firms can be used for such applications as: car screen washers; radio and television tuning motors; film slide projectors and miniature R/C installations.

The "Stumpi" low voltage connectors were featured by **Thorn-Bendix Ltd.**, Great Cambridge Road, Enfield, Middlesex. The connectors are designed for general purpose use and available with pin or socket contacts rated at 5, 20 and 40A.

Mallory Batteries Ltd. demonstrated the versatility of their mercury and alkaline batteries for use in hearing aids and cine camera drives.

The many uses of Sellotape insulating tape was the theme of **Sellotape Products Ltd.** stand. Their new "Resin Bond Polyester Thermosetting 1615 Tape" is claimed to have three times greater adhesion to itself than other polyester tapes. The breakdown voltage of the tape is 5,000 volts.

Finally, a new microminiature display, see photograph for actual size, has been designed and developed by **Counting Instruments Ltd.**, and features a novel system of plastics moulded lenses.

A multiple of five units, each unit is capable of displaying 11 different numbers, letters, symbols or colours. It contains an assembly of 11 miniature lamps at the back, a negative with 11 message displays, a series of lenses, and a front viewing screen. On lighting one or more of the lamps the corresponding part of the negative is illuminated and focused through the lens system onto the viewing screen.

the 73 page by Jack Hum G5UM

Field Day Time

Now is the time a young man's fancy turns to thoughts of lugging radio transmitting equipment to some inaccessible hilltop for the purpose of participating in a contest. For now is the time of the great outdoors for the amateur transmitting enthusiast, interspersed with dives for the dry inside the operating tent as the next rain squall booms overhead.

In other words, whatever the effort of setting up portable transmitting stations out in the open, and whatever the vagaries of the British weather, there's no deterring the many hundreds who enjoy this sport. For sporting chance indeed governs much of what goes on when field days come round. Station is pitted against station—and the general feeling is "may the best one win".

May until September is the season of outdoor radio, ushered in by what is officially known as the 144MHz Portable Contest during the first weekend of every May, and brought to a grand finale by V.H.F. National Field Day in the first weekend of every September.

This is not to suggest that all field days are v.h.f. ones. Yet it does happen to be the case that the "very highs" offer special attractions for portable operation both in respect of aerials, which being small and light can be erected high and in the clear, and in respect of equipment, which may be modest in physical size and ideal for portability for the very good reason that the high gains achieved by directional aerials call for only a nominal output from the associated transmitter.

Perhaps because of the ease with which a v.h.f. station may be set up in a field or operated from vehicles, more portable events are organised for the metre wave bands than for any other. Yet the hardiest annual transmitting contest of all is one that utilises what are sometimes facetiously called "the d.c. bands"—or more accurately the h.f. bands in contradistinction to the v.h.f. ones. This event is National Field Day, initiated by the Radio Society of Great Britain as long ago as 1933, traditionally held during the first weekend of June, and representing the climax of many months of planning and practise by clubs and groups throughout the land.

Six Band Operation

For National Field Day, local radio groups customarily enter two stations sharing operations on the six h.f. amateur bands. "Which stations for what bands?" is a question that calls for an assessment of operating tactics to be adopted on The Day. Certain groups and clubs prefer to allocate the three lower frequency bands of 1·8MHz, 3·5MHz and 7MHz to one station, and the higher frequency bands of 14, 21 and 28MHz to the second station, for the practical reason that an aerial cut for one of the three can be made to "fit" the other two reasonably well.

But it happens to be the case that the lower frequency bands offer at certain times a greater scoring potential than the higher frequency ones—yet you cannot operate one station on two bands at the same time! So the pay-off tactic is to allocate one of the higher scoring bands to the second station so that both will be kept plugging away hard at it most of the time. To do this complicates the aerial situation. You simply can't win! Yet the object of entering National Field Day is to do precisely that!

Radio Logistics

Well before N.F.D. Weekend the permutations of bands and aerials are sorted out by intending participants as part of the major planning effort which every National Field Day demands. A complicated exercise in logistics is performed in order to provide the aerials already mentioned, along with the transmitting and receiving equipment into which they will work; the power supplies—some of them far from portable for a so-called "portable" event; the tented accommodation ("Stations must be operated from tents" has long been a regulation), and the furnishings for the tents. Further tents for those who will sleep at the site. As for the personnel themselves: the Morse-men of fortitude who will keep two stations active on six bands for 24 hours non-stop; if there is any "most important component" on Field Day, it is they.

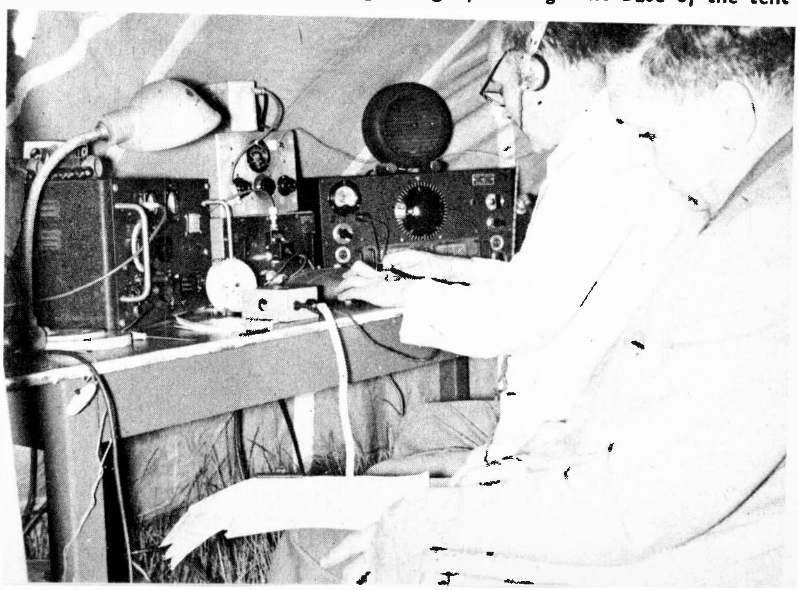
Thirty Four Years Old

It is curious to reflect that National Field Day, thirty four years old this year, sprang from a custom developed by a group of London transmitting amateurs in the early Nineteen Thirties of retiring to a rural retreat deep in the heart of Essex to enjoy a "radio weekend".

The success of these events suggested their development on a national basis. And so National Field Day was born.

Today's N.F.D. techniques are a world removed from the simple two-valve transmitters and straight receivers, battery powered as like as not, that did adequate duty on the air in the spacious days of three and a half decades ago. Change, the essence of radio communication, embraces National Field Day as it does everything else. How in certain important particulars it has influenced the event this year is something to which attention will be given on this page next time.

A scene repeated a hundredfold during the annual National Field Day transmitting contest: an operator sending swift Morse on an automatic key, a second man logging. And grass growing up through the base of the tent



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4-Speed Mono Players 2-tone Cabinets 17×15×8½in. High flux loudspeaker and High Quality Amplifiers ready built. Quality output. Volume and Bass controls. Special instructions enable assembly in 30 minutes, only 5 wires to join. 12 months' guarantee.

TO BUILD YOURSELF

Post 2/6 per item.

PORTABLE CABINET As illustrated. To fit standard player or autochanger. **69/6**

RCS AMPLIFIER 3 WATT. Ready made and tested with UCL82 triode pentode valve and loudspeaker. **59/6**

SUPERIOR AMPLIFIER. Ready made and tested. Guaranteed better sound! Fully isolated AC Mains Transformer 4 watt output. ECL86 triode pentode valve. Volume and tone controls with knobs. Quality Loudspeaker. **89/6**

SINGLE PLAY UNITS		AUTOCHANGE UNITS	
BSR GU7	£4.19.6	BSR Superslim	£5.19.6
Garrard SRP12	£4.19.6	Garrard 1000	£5.19.6
Garrard SP25	£10.19.6	Garrard 2000	£6.19.6
Philips AG1016	£12. 9.6	Garrard 3000	£8. 9.6
Garrard A70	£19.19.6	Garrard AT60 Mk. II	
Garrard LAB80	£24.19.6	diecast turntable £12.19.6	
Garrard 401	£29.19.6		

All with mono cartridge (Stereo 12/6 extra)

GARRARD TEAKWOOD BASE WB.1 Ready cut for mounting 1000, 2000, 3000. SP25. AT60. **72/6**

A.18 TRANSCRIPTION TONE ARM with tracking template and two plug-in shells. Original price £13.19.6. OUR PRICE **5 gns.**
Decca Deram Stereo Diamond Cartridge £4.14.6 extra.

Q MAX CHASSIS CUTTER

Complete: a die, a punch, an Allen screw and key
⅜in. 14/6 ⅝in. 15/9 1⅛in. 18/- 1⅜in. 20/6 2⅜in. 37/9
½in. 14/9 1in. 18/- 1¼in. 18/3 1½in. 22/6 2½in. 44/3
¾in. 15/6 1 1/16in. 18/- 1¾in. 20/- 2in. 34/3 1in. sq. 31/6

BARGAIN XTAL PICK-UP ARM Complete with ACOS LP-78 Turnover Head and Stylii 20/-; Stereo 30/-.
SPEAKER FRET Tygan various colours, 52in. wide, from 10/- ft.; 26in. wide from 5/- ft. SAMPLES S.A.E.
EXPANDED METAL Gold or Silver 12 × 12 in. 6/-.
NEW GARRARD GRAM MOTORS 2,500 r.p.m. 100-130v. 15/- pair for 200/250v. A.C. (in series), or 10/- ea. Post 2/6.

FULL WAVE BRIDGE SELENIUM RECTIFIERS: 6 or 12 v. outputs, 1½ amp., 8/9; 2 a. 11/3; 4 a., 17/6.
CHARGER TRANSFORMERS. P. & P. 2/6. Input 200/250 v. for charging at 6 or 12 v., 1½ amps., 17/6; 2 amps., 21/-; 4 amps., 25/-. Circuit free. Ammeter 0 to 5 amp. 10/6.

MOVING COIL MULTIMETER TK 25. 0-1,000v. A.C./D.C., ohms 0 to 100k. etc. **47/6**
MOVING COIL MULTIMETER EP10K. 0-1,000v. A.C./D.C., ohms 0 to 3 meg. etc. **79/6**
MOVING COIL MULTIMETER EP20K. 0-2,500v. D.C. 20,000 ohms per volt. 0-1,000v. A.C. Ohms 0 to 6 meg. 50 Microamps full scale. **99/6**

NEW MULLARD TRANSISTORS

OC71 6/-; OC72 7/6; OC81D 6/-; OC81 6/-; AF115 8/-; AF114 8/6; OC44 8/-; OC45 8/-; OC171 9/-; OC170 8/6; AF117 7/-. OC26 12/6; AD140 15/-; OC35 15/- Holders 1/3.

ARDENTE TRANSISTOR TRANSFORMERS
D3035, 7.3 CT : 1 Push Pull to 3 ohms for OC72, OC81 .. 11/-
D3034, 1.75 : 1 CT. Push Pull Driver for OC72, OC81 .. 11/-
D3058, 11.5 : 1 Output to 3 ohms for OC72, OC81 .... 11/-

TRANSISTOR MAINS ELIMINATORS. FAMOUS "POWER MITE". 9 VOLT. SAME SIZE AS PP9 BATTERY. FULLY SMOOTHED. 150mA. FULL WAVE CIRCUIT. **45/-**

WEYRAD P50 — Transistor Coils

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

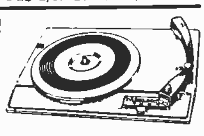
Volume Controls

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.

80 ohm Coax 6d yd.
Semi-air spaced Cable 100 yd. drum 50/- post free.
FRINGE LOW LOSS Ideal 625 lines **1/6 yd.**

COAXIAL PLUG 1/-. PANEL SOCKETS 1/-. LINE SOCKETS 2/-. OUTLET BOXES, SURFACE OR FLUSH 4/6. BALANCED TWIN FEEDERS 1/- yd., 80 or 300 ohms. TELESCOPIC CHROME AERIALS. 6in. extends to 23in. 6/6 each. CAR AERIAL PLUGS 1/6. Sockets 1/3.

SPECIAL PURCHASE!
B.S.R. GU7 9 volt Battery Operated Record Player Decks



4 speeds, automatic stop. Plays any size record. Complete with mono LP/78 xtal and sapphire stylus. (With stereo cartridge 12/6 extra). ONLY **69/6** P. & P. 5/6

STELLA RECORD PLAYER AMPLIFIER

4 watt. 2 stage. 3 to 7 ohm. Neg. feed back. UCL82. UY85. 200-250v. A.C. tapped input. Chassis size 8 x 2½ x 4in. high. Gold/Walnut knobs. Volume and Tone controls on separate Polished Wood Panel 6 x 2in. Brand new with makers' guarantee. BARGAIN PRICE P. & P. 2/6. **78/6**

NEW TUBULAR ELECTROLYTICS				CAN TYPES	
2/350 v.	2/3	100/25 v.	2/-	8/600 v.	9/6
4/350 v.	2/3	250/25 v.	2/6	16/600 v.	12/6
8/450 v.	2/3	500/15 v.	3/-	16+16/500 v.	7/6
16/450 v.	3/-	8+8/450 v.	3/6	32+32/450 v.	6/-
32/450 v.	3/9	8+16/450 v.	3/9	50+50/350 v.	7/-
25/25 v.	1/9	16+16/450 v.	4/3	60+100/350 v.	11/6
50/50 v.	2/-	32+32/350 v.	4/6	100+200/275 v.	12/6

PAPER TUBULARS
350v.-0.1 9d., 0.5 2/6; 1 mfd. 3/-; 2 mfd. 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.
E.H.T. CONDENSERS. 0.001mfd., 7kV., 6/6; 20kV., 10/6.

SUB-MIN. ELECTROLYTICS. 1, 2, 4, 5, 8, 16, 25, 30, 50, 100, 250 mfd. 15v. 2/6; 500, 1000 mfd. 12v. 3/6 2000 mfd. 25v. 9/6.
CERAMIC. 500 v. 1 pF. to 0.01 mfd., 9d. Discs 1/-.
SILVER MICA. Close tolerance (plus or minus ½ pF.). 5 to 47 pF., 1/-; ditto 1%, 50 to 800 pF., 1/-; 1,000 to 5,000 pF., 2/-.
TWIN GANG. "0-0" 208 pF. + 176 pF., 10/6; 365 pF., miniature 10/-; 500 pF. standard with trimmers, 9/6; 500pF. midget less trimmers, 7/6; 500 pF. slow motion, standard 9/-; small 3-gang 500 pF. 18/9. Single "0" 365 pF. 7/6. Twin 10/-.
SHORT WAVE. Single 10 pF., 25 pF., 50 pF., 75 pF., 100 pF., 160 pF., 5/6 each. Can be ganged. Couplers 9d. each.
TUNING. Solid dielectric. 100 pF., 300 pF., 500 pF., 3/6 each.
TRIMMERS. Compression ceramic 30, 50, 70 pF., 9d.; 100 pF., 150 pF., 1/3; 250 pF., 1/6; 600 pF., 750 pF., 1/9.

250v. RECTIFIERS. Selenium ½ wave 100mA 5/-; BY100 10/-.
CONTACT COOLED ½ wave 60mA 7/6; 85mA 9/6.
Full wave 75mA 10/-; 150mA. 19/6; T.V. rects. 10/-.

NEW B.A.S.F. LIBRARY BOXED TAPE

7 in. L.P. 1,800 ft. 45/-; 7 in. D.P. 2,400 ft. 70/-
60 min. Cassette C60 (For Philips, etc.) 17/6
Spare Spools 2/6. Tape Splicer 5/-. Leader Tape 4/6.
Tape Heads: Collaro 2 track 28/6 pair. B.S.R. 4 track 99/6

MAINS TRANSFORMERS

Post 2/6 each

250-0-250 80 mA. 6.3 v. 3.5 a. 6.3 v. 1 a. or 5 v. 2 a. 25/-
350-0-350 80 mA. 6.3 v. 3.5 a. 6.3 v. 1 a. or 5 v. 2 a. 29/6
MT. 510/300-0-300 v. 120 mA., 6.3 v. 4 a. 29/6
MINIATURE 200 v. 20 mA., 6.3 v. 1 a. 10/6
MIDGET 220 v. 45 mA., 6.3 v. 2 a. 15/6
SMALL 250-0-250 50 mA. 6.3 v. 2 a. 19/6
HEATER TRANS. 6.3 v. 1½ a., 8/6; 6.3 v. 4 a. 10/6
Ditto tapped sec. 1.4 v., 2, 3, 4, 5, 6.3 v. 1½ amp. .. 10/6
GENERAL PURPOSE LOW VOLTAGE. Outputs 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30 v. at 2 a. 25/-
1 amp., 5, 10, 15, 20, 25, 30, 35, 40, 45, 55, 60, 29/6 ; 2 a., 47/6
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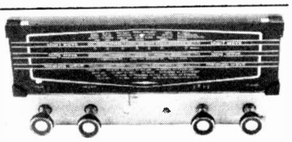

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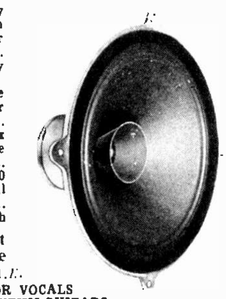

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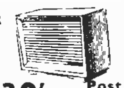

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JOHN VALENCE

AT FARNBOROUGH

Most of us associate Farnborough with flying displays, and the opportunity to see at close quarters the latest products of the British Aircraft Industry. On such occasions the tarmac and the sky are the two focal points for the visitors' eyes, while the great complex of buildings which comprise the Royal Aircraft Establishment is a barely distinguishable backcloth to the main proceedings.

But all this was changed for a few days just recently when the permanent buildings basked in the floodlights, as it were, during the first Open Days to be held for six years.

Immediate impressions: an extensive conurbation in the midst of Hampshire countryside—but no drab uniformity in style of buildings. The varied styles are indicative of the continual growth of the Establishment over the past 50 years or more. The buildings themselves afford an interesting side study for any architecturally and historically minded visitor meandering from one department to another.

Even more varied in character than the buildings, are the activities they house. So far as electronics is concerned, the R.A.E. would appear to be a real forcing ground for research and development in all aspects of the technology. There would seem to be hardly any branch of electronics which is not making some contribution to the progress of air and space travel, whether in the testing of structural materials, recording aircraft behaviour during flight, or in navigation and communication aids.

ELEMENTARY, DEAR WATSON

Much of the research at the R.A.E. is, of course, directed towards making aircraft as safe as possible, and able to withstand any hazards encountered in flight. But accidents do unfortunately happen, and special attention is given to the development of techniques for investigating and analysing wreckage from crashed aircraft.

Significant information can be obtained from the examination of simple items such as cockpit indicator lamps and radio valves. This was illustrated by an exhibit where a fibroscope had been inserted into wreckage and a magnified view of a warning lamp obtained on a closed circuit TV monitor. This picture showed that the lamp filament was unbroken, but distorted. From this it can be deduced that the lamp was on at the time of the crash. If it had been off, the cold filament would either have sprung back or broken as a result of the impact.

Similar evidence can be derived from a broken radio valve. A discoloured valve heated filament will suggest that the valve was "on" at the time of accident, for a cold filament never oxidises.

Although rather elaborate flight recording devises are fitted nowadays to many aircraft, it seems there is still scope for intelligent detective work by the technician working amongst the recovered wreckage.

One point does occur to me however. The replacement of valves by semiconductors, and (in the not too distant future) the replacement of filament lamp by luminous semiconductors, will remove this particular source of evidence concerning the state of operation of airborne equipment. Does the semiconductor provide any similar tell-tale information for the investigators?

It seems that the rugged character of these devices precludes their acting as silent witnesses, as do their thermionic counterparts. But this attribute of the semiconductor will of course greatly enhance the reliability of the black boxes—or flight recorders.

"Make up your mind Dave, it's either fish and chips for supper, or the Forsyte Saga"

SET-TOP BATTLE

Improved sensitivity of modern receivers and the development of efficient ferrox rods have made the external aerial almost extinct, so far as normal radio broadcast reception is concerned. Even for television reception the drift is towards simple, inexpensive set-top aerials. No matter that the results are often far from perfect, the general viewing public is well satisfied, it seems.

Now with colour TV on the way the broadcasting authorities and the receivers manufacturers are a little concerned—to put it mildly—about this reticence on the part of the public to invest in good efficient roof top aerial systems.

I reckon what is needed is a publicity drive to re-educate the public on this matter. How more ludicrous a situation can you have than a person paying out £250–£300 for a colour receiver and then trying to get by with a thirty bob toast rack stuck on top of the set?

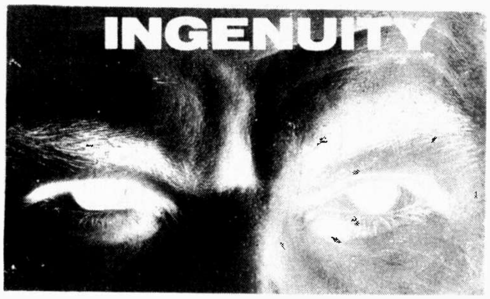
All praise then to Belling Lee who have announced their intention to cease production of all u.h.f. set-top aerials. And "thumbs down" to their competitors Antiference who have decided to pursue the opposite course.

In support of this policy, Antiference make the following pronouncement:

"Furthermore, we do not consider that the Aerial Industry can or should dictate to Trade or Consumer what standard of reception is acceptable, since this is a matter of personal choice and experience and varies from one individual to another."

Some people might consider it part of the aerial industry's responsibility to lead and educate the public in such technical matters.

Leave it to the customer indeed! Why bother to purchase an aerial *at all* if a screwdriver stuck in the aerial socket gives some kind of picture. After all, so we are told, the customer is the sole arbiter of picture quality!



UNLIMITED!

IN THIS feature we hope, from time to time, to be able to publish suggestions submitted by some of our readers on the possible improvement of projects previously described in PRACTICAL ELECTRONICS; short contributions on other subjects may be included. The aim is not to find fault or undermine the abilities or knowledge of our contributors. It may well be that the original article is *par exellence* but it could be improved or adapted to suit individual requirements. The views expressed by readers are not necessarily those of the Editor.

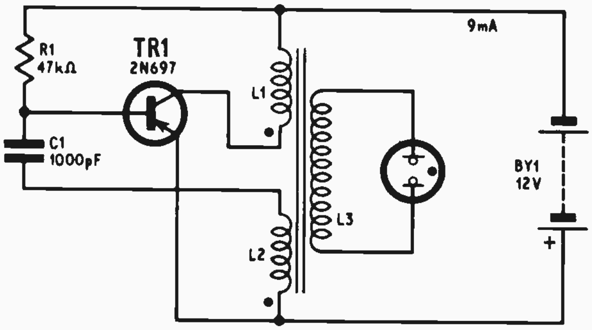
LOW VOLTAGE NEON INDICATOR

THE smallest indicator lamps generally available require currents in the order of 40mA and this can be prohibitive in battery equipment. Small neon lamps are easily obtained, however, with (or without) limiting resistors of $\frac{1}{10}$ to $\frac{1}{4}$ watt rating and giving reasonable light output for only a few microamps current at 100V plus.

The use of a "ringing choke" converter allows such lamps to light from currents as low as 4mA (at 6V) dependant upon the efficiency of the converter—the one illustrated draws 9mA at 12V and operates down to 5V.

The transformer can be wound on a variety of formers, success having been achieved even with a piece of ferrite $\frac{1}{16}$in × $\frac{3}{16}$in. L2 should have an inductance approximately one-fifth of that of L1 and tunes with C1 at frequencies up to 1MHz depending upon the core material.

L3 should be wound to produce at least 150V to ensure reliable striking.



In small units no lamp series resistor is necessary, R1 being kept as high as possible.

To prevent interference the supply should be decoupled and the components screened.

J. A. Tennant,
Maidstone,
Kent.

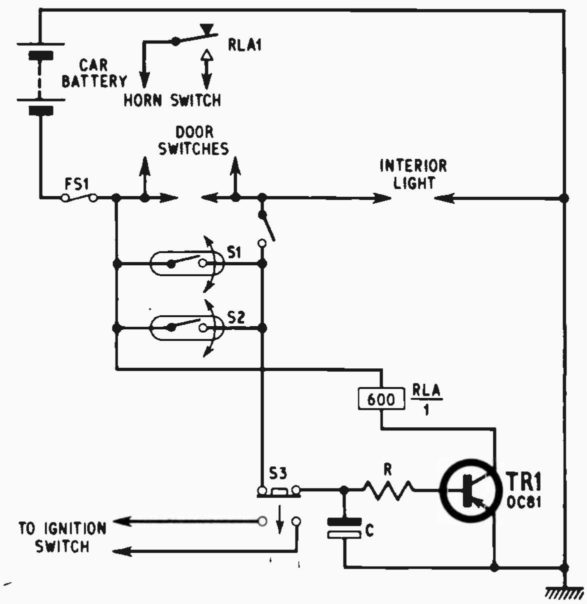
MERCURY SWITCH ALARM

WITH reference to the *Car Burglar Alarm System* by M. J. Bruce described in the February issue, it has two disadvantages. First, once the alarm has been set off, maybe accidentally by someone leaning on the car, it can't be stopped unless the owner of the car is present. Second, with the car in use and the alarm switched off, the mercury switches are still in circuit. If the car goes over a bumpy road the interior light flashes on and off accordingly.

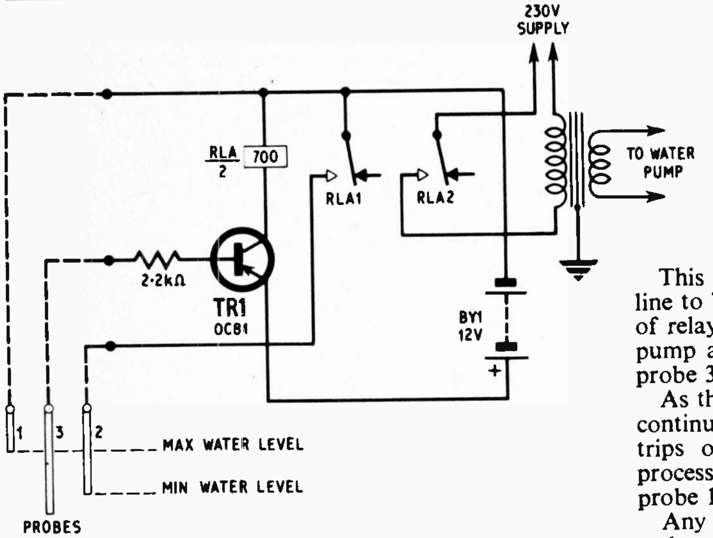
One way of overcoming the first problem is to fit some form of time device which would allow the horn to blow for, say, 30 seconds, switch off and re-set the alarm. A foolproof alarm system is shown here. Once the alarm is set off it will sound the horn for about 30 seconds (depending on values of C and R), switch off and re-set automatically.

When S1a or b is operated, capacitor C charges to the full potential of the supply (12V) causing a negative voltage to be applied to the base of TR1. The collector current energises RLA therefore closing contacts RLA1 sounding the horn. When the switch S1 is opened again C discharges through R and the base-emitter junction of TR1. After a period, C discharges sufficiently to cause a reduced collector current to flow through the relay coil. The relay now de-energises and the time cycle is now complete.

A. Shaw,
Bolton,
Lancashire.



AUTO CONTROL OF WATER LEVEL



THIS circuit was primarily designed to pump water automatically out of the car inspection pit in my garage, in which there was a constant water seepage. It may be adapted to control water levels in tanks or small ponds to prevent overflow.

Current drain is quite small and dry batteries will last well over 12 months. With relay RLA energised the current drain is about 10–15mA. Standby current drain is only a few microamps.

Probe No. 1 is set to maximum water level required. Probe No. 3 is set to minimum water level required. Probe No. 2 is set about ½in below probe No. 3.

When the water level increases it reaches probes 2 and 3, but due to the relay contacts being in the open position there is no current flow from the negative line to the base of TR1 and so RLA remains de-energised. The water continues to rise until it reaches probe 1.

This then causes a current flow from the negative line to TR1 base; the relay then energises. Both sets of relay contacts close, one set switches on the water pump and the other set connects the negative line to probe 3.

As the water level starts to fall it leaves probe 1 and continues to fall until it leaves probe 3, the relay then trips out and the water pump stops. The whole process is repeated as soon as the water level reaches probe 1.

Any double-pole relay which will pull in at 10mA or less is suitable.

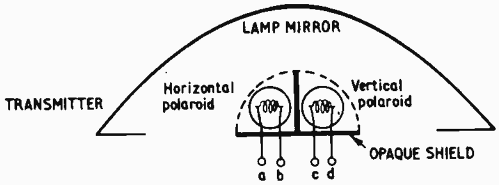
The coil resistance of the relay is 700 ohms; heavy duty contacts are desirable. The probes are made from 10 s.w.g. tinned copper wire, 12in long each. A suitable water pump is obtainable on the surplus market.

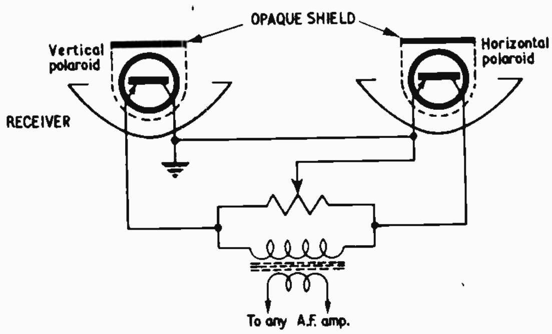
The control unit has been in use for about 16 months without any attention whatsoever and still works perfectly.

F. J. Brown,
Wirral,
Cheshire.

OPTICAL COMMUNICATION

THE following idea may be useful to your readers interested in optical communication. In the transmitter two bulbs are driven in push-pull by the signal to be sent. Each must have a polarising current in it to prevent frequency doubling and this might be obtained from the standing current in a class-A amplifier. A piece of polaroid covers each bulb and these are orthogonally polarised. The combined light output will appear to be steady to an observer. The receiver has two similar polaroid filters in front of two photo-transistors. The output of the transistors is applied in push-pull to the input of an audio amplifier.

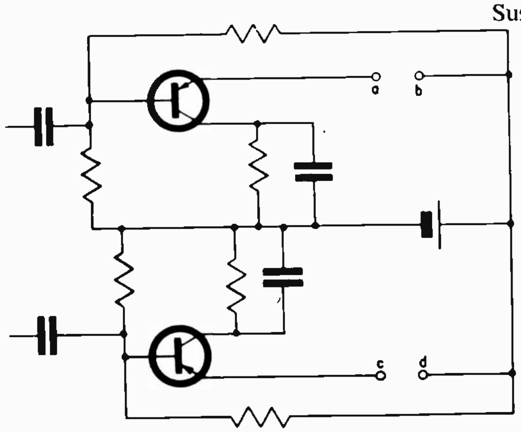




It will be seen that a pulse of randomly polarised light will give no audio output as the push-pull input cancels the two photo-transistor outputs. This gives immunity from interference.

The transmitter is apparently a steady light and can only be received by a receiver with a polarised screen. A suggested output configuration for the transmitter is shown below.

D. J. Summer,
Horsham,
Sussex.



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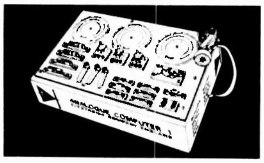

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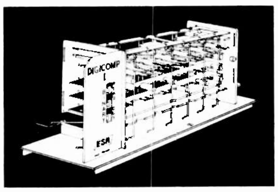

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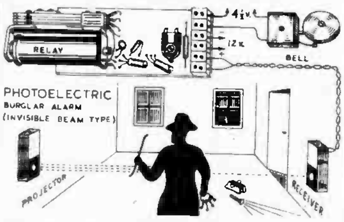

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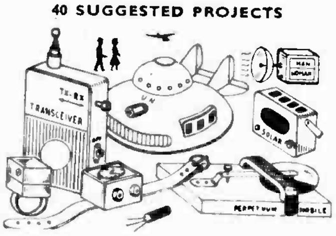

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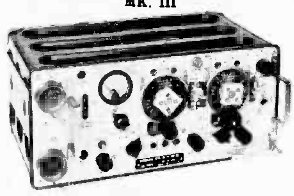

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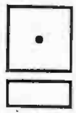

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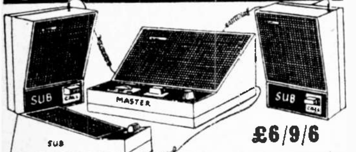

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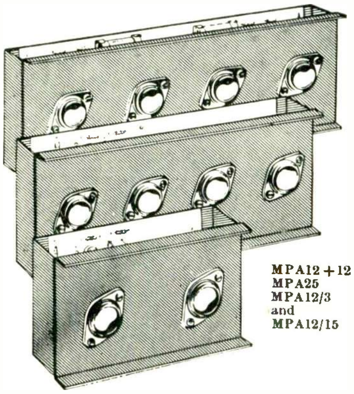
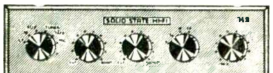
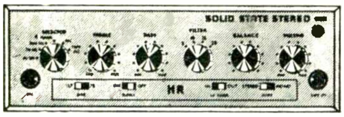


MPA12+12
MPA25
MPA12/3
and
MPA12/15



◀ MP3

SP6-2 ▼



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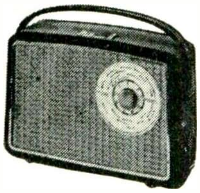

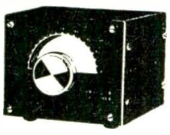

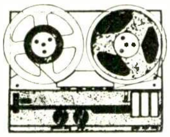

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