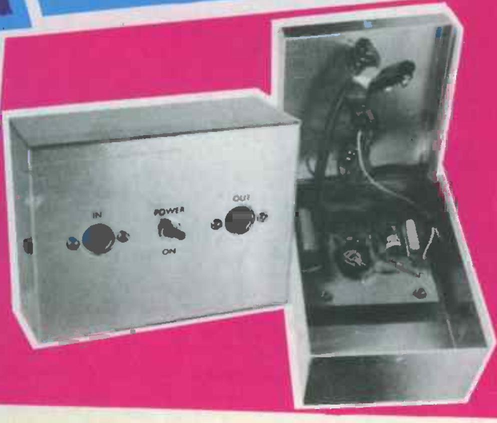
RADIO ELECTRONICS CONSTRUCTOR

OCTOBER 1980
60p

GO - NO GO TRANSISTOR TESTER

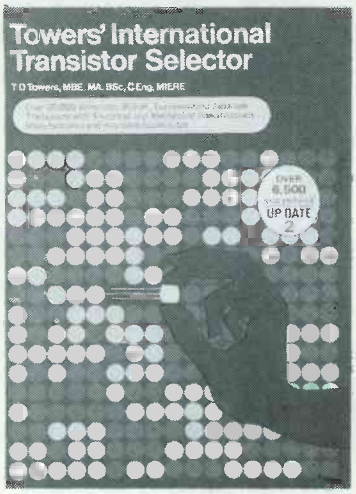
TWO 20dB AMPLIFIERS



Personal MEDIUM WAVE RADIO

ALSO FEATURED HI-FI P.C.M.

DIRECT SUPPLY SERVICE TO READERS



This is dead!

Would this replace it?

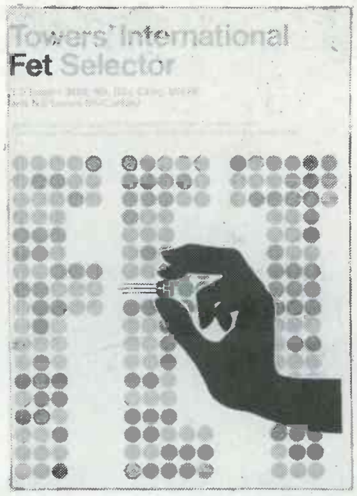
If it takes you longer than 1 minute to find out all about these transistors then you need a copy of TOWER'S INTERNATIONAL TRANSISTOR SELECTOR. It's one of the most useful working books you will be offered this year. And probably the cheapest!

In it, you will find a really international selection of 13,000 transistor types — British, Continental European, American and Japanese. And we think that they will solve 90% of your transistor enquiries.

Current and widely used obsolete types were carefully selected and arranged in Numero-Alphabetical order by an author who was uniquely qualified to do the job. With his compendium, all you need to know is the type number and you can learn all about a transistor's specification; who made it and where to contact them; or what to use to replace it.

Price £10.35 inc P&P

TOWERS INTERNATIONAL FET SELECTOR



If you deal with field effect transistors, or fet's — whether as a student, a hobbyist, a circuit engineer, a buyer, a teacher or a serviceman — you often want data on a specific fet of which you know only the type number.

Specifications apart, you may be even more interested in where you can get the device in question. And perhaps more important still (particularly with obsolete devices), you may want guidance on a readily available possible substitute.

This fet compendium, a comprehensive tabulation of basic specification, offers information on:

1. Ratings
2. Characteristics
3. Case details
4. Terminal identifications
5. Applications use
6. Manufacturers
7. Substitution equivalents (both European and American)

The many fet's covered in this compendium are most of the more common current and widely-used obsolete types.

It is international in scope and covers fet's not only from the USA and Continental Europe, but also from the United Kingdom and the Far East (Japan).

Price £4.00 inc P&P

(Please allow 21 days for delivery)

Tower's International Transistor Selector

by T. D. Towers
MBE, MA, BSc, C Eng, MIERE
£10.35
inc. post and packing

To:—DATA PUBLICATIONS LTD.
57 MAIDA VALE
LONDON W9 1SN

Please send me . . . . copy/copies to the address shown below

NAME . . . .

ADDRESS . . . .

. . . .

. . . .

. . . . (Block capitals)

Tower's International FET Selector

by T. D. TOWERS
MBE, MA, BSc, C Eng, MIERE
£4.00
inc. post and packing

To:—DATA PUBLICATIONS LTD.
57 MAIDA VALE
LONDON W9 1SN

Please send me . . . . copy/copies to the address shown below

NAME . . . .

ADDRESS . . . .

. . . .

. . . .

. . . . (Block capitals)

RADIO & ELECTRONICS CONSTRUCTOR

OCTOBER 1980
Volume 34 No.2

Published Monthly

First published in 1947

Incorporating The Radio Amateur

Editorial and Advertising Offices
57 MAIDA VALE LONDON W9 1SN

Telephone
01-286 6141

Telegrams
Databux, London

Annual Subscription: £9.50, Eire and Overseas £10.50 (U.S.A. and Canada $25.00) including postage. Remittances should be made payable to "Data Publications Ltd". Overseas readers, please pay by cheque or International Money Order.

Technical Queries. We regret that we are unable to answer queries other than those arising from articles appearing in this magazine nor can we advise on modifications to equipment described. We regret that queries cannot be answered over the telephone, they must be submitted in writing and accompanied by a stamped addressed envelope for reply.

Correspondence should be addressed to the Editor, Advertising Manager, Subscription Manager or the Publishers as appropriate.

Opinions expressed by contributors are not necessarily those of the Editor or proprietors.

Production – Web Offset.

Published in Great Britain by the Proprietors and Publishers, Data Publications Ltd, 57 Maida Vale, London W9 1SN.

The *Radio & Electronics Constructor* is printed by LSG Printers, Portland Street, Lincoln.

OUR NEXT ISSUE WILL BE PUBLISHED IN LATTER PART OF OCTOBER

AND THERE'S MORE WHERE THIS CAME FROM

It's a long time since one of our adverts was presented in 'list' form - but simply because we do not try to squeeze this lot in every time doesn't mean that it's not available. Our new style price list (now some 40 pages long) includes all this and more, including quantity prices and a brief description. The kits, modules and specialized RF components - such as TOKO coils, filters etc. are covered in the general price list - so send now for a free copy (with an SAE please). Part 4 of the catalogue is due out now (incorporating a revised version of pt.1).

LINEAR ICs - NUMERIC LISTINGS

TBA120S	1.00
L200	1.95
U237B	1.28
U247B	1.28
U257B	1.28
U267B	1.28
LM301H	0.67
LM301N	0.30
LM308H	0.96
LM308N	0.65
LM339N	0.66
LM348N	1.86
LF351N	0.38
LF353N	0.76
LM374N	3.75
LM380N-14	1.00
LM380N-8	1.00
LM381N	1.81
2N419CE	1.95
NE544N	1.80
NE555N	0.30
NE556N	0.50
NE560N	3.50
NE562N	4.05
NE564N	4.29
NE565N	1.00
NE566N	1.60
NE570N	3.85
SL624	3.28
TBA651	1.81
uA709HC	0.64
uA709PC	0.36
uA710HC	0.65
uA710PC	0.59
uA741CH	0.66
uA741CN	0.27
uA747CN	0.70
uA748CN	0.36
uA753	2.44
uA758	2.35
TBA810AS	1.09
TBA820M	0.75
TCA940E	1.80
TDA1028	2.11
TDA1029	2.11
TDA1054	1.45
TDA1062	1.95
TDA1072	2.69
TDA1074A	5.04
TDA1083	1.95
TDA1090	3.05
HA1137	1.20
HA1196	2.00
HA1197	1.00
TDA1220	1.40
LM1303	0.99
LM1307	1.55
MC1310P	1.90
MC1330	1.20
MC1350	1.20
HA1370	1.90
HA1388	2.75
TDA1490	1.86
MC1496P	1.25
SL1610P	1.60
SL1611P	1.60
SL1612P	1.60
SL1613P	1.89
SL1620P	2.17
SL1621P	2.17
SL1623P	2.24
SL624C	3.28
SL1625P	2.17
SL1626P	2.44
SL1630P	1.62
SL1640P	1.89
SL1641P	1.89
TDA2002	1.25
TDA2020	3.00
ULN2242A	3.05
ULN2283B	1.00
CA3080E	0.70
CA3089E	1.84
CA3090AQ	3.35
CA3123E	1.40
CA3130E	0.80
CA3130T	0.90
CA3140E	0.46
CA3189E	2.20
MC3357P	2.35
LM3900N	0.60
LM3909N	0.68
LM3914N	2.80
LM3915N	2.80
KB4400	0.80
KB4406	0.60
KB4412	1.95
KB4413	1.95
KB4417	1.80
TDA4420	2.25
KB4420B	1.09
KB4423	2.30
KB4424	1.65
KB4431	1.95
KB4432	1.95
KB4433	1.52
KB4436	2.53
KB4437	1.75
KB4438	2.22
KB4441	1.35
KB4445	1.29
KB4446	2.75
KB4448	1.65
NE5044N	2.26
NE5532N	1.85
SD6000	3.75
SL6270	2.03
SL6310	2.03
SL6600	3.75
SL6640	2.75
SL6690	3.20
SL6700	2.35
ICL8038CC	4.50
MSL9362	1.75
MSL9363	1.75
HA11211	1.95
HA11223	2.15
HA11225	1.45
HA12002	1.45
HA12017	0.80
HA12402	1.95
HA12411	1.20
HA12412	1.55
LF13741	0.33
SN76660N	0.80

FREQUENCY DISPLAY & SYNTHESISER ICs

SAA1056	3.75
SAA1058	3.35
SAA1059	3.35
11C90DC	14.00
LN1232	19.00
LN1242	19.00
MSL2318	3.84
MSM5523	11.30
MSM5524	11.30
MSM5525	7.85
MSM5526	7.85
MSM5527	9.75
MSM55271	9.75
ICM7106CP	9.55
ICM7107CP	9.55
ICM7216B	19.25
ICM7217A	9.50
SP8629	3.85
SP8647	6.00
95H90PC	6.00
HD10551	2.45
HD44015	4.45
HD12009	6.00
HD44752	8.00

CMOS 4000 SERIES

4001	0.17
4000	0.17
4002	0.23
4008	0.80
4009	0.58
4010B	0.58
4011AE	0.20
4011B	0.20
4012	0.55
4013	0.55
4015	0.95
4016	0.52
4017	0.80
4019	0.60
4020B	0.93
4021	0.82
4022	0.90
4023	0.17
4024	0.76
4025	0.17
4026	1.80
4028	0.72
4029	1.00
4030	0.58
4035	1.20
4040	0.83
4042	0.85
4043	0.85
4044	0.80
4046	1.30
4047	0.99
4049	0.52
4050	0.55
4051	0.65
4052	0.65
4053	0.65
4063	1.09
4066	0.56
4068	0.25
4069	0.20
4070	0.20
4071	0.20
4072	0.20
4073	0.20
4075	0.20
4076	0.90
4077	0.20
4078	0.20
4082	0.20
4093	0.78
4175	0.95
4503	0.69
4506	0.51
4510	0.99
4511	1.49
4512	0.98
4514	2.55
4518	1.03
4520	1.09
4521	2.36
4522	1.49
4529	1.41
4539	1.10
4549	3.50
4554	1.53
4560	2.18
4566	1.59
4568	2.18
4569	3.03
4572	0.30
4585	1.10

TTL N and LSN

7400N	0.13
74LS00	0.20
7401N	0.13
74LS01	0.20
7402N	0.14
74LS02	0.20
7403N	0.14
74LS03	0.20
7404N	0.14
74LS04	0.24
7405N	0.18
74LS05	0.26
7406N	0.28
7407N	0.38
7408N	0.17
74LS08	0.24
7409N	0.17
74LS09	0.24
7410N	0.15
74LS10	0.24
7411N	0.20
74LS11	0.24
7412N	0.17
7413N	0.30
7414N	0.51
74LS15	0.24
7416N	0.30
7417N	0.30
7420N	0.16
74LS20	0.24
7421N	0.29
74LS21	0.24
7423N	0.27
7425N	0.27
7427N	0.27
74LS27	0.44
7428N	0.35
74LS28	0.32
7430N	0.17
74LS30	0.24
7432N	0.25
74LS32	0.24
7437N	0.40
7438N	0.33
74LS38	0.24
7440N	0.17
74LS40	0.24
7441N	0.74
7442N	0.70
74LS42	0.99
7443N	1.15
7444N	1.12
7445N	0.94
7446N	0.94
74LS47	0.89
7448N	0.56
74LS48	0.99
74LS49	0.99
7451N	0.17
74LS51	0.24
7453N	0.17
7454N	0.17
74LS54	0.24
74LS55	0.24
7460N	0.17
74LS63	1.24
7470N	0.28
7472N	0.28
7473N	0.32
74LS73	0.38
7474N	0.27
74LS74	0.28
7475N	0.38
7476N	0.37
74LS76	0.38
74LS78	0.38
7480N	0.48
7481N	0.86
7482N	0.69
7485N	1.04
74LS85	0.99
74LS86	0.40
7489N	2.05
7490N	0.33
74LS90	0.90
7491N	0.76
74LS91	1.10
7492N	0.38
74LS92	0.78
7493N	0.32
74LS93	0.99
7494N	0.78
7495N	0.65
74LS95	1.14
7496N	0.58
74LS96	1.20
7497N	1.85
74LS107	0.38
74109N	0.63
74LS109	0.70
74110N	0.54
74111N	0.68
74LS112	0.38
74LS113	0.38
74LS114	0.38
74118N	0.83
74120N	1.15
74121N	0.42
74122N	0.46
74123N	0.73
74LS124	1.75
74125N	0.38
74LS125	0.44
74126N	0.57
74LS126	0.44
74128N	0.74
74132N	0.73
74LS132	0.78
74LS136	0.40
74LS138	0.60
74141N	0.56
74142N	2.65
74143N	3.12
74144N	3.12
74LS145	0.97
74147N	1.75
74148N	1.09
74LS148	1.19
74150N	0.99
74151N	0.55
74LS151	0.84
74153N	0.64
74LS153	0.54
74154N	0.96
74155N	0.54
74LS155	1.10
74156N	0.80
74157N	0.67
74LS157	0.55
74LS158	0.60
74159N	2.10
74160N	0.82
74LS160	1.30
74161N	0.92
74LS161	0.78
74LS162	1.30
74163N	0.92
74LS163	0.78
74164N	1.04
74LS164	1.30
74165N	1.05
74LS165	1.04
74167N	2.50
74LS169	2.00
74170N	2.30
74LS170	2.00
74LS174	1.20
74175N	0.87
74LS175	1.10
74176N	0.75
74177N	0.78
74181N	1.65
74LS181	3.50
74LS183	2.10
74184N	1.35
74185N	1.34
74LS190	0.92
74192N	1.05
74LS192	1.80
74193N	1.05
74LS193	1.80
74194N	1.05
74196N	0.99
74LS196	1.10
74LS197	1.10
74198N	1.50
74199N	1.60
74LS247	0.93
74LS257	1.08
74LS260	1.53
74LS279	0.52
74LS283	1.20
74LS293	0.95
74LS365	0.49
74LS366	0.49
74LS367	0.43
74LS368	0.49
74LS374	1.80
74LS377	1.95
74LS379	1.30
74LS393	1.40

VARICAP TUNING DIODES

BA102	0.30
BA121	0.30
ITT210	0.30
BB204B	0.36
BB105B	0.36
BB109	0.27
MVM125	1.05
BB212	1.95
KV1210	2.45
KV1211	1.75
KV1226	1.95
KV1225	2.75
KV1215	2.55
KV1225	2.75

SWITCHING AND PIN DIODES

SHOTTKY DIODES

1N6263	0.62
BA182	0.19
BA244	0.17
BA379	0.35
TDA1061	0.95

SIGNAL DIODES & RECTIFIERS

1N4148	0.06
1N4001	0.06
1N4002	0.07
1N5402	0.15
OA91	0.07
AA112	0.25
BRIDGES:	
1A/50V	0.35
6A/200V	0.75

TRANSISTORS

AUDIO DEVICES

BC237	0.08
BC238	0.08
BC239	0.08
BC307	0.08
BC308	0.08
BC309	0.08
BC413	0.10
BC414	0.11
BC415	0.07
BC416	0.08
BC546	0.12
BC556	0.12
BC550	0.12
BC560	0.12
BC639	0.22
BC640	0.23
2SC1775	0.18
2SA872A	0.14
2SD666A	0.30
2SB646A	0.30
2SD668A	0.40
2SB648A	0.40
2SD760	0.45
2SB720	0.45
2SC2546	0.19
2SA1084	0.20
2SC2547	0.19
2SA1085	0.20

AUDIO POWER DEVICES

2SB753	2.34
2SB723	2.34
2SK133	3.00
2SJ 48	3.00
2SK134	3.10
2SK135	3.75
2SJ 50	3.75
BD535	0.52
BD536	0.52
BD377	0.33
BD378	0.33
BD165	0.30
BD166	0.31

SMALL SIGNAL RF DEVICES

BF194	0.18
BF195	0.18
BF224	0.22
BF241	0.18
BF274	0.18
BF440	0.21
BF441	0.21
BF362	0.49
BF395	0.18
BF479	0.66
BF679S	0.55
BFR91	1.33
BFW92	0.60
BFT95	0.99
BFY90	0.90
40238	0.85

RF POWER DEVICES

VN66AF	0.95
2N3866	0.85

SMALL SIGNAL RF FET/MOSFET

BF256	0.38
2SK55	0.28
2SK168	0.35
J310	0.69
J176	0.65
40823	0.65
40673	3SK51
3SK45	0.49
3SK51	0.54
3SK60	0.58
MEM680	0.75
BF961	0.70
BF960	1.24
3SK48	1.64

CAPACITORS

All 5mm or less spacing

- CERAMIC 50v
- 2P2,3P3,4P7,6P8
- 8P2,10P,15P,18P..0.04
- 22P,27P,33P,47P
- 56P,68P,82P,100P.0.05
- 150P,220P,270P
- 330P,390P,470P...0.055
- 1N0,2N2,3N3,4N7..0.06
- 10N (0.01uF)....0.05
- 22N,47N..........0.06
- 100N,220N.........0.09
- MONOLITHIC CERAMIC
- 10N,100N.........0.16
- FEEDTHRU
- 1N0 SOLDER IN....0.09
- POLYESTER (SIEMENS)
- 10mm LEAD SPACING
- 10N,22N,33N......0.17
- 47N,68N,100N.....0.19
- 220N,470N........0.22
- 1uF..............0.29
- POLYESTER (GENERAL)
- 10mm LEAD SPACING
- 10N,15N,22N,33N..0.06
- 47N,68N,100N.....0.08
- 220N.............0.11
- 20mm LEAD SPACING
- 220N,330N,470N...0.18
- MYLAR
- 5mm LEAD SPACING
- 1N0,10N,22N,33N..0.08
- 100N.............0.09
- 20mm LEAD SPACING
- 220N,470N....... 0.17
- POLYSTYRENE
- 10P,15P,18P,22P,
- 27P,47P,56P,68P..0.08
- 100P,180P,220P,
- 270P,330P,390P...0.09
- 470P,680P,820P...0.10
- 1N0,1N2,1N5,1N8..0.11
- 2N2,2N7,3N3,3N9..0.12
- 4N7,5N6,6N8,10N..0.13
- TANTALUM BEAD CAPS
- 16v: 0.22,0.33,
- 0.68,1.0.........0.18
- 16v: 2.2,4.7,10..0.19
- 6v3: 22,47.......0.30
- 10v: 22,100......0.35

ALUMIN ELECTROLYTICS RADIAL (VERT. MOUNT)

- (uF/voltage)
- 1/63,2.2/50,4.7/35
- 10/16,15/16,22/10
- 33/6.3...........0.08
- 22/16,33/10,
- 47/10............0.09
- 10/63,22/50,33/50,
- 47/16,100/16.....0.10
- 47/63,100/25,220/16
- 470/6.3..........0.12
- 100/63,470/16,
- 1000/10..........0.18
- 1000/16,470/63...0.23
- 1000/25,2200/16..0.30
- 3300/25..........0.69
- 1000/100.........0.88
- 10000/70.........3.00
- AXIAL (HORIZ. MOUNT)
- 1/25,4.7/16,6.4/25
- 10/16............0.08
- 4.7/63,22/10,22/16
- 33/16............0.09
- 47/25,100/16.....0.10
- 100/25...........0.11
- 1000/16..........0.25
- 2200/16,1000/25..0.36
- 1000/35,4700/16..0.45
- 1000/50..........0.58

RESISTORS

- 0.25W, 5% E12 CARBON
- 1ohm-10M.........0.02
- 0.25W 1% E12 METAL FILM
- 1.1ohm-1M........0.05
- HORIZ CARBON PRESETS
- 10mm TYPE
- 100ohms-2M5......0.12
- HORIZ CERMET PRESETS
- 1k, 10k..........0.27

TOKO COILS AND FILTERS SEE THE EXTENSIVE SECTION IN OUR NEW PRICE LISTS AND CATALOGUE

LF/HF FIXED INDUCTORS —FULL E12 RANGE

7BA series 1uH-1mH	0.16
8RB series 100uH-33mH	0.19
10RB series 33mH-120mH	0.33
10RBH series 120mH-1.5H	0.55
PIEZO SOUNDER PB2720	0.44

VOLTAGE REGULATORS

78series	0.95
79series	1.00
78Mseries	0.65
78Lseries	0.35
79L05	0.85
78MGT2C	1.75
79MGT2C	1.75
723CN	0.65
L200	1.95
TDA1412	0.75
NE553N	1.25
LM317MP	1.48
LM337MP	1.48

MICROMARKET

8080A/2	7.50
8212	2.30
8214	3.50
8216	1.95
8224	3.50
8251	6.25
8255	5.40
6800P	7.50
6810	5.95
6820	7.45
6850	4.90
6852	4.85
MC2708	7.50
2114	6.50
4027	5.78
2102	1.70
2112	3.40
2513	7.54
HM4716	4.50
81LS97	1.25

CRYSTAL FILTER PRODUCTS

10.7MHZ 2 POLE TYPES:	
10M15A 15KHZ BW	2.49
10.7MHZ 8 POLE TYPES:	
10M4B1 15kHz BW	14.50
H4402 7.5KHZ BW	15.50
10M22D 2.4KHZ SSB	17.20
HF FIRST FILTER:	
B34F8A 34.5MHZ HF	32.00

RADIO CONTROL CRYSTALS

(No splits available)	
AM TX:-	
3rd OT 30pF HC25U	1.65
AM/FM RX:-	
3rd OT 30pF HC25U	1.65
FM TX :-	
Fund 20pF HC25U	1.85
Pairs FM	3.25
Pairs AM	3.10

CRYSTALS

32.768 kHz	2.70
100kHZ	3.85
455kHZ	5.00
1.0MHz	3.00
3.2768MHz	2.70
4.000MHz	2.00
4.19439MHz	2.30
6.5536MHz	2.10
10.0MHz	2.50
10.6985MHz	2.50
10.7015MHz	2.50
10.245MHz	2.50
10.7MHz	3.00
11.52MHz	2.50
100MHz	3.00

LEDs

5MM RED	0.12
3MM RED CLEAR	0.15
3MM RED	0.15
2.5 X 5MM RED	0.17
5MM GREEN	0.15
3MM GN CLEAR	0.16
3MM GREEN	0.16
2.5 X 5MM GN	0.20
5MM YELLOW	0.15
3MM YELLOW CL	0.16
3MM YELLOW	0.18
2.5 X 5MM YE	0.20
5MM ORANGERED	0.20
3MM ORA CL	0.29
3MM ORANGERED	0.19
2.5 X 5MM ORA	0.24
5MM INFRA RED	0.56
BPW41 IR DET	1.51
IR OPT CPLR	1.44
5MM CLIP	0.04

LCDs

3.5 digit	9.45
4 digit	8.95
5 digit	8.95

SCHOTTKY DIODE BAL MIXERS (SBL1=MD108)

SBL1 1-500MHz	4.25
SBL1-8 .1-200MHz	4.55
SBL1-X 10-1000MHz	5.75
SRA1 .5-500MHz	8.45
SRA1-1 .1-500MHz	9.25
SRA1H .5-500MHz	13.35
SRA3 .025-200MHz	10.25

LCD Module

CM161. Miniature clock, 12/24 hr., alarm, day, date, backlight. All for......9.95

PRICES EXCLUDE VAT - PLEASE ADD 15%* Postage 35p per order. CWO please. (*UK only)

CWO PLEASE : Commercial MA terms on application. Goods are offered subject to availability, prices subject to change - so please phone and check if in doubt.

Please send an SAE with all enquiries. Access/Barclaycd (min £5 please) Callers welcome

ambit INTERNATIONAL

200 North Service Road, Brentwood, Essex

TELEPHONE (STD 0277) 230909 TELEX 995194 AMBIT G POSTCODE CM14 4SG

CATALOGUES
2 & 3....60p ea
4...........75p
(4 inc. rev. of part 1)
ALL PARTS : ......£1.75......

If you want an Autoranging 3½-digit LCD DMM For only £39.95 (inc VAT)

We've got to hand it to you!

- ZERO ADJUSTMENT
- 3½-DIGIT LCD WITH 200 HRS CONTINUOUS BATTERY LIFE
- AUTO 'BATT' WARNING
- FULL AUTORANGING
- AUTO UNIT DISPLAY
- CONTINUITY TEST (6110 and 6100 only)
- 10 AMP AC/DC (6110 and 6220 only)

Introducing the latest professional state-of-the-art 3½-digit DMM – at really old-fashioned prices! From just an unbelievable £39.95 inc. VAT, plus £1.15 p&p!

	6100	6110	6200	6220
RESOLUTION	1mV, 10µA, 0.1Ω on all models			
FULL AUTO RANGING	✓	✓	✓	✓
RANGE HOLD	✓	✓		
UNITS OF MEASUREMENT DISPLAYED	mV, V, mA	mV, V, mA, A	mV, V, mA	mV, V, mA, A
FUNCTIONS DISPLAYED	Ω, KΩ, AUTO, BATT, ADJ, LO, – and AC			
MEASURES DC VOLTAGE TO:	1000V	1000V	1000V	1000V
MEASURES AC VOLTAGE TO:	750V	750V	750V	750V
MEASURES AC/DC CURRENT TO:	200mA	10A	200mA	10A
ZERO ADJUSTMENT	Zeros out minute test-lead resistances for precise measurements			
ACCURACY	0.5%	0.5%	0.8%	0.8%
LOW POWER OHM RANGES	For in-circuit resistance measurements on all models			
BUZZER – Continuity Test	✓	✓		
BUZZER – Over Range Indicator	✓	✓		
COMPLETE WITH	Batteries, pair of Test Leads, Spare Fuse, One Year's Guarantee			
PRICE	ONLY £64.95	ONLY £74.95	ONLY £39.95	ONLY £49.95
p&p	£1.15	£1.15	£1.15	£1.15

Why such a low, low price? Because the A/D converter and display are custom built! This is a genuine top-spec DMM. Check these features for *unbeatable* value – you won't find a hand-held DMM with these features at these prices again!

I believe you! Please send me the DMM/s as marked.

______6200 @ **£41.10** each, inc. VAT, p&p. Total price £______
______6220 @ **£51.10** each, inc. VAT, p&p. Total price £______
______6100 @ **£66.10** each, inc. VAT, p&p. Total price £______
______6110 @ **£76.10** each, inc. VAT, p&p. Total price £______

Total cash/cheque enclosed £______
Cheques payable to Maclin-Zand Electronics Ltd., please.

ACCESS orders taken. Please write card no. and signature.

ACCESS NO ______

Name ______

Address ______

Signed ______

Available exclusively from the company that gives you tomorrow's technology today.
38 Mount Pleasant, London WC1X 0AP.
Tel. 01-278 7369/01-837 1165

ME
Maclin-Zand
Making state-of-the-art affordable

To: Maclin-Zand Electronics Ltd., 38 Mount Pleasant, London WC1X 0AP.
Despatch by return. For overseas orders, please add £5 to cost of total order package.
Allow 4-6 weeks for delivery

2REC

PRICES SO LOW, THE POLICE INVESTIGATED ME TWICE

ALL ENQUIRIES, ETC. MUST BE ACCOMPANIED BY A STAMPED ADDRESSED ENVELOPE

VAT & POST PAID

(2nd Class or Parcel)

MINIMUM ORDER £3 (excluding catalogue) OTHERWISE ADD 50% FOR SMALL ORDER HANDLING COSTS (UNDER £1.00 TOTAL ALSO INCLUDE 12p S.A.E.)

UK – Postal Orders for same day service. Cheques require 8 days from a Monday banking to ensure clearance. Export – banker's draft (sterling) same day service. Foreign currency not accepted. VAT content becomes documentation charge.

OPTO ELECTRONICS

Photo Diodes: BPX40, BPX42, BPY10, CQY77, CQY17, BPY68, BPY69, BPY77 36p.
Wire end neons 4p.
Photo transistors: BPX43, BP103, 2N5777 Darlington. 36p. OCP71 40p. LED's (Mullard Seimans) Red .2" 8p. .125" 9p; Green .2" 11p; .125" 12½p; Micro Yellow LD481 7½p.
PHOTO SILICON CONTROLLED SWITCH BPX66 PNPN 10 amp 36p
CA3062 Photo Detector and power amp. £1

7 SEGMENT L.E.D. DISPLAYS

.3" Red com. anode 81p
.6" Green R.S.C.A. £1.77
5082-7650 Red com. anode
5082-7653 Red com. cath
5082-7600 Yellow com. anode
H.P. Highbrilliance .43" 72p

HEWLIT PACKARD MULTIPLEXED .12" 7 SEGMENT LED DISPLAYS

3 Digit HP 5082 7413 45p
4 Digit HP 5082 7414 45p
5 Digit HP 5082 7415 45p
Infra red transmit diodes CQY11B or LD27 High power 1.6-2v or 3-3.5v Pulse 32p
LD242 36p
H15B Photon coupled isolator I.R. diode and NPN Photo-Darlington amp 26p
Data Sheet 10p
CNY17/1 opto coupler 70p
Cold cathode tubes I.T.T. G517A or 5870L 60p

SPECIAL OFFER

IN4004 or IN4006. Sealed manufacturers carton of 300.
£6.75

HIGH VOLTAGE CAPACITORS

2500 VOLT
1000 pF 16p
.01, .03, .05 30p

3000 VOLT
470pF 2p
150, 300, 1800pF 17p
.012 MFD 22p

4000 VOLT
330pF 18p 1000pF 22p

5000 VOLT
.02 MFD 45p

10,000 VOLT
1000pF 14p

20,000 VOLT
500pF 60p

8/12 KV PULSE TUBE

10 2p. 68 12p. 140 12p.
12 12p. 82 2p. 200 12p.
47 2p. 100 2p. 300 2p.
56 2p. 120 2p. 350 12p.

8KV LOW IONISATION DISC.

10 15p. 15 15p. 20 15p. 27 15p. 30 15p. 33 15p. 68 15p. 75 2p. 100 16½p. 150 16½p. 160 — 36p pack 3. 180 16½p. 210 — 36p pack 3.

2.8 Volt 200 M/A Nicad Battery Unit. Recharges direct from mains. 80p

DIODES

AA119	7p
AA133	9p
AAZ15	15p
B1	11p
BA116	30p
BA128	2½p
BA145	2½p
BA148	12p
BA182 Varicap	6p
BAX14	2½p
BAX54	8p
BAY36P	2½p
BB103 Varicap	6p
BB104 Varicap	16p
BB109 Varicap	24p
BB110B Varicap	24p
BB113 Triple Varicap	43p
BB139	£1
BY206	7½p
BY207	23p
BY402	2½p
BY403	2½p
Centercell	3p
CG651	9p
CR HG/3	10p
CSD117YLZ	40p
CV7095	2½p
CV7098	2½p
D3202Y Diac.	11p
DC2845 Microwave	20p
DOG53	11p
FSY28A	40p
HG1012	10p
HS2091	11p
MPN3401	30p

OA5	25p
OA7	25p
OA10	25p
OA47	7p
OA70	10p
OA75	11p
OA79	11p
OA81	3½p
OA95	8p
OA200	2½p
OA202	2½p
IGP7	11p
IGP10	11p
IN662	2½p
IN914	1½p
IN916	2½p
IN935B	7½p
IN936B	7½p
IN937B	7½p
IN941B	7½p
IN942B	7½p
IN943B	7½p
IN3064	2½p
IN3716 Tunnel Diode	30p
IN4009	2½p
IN4148	1p
IN4150	2½p
IN4151	2½p
IN4446	2½p
IN4449	2½p
IN5456	15p
5082 2900 RF Schotky Barrier	20p

RECTIFIERS

Type	Volt	Amp	Price
BY127	1250	1	4p
BY212	EHT		6p
BY235	600	1½	7½p
BY236	900	1½	7½p
BY264	300	3	9p
BY265	600	3	11½p
BY266	900	3	15p
BY274	300	5	14½p
BY275	600	5	17½p
BY277	1200	5	27p
BY299	800	2	4p
BY1202	2kV	10mA	6p
BYX20-200	200	25	72p
BYX22-200	300	1½	25p
BYX38-300R	300	2½	48p
BYX38-600	600	2½	52p
BYX38-900	900	2½	60p
BYX38-1200	1200	2½	65p
BYX42-300	300	10	36p
BYX42-600	600	10	46p
BYX42-900	900	10	92p
BYX42-1200	1200	10	£1.07
BYX46-300R	300	15 Avalanche	£1.19
BYX46-400R	400	15 Avalanche	£1.75
BYX46-500R	500	15 Avalanche	£2.00
BYX46-600	600	15 Avalanche	£2.30
BYX48-300R	300	6	47p
BYX48-600	600	6	60p
BYX48-900	900	6	70p
BYX48-1200R	1200	6	92p
BYX49-300R	300	3	35p
BYX49-600	600	3	42p
BYX49-900R	900	3	47p
BYX49-1200	1200	3	60p
BYX52-300	300	40	£2.05
BYX52-1200	1200	40	£2.90
BYX72-150R	150	10	42p
BYX72-300R	300	10	52p
BYX72-500R	500	10	65p
BYX94	1250	1	5p
E250C50	250	½	14p
LT102	30	2	15p
M1	68	1	5p
MR856	600	3	24p
OA210	400	5	33p
RAS3 1OAF Avalanche	1250	1½	48p
REC53A	1250	1½	16p
S10BR30	1000	30	£2.00
SKE4G	200	6	30p
SR100	100	1½	9p
SR400	400	1½	10p
IN3254	400	1	4p
IN4002	100	1	3p
IN4004	400	1	4½p
IN4005	600	1	6p
IN4006	800	1	6p
IN4007	1250	1	6p
IN5059	200	1½	10p
IN5401	100	3	10p
IS138	800	½	2½p
IS921	100	½	8p
25G100	100	60	£4.35
3052	200	3	11p

16 PIN DIL RESISTOR NETWORK

8 x 33K or 8 x 10K 16p

BRIDGE RECTIFIERS

½	60V	BC30 C350	23p
½	1,600	BYX10	34p
0.6	110	EC433	20p
1	50V	WO05	19p
1	140	OSH01-200	25p
1	200V	WO2 Ex Equip	15p
1	400V	WO4	28p
1	400V	MDA104	29p
1	800V	WO8	27p
1	1000	W10	36p
1½	75V	IBIBY234	11½p
1½	150V	IBIBY235	15p
2½	100	I.R.	40p
2½	350V	9F2	70p
2½	500V	9E4	85p
3	50	KBS005	30p
3	100	KBS01	30p
3	200	KBS02	30p
3	400	KBS04	30p
3	600	KBS06	30p
3½	100	B40C 3200	58p
5	400	Texas	85p
Miniature	Meter	Type	34p

Thyristors

Amp	Volt		
1	240	BTX18-200	35p
1	240	BTX30-200	35p
1	400	BTX18-300	41p
4	500	40506 with heatsink	58p
4	600	2N3228	36p
6.5	500	BT109/SCR957	71p
2	400	S2710D with heatsink	40p
8	100	S2800A	36p
4	600	C106M sensitive gate	36p
20	600	BTW92-600RM	£3.40
15	800	BTX95-800 Pulse Modulated	£1
0.8	50	2N5061	3p
0.8	200	2N5064	18p
3	600	T3N06C00	53p
3	100	T3N1C00	36p
110	20	72RC2A	£3
75	800	71CG80	£6
150	1000	151RA100	£10
150	1200	151RA120	£11
12	1000	CR121103-RB	£8
10	200	S2800B	54p
5	600	S5800M	44p
8	600	S112M	54p
5	400	S3700D	44p
4	50	S2060F	36p
7	400	S2620D	45p
7	600	S2620M	45p

BT 106 70p
BT 121 70p
BT 107 £1

TRIACS

Amp	Volt		
0.1	40	7W84	3p
25	100	BTX94-100	£2.25
25	1200	BTX94-1200	£5
6	200	T2500B/41014	54p
2.5	600	2N5757	44p
8	400	T2850D	72p
4	400	T2716D/40730	74p
6	400	T2500D	72p

ZENER DIODES

4/500MW. BZY88, BZX97, etc. 5p
2v. 2v7. 3v. 3v3. 3v6. 3v9. 4v3. 4v7. 5v1. 5v6. 6v2. 6v8. 7v5. 8v2. 9v1. 10v. 11v. 12v. 13v. 13v5. 15v. 18v. 20v. 22v. 24v. 27v. 30v. 33v. 43v.
1.3/1.5WT BZX61, BZY97, etc. 11p
2v4. 2v7. 3v. 3v6. 3v9. 4v3. 4v7. 5v6. 6v2. 6v8. 8v2. 10v. 11v. 15v. 18v. 27v. 33v.
2.5WT BZX70, etc. 13p
v75. 1v. 2v4. 3v6. 3v9. 5v6. 6v2. 7v. 7v5. 8v. 9v. 10v. 11v. 14v. 15v. (8p). 20v. 22v. 24v. 26v.
5WT BZV40, etc. 15p
3v3. 3v6. 3v9. 4v3. 4v7. 5v1. 5v6. 6v2. 6v8. 7v5. 8v2. 8v7. 9v1. 10v. 11v. 12v. 15v. 33v. 68v. 120v.
10WT Z5D, ZX, etc. 20p
4v3. 4v7. 5v1. 5v6. 6v2. 6v8. 7v5. 8v2. 11v. 12v. 13v. 16v. 18v. 21v. 22v. 33v. 36v. 39v. 68v. 150v.
BZY61 Laboratory Standard 400MW 7v5. Voltage Regulator Diode 12p
20WT BZY93, etc. 44p
8v2. 12v. 39v.

WIREWOUND RESISTORS

23/25 WATT

15	24p	380	24p	1K5	24p
110	24p	800	24p	2K	24p
300	24p	1K2	24p	10K	24p

30 WATT

1	10p	80	34p	940	34p
2.3	34p	100	34p	1K	34p
20	10p	190	9p	3K3	34p
25	6p	200	9p	6K8	34p
36	22p	250	34p	15K	34p
60	34p	400	34p		
75	34p	726	34p		

50/60 WATT

47	50p	100	50p	3K	50p
50	50p	250	50p	5K	50p
62	50p	750	50p	22K	50p

100 WATT

15K 80p

BRIAN J. REED

SEE PRECEDING PAGES FOR ORDERING INSTRUCTIONS
Cut out and keep these 3 pages. Over the months they will bring to you some of the 6,000 items stocked.

INTEGRATED CIRCUITS

542 Servo Amp	18p
555 Timer	20p
702 CL	25p
709/72709 OP Amp. (14 pin 10p)	18½p
710	28p
724	20p
741 OP Amp	16p
747 Dual OP Amp	44p
930DC	4p
933DC	4p
936DC	4p
937DC	4p
946DC	4p
949DC	4p
953—42300 Trip .2 Innand	4p
961DC	4p
962DC	4p
963DC	4p
1315P2	36p
2102 Memory	73p
2716 Eprom	£10.35
3351-2DC 40 x 9 Bit FIFO 2MHZ	£1.07
4060 Dymamic RAM 300ns	£1.45
7400 } Quad 2 Input Posative Nand Gates	10p
74H00	26p
74LS00	13p
74S00	18p
7401	7½p
74H01	26p
7402	11p
7404	11p
54/7406	15p
74LS08	15p
7410 } Triple 3 Input Posative Nand Gates	10p
74L10	25p
74H10	26p
7411	8p
7414	29p
7417	18p
7420 } Dual 4 Input Posative Nand Gates	11p
74S20	50p
74S22	18p
7425	18p
7426	16p
5430	12p
7430	11p
74L30	11½p
7432	13p
54/7437	13p
7438	14p
74H40	26p
7442 BCD to Decimal Decoder	26p
74LS42 BCD to Decimal Decoder	40p
7445	42p
7450 } Expandable Dual 2 Wide 2 Input and/or Inv.	11p
74H50	26p
7451	7½p
7454	11p
74L54	11½p
54/7472 } And Gated JK Master Slave F.F. Preset + Clear	17½p
74L72	25p
5473 } Dual JK Master Slave Flip Flops with Clear	12p
7473	17p
74H73	26p
7474	13p
74L74	25p
7475	24p
54/7476	19p
5480	22p
7482	35p
7483	45p
74LS83	47p
54/7486	18½p
5490	25p
7493 Binary Counter 4 Bit	25p
54/74L95	25p
74LS98	£1.25
74107	20p
74S112	38p
74118	75p
74121	12p
74122	18p
54/74123	35p
74132	44p
74141	42p
74LS145	93p
74150	12p
74151	32p
74154 16 Way Dist.	35p
74155	12p
74157	12p
74165	58p
74167	23p
74173	44p
74176/8280	30p
74180	12p
74192	33p
74LS192	60p
74193	38p
74196	36p
74S196/82S90	65p

74LS221 Dual Monostable M/VIB	52p
74LS290	47p
74293	80p
74298	£1
74490	£1.30
7905—5v Reg. 1 Amp	54p
8080A C.P.U.	£3.60
8086MPU	£3.60
82S129	£5
9093DC	4p
9112DC	4p
93S10	£1
9311	£1.20
93L16	36p
9370	25p
930399-256 Bit Shift Register	4p
930399-480 Bit Shift Register	4p
930399-500 Bit Shift Register	4p
AJ371-002	4p
AY58300 Ch/Time Display	36p
BRCM300 Volt Reg.	£1.40
BTT822	£1.25
C500 Calculator	37p
CA101 Wide Band Op. Amp	36p
CA139AG Quad Volt Comp.	54p
(T)CA270AE	£1
(T)CA270CW/AW	35½p
(T)CA270CE	36p
CA758 (MC1311)	36p
CA920 TV Horiz. system	72p
CA3001 RF Amp	86p
CA3028A	75p
CA3044	£1.20
CA3046 Transistor Array	40p
CA3054	69p
CA3060	72p
CA3065	36p
CA3083	65p
CA3086	29p
CA3089	54p
CA3090AQ	72p
CA3093	36p
CA3094 Prog. Sw. Pwr. OP Amp.	36p
CA3097	36p
CA3123	73p
CA3132EM	£2.22
CA3146E	90p
CA3183	80p
CA3189	73p
CA3401 (LM3900) Quad OP Amp	36p
CD2500E 30mA/Seg Dcml Point Dvr	90p
CD4000 Dual 3 input Nor + Inv.	12p
CD4001 Quad 2 Input Nor	14p
CD4002 Dual 4 Input Nor	12p
CD4006 18 Stage Static Shift Reg.	36p
CD4007 Dual Comp. Pair + Inv.	12p
CD4008 4 Bit Binary Full Adder	54p
CD4010 Hex Buffers	30p
CD4011 Quad 2 Input Nand	14p
CD4012 Dual 4 Input Nand	13p
CD4013 Dual D Flip Flop	36p
CD4014 8 Bit Shift Register	36p
CD4016 Quad Bilateral Latch	36p
CD4017 Decade Count/Divide	54p
CD4018 Preset Divide N Count	43p
CD4019 Quad 2 Input Multiplex	25p
CD4020 14 Stage Binary Count	54p
CD4021 8 Bit Shift Register	54p
CD4022 Divide by 8 Count/Divide	36p
CD4023 Triple 3 Input Nand	19p
CD4025 Triple 3 Input Nor	14p
CD4026 Dec. Count + 7 Seg. Out	72p
CD4028/MC14028 BCD/Decimal	42p
CD4029 Synch. Preset Bin/Dec	54p
CD4030 Quad Exclusive or	36p
CD4031	£1.20
CD4032	72p
CD4033 Dec. Count. 7 Seg. Output	72p
CD4035 4 Bit Par. in out Shift	54p
CD4037	72p
CD4038	54p
CD4041 Quad True/Comp. Buffer	54p
CD4043 Quad Nor R/S Latch	54p
CD4044 Quad Nand R/S Latch	54p
CD4045 4 Bit Par. in out shift	54p
CD4046 Micro Power PH. Lock Loop	36p
CD4048	36p
CD4049 Hex Inverter Buffers	36p
CD4050 Hex Buffers	25p
CD4051 Analogue Multi/Demulti	36p
CD4053 Analogue Multi/Demulti	54p
CD4055	72p
CD4056	72p
CD4063	72p
CD4066 Quad Bilateral Switch	27p
CD4067	£2.12
CD4068 8 Input Nand	20p
CD4069 Hex Inverter	13p
CD4076 Quad D Flip-Flop	54p

CD4077 Quad Exclusive Nor	30p
CD4078 8 Input Nor	19p
CD4081 Quad 2 Input and Buffer	15p
CD4086 4 Wide 2 Input and/or Inv.	54p
CD4093 Quad 2 Input Nand S.T.	54p
CD4094	72p
CD4096	72p
CD40100 32 bit L/R Shift Reg.	£1.78
CD40101	£1.08
CD40162	72p
CD40181BE Quad 2 Input and	£2.12
CD40182	72p
CD40192	72p
CD40194	72p
CD40208BF	£2.12
CD4502 Strobed Hex Invertor	44p
CD4508BF	£1.78
CD4514	£1.45
CD4516 Binary up/down counter	54p
CD4519/MC14519	54p
CD4520 Dual Synch. 4 Bit Binary	72p
CD4532	£1.08
CD4527	£1.20
CD4555	72p
CD22100	£1.45
CDP1802 Cosmac MPU	£3.60
CDP1833 Cosmac Rom 1824 x 8	£3.60
D3624	36p
DM8214 Interupt (8080 support)	36p
FCH111 8 input Nand/Nor	8p
FCH201	18p
FCJ101	50p
FPQ/MPQ3725 4 Tr. Array	45p
FZH151	18p
FZH191	18p
FZH201	18p
IM5623 MPU	36p
LM300 Volt Reg.	42p
LM309 (Ex Equip.) + 5v Reg. 1.2A	60p
LM326 Volt Reg.	20p
LM340T6 6v Reg.	36p
LM343 Amp	4p
LM1303N Dual Stereo Pre Amp	65p
LM/MC1458N Dual OP Amp	19p
LM3900 Quad Op. Amp (C.B. Amp)	36p
MC830P	4p
MC833P	4p
MC837P	4p
MC846P	4p
MC862P	4p
MC863P	4p
MC1306P	40p
MC1307P	35½p
MC/CA/BRC 1310P St. Dec.	35½p
MC1312P Stereo Decoder	40p
MC1314P	35½p
MC1315P	35½p
MC/BRC1330 Video Detector	85p
MC1350P	35½p
MC1357P	35½p
MC1358PQ	35½p
MC1596L	35½p
MC3302L	75p
MC4044P	£1
MC4344P	£3.50
MIC7C	25p
MK2686	36p
MK4012 Memory	38p
ML237B	£1
MM5335D M.P.U.	36p
MM8008 M.P.U.	36p
MPC900 10A—4 to 30v Reg.	75p
MT300 Volt Reg.	8p
MT305 Volt Reg.	8p
SAA661	36p
SAA1010	34½p
SAA1025	£4
SAS580	18p
SAS590	18p
SGS308 Op. Amp	4p
SL403A 3Wt. Amp	38p
SL442	36p
SN7528	11½p
SN15836	25p
SN15845	50p
SN15846	37p
SN15851	50p
SN15858N	55p
SN15862	6p
SN75107 Interface	£1.15
SN75108	36p
SN75110	46p
SN75150	18p
SN75235N	11p
SN75451	36p
SN76001	36p
SN76003 5Wt. Amp	36p
SN76003N 5Wt. Amp	£1.10
SN76013 5Wt. Amp	36p
SN76013N 5 Wt. Amplifier	92p
SN76013ND 5Wt. Amp	£1.18

SN76023 5Wt. Amp	36p
SN76110P	35½p
SN76115N Stereo Decoder	35½p
SN76131	58p
SN76227	59p
SN76228N	£1.60
SN76396 (TBA396)	35½p
SN76620 AN	18p
SN76650N	50p
SN76660N	35½p
SN76666N	35½p
SN158093	50p
SN158097	4p
SN158099	50p
TAA263 Amp	75p
TAA300 1Wt. Amp	£1
TAA320	35p
TAA550 Volt Reg.	10½p
TAA700	£2.30
TAD100 AM Radio	£1.22
TBA120S/CQ/SB/B TV Amp	25p
TBA240	£3.90
TBA395Q	£1.50
TBA396	36p
TBA550Q	£1.25
TBA560C	52p
TBA800 Amp 5 Watt Audio	52p
TBA810 Amp 7 Watt Audio	70p
TBA920 TV Line System	70p
TCA270Q/SA/AE/OS	£1
TCA270SQ	55p
TCA440 A.M. Receiver	£1.25
TCA830S Ex. Equip.	18p
TCA830S	37p
TCA4401	£1.25
TCEP100	£1
TDA/MC1327 Dual Chroma Demod	18p
TDA2610	71p
TDA2680	71p
TDA2690	71p
TL720	28p
TMS4034 Memory	£1.08
TYA0171	4p
XR215	£2
ZN414 AM Radio Receiver	79p
ZST131A 5 Input Power NOR	8p

FUSIBLE WIREWOUND RESISTORS

5 Watt
80Ω 22p 100Ω 22p 270Ω 22p
4K7 22p

7 Watt
200Ω 22p

10 Watt
7Ω 22p 220 22p 3K2 22p
750 22p

15 Watt
750Ω 22p 2K2 22p

20 Watt
5.6Ω 8p

23 Watt
180Ω 9p

HISTAB POLY/CERAMIC 1% AND 2% CAPACITORS

10pF	6p	470	6p	5N75	6p
20	6p	680	6p	0.01	6p
47	6p	1N2	6p	0.0147	6p
50	6p	IN28	6p	0.015	6p
68	6p	IN75	6p	0.0285	6p
79	6p	2N	6p	0.033	6p
88	6p	2N2	6p	0.047	6p
110	6p	2N34	6p	0.068	2½p
130	6p	2N5	6p	0.082	5p
140	6p	2N7	6p	0.09	6p
150	6p	2N8	6p	0.1	6p
180	6p	3N04	6p	0.22	10p
250	6p	3N3	6p	0.4	15p
270	6p	3N96	6p	0.5	15p
370	6p	4N07	6p	0.68	10p
420	6p	4N7	6p	1 MFD 250v	30p

above are various voltages up to 500.

750 Volt
82pF 22p 88pF 22p 150pF 22p

2000 Volt
390pF 48p 600pF 48p

½% 0.25 MFD 125v 30p

LEAD THROUGH CAPACITORS

1000pF	£2.20 per 100
500 or 1000pF High Volt/Current	£6.20 per 100
0.05 MFD 20 Amp	60p
Non Capacitive Lead Through	2p

TRIPLE CERAMIC CAPACITOR

3 x 1000 pF in small tubular construction. Series or parallel to give various values

10 for 35p

MOTORS

1.5-6VDC Model Motors **22p.** Sub. Min. 'Big Inch' 115VAC 3rpm Motors **32p.** 6 volt standard cassette motors new **£1.20.** 8 track 12V Replacement Motors **55p.** Cassette Motors 5-8VDC ex. equip. **70p.** Geared Mains Motors (240V) 2.5 rpm **75p.** 115VAC 4rpm Geared Motors **95p.**

SEMICONDUCTORS

LM340 **80p.** BY103 **10p.** 2N5062 100V 800mA SCR **18p.** BX504 Opto Isolator **25p.** CA3130 **95p.** CA3020 **45p.** 741 **22p.** 741S **35p.** 723 **35p.** NE555 **24p.** 2N3773 **£1.70.** NE556 **50p.** ZN414 **75p.** BD238 **28p.** BD438 **28p.** CB4069 **15p.** TIL305 alpha numeric displays **£2.50.** TIL209 Red Leds 10 for **75p.** Man3A 3mm Led Displays **40p.**

PROJECT BOXES

Sturdy ABS black plastic boxes with brass inserts and lid. 75 x 56 x 35mm **65p.** 95 x 71 x 35mm **75p.** 115 x 95 x 37mm **85p.**

MOTOROLA PIEZO CERAMIC TWEETERS

No crossover required

2.5" Direct Radiating Tweeter, maximum rating 25 volts R.M.S. 100 watts across 8 ohms. Freq. range 3.8kHz-28kHz, **£3.65**

TOOL SALE

Small side cutters 5" insulated handles **£1.** Radio-pliers, snipe nosed insulated handles **£1.** Heavy duty pliers insulated handles **£1.10.** Draper side cutters spring loaded **£1.**

SWIVEL BASE VICES

(with anvil)

With anvil, bench clamp, and plated parts, body smooth, lacquered finish. Jaw width 2", jaw opening 2¼" **£5.55 + £1.20 P&P.**

MORSE KEYS

Beginners practice key **£1.05.** All metal full adjustable type. **£2.60**

MINIATURE LEVEL METERS

1 Centre Zero 17 x 17mm **75p.** 2 (scaled 0-10) 28 x 25mm **75p.** 3 Grundig 40 x 27mm **£1.25.**

JVC NIVICO STEREO CASSETTE MECHANISM. Music centre type. Rev. counter, remote operation **£13.50 and £1.00 p&p.**

JUMPER TEST LEAD SETS

10 pairs of leads with various coloured croc clips each end (20 clips) **90p** per set.

TRANSFORMERS

All 240VAC Primary (postage per transformer is shown after price). MINIATURE RANGE: 6-0-6V 100mA, 9-0-9V 75mA and 12-0-12V 50mA **all 79p** each **(15p).** 0-6, 0-6V, 280mA **£1.20 (20p).** 6V 500mA **£1.20 (15p).** 12V 2 amp **£2.75 (45p).** 15-0-15V 3 amp Transformer at **£2.85 (54p).** 30-0-30V 1 amp **£2.85 (54p).** 20-0-20V 2 amp **£3.65 (54p).** 0-12-15-20-24-30V 2 amp **£4.75 (54p).** 20V 2.5 amp **£2.45 (54p).**

TRIAC/XENON PULSE TRANSFORMERS

1:1 (gpo style) **30p.** 1:1 plus 1 sub. min. pcb mounting type **60p** each.

MICROPHONES

Min. tie pin. Omni, uses deaf aid battery (supplied), **£4.95,** ECM105 low cost condenser, Omni, 600 ohms, on/off switch, standard jack plug, **£2.95.** EM507 Condenser, uni, 600 ohms, 30-18kHz., highly polished metal body **£7.92.** DYNAMIC stick microphone dual imp., 600 ohms or 20K, 70-kHz., attractive black metal body **£7.75.** EM506 dual impedance condenser microphone 600 ohms or 50K, heavy chromed copper body, **£12.95** CASSETTE replacement microphone with 2.5/3.5 plugs **£1.35.** INSERT Crystal replacement 35 x 10mm **40p.** GRUNDIG electric inserts with FET preamp, 3-6VDC operation **£1.00.**

LIGHT DIMMER

240VAC 800 watts max. wall mounting, has built in photo cell for automatic swich on when dark **£4.50**

RIBBON CABLE

8 way single strand miniature **22p** per metre.

SPECIAL OFFER TAPE HEAD DEMAGNETIZER

240VAC with curved probe suitable for reel to reel or cassette machines, **£1.95.**

STEREO FM/GRAM TUNER AMPLIFIER CHASSIS, VHF and AM. Bass, treble and volume controls, Gram. 8-track inputs, headphone output jack, 3 watts per channel with power supply. **£14.95** and **£1.20 p&p** (CCT supplied).

MULTIMETER BARGAINS

Pocket Multimeter, 1,000 opv sensitivity. Ranges 1KV AC/DC Volts, 150ma DC current, resistance 0-2.5K, 0-100K, **£4.50**

20,000 opv., 1,000 volts AC/DC, DC current to 500ma, 5 ranges, resistance 4 ranges to 6 meg. Mirror scale, carrying handle, **£975.**

40kHz Transducers. Rec/Sender **£3.50 pair.**

TELEPHONE PICK UP COIL

Sucker type with lead and 3.5mm plug **62p.**

RELAYS

Plastic Encap. Reed Relay, 0.1 matrix. 1k Ω coil,, 9-12VDC normally open, **35p.** Miniature encapsulated reed relay 0.1 matrix mounting, single pole make, operates on 12VDC **50p** each. Continental series, sealed plastic case relays, 24VDC 3pole change over 5 amp contacts, new **65p.** Min. sealed relay, P.C. mounting, 6-9vdc operation changeover 3 amp contacts, new **85p.** Metal Cased Reed Relay, 50 x 45 x 17mm, has 4 heavy duty make reed inserts, operates on 12VDC **35p** each. Magnets ½" long ⅛" thick with fixing hole, 10 for **40p.**

Dalo 33PC Etch Resist printed circuit maker pen, with spare tip, **79p.**

TERMS:

Cash with order (Official Orders welcomed from colleges etc). 30p postage please unless otherwise shown. VAT inclusive.

S.A.E. for illustrated lists

TMK500 MULTIMETER

TMK500 30,000 ohms per volt. IKV AC/DC., D.C. Current to 12 amps. Resistance to 60 meg in 4 ranges, mirror scale, with built in buzzer for continuity testing **£20.95**

YN360TR MULTIMETER

YN360 M/Meter. 20,000 ohms per volt. IKV AC/DC volts. 250ma dc current, 4 resistance ranges to 20meg, also has built in transistor tester with leakage and gain ranges. **£12.50**

CRIMPING TOOL

Combination type for crimping red blue and yellow terminations also incorporates a wire stripper (6 gauges) and wire cutter. with insulated handles only **£2.30.**

POWER SUPPLIES

SWITCHED TYPE, plugs into 13 amp socket, has 3-4.5-6-7.5 and 9 volt DC out at either 100 or 40 0mA, switchable **£3.45.** HC244R STABLISED SUPPLY. 3-6-7.5-9 volts DC out at 400mA max., with on/off switch, polarity reversing switch and voltage selector switch, fully regulated to supply exact voltage from no load to max. current **£4.95.**

AMPHENOL CONNECTORS

(PL259) PLUGS **47p.** Chassis sockets **42p.** Elbows PL259/SO239 **90p.** Double in line male connector (2XPL259) **65p.** Plug reducers **13p.** PL259 Dummy load, 52 ohms 1 watt with indicator bulb **95p.**

BUZZERS

MINIATURE SOLID STATE BUZZERS, 33 x 17 x 15mm white plastic case, output at three feet 70db (approx), low consumption only 15mA, voltage operating 4-15VDC, **75p** each. LOUD 12VDC BUZZER, Cream plastic case, 50mm diam. x 30mm high **63p.** Carters 12 volt Minimite Alarm sirens **£7.65p.** 12VDC siren, all metal rotary type, high pitched wail, **£6.25.**

TOOLS

SOLDER SUCKER, plunger type, high suction, teflon nozzle, **£4.99** (spare nozzles **69p** each).
All Antex irons still at pre increase prices, order now as new stock will be going up next month.
Antex Model C 15 watt soldering irons, 240VAC **£3.95**
Antex Model CX 17 watt soldering irons, 240VAC **£3.95**
Antex Model X25 25 watt soldering irons, 240VAC **£3.95**
ANTEX ST3 iron stands, suits all above models **£1.65**
Antex heat shunts **12p** each.
Servisol Solder Mop **50p** each.
Neon Tester Screwdrivers 8" long **59p** each.
Miyarna IC test clips 16 pin **£1.95**

SWITCHES

Sub. miniature toggles: SPST (8 x 5 x 7mm) **42p.** DPDT (8 x 7 x 7mm) **55p.** DPDT centre off 12 x 11 x 9mm **77p.** PUSH SWITCHES, 16mm x 6mm, red top, push to make **14p** each, push to break version (black top) **16p** each.

Electrolytic Caps, can type, 2,200mfd and 2,200mfd 50VDC **35p** each.

RES. SUB BOX

Resistance Substitution Box. Swivelling disc provides close tolerance resistors of 36 values from 5 ohms to 1 meg. **£3.95.**

Signal Generator. Ranges 250Hz-100MHz in 6 Bands, 100MHz-300MHz (harmonics) internal modulator at 100Hz. R.F., output Max. 0.1vRMS. All transistorised unit with calibrating device. 220-240VAC operation, **£48.95.**

TAPE HEADS

Mono cassette **£1.75.** Stereo cassette **£3.90.** Standard 8 track stereo **£1.95** BSR MN1330 ½ track **50p.** BSR SRP90 ¼ track **£1.95.** TD10 tape head assembly — 2 heads both ½ track R/P with built in erase, mounted on bracket **£1.20**

PROGRESSIVE RADIO

31 CHEAPSIDE, LIVERPOOL 2.

ALL ORDERS DESPATCHED BY RETURN POST

NEWS . . . AND

At the very least, an incorrectly wired socket can damage valuable electrical equipment; at its worst it can be physically dangerous.

Martindale, the Neasden-based company that specialises in industrial safety equipment and electrical test instruments, has now introduced its simple Ring Main Tester for use by householders etc.

No larger than a conventional plug, the Tester is simply fitted into a standard 13 amp socket to give instant visual identification of the polarity of the wiring. Correct wiring, faulty earth connections, faulty neutral and reversed live/neutral connections are immediately shown by combinations of the carefully selected neons on the face of the Tester adjacent to explanatory diagrams. A fault in the live connection or supply is indicated when no neons are lit.

The Martindale Ring Main Tester, constructed from flame retardant plastic is virtually indestructible and, weighing less than 4 ounces, can be carried in the pocket or toolbox or can be permanently plugged into an extension lead.

Available from local electrical retail outlets at a recommended retail price of £4.70 plus VAT. Any difficulty in obtaining supplies should be reported to Martindale Electric Company Ltd., Neasden Lane, London. NW10 1RN,

The Martindale Ring Main Tester that is simply fitted into a standard 13 amp socket to give instant visual identification of the polarity of the wiring

AMATEUR RADIO IN HOSPITAL

Providing permission is obtained in advance, there is usually no objection to the use of amateur radio transmitting equipment by licenced operators during a spell in hospital. However, there are certain rules that must be observed aside from obtaining permission in the first place. Small 2 metre equipment is the obvious choice except in cases where the stay in hospital may be for a very considerable time e.g., in a hospital or home for the handicapped.

Permission for use of radio or indeed any electrical equipment should be obtained as much in advance as possible from the Unit Administrator and/or District Works Officer c/o the hospital concerned.

This is important in hospitals where sensitive electronic equipment is in use for example, operating theatre life support systems and in intensive care units etc. It is vital that radiation, however low, cannot cause interference. Tests with respect to this are absolutely essential and hospital staff will normally be willing to co-operate. It is also essential that any equipment connected directly to a mains socket (usually available at bedsides) meets electrical standard safety regulations. This aspect can be checked by an appropriate member of the hospital staff. Providing such equipment takes negligible power from the mains e.g., a small charger unit for a portable battery operated 2 metre hand-held or low power mains operated TX/RX there may be no charge for electricity consumed. Check on this.

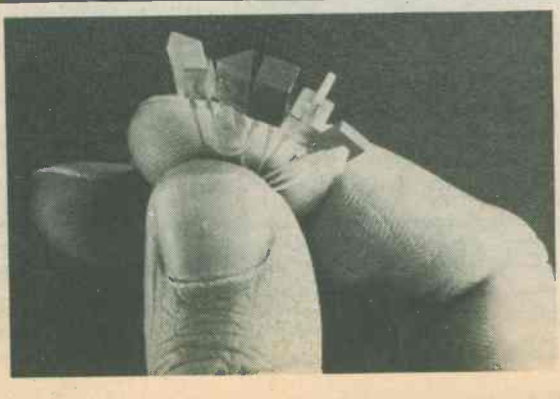
The following conditions concerned with actual operation are recommended:–

Use lowest transmitting power possible. Your hospital may not be too far from a repeater station.

Have regard for other patients by using an earphone for listening (or mic/earphone) and keep voice level to a minimum when talking.

Close down immediately if asked to do so.

The writer is indebted to Senior Staff Members of the Norfolk and Norwich Hospital, Norwich for guidance on the above, and we, in turn are indebted to F. C. Judd, the well known radio amateur and technical author, for this information.



SHAPED L.E.D. LAMPS

In addition to conventional tubular L.E.D. lamps, Sharp Corporation offer a range of special shapes.

Designed for flush fitting in front panels, the shapes presently offered include round 'point' indicators, equilateral and isosceles triangles, square and flat sections in three different sizes (basically 3, 4 and 5 mm) and colours (red, yellow and green).

Prices are very attractive, for 1,000 pieces these are in the region of 5p. to 10p. each, depending on size, shape and colour.

For further details contact: C. R. P. Electronics Ltd., 13 Hazelbury Crescent, Luton LU1 1DF.

. . . COMMENT

TELETEXT GOING "GREAT GUNS"

BBC CEEFAX Editor, Colin McIntyre, told a Radio Industries' Club luncheon in London recently that teletext was going great guns in Britain, but that British manufacturers still needed to 'look lively' or their two-year lead would be overtaken overseas.

"Britain has made all the running throughout the 1970's, and is streets ahead of the rest of the world in establishing a public service of teletext. But those elsewhere who have sat on the sidelines during the pioneering days were now beginning to make all sorts of claims and were muddying the issues. It is up to British manufacturers to get out and sell the necessary transmission and receiving equipment outside the United Kingdom – to ensure that trade followed the efforts of the broadcasting missionaries."

Colin McIntyre reported some 80,000 to 90,000 teletext in Britain, which were now selling or renting at about 5,000 to 6,000 a month. With a little boom at Christmas this could mean 150,000 by the end of 1980, and a quarter-of-a-million by the end of 1981.

CEEFAX and the ITV's service Oracle were now fully established in Britain, but it was very encouraging to see U.K. standards succeeding abroad. Austria and Australia were probably the furthest ahead, which gave a nice alphabetical fillip to other teletext activity in Belgium, Denmark, Germany, Holland and Sweden.

"The most exciting and exhilarating thing about teletext (Colin McIntyre said) is that it is on the move on an almost daily basis."

TANDY MOVES INTO SCOTLAND

Tandy, the international retail and manufacturing electronics group, have opened their first store in Scotland. The store, at 28 Jamaica Street, Glasgow, is the first of a number due to be opened in Scotland.

Tandy Corporation (Branch UK), an off-shoot of the Tandy Corporation in Fort Worth, Texas, USA, with 7,600 stores worldwide, was set up in 1973 and already has a network of nearly 200 retail outlets in England and Wales. In addition to a huge range of over 2,000 electronic products, Tandy manufacture and sell the world's leading microcomputer, the TRS-80.

The opening of the Glasgow shop will be followed in September by the opening of a store in Edinburgh. It is planned that a total of 12 stores will be opened throughout Scotland in the near future.

We regret that with this issue our cover price has had to be increased by 5p to 60p. The reason is, of course, the continuing rising costs due to inflation. Annual subscriptions have also had to be increased to £9.50 for UK subscribers and to £10.50 for readers in Eire and overseas.

A glance at our contents list will confirm that we continue to give excellent value for money and we have many first class articles in the pipe line.

We are continuing to publish at shorter than monthly intervals, following the hiatus caused by our previous printers ceasing to trade. Therefore readers should keep a sharp lookout at newsagents to make sure they do not miss an issue.

POWER SCREWDRIVER

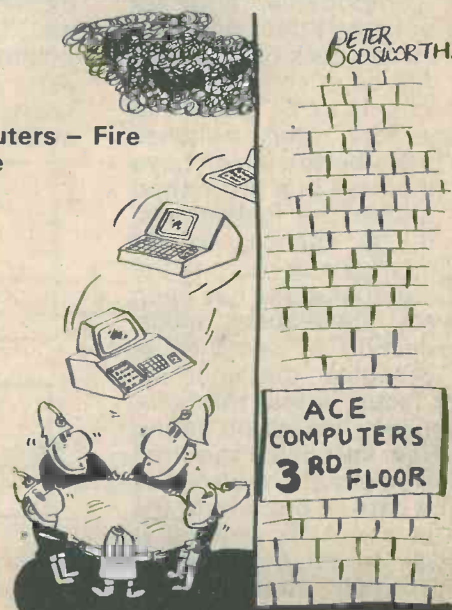
A powerful new screwdriver, the DMS2, has been introduced by Klippon.

This hand tool offers the very latest in design, enabling it to be used easily in confined and awkward spaces. Its high technical specification offers a preset automatic torque limitation; variable speed from 350 to 700 RPM; automatic switch-on possible only when pressure is applied to the screwdriver bit; increased speed through increasing pressure on the bit; ON-OFF switch for isolation; forward and reverse switch and a chuck for standard 5.5mm hexagonal socket to DIN3126 suitable for use with other tool inserts.

The DMS2 is a light weight tool, quiet in operation, with full electronic control. It will continue to maintain its high accuracy even in repetitive production work and meets Safety Classification 11 to DIN 57740, VDE 0740 and CEE. Operating voltage is 220/240V a.c. 50Hz. Power consumption is 45W and current consumption is just 0.20A. A 110V version will be available in due course.

For further details contact: Klippon, Power Station Road, Sheerness, Kent, ME12 3AB.

Computers – Fire Escape



SUGGESTED CIRCUIT

CAPACITANCE COMBINATION LOCK

By G. A. French

In these times, when one's thoughts tend to concentrate more and more on the question of security, a wide field of application is open for the design of electronic intruder alarms, proximity detectors and similar equipment. One particularly challenging sector is concerned with the construction of combination lock switches which, when operated in the correct sequence, cause a solenoid to unlock a door or the lid of a box. Such combination locks can employ press-buttons, rotary switches and a number of relatively inexpensive electronic components, and are much less costly than would be a mechanical lock offering the same degree of complexity.

The circuit to be described employs four rotary switches and a press-button which have to be operated in a prescribed order before the lock opens. Even if, by chance, correct selection of one or more of the switching operations has been achieved, subsequent incorrect selection of switches at once disables the lock. A further factor is that the combination lock has inbuilt timing protection. Part of the required succession of switch selections must be carried out within the space of about six seconds if the lock is to be opened. Finally, even after all the switches have been taken through the right sequence, there is still a further time delay before the lock opens.

How, the question may be asked, can anybody not knowing the combination open the lock? The answer is: with great difficulty!

BASIC CIRCUIT

As an introduction to the functioning of the lock, a simplified version of the basic circuit is given in Fig.1. Here, S1 and S2 are two "ways" of a 12-way rotary switch, whilst S3 is a single "way" of a third such switch. The latch after S3 can be triggered from the "lock closed" to the "lock open" state by momentarily passing a positive voltage to its input. After switch-on of power, the latch is in the "lock closed" state.

To trigger the latch, the press-button in Fig. 1 is pushed whilst S1 is in the upper position. This causes capacitor C1 to charge to the supply potential of 9 volts. S1 is then moved to its lower position, whereupon C2 is connected in parallel with C1 via S2 in its upper position. The charge in C1 is shared between the two capacitors. If S2 is now moved to its lower position the positive voltage on the upper terminal of C2 is applied, through S3, to the input terminal of the latch, which is then triggered to the "lock open" state.

Before proceeding further, it is necessary to consider the values required in C1 and C2. When a single capacitor with no connections made to its terminals is charged, the relationship between the

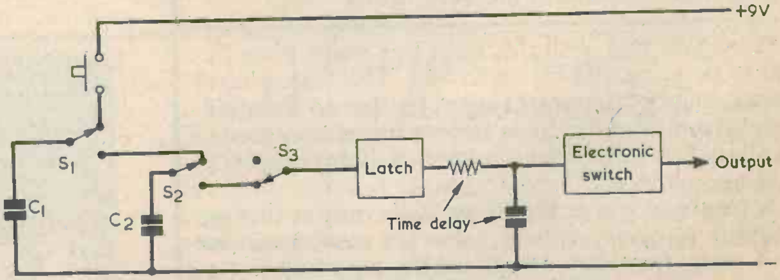


Fig.1. Simplified circuit illustrating the sequential operation required in S1 and S2, and the time delay components between the latch and electronic switching sections of the combination lock.

charge, the capacitance and the voltage across the capacitor is governed by the equation Q = CV, where Q is the charge in coulombs (or quantity of electricity) C is the capacitance in farads and V is the voltage across the capacitor. If an uncharged capacitor is connected across the charged capacitor the charge becomes shared between the two capacitors. Since the number of coulombs is not altered, and since the two capacitors in parallel are the equivalent of a single capacitor having a value equal to the sum of the two capacitances, voltage V drops accordingly. In Fig. 1 C1 is initially charged to 9 volts. If C2 had the same value as C1 connecting C2 across C1 by means of S1 and S2 would result in the voltage across the two changing to half of 9 volts, or 4.5 volts. In the present application we need a voltage which is higher than 4.5 volts to trigger the latch, and we achieve this by giving C2 a much lower value than that of C1. C1, in the full circuit, has a value of 1,000μF whilst C2 has a value of 22μF only. After C1 has been charged to 9 volts and C2 is then connected in parallel with it, the total capacitance becomes 1,022μF. The voltage across the two capacitors then becomes 9 multiplied by 1,000 and divided by 1,022, which calculates as 8.8 volts. Setting S2 to its lower position causes the 8.8 volts to be applied to the latch via S3.

To introduce a time factor, fixed resistors are connected across C1 and C2 in the practical circuit. The latch needs a positive input voltage in the order of 6 to 7 volts to be triggered. The result is that, after the press-button has been pushed to charge C1, S1 and S2 have to be operated quickly if a sufficiently high trigger voltage is to be applied through S3 to the latch.

When a person is attempting to open an electronic combination lock by random manipulation of the switches there is an extremely unlikely possibility that he may stumble on the correct combination, whereupon he could be at once rewarded by the sound of, say, a click from a relay or solenoid. Such is not the case with the present circuit. Even after the latch has been successfully triggered, there is a time delay before the electronic switch which follows it is, in turn, triggered and the lock opens. During that time delay operation of the combination lock switches could well return the latch to its previous "lock closed" condition.

FULL CIRCUIT

The complete circuit of the combination lock appears in Fig.2. The two "ways" of S1 in Fig.1 are now given at positions 1 and 2 of the 12-way rotary switch shown, and the two "ways" of S2 are given at positions 10 and 9 respectively of the complete 12-way switch. When S3 is in position 8 it cou-

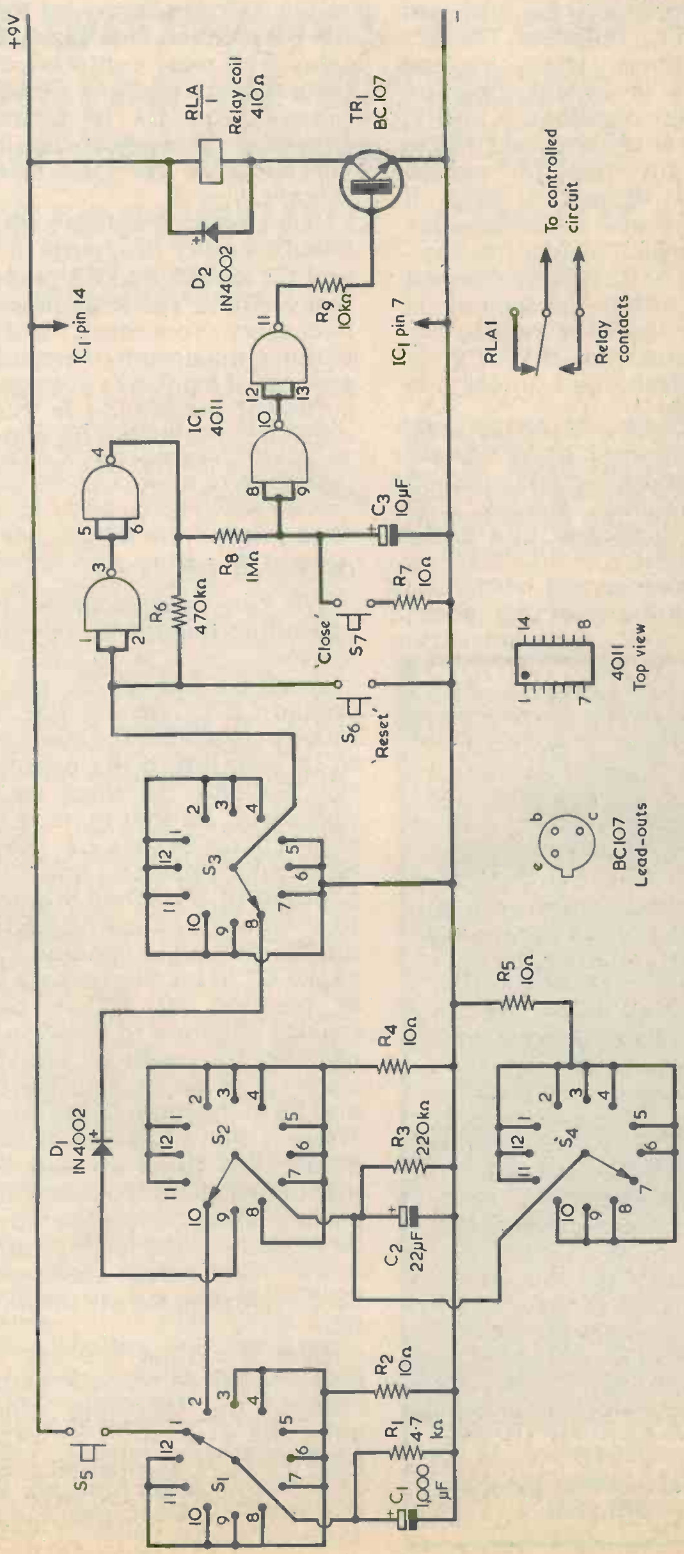


Fig.2. Full circuit of the combination lock. If any of the rotary switches is at an incorrect setting one of the two sequence capacitors is short-circuited or the latch input is taken to the negative rail.

ples the input of the latch to position 9 of S2. Note that diode D1 is now interposed between S2 and S3. This diode enables a positive voltage from C2 to trigger the latch and prevents the latch from reverting to its previous state when C2 discharges. All switch contacts which do not contribute to the lock opening process are returned to the negative rail, either directly, or by 10Ω current limiting resistors. Thus C1 is effectively short-circuited when S1 is at any position other than positions 1 and 2, and C2 is short-circuited if S2 is set to any position except positions 10 and 9. Even if either of these capacitors has been charged, an incorrect setting of S1 or S2 will discharge it again. Further protection is given by the new switch, S4, which ensures that C2 is always discharged unless it is in position 7.

The latch of Fig.1 is given by the two NAND gates of IC1 which are associated with pins 1 to 6. After the Reset button has been pressed, or S3 set to an incorrect position, this latches with a low input at pins 1 and 2, and a low output at pin 4. When it latches to its alternate "lock open" state, pin 4 goes high and C3 charges slowly via R8. The electronic switch in Fig.1 consists of the remaining two NAND gates of IC1. When C3 has charged sufficiently, after a time delay of around 12 seconds, the output at pin 11 goes high and turns on TR1 which energises the relay. The relay contacts complete the lock opening circuit. If press-button S7 is pushed, capacitor C3 is short-circuited via R7 and the lock closes quickly.

The fixed resistors which ensure a quick discharge in C1 and C2 are R1 and R3 respectively. These resistors make it necessary to operate S1 and S2 within a maximum of around 6 seconds if a positive voltage of sufficient magnitude is to be applied to the latch. This allows 3 seconds for the operation of each switch.

OPENING THE LOCK

We can now examine the procedure needed for opening the lock.

First, S3 has to be set to position 8 to ensure that the input to the latch is connected to D1 and not to the negative rail. Second, S4 must be in position 7, so that there is no short-circuit across C2. Next, S1 is put to position 1 and S2 to position 10. S5 is then pressed, to charge C1, after which S1 is quickly moved to position 2 to cause C2 to be charged via S2 at position 10. S2 is next quickly changed to position 9, causing the positive voltage from C2 to be applied via D1 and S3 to the input of the latch. There is then a 12 second delay before TR1 turns on and the lock opens. If, during that delay period, either S3 is adjusted or S6 is pushed, the latch returns to the "lock closed" state, with C3 discharging slowly through R8.

Thus the total process of breaking the combination consists of the following sequence: S3 at postion 8, S4 at position 7, S1 at position 1, S2 at position 10, S5 pressed, S1 to position 2, S2 to position 9, 12 second wait.

CONSTRUCTION

The method of assembly is left to the constructor but there will obviously need to be a front panel of some kind, on which are mounted the four rotary switches and the three press-buttons. The rotary switches can of course be wired so that contact positions other than those shown in Fig. 2 need to be selected, although with S1 and S2 the two positions should be adjacent to each other. All the switches can be positioned on the panel with any layout preferred.

The switches may all be miniature 12-way rotary and they will need to be fitted with pointer knobs, and have numbers from "1" to "12" marked out on the panel behind them. The relay employed with the prototype circuit was an "Open Relay" with a 410Ω coil and changeover contacts which is available from Maplin Electronic Supplies and other mail-order retailers. The three electrolytic capacitors should have working voltages of 10 or more. All the resistors are ¼ watt 5%.

If desired, a simplification can be achieved by omitting S4 and R5, and this will result in having one less number in the combination to remember. The Reset button could also be omitted since its function is carried out by setting S3 to any contact other than 8. However, S6 provides a small extra safeguard insofar that, if the latch has been triggered, it will return to its previous state if S6 is inadvertently pressed.

The current drawn from the 9 volt supply by the circuit in the quiescent state is too small to be indicated by a multimeter switched to a 50μA range. The current rises to some 3mA in the switching NAND gates about 10 seconds after the latch has been triggered and then remains steady at approximately 20mA when the relay energises. ■

APOLOGY

We regret that in our last issue pages numbered 24 and 30 were transposed during the course of production. It appears that readers soon realised what had happened, nevertheless we apologise for the inconvenience caused.

HI-FI P.C.M.

By J. R. Davies

An introduction to pulse code modulation techniques, as currently employed in the transmission and reception of high quality stereophonic sound signals.

We are all familiar with the analogue method of handling audio frequency signals, for the simple reason that this is the only method with which such signals can be dealt with using simple equipment. Sound picked up by a microphone is converted to its electrical analogue and this analogue signal is then passed through the a.f. chain to the reproducing loudspeaker. Links in the chain can consist of a tape recording head, tape and tape replay head; a record cutter, disc and pick-up; a land line; or a radio transmitter and receiver. All these links introduce distortion and noise. With all its varied frequencies, and its amplitudes and phase relationships, the analogue a.f. signal can suffer partial degradation at any stage between the input microphone and the reproducing loudspeaker.

PULSE CODE MODULATION

Considerable interest in the high fidelity world is now centred on pulse code modulation as an alternative process for the handling of audio frequency signals. At an early stage in the signal path between audio input and the output loudspeaker the signal is changed to a pulse code modulation equivalent by an analogue-to-digital converter (a.d.c.), and at a late stage in the signal path it is changed back to its original form by a digital-to-analogue converter (d.a.c.). The p.c.m. signal is purely digital in nature and consists of a series of binary digits (bits) which contain signal information by the presentation of 1 (bit pulse present) or 0 (bit pulse absent). The p.c.m. signal is extremely robust and is capable of being converted back faithfully to the analogue original even when accompanied by noise levels which would make the analogue signal worthless. The p.c.m. signal can pass through suitable tape and disc links in the signal path without degradation. When properly encoded and decoded, the p.c.m. process introduces negligible distortion. It does cause the formation of a low noise level but this can be held at an extremely small level.

On the debit side is the fact that the circuits and links carrying a p.c.m. audio signal must have a bandwidth considerably wider than would be required by the signal in its analogue form. Also, the a.d.c. coding circuits and the d.a.c. decoding circuits are fairly complex. However, the wide bandwidth required by a p.c.m. audio channel presents few serious difficulties. Transmission, reception, recording and replay facilities intended for video signals are readily available and these offer more than adequate bandwidth for p.c.m. audio signals. Similarly, the coding and decoding processes, although not simple, are well within the capabilities of present-day logic components and techniques.

An engineer setting up a test procedure on the BBC p.c.m. system. (Courtesy BBC).

The use of p.c.m. channels for high quality audio signals has been established in the UK for a number of years now, and is employed internally by the BBC for the distribution of high quality stereophonic sound from studio centres to sound transmitters. The p.c.m. signals are passed over conventional 5.5MHz television microwave links, which replace earlier analogue "music lines" provided by the British Post Office. To give an idea of the bandwidth required by a p.c.m. audio signal, each BBC 5. 5MHz microwave link carries 13 audio channels, these consisting of 3 stereo programmes plus seven mono channels. The 13 channels are time multiplexed, i.e. successive signals are "interleaved" in terms of time, but we will not deal with multiplexing in this short article. Instead, and at the expense of some simplification, we shall deal with the basic elements of pulse code modulation when employed with a single mono audio signal. In passing, nevertheless, it is worth observing that if 13 audio channels can be accommodated in a signal path having a bandwidth of 5.5MHz, it becomes quite feasible to pass a 2 channel high fidelity p.c.m. stereo programme through a system having the bandwidth available with current video recording and reproducing equipment.

CODING

To convert an analogue signal to its p.c.m. equivalent, the amplitude of the analogue signal has to be sampled at regular intervals. In Fig. 1(a) we have a short part of an analogue signal, this being sampled at the points indicated. The result of the sampling process is the series of pulses shown in Fig. 1(b), the height of each pulse corresponding to the amplitude of the analogue signal at the time of sampling. The pulses constitute a pulse amplitude modulation (p.a.m.) version of the analogue signal.

In Fig. 2(a) the height of each pulse in the p.a.m. signal is assessed against an arbitrarily derived series of equally spaced amplitude levels calibrated in binary numbers from 0000 to 1111 (15 in decimal). The pulse tips will either coincide with a binary amplitude level or, much more probably, lie between two amplitude levels. Each pulse is then assigned the binary number for the level with which its tip is coincident or, according to the coding system employed, is assigned a binary number corresponding to the level immediately below it or that immediately above it. Assuming that the first of the two coding systems is used, the pulse train can then be represented by the binary numbers shown in the diagram below the pulses. In Fig. 2(b) the binary numbers are presented as a new series of pulses. All the pulses have the same amplitude and they represent the binary levels by having a pulse present for digit 1 and a pulse absent for digit 0.

The signal shown in Fig. 2(b) is the p.c.m. version of the analogue signal of Fig. 1(a).

The process of assessing the height of each p.a.m. pulse in terms of pre-determined discrete levels is known as quantising or quantisation. In Fig. 2(a) there are only 16 quantising levels (taking into account the 0000 level) whereupon the p.c.m. version of the analogue signal has very poor accuracy. It will be obvious that we can increase the accuracy of the p.c.m. signal by providing more quantising levels. An improvement would be given by going up to 32 quantising levels, these consisting of binary 00000 to 11111 (31 in decimal), and a further improvement by using 64 levels, given by 000000 to 111111 (63 in decimal). Note that to obtain maximum advantage of the binary coding each increase in quantising levels is from one power of 2 to the next power of 2. 32 is 2 to the power of 5 and 64 is 2 to the power of 6. 32 levels can be represented by 5 binary digits and 64 levels by 6 binary digits.

When we start dealing with high quality audio signals we need very many quantising levels. As the number of quantising levels increases the levels become more closely spaced and each binary assessment of analogue signal amplitude represents more accurately the actual analogue amplitude at the time of sampling. If, in practice, we use 1,024 (2 to the power of 10) quantising levels we are just below the

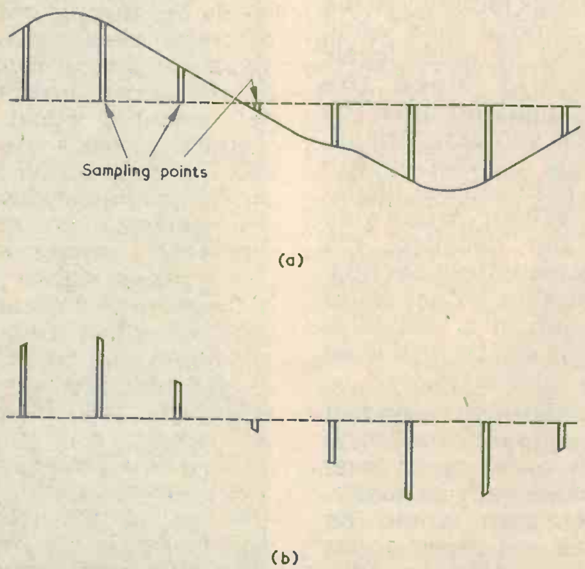


Fig. 1(a). The amplitude of an analogue signal is sampled at regular intervals. (b). Each sampling operation produces a pulse whose amplitude is equal to the amplitude of the analogue signal at the time of sampling. This is a pulse amplitude modulation version of the analogue signal.

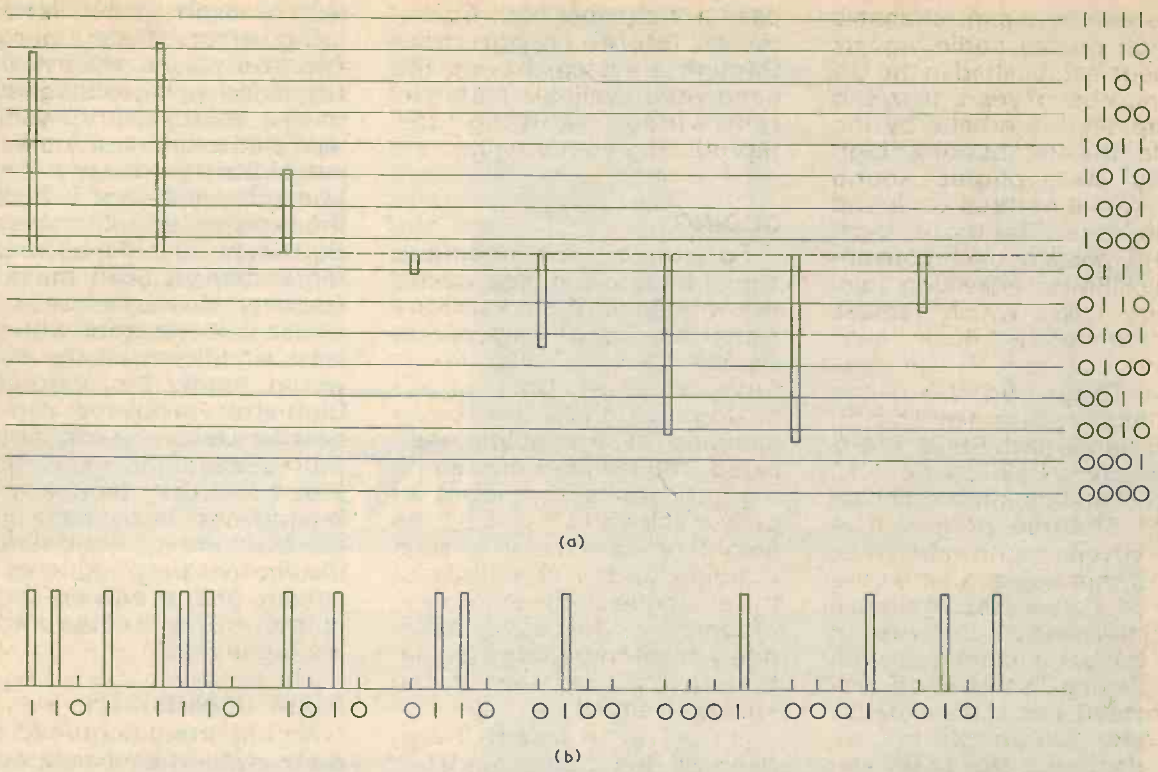


Fig. 2(a). The height of each pulse in the p.a.m. signal of Fig. 1(b) is assigned a binary number corresponding to the quantising level at or near the pulse tip. (b). The quantising numbers constitute the p.c.m. equivalent of the original analogue signal, and are passed along the signal chain in the form of bit streams. The 16 quantising levels employed here give a 4-bit p.c.m. system.

situation at which high quality audio can be handled in p.c.m. form without noticeable distortion. The situation improves with 2,048 quantising levels, and at 4,096 quantising levels the distortion introduced by the p.c.m. processing is virtually negligible. A further improvement, barely perceptible subjectively, is given by going up to the next step of 8,192 (2 to the power of 13) levels. With this number of levels each sample p.a.m. pulse is converted to a pulse bit stream of 13 bits. 13 bit quantising is employed in the BBC p.c.m. system.

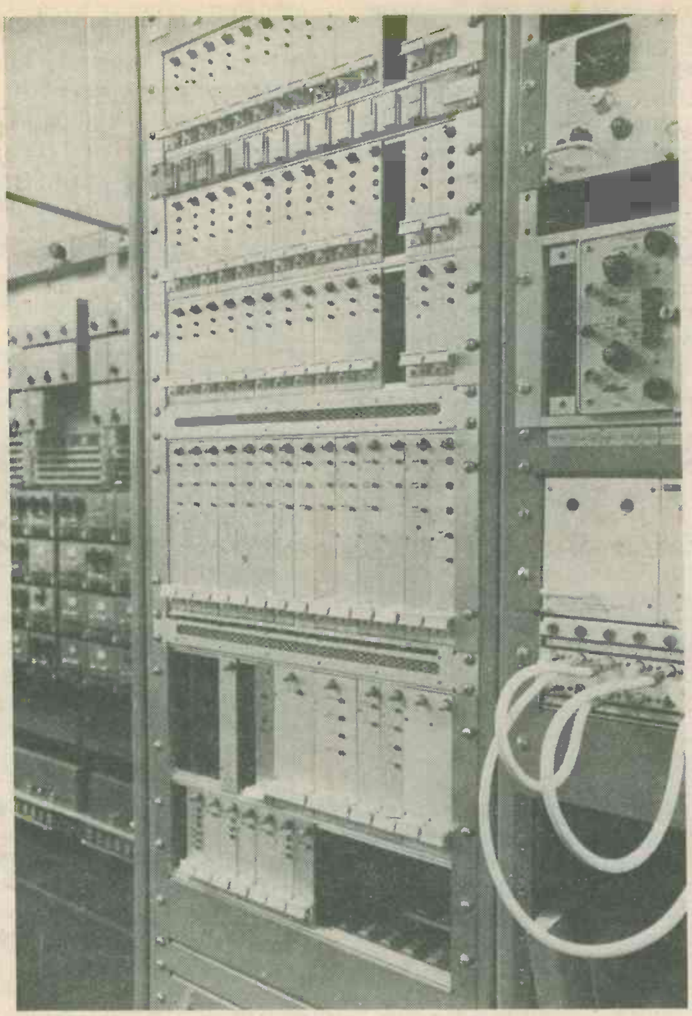
SAMPLING RATE

Intuition tells us that the rate in time at which amplitude samples of the analogue signal are taken must be at some frequency which is higher than the highest frequency in the analogue signal. If, for instance, the sampling rate were only 10kHz, the p.c.m. signal could not possibly represent with any accuracy the successive amplitude states of the higher frequencies in a high quality audio signal. The situation here is governed by a well-known waveform sampling theorem due to Nyquist. The Nyquist sampling theorem states that if any analogue signal, however complex, has its highest frequency limited to FHz, it can be reproduced truly and in its entirety by sampling at a frequency of 2FHz. Sampling must not be carried out at less than 2FHz but it can, of course, be carried out at more than 2FHz. In the BBC p.c.m. system the maximum analogue frequency passed to the a.d.c. is 15kHz, and sampling is carried out at 32kHz. (Another reason for choosing this particular sampling frequency is applicable to BBC requirements. 32kHz is 4 times the sampling frequency used in BPO telephony p.c.m. circuits, and synchronising problems would be eased if, in the future, BPO lines were used by the BBC for carrying high quality p.c.m. audio.)

QUANTISING NOISE

Even with 8,192 quantising levels there must still be tiny discrepancies between the actual heights of most p.a.m. pulses derived from the original analogue signal and the quantising levels assigned to them. Provided that there are enough quantising levels these discrepancies do not make themselves evident as distortion but they appear, instead, in the form of a random background noise. Subjectively, this quantising noise is similar to random "white noise", although the frequencies which appear in it are governed by a different probability function. Quantising noise reduces as the number of quantising levels increases, because the discrepancies are then made smaller. With 1,024 levels the peak signal to r.m.s. quantising noise ratio is 65dB, with 4,096 levels it is 77dB, and with 8,192 quantising levels it is 83dB.

Several precautions have to be undertaken before the



A close-up of one of the bays of equipment in the BBC p.c.m. system. (Courtesy BBC).

analogue signal is presented to the a.d.c. for conversion to p.c.m. First, the analogue signal must be filtered so that its maximum frequency does not exceed half the sampling frequency. Second, its amplitude must be limited so that it does not exceed the highest quantising level. If it did, the result would be clipping distortion similar to the clipping distortion given in overloaded totem pole audio amplifier output stages.

Another problem arises when the analogue signal has an extremely low amplitude, as can occur during a very quiet passage in a broadcast programme. If signal excursion is then too small to bring about a change from one quantising level to the next with successive p.a.m. pulses, there is no sound signal from the decoding circuit. Should this effect take place as part of a waveform which is also at a low level, it will produce a discontinuity and consequent heavy distortion. There is an analogous "granular effect" in telephony with carbon microphones, with which very low audible signal levels may be unable to overcome mechanical inertia in the carbon granules and thereby alter the contact resistance which they offer. The BBC solution is to add a "dither" signal to the analogue signal before coding, this consisting of a signal, at half sampling frequency, which has an amplitude of half a quantising step. To this is added a smaller level of random white noise. By this artifice the analogue signal must always keep shifting from one quantising level to another, even if only between two neighbouring quantising levels, and decoded signal discontinuities at very quiet programme levels are eradicated.

Digit-error effects are possible in a p.c.m. system. Due, say, to fading or static in a microwave link, or to drop-out in a tape transcription, a 1 may be lost at the decoder or a 0 may be represented as a 1. Should the error occur with the most significant bit in the bit stream representing a p.a.m. pulse the result would be a loud click, whilst if it occurred with the least significant bit the effect would hardly be noticeable. Digit-error problems can be eased by adding a parity bit to each signal bit stream. When, at the decoder, the parity bit indicates that there is an incorrect bit in the signal bit stream, the decoder simply ignores the stream and produces, in its output, the result of the preceding bit stream.

P.C.M. BANDWIDTH

An important feature of any p.c.m. system is the bandwidth needed in the channel which carries the p.c.m. signal. In this article we shall look upon bandwidth requirements in a simplified manner.

Taking the p.c.m. signal as so far described, we may visualise it as consisting of 14 bit streams (13 bits plus a parity bit) produced at a sampling frequency of 32kHz. If each 14 bit stream were immediately followed by the next 14 bit stream, there would then be 14 times 32,000, or 448,000 signal information bits per second. This signal can be passed through a channel having a bandwidth of 224kHz. The bandwidth must not be less than 224kHz, and it would be desirable in practice to have it greater than this figure. At first sight it may be surprising to find that the minimum channel bandwidth in Hertz is equal to half the number of bits per second, but this finding is another expression of the Nyquist sampling theorem.

It must be emphasised that the last paragraph represents a simplified state of affairs, because it would be impracticable to work with a p.c.m. signal made up in the manner described. In the BBC 13 channel system, for instance, the channels are time multiplexed and the signal includes not only 13 bit and parity bit streams but also synchronising bits to keep the d.a.c. decoder in step with the a.d.c. coder. Included, too, are auxiliary bits for other purposes. In our simplified approach of the last paragraph we referred to 448,000 signal information bits per second for a channel and if we multiply this by 13 (for 13 channels) we arrive at a megabit per second figure of 5.824. This figure applies only to our simplified version of the signal, and the bit rate of the BBC 13 channel p.c.m. signal, taking into account multiplexing, synchronising and auxiliary bits, is actually 6.336 megabits per second. The sampling theorem states that this could pass through a channel having a minimum bandwidth of 3.168MHz. The 5.5MHz bandwidth of a television signal link is comfortably above the minimum required.

ACKNOWLEDGMENT

The author is grateful to the Engineering Information Department of the British Broadcasting Corporation, who have provided extensive details of the BBC p.c.m. system for the preparation of this article. ■

TRADE NEWS

P.C.M. AUDIO DISC STANDARD

The mutual co-operation between N.V. Philips' Gloeilampenfabrieken of the Netherlands and Sony Corporation of Japan has led to further improvements in the optical Digital Compact Disc system which was announced by Philips in March 1979. These further improvements are in the field of modulation and error correction.

The Digital Compact Disc system permits the recording and reproduction of sound as discontinuous pulse signals and allows wider frequency response with a much greater dynamic range and greatly improved sound quality. Although the disc diameter is only 12cm (4.72in.) the system, with improved modulation and error correction, permits 60 minutes of high-density recording on one side of the disc.

The main characteristics of the system are:

1. It is optical. Due to the non-contact pick-up system a long life for disc and player is ensured.
2. It is a 16 bit system. The distortion and errors which are inherent in the conventional analogue recording system are eliminated by the use of pulse code modulation.
3. It is compact. The compactness of the player offers wide application possibilities in various consumer products, while the handling and storing of discs is much easier when compared with conventional audio records.

The world-wide Polygram group, one of the world's leading record manufacturers, has announced that they will release their music programmes in this format. CBS/Sony (Japan) will also be releasing both CBS and CBS/Sony repertoires on the Digital Compact Disc. CBS Incorporated has announced that it will work closely with Sony and Philips on future developments of the new system. It is anticipated that the Digital Compact Disc will become a future international standard for disc recording and reproduction.

SEMICONDUCTOR REORGANISATION

All the semiconductor activities of GEC-Marconi Electronics Limited are being combined under the aegis of a single company, Marconi Electronic Devices Limited. This will incorporate AEI Semiconductors Limited, GEC Semiconductors Limited and the Microelectronics Division of Marconi Space and Defence Systems Limited.

Marconi Electronic Devices will design, develop and manufacture integrated circuits, hybrid microelectronics, microwave semiconductor devices and assemblies, and power semiconductor devices and assemblies.

The breadth of semiconductor technology available to Marconi Electronic Devices now puts the company in a unique position to tackle wide-ranging solid-state systems requirements from in-house capabilities. These can involve silicon power, r.f. and microwave device and component expertise, thick film custom design microcircuitry and specialised design for large scale integration in MOS technology.

An agreement has been signed with Mitel Corporation of Canada to obtain their advanced ISO-CMOS integrated circuit technology which has been very successfully applied in the telecommunications industry. Further research and development of this process will be undertaken jointly by the GPO and GEC with the object of keeping the U.K. ahead in the area of large scale integration applied to telecommunications.

PERSONAL MEDIUM WAVE RADIO

By R. A. Penfold

•Full medium wave coverage.
•Particularly suited to the beginner.
•Low battery current consumption.

This very simple medium wave receiver has been specifically designed for ease of construction and is therefore ideal as a beginner's project. The circuit is of the t.r.f. (tuned radio frequency) type and the completed set requires no alignment. Only one adjustment has to be made to the finished receiver, this merely consisting of setting up a pre-set potentiometer for optimum sensitivity. In some instances, it may be necessary also to adjust the position of the ferrite aerial coil.

The receiver's internal ferrite rod aerial provides good reception of the three national BBC medium wave networks, plus local medium wave stations where these are in operation. A few Continental stations, including Radio Luxembourg, should be received in most parts of the U.K. after dark and at reasonable volume. The output is suitable for a crystal earpiece, high impedance magnetic headphones or a high impedance magnetic earphone. These last two should have impedances of 1kΩ or more. The set cannot be used with a low impedance earphone or headphones. Power is obtained from a PP3 9 volt battery. This will have an extended life as the current consumption is only about 1.5mA.

THE CIRCUIT

As can be seen from the circuit diagram of Fig.1, the receiver requires few components. There are only two transistors. TR1 is a junction gate field effect transistor (Jfet) which functions as a regenerative detector, whilst TR2 is a high gain silicon transistor acting as an audio amplifier.

L1 is the tuned winding of the ferrite rod aerial, and this is tuned over the entire medium wave band by the variable capacitor, VC1. The tuned circuit can be coupled directly to the gate of TR1, which has a very high input impedance. So far as bias is concerned, the gate is held by L1 at the same potential as the negative rail, and the source is taken positive of the gate by the voltage dropped across R3. C2 functions as a bypass capacitor at radio frequencies.

TR1 detects the signal tuned in by L1 and VC1 due to non-linearity in its characteristic, and the detected a.f. signal appears at its source. This is passed via C3 to the base of TR2. An amplified r.f. signal is present at the drain of TR1, and this is fed back via R1, C1 and coupling winding L2 to the tuned winding, L1. There is a reversal of phase

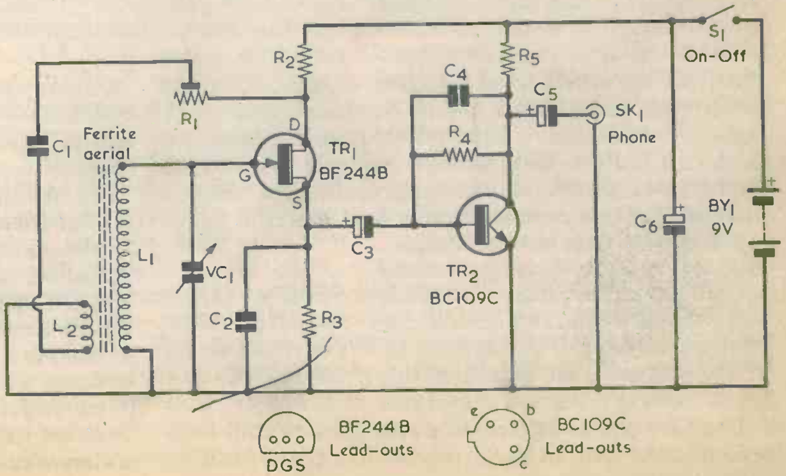


Fig.1. The circuit of the medium wave personal receiver. This is very simple and requires few components.

To ensure that the ferrite rod aerial is not screened the receiver is housed in a plastic case.

between the gate and drain of TR1, and a further reversal of phase in the coupling between L2 and L1. As a result, the r.f. feedback is positive. R1 is adjusted so that the feedback is slightly below the level at which oscillation occurs, and the feedback gives a considerable boost to both sensitivity and selectivity.

TR2 is a standard high gain common emitter amplifier, and the amplified signal at its collector is passed by way of d.c. blocking capacitor C5 to the output jack socket, SK1. C4 provides negative feedback at radio frequencies and assists in maintaining stability. S1 is the on-off switch and C6 is the supply bypass capacitor.

COMPONENTS

The prototype receiver is housed in a plastic box with approximate dimensions of 155 by 90 by 50mm. This is a Teko case type TEK P3P, and is available from West Hyde Developments Ltd., Unit 9, Park Street Industrial Estate, Aylesbury, Bucks, HP20 1ET. Any other all-plastic case of about the same dimensions which can take the components, including the 5in. ferrite aerial rod, could be used instead. A metal case cannot be employed as this would screen the ferrite aerial.

The transistor specified for TR1 is available from several suppliers including Greenweld, 443 Millbrook Road, Southampton, SO1 0HX. If difficulty is experienced in obtaining the ferrite rod aerial, it may be purchased direct from the manufacturer at Denco (Clacton) Ltd., 357/9 Old Road, Clacton-on-Sea, Essex, CO15 3RH. The 300pF Dilecon variable capacitor listed for VC1 can be obtained from Maplin Electronic Supplies. In the prototype, on-off switch S1 was one pole of a 4-pole 2-way rotary switch with no connections made to the unused poles. Any other type of switch, such as a toggle or slide component, could be used instead.

The ferrite rod has to be secured to the Veroboard panel by two non-metallic clamps. The author used two nylon cable clamps, described as "Cable 'P' Clips", which are available from Maplin Electronic Supplies. The clamps should be the size which is suitable for cables of diameter 9.5 to 12mm. The two 1μF electrolytic capacitors in the Components List are specified as 10 volts working. In practice it will be found difficult to

COMPONENTS

Resistors
(All fixed values $\frac{1}{4}$ watt 5% unless otherwise stated)
R1 10kΩ pre-set potentiometer, 0.1 watt horizontal
R2 560Ω
R3 2.7kΩ
R4 1.8MΩ 10%
R5 4.7kΩ

Capacitors
C1 100pF ceramic plate
C2 0.047μF polyester type C280
C3 1μF electrolytic, 10V. Wkg. (see text)
C4 47pF ceramic plate
C5 1μF electrolytic, 10V. Wkg.
C6 100μF electrolytic, 10V. Wkg.
VC1 300pF variable, Dilecon (Jackson)

Inductor
L1, L2 medium wave ferrite aerial type MW.5FR (Denco)

Transistors
TR1 BF244B
TR2 BC109C

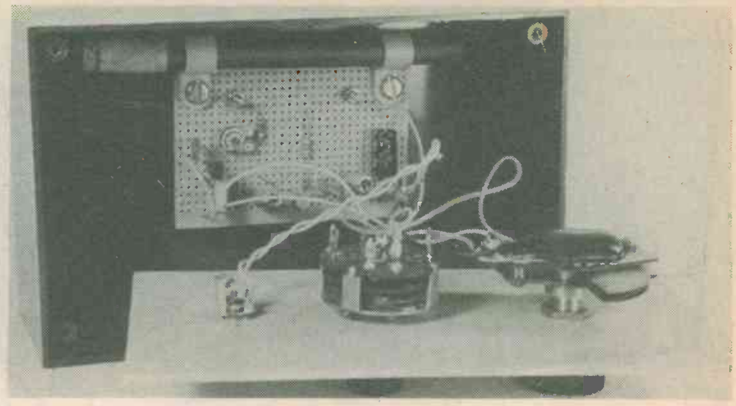
Socket
SK1 3.5mm. jack socket

Switch
S1 s.p.s.t., rotary (see text)

Battery
BY1 9-volt battery type PP3

Miscellaneous
Plastic case (see text)
Veroboard, 0.1 in. matrix
2 control knobs
Battery connector
2 cable clips (see text)
Crystal or high impedance magnetic earphone with 3.5mm. jack plug (see text)
Wire, solder, etc.

Most of the parts are assembled on a Vero board panel. This connects to the front panel components by way of short flexible leads.



obtain these capacitors with a working voltage as low as this, and it will be quite in order to use 1μF capacitors with a much higher working voltage, such as 63 volts. The 100μF capacitor may also have a higher working voltage, such as 16, if this is found more convenient to obtain. The fixed resistors are listed as ¼ watt. If desired, ⅓ watt resistors may alternatively be employed.

CONSTRUCTION

As can be seen from the photographs, the output jack socket, the on-off switch and the tuning capacitor are all mounted on the front panel of the case. SK1 is to the left, VC1 to the right and S1 is between these two components. Apart from the battery, all the remaining components are fitted to a Veroboard panel of 0.1in. matrix having 18 copper strips by 30 holes. The layout is shown in Fig.2. The panel is not a standard size and has to be cut from a larger Veroboard by means of a small hacksaw. If necessary, the cut edges of the panel are then cleaned up to give a neat appearance with the aid of a file. The two 3.3mm. mounting holes are next drilled, these being clearance size for M3 (or 6BA) screws. After this, the two 4.5mm. holes (clearance for M4 screws) are drilled to take the ferrite aerial mounting clamp sec-

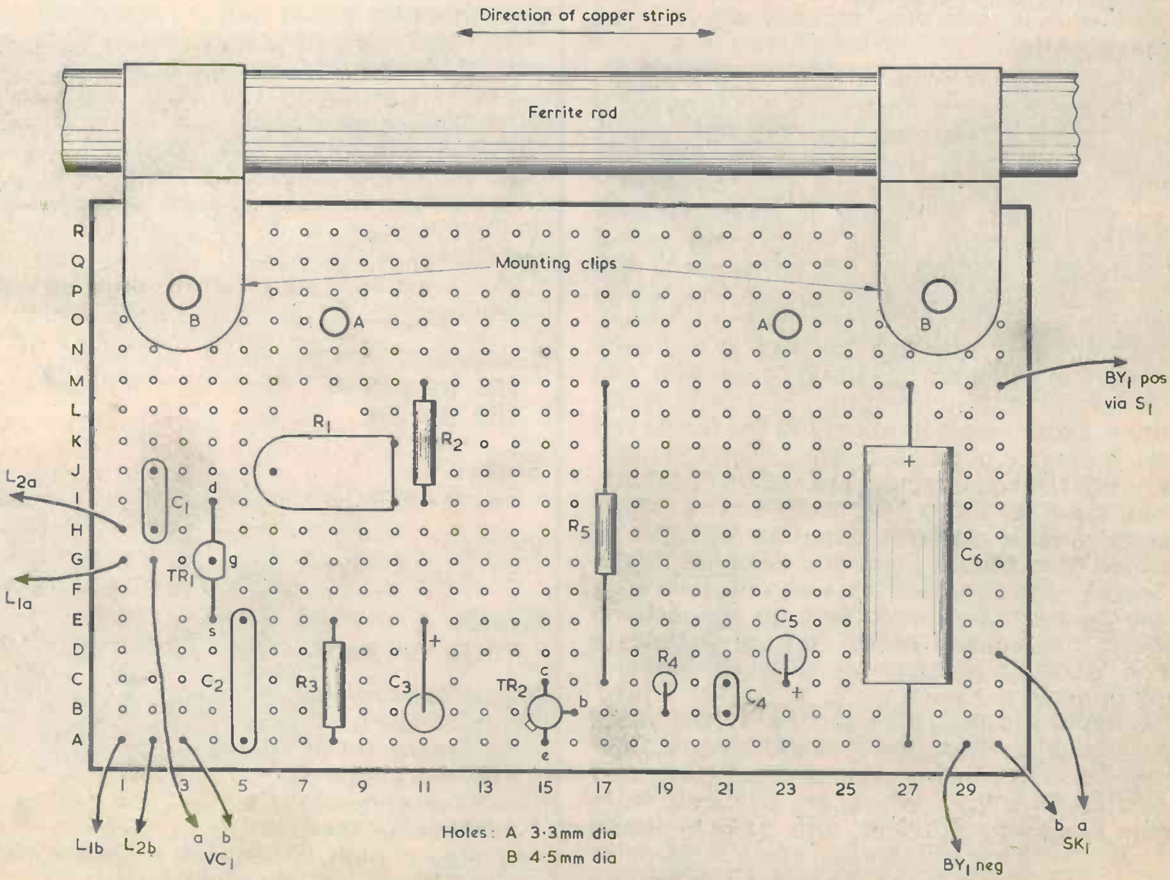


Fig.2. How the components are assembled on the Veroboard panel. There are no breaks in the copper strips.

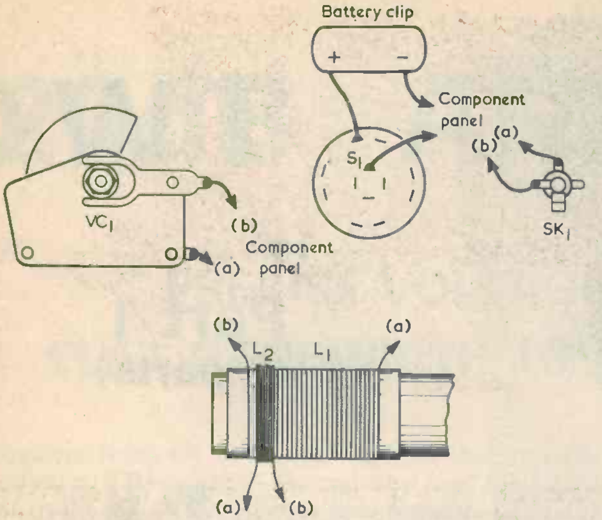


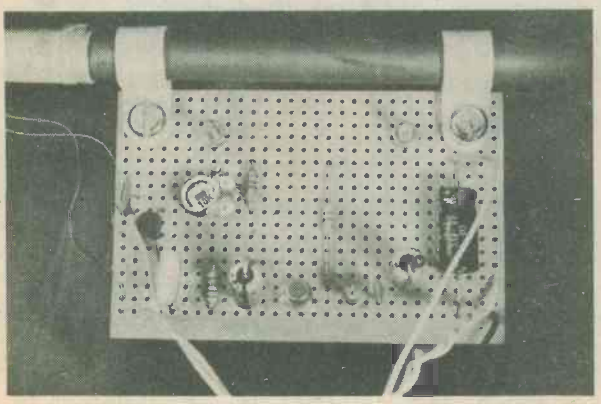
Fig.3. The connections to VC1, S1, SK1 and the ferrite aerial windings.

uring bolts. No further board preparation is required, as there are no breaks in the copper strips.

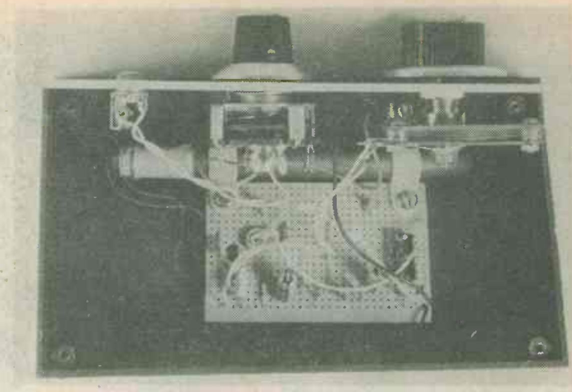
The ferrite aerial is next mounted to the Veroboard, using two short M4 bolts with nuts. The end of the aerial coil former should be roughly flush with the end of the ferrite rod, and the coil should be to the left of the Veroboard, as seen in the view of Fig.2. The coupling winding, L2, should be nearer the end of the rod. Mount the ferrite aerial such that the coil can be moved slightly further onto the rod, should this prove necessary later.

Next, wire up the components, as in Fig.2. Flexible wires pass from the board to S1, VC1 and SK1, and these should be kept reasonably short. The connections at S1, VC1 and SK1 are illustrated in Fig.3, as also are the ferrite aerial connections. It is not difficult to identify the ferrite aerial lead-out wires due to the fact that the two windings can be clearly seen and are wound with wire of different colours. The ends of the lead-out wires are tinned with solder by the manufacturer. Do *not* trim these wires as the coils are wound with multi-strand Litz wire, which can be very difficult to solder.

The finished component panel is fixed to the



A closer look at the Veroboard assembly. The ferrite rod is secured to this with two plastic clamps.



Another view of the receiver with the front panel removed.

back of the case using M3 or 6BA screws and nuts. Spacing washers are needed between the panel underside and the inside surface of the case to prevent strain on the panel when the nuts and bolts are tightened up. The ferrite aerial should be towards the top of the case as, otherwise, the performance of the set might be seriously degraded if it is placed on a metal surface. The positions of the two holes required in the back of the case can be marked out with the aid of the component panel.

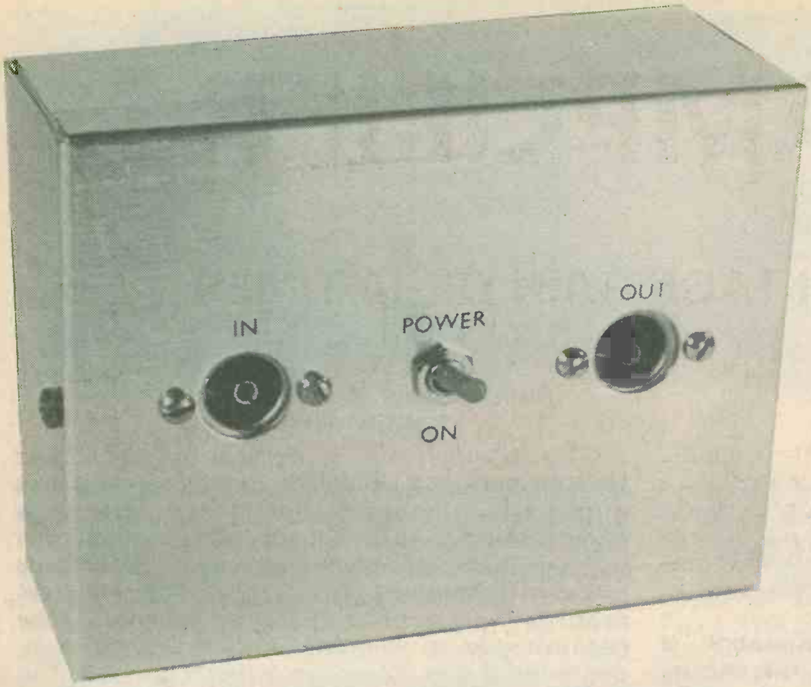
There is plenty of space for the battery, and some plastic foam material can be used to keep it in place when the front panel of the case is fitted. Alternatively, a simple home-made clamp can be made up to secure it.

ADJUSTMENT

After completion of the receiver, R1 should be adjusted to insert maximum resistance into circuit. This is fully clockwise as illustrated in Fig.2. It should then be possible to tune in a few stations, although probably at fairly low volume only. Sensitivity will increase if the slider of R1 is slowly advanced to insert less resistance. A setting will be reached at which the receiver goes into oscillation, causing whistles of varying pitch to be heard as stations are tuned through on part or nearly all of the band. Optimum sensitivity and selectivity are given with R1 backed off just enough to prevent oscillation occurring at any setting of VC1.

It should be found that the set tunes over the full medium wave band. If there is an obvious lack of coverage at the low frequency end of the band (the end where VC1 vanes are fully enmeshed) the situation can be corrected by moving the aerial coil further onto the rod. Any obvious lack of coverage at the other end of the band can be corrected by moving the aerial closer to the end of the ferrite rod. The position of the aerial coil on the rod is not especially critical as VC1 gives a tuning range which is slightly greater than is needed to cover the medium wave band. It will be necessary to re-adjust R1 if the aerial coil is moved along the ferrite rod to alter the coverage.

In practice, it may be found that tuning is so sharp that accurate adjustment becomes difficult. Should this occur, R1 may be backed off a little further from the setting which is just short of the oscillation point. Tuning will be easier if VC1 is fitted with a large control knob. ■



The a.c. coupled 20dB amplifier is fitted in an aluminium box which provides complete screen.

TWO

Part 1
(2 parts)

By
M. V. Hastings

This 2-part article describes two amplifiers, each of which has a voltage gain of 20 dB, or 10 times. The first of the amplifiers employs a simple a.c. coupled circuit incorporating two transistors. The second amplifier, to be described next month, has a more complex circuit, uses a CMOS operational amplifier and is d.c. coupled throughout.

WIDEBAND CIRCUIT

The amplifier which is dealt with in this month's issue has a wideband circuit offering a frequency response which is flat up to at least 20MHz. This figure is actually the maximum at which the author's test equipment permits accurate gain measurements to be made, and the response almost certainly extends well beyond 20MHz. At the other end of the frequency spectrum the response has a –6 dB point at approximately 17Hz. The input impedance is of the order of 8kΩ although, as with any normal amplifier, this reduces somewhat at high frequencies due to a certain amount of input capacitance. The output impedance is a little under 100Ω and, again as normal, this alters slightly at high frequencies.

The main use for an amplifier of this type is as a pre-amplifier for an oscilloscope when measuring or displaying low level high frequency or wide bandwidth signals. As the upper frequency response of the amplifier extends well beyond that of most workshop oscilloscopes, adding the amplifier does not have a detrimental effect on the frequency response of the equipment. Since it provides a voltage gain of 10 times, any oscilloscope calibration is still functional and readings merely have to be multiplied by 10 to arrive at the correct figure.

The amplifier has other applications, of course, and it can for example be used as a pre-amplifier for a digital frequency meter or an r.f. voltmeter. This unit has not been designed to function as an untuned pre-amplifier for a receiver, and is not recommended for this application in which its noise performance may be inadequate.

THE CIRCUIT

The circuit of the amplifier is shown in Fig. 1 and is basically a conventional 2-stage directly coupled common emitter arrangement of the type often employed in audio pre-amplifiers. The first transistor, TR1, has R1 as its collector load resistance. R2 provides local negative feedback and enables overall

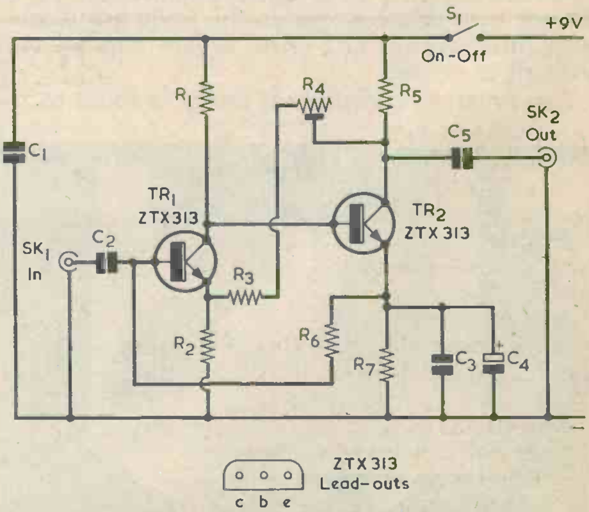


Fig. 1. The circuit of the a.c. coupled 20dB amplifier. Both transistors are high speed devices, giving a bandwidth extending to at least 20MHz.

20dB AMPLIFIERS

PRECISE VOLTAGE GAIN OF 10 TIMES. FLAT BANDWIDTH UP TO AT LEAST 20 MHz.

negative feedback to be applied from the amplifier output to TR1 emitter. The collector load for TR2 is R5, with R7 as the emitter bias resistor. C4 is the emitter bypass capacitor, C3 being connected across it to improve the bypass performance at high frequencies. R6 biases TR1, and TR2 is biased by the collector voltage of TR1.

Overall negative feedback is given by R4 and R3. If the amplifier had a very high open loop voltage gain, the amplifier gain would be equal to the sum of R4 and R3 divided by R2. However, the open loop of TR1 and TR2 is only about 100 times and the gain given in practice when R4, R3 and R2 have values calculated for 10 times would be of the order of 9 times only. In this circuit, R4 is made variable so that the actual voltage gain of the amplifier can be trimmed to 10 times.

The high frequency performance of the amplifier is due to the use of high speed transistors for TR1 and TR2. The ZTX313 transistors specified (which are available from Maplin Electronic Supplies) have an fT rating of 500MHz. In order to obtain this fT figure it is necessary to run the transistors at a reasonably high collector current, and TR1 operates at a little over 5mA whilst TR2 has a quiescent collector current of just over 14mA. The use of local and overall negative feedback also helps to give a wide and flat frequency response.

C1 is the supply decoupling capacitor, and C2 and C5 are input and output d.c. blocking capacitors respectively. The total current consumption is approximately 20mA. The PP3 battery employed with the author's prototype has a reasonable life if the amplifier is not used frequently, but a larger battery such as a PP6 or even a PP9 is recommended if the amplifier is to be operated over long periods.

CONSTRUCTION

The amplifier should be housed in an all-metal box to provide screening, and the author employed an aluminium box measuring 4 by 3 by 1½in. which is available from Harrison Bros., P.O. Box 55, Westcliff-on-Sea, Essex, SS0 7LQ. A somewhat larger box will be required if a PP6 or PP9 battery is employed, and aluminium boxes with a wide range of dimensions are available from many mail-order retail suppliers. The metal box ensures that the amplifier is screened from radio signals and other possible sources of interference.

Flush mounting coaxial sockets are used for input and output connections and, in company with the on-off switch, these are mounted on the lid of the box, which is used as the front panel. A solder tag is fitted under one of the securing nuts for each socket. The printed board is connected to these sockets by way of

COMPONENTS

Semiconductors
TR1 ZTX313.
TR2 ZTX313.

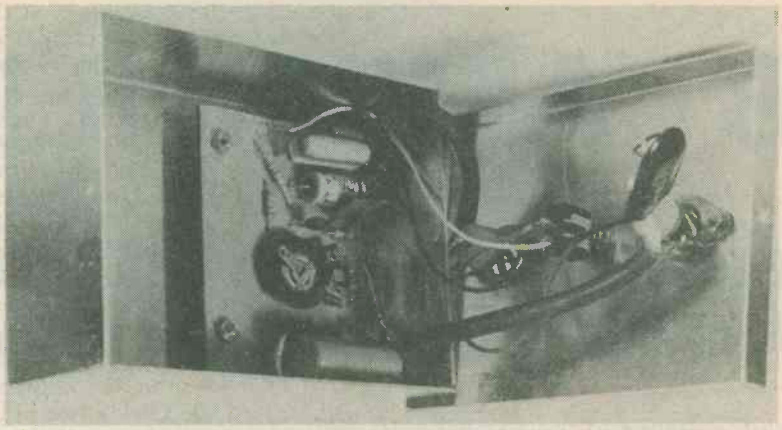
Switch
S1 s.p.s.t. toggle.

Sockets
SK1 coaxial socket, flush mounting.
SK2 coaxial socket, flush mounting.

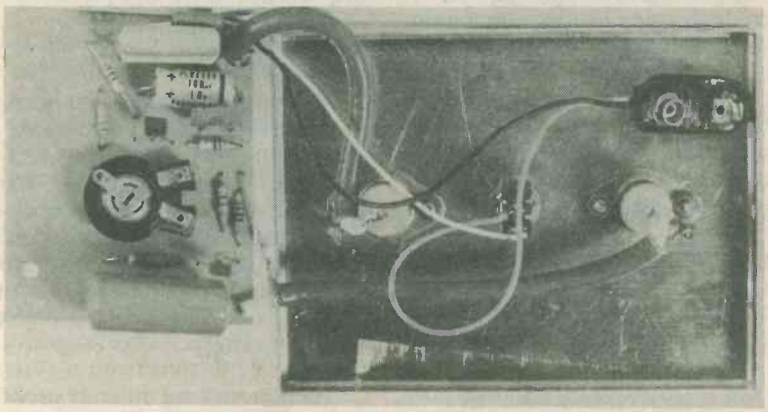
Miscellaneous
Aluminium box (see text).
Printed circuit board.
9-volt battery type PP3 (see text).
Battery connector.
Coaxial cable.
Nuts, bolts, wire, etc.

Resistors
(All fixed values ¼ watt 5%)
R1 1kΩ.
R2 100Ω.
R3 470Ω.
R4 1kΩ pre-set potentiometer, 0.25 watt horizontal.
R5 270Ω.
R6 12kΩ.
R7 270Ω.

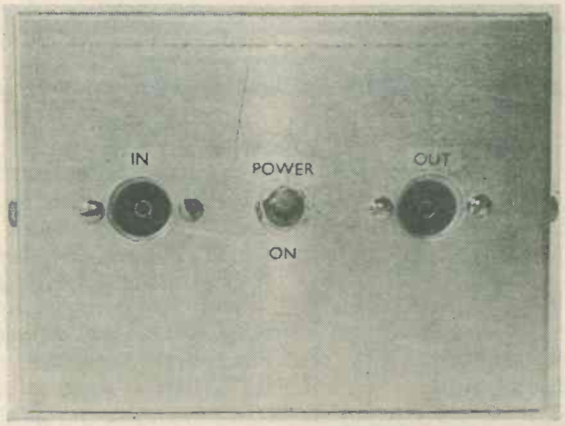
Capacitors
C1 0.1μF polyester type C280.
C2 2.2μF polyester type C280.
C3 0.01μF ceramic.
C4 100μF electrolytic, 10V. Wkg.
C5 0.47μF polyester type C280.



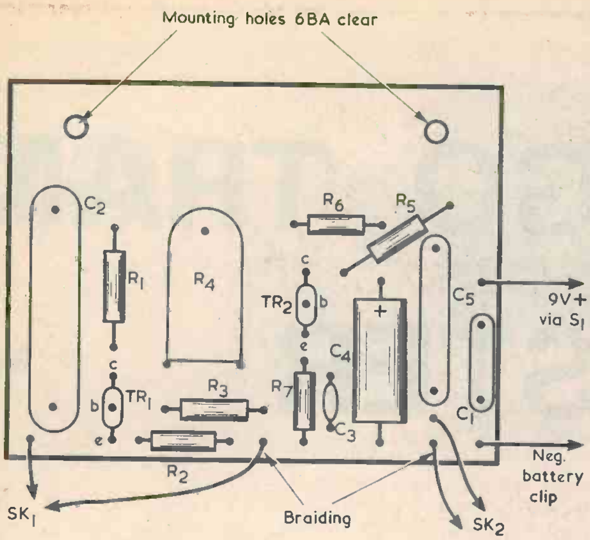
The printed circuit board is secured inside the case with two 6BA bolts and nuts with spacing washers.



The front panel and board removed from the case.



On the front panel the input socket is to the left and the output socket to the right. The on-off switch is mounted centrally.



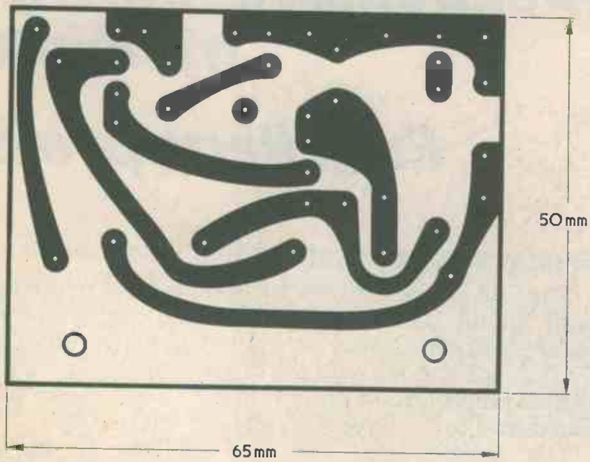


Fig. 2. The layout of the amplifier is rather critical. A suitable printed circuit board is shown here, reproduced full size.

short lengths of coaxial cable, the braiding of which is soldered to the solder tags at the sockets.

The remaining components are assembled on the printed circuit board, which is shown full size in Fig. 2. It is not recommended that any other form of construction be employed as component layout is rather critical due to the wide bandwidth of the amplifier. Another factor is that the input and output are in phase, so that any significant stray feedback is likely to cause instability. The braiding of the input and output coaxial cables is connected to the printed board at the points indicated. The holes in the board will be too small to take the braiding itself and this is connected to the board by way of pins at the board holes or via short lengths of tinned copper wire.

The board is mounted at the right hand side of the case, behind SK2, using two 6BA bolts and nuts with spacing washers to keep the underside of the board clear of the inside surface of the case. The battery is then fitted inside the case to the left of the board.

ADJUSTMENT

To set up the voltage gain of the amplifier it is necessary to have a signal generator and an amplitude measuring instrument such as an a.f. voltmeter or an oscilloscope. A signal of known amplitude is applied to the input of the amplifier. Its amplitude should be measured whilst connected to the amplifier in case the loading given by the amplifier input circuit changes it by any significant amount. R4 is then adjusted to give an output amplitude which is 10 times the input level. The input signal should be between 100Hz and 20MHz and should not produce an output greater than about 1 volt r.m.s., which is the maximum unclipped level the amplifier can provide.

If the amplifier is to be used as a pre-amplifier for a digital frequency meter, or in any other application where its precise voltage gain is of no importance, R4 can simply be adjusted to insert into circuit slightly more than half its maximum resistance. The amplifier gain will then be roughly 10 times.

NEXT MONTH

In part 2 of this article, to be published next month, the second 20dB amplifier will be described.

(To be concluded)

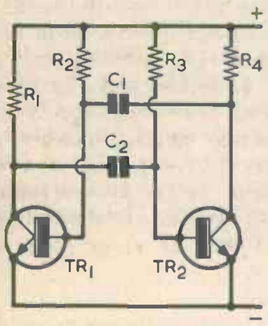
GO-NO GO TRANS TESTER

By A. F

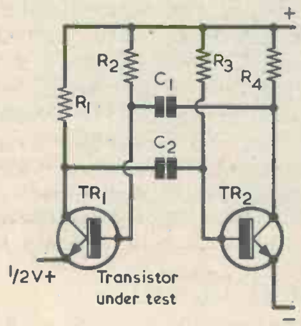
This inexpensive project is a very useful item of test equipment to have around the electronics workshop as it provides a quick and reliable check of bipolar transistors. It is merely necessary to switch the unit to n.p.n. or p.n.p. as applicable, and then connect the device to be tested. If the test transistor is operational a tone is heard in a crystal earphone; the absence of the tone means that the test transistor is a dud.

Inexpensive unit give transistor s

Excellent project



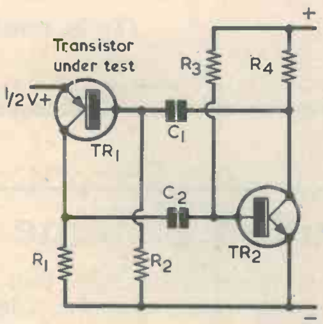
(a)



(b)

Fig.1(a). Basic astable multivibrator with n.p.n. transistors.

(b). To simplify polarity switching requirements in the transistor tester, the emitter of TR1 (which becomes the transistor under test) is returned to a supply voltage midway between the positive and negative rails.



(c)

(c). A p.n.p. transistor can be catered for by returning R1 and R2 to the negative rail. This produces a different mode of oscillation.

OPERATING PRINCIPLE

The unit is based on the standard astable multivibrator circuit shown in Fig.1(a). The multivibrator oscillates at a frequency dependent upon the values of C1, C2, R2 and R3, and the cross-coupling and high mutual amplification present in the circuit causes the transistors to be turned on and off alternately.

The multivibrator will also oscillate if, as in Fig.1(b), the emitter of the left-hand transistor, which can now be looked on as the transistor under test, is connected to a voltage midway between the supply rails instead of directly to the negative rail. This altered method of connection allows a simple n.p.n. – p.n.p. switching circuit to be used in the transistor tester.

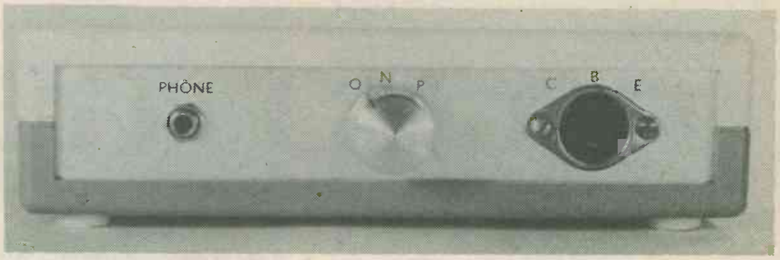
The circuits of Figs. 1(a) and (b) apply to an n.p.n. test transistor. The configuration shown in Fig.1(c) is set up if the test transistor is p.n.p. The collector and base resistors, R1 and R2, are now returned to the negative rail, giving the required supply polarity for a p.n.p. transistor. Also, the mode of oscillation is different. Both transistors are on at the same time and then turn off at the same time during the oscillation cycle.

At switch-on of the power supply in Fig.1(c) both C1 and C2 are discharged. R4 and C1 hold the base of TR1 positive of its emitter and R1 and C2 hold TR2 base at the same potential as the negative rail. The two transistors are thus turned off. C1 now charges via R2 and C2 charges via R3. The base of TR2 is soon taken 0.6 volt positive of its emitter and TR2 starts to turn on. Its collector goes negative, taking TR1 base negative by way of C1, whereupon TR1 collector then takes TR2 base positive by way of C2. Both transistors are turned hard on at this instant.

C1 and C2 start to take up charges corresponding to this new situation with the result that, after a period, the base of one of the transistors is biased only

ISTOR

Roberts



The Go-No Go Transistor Tester. The only control is the 3-way switch in the centre of the front panel, and this selects "Off", "N.P.N." and "P.N.P." The test transistor connects to the DIN socket on the right of the panel.

s positive indication of erviceability.

or the newcomer.

by the current flowing through its base bias resistor. Neither transistor is now saturated and both are capable of linear amplification, with a very high degree of mutual amplification between the two. The very small reduction in the base current of the transistor whose base capacitor has charged results in a very rapid changeover with both transistors turned off. C1 now holds TR1 base positive of its emitter and C2 holds TR2 base negative of its emitter. The capacitors charge as before, causing both transistors to turn on again after a period. The cycles then proceed.

The frequency of oscillation with the circuit of Fig.1(c) differs slightly from that given by the circuit of Fig.1(b). If the resistors and capacitors in both circuits have the same values, the oscillator of Fig.1(c) runs at a higher frequency.

FULL CIRCUIT

The full circuit of the transistor checker appears in Fig.2. The right hand transistor in the circuits of Fig.1 is now TR1, with R5 as its base resistor and R6 as its collector resistor. The two cross-coupling capacitors are C3 and C4. R1 and R2 provide the half-voltage supply point of Figs. 1(b) and (c), with C2 functioning as bypass capacitor. R3 and R4 are the base and collector resistors respectively for the test transistor, and S1(a) returns these to the positive rail for n.p.n. transistors and to the negative rail for p.n.p. transistors. S1(b) provides on-off switching. These two switches are two sections of a 4-pole 3-way rotary switch, with no connections being made to the unused sections. This switch is the only control in the unit. C1 is a supply bypass component. The current consumption of the circuit is about 7mA, both with no test transistor connected and when the astable is oscillating.

Oscillation is at an audio frequency and the signal amplitude at TR1 collector is about 9 volts peak-to-peak. This is too high for comfortable listening with a crystal earphone and R7 is included in series to provide attenuation. The crystal earphone is plugged into socket SK1. An output tone is only produced when a serviceable transistor is correctly connected to the unit and the function switch is set to the proper position. Open-circuit, short-circuit and very low gain test transistors will not oscillate to give the audio tone in the earphone.

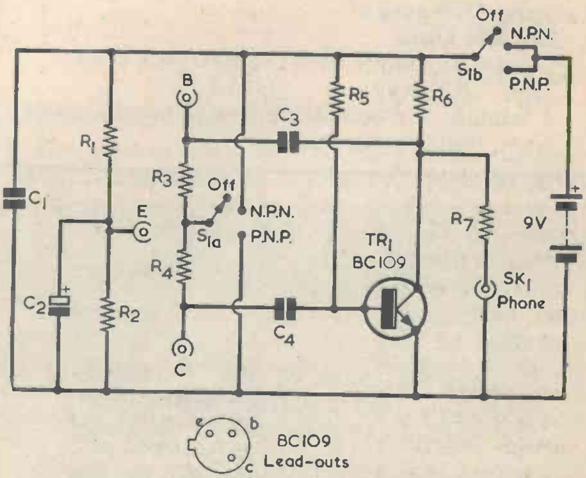
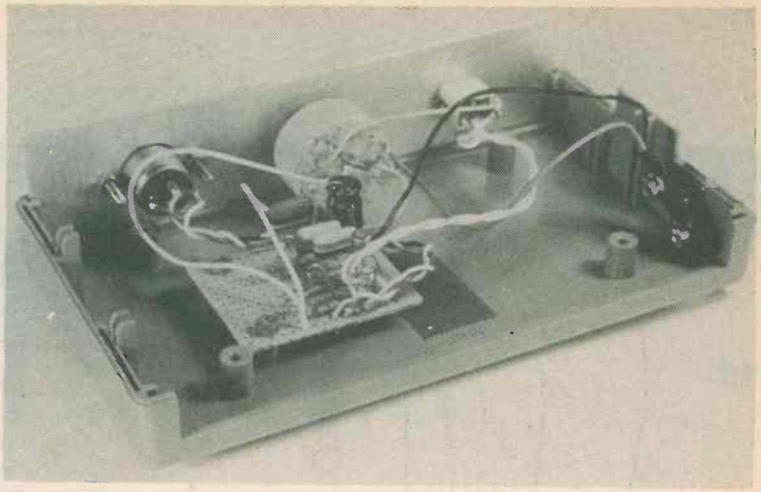


Fig.2. The circuit of the Go-No Go Transistor Tester. The transistor under test connects to the points indicated as "E", "B" and "C".

The transistor tester with its top cover removed. A phone jack socket different to the more common "open" type shown in Fig.3 was used in the prototype.



COMPONENTS

Resistors
(All ¼ watt 5%)
R1 820Ω
R2 820Ω
R3 27kΩ
R4 4.7kΩ
R5 47kΩ
R6 4.7kΩ
R7 560kΩ

Capacitors
C1 0.1μF polyester, type C280
C2 100μF electrolytic, 10V. Wkg.
C3 0.047μF polyester, type C280
C4 0.047μF polyester, type C280

Semiconductor
TR1 BC109

Switch
S1(a) (b) 4 pole 3 way, rotary

Socket
SK1 3.5mm. jack socket

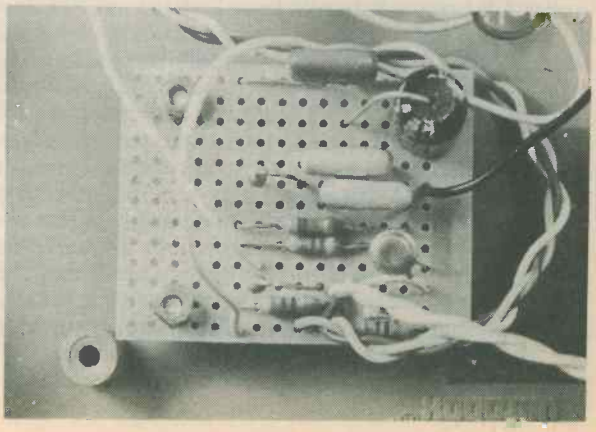
Miscellaneous
Verocase type 75-1237J
9-volt battery type PP3
Battery connector
Veroboard, 0.1 in matrix
3-pin DIN socket
Control knob
Crystal earphone with 3.5mm. jack plug
3-pin DIN plug
3 miniature crocodile clips with vinyl sleeves
Nuts, bolts, wire, etc.

CONSTRUCTION

The prototype is housed in a Verocase type 75-1237J, which has dimensions of 153 by 84 by 39.5mm. As can be seen from the photographs, S1(a) (b) is mounted in the centre of the front panel, with output socket SK1, to its left and a 3-pin DIN socket to its right. Connections to the test transistor are made by way of this socket.

All the remaining components, apart from the battery, are assembled on a 0.1in. matrix Veroboard panel having 15 copper strips by 13 holes. There are no breaks in the copper strips, and the component wiring layout is shown in Fig.3. Also shown in this diagram are the connections from the board to the front panel components. The Veroboard panel is secured to the base of the case with 6BA or M3 bolts and nuts, using spacing washers to keep the board underside clear of the case bottom. The board is positioned to the rear of S1(a) (b) and the DIN socket, as shown in the photograph of the case interior, with strip "O" towards the centre of the case. This leaves plenty of space for the PP3 battery.

A close-up view of the Veroboard assembly. This is bolted, with spacing washers, to the bottom of the case.



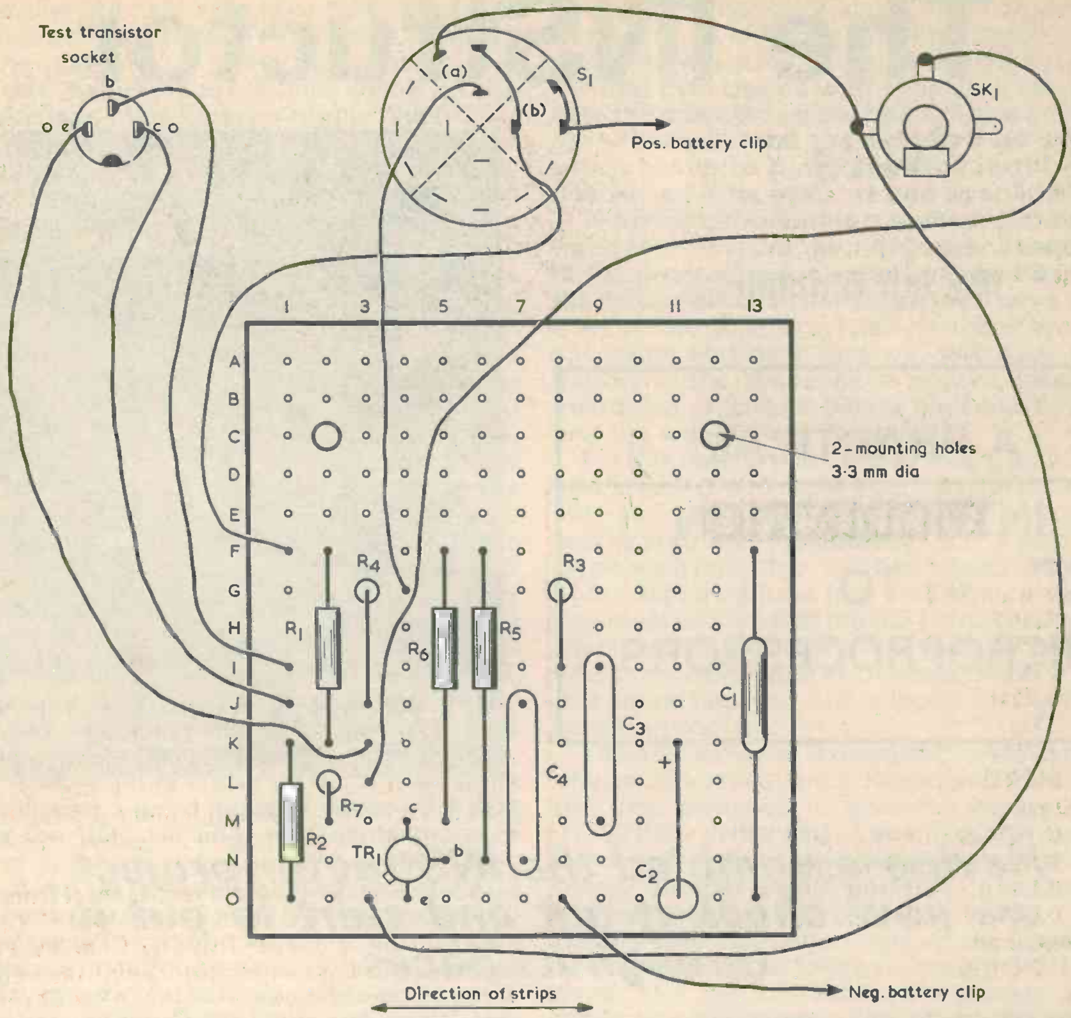
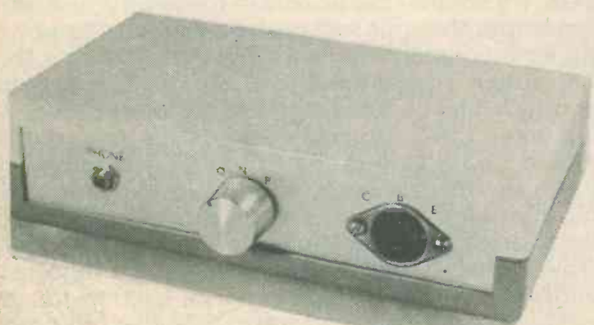


Fig.3. Wiring up the transistor tester. There are no breaks in the copper strips of the Veroboard. Before wiring to S1(a) (b) confirm the corresponding inner and outer tags with a continuity tester in case the switch employed has a different tag layout to that shown here.



The use of a readily available manufactured case simplifies construction and gives the completed transistor tester a neat and professional appearance.

USING THE UNIT

The leads of many TO-18, TO-5 and plastic encapsulated transistors will be found to plug into the DIN socket without difficulty. Take care to ensure that the test transistor is connected correctly and that the function switch is at the proper setting, so that misleading results are avoided.

Some transistors, particularly power types, cannot connect directly to the socket, and a test lead assembly is made to cater for these. The assembly consists of a 3-pin DIN plug with three short flexible p.v.c. covered leads of different colours connected to it. The free ends of the leads are terminated in miniature crocodile clips with vinyl sleeves.

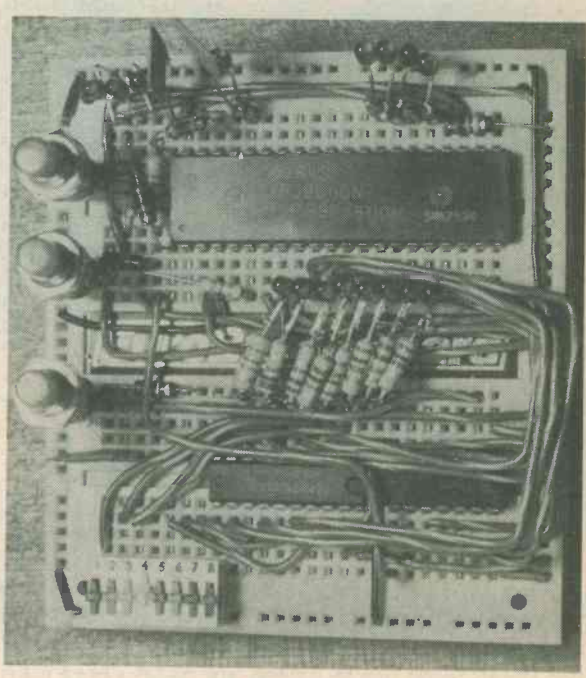
It should be noted that the unit is only suitable for use with a crystal earphone. The tone is hardly perceptible if a low impedance magnetic type is employed. ■

The INStructor

Part 3

By Ian Sinclair

A PRACTICAL INTRODUCTION TO MICROPROCESSORS



Having assembled the INStructor project we now check it out and start to put it through its paces.

Now the INStructor assembly is all ready to go, but we've got a few odds and ends to sort out first. First of all, remove the shorting link you fitted before inserting the 8060 – it's not good for power supplies to have positive and negative shorted. Next make sure that you know what each l.e.d. signals and what each switch is for. Keep last month's article opened out at its Fig.3, and this will act as a reminder about these points.

POWER SUPPLY

Connect up the board to the power supply. The negative supply goes to either of the Y lines and the positive to one of the holes along line X1. With a 4.5 volt battery, this simply means making the two connections. Mains power supplies often have an earth connection which is separate from the positive and negative terminals. If you're using such a supply connect the earth to one of the Y lines, then connect the negative and finally connect the positive. By this time you've checked the board often enough – I hope – and all you need to do is to make sure that you've removed the shorting link, and plugged in the supplies correctly. Remember that the voltage of a mains supply, unless it's a regulated 5 volt supply, should be checked before plugging in – it's no use switching on and only then remembering that you had set it to 12 volts, your microprocessor will have gone long before you reach for the switch again.

If all is well switch on, and look at the l.e.d.'s. When any digital circuit is switched on, every flip-flop comes on at random, so that some store 1's and others store 0's. The microprocessor is no exception, so you'll find that various l.e.d.'s come on. If nothing comes on, it's probably because there's no supply voltage or because the oscillator isn't oscillating. The time constants we've used, in the form of the capacitors between A17, A21 and the Y1 line, are on the long side for the 8060 and though all of mine oscillated happily, yours might not. If you're *sure* that everything else is OK, try smaller capacitors in these portions, but remember that this will probably mean changing the time constant at the GO switch. Now for the real crunch – press the RESET button. This should extinguish all l.e.d.'s while the button is pressed, and when the button is released only two l.e.d.'s should be lit. One is the READ l.e.d., indicating that the microprocessor is waiting for some information to go in, the other is the first l.e.d. of the address group at the top of the board, which shows address 0001. These two l.e.d.'s together tell us that the microprocessor is waiting for its first byte of data from address 0001. In a full-scale system this would come out of a read-only memory, and the whole action would take only a few microseconds. In our system, the data comes from the data switch, and the action takes as long as you like!

Having checked that the reset action is working satisfactorily, the next step is to make sure that the system will go smoothly from one program step to the next, with no "bouncing" problem. We can do this by setting up an instruction on the data switches – the binary number 00001000, which on our switches means switch 5 up and the rest down. When you set this you'll see the data l.e.d.'s displaying the same number unless there's a data wire crossed somewhere. That's because the microprocessor is waiting at the "read" part of its cycle, so that the buffer i.c. is allowing the data switches to affect the l.e.d.'s. The data *isn't actually read into* the microprocessor at this point. With the INS8060 the data is read in at the *back* edge of the pulse from the NRDS pin and that happens just at the instant when you press the GO button. Press RESET and release, and you should have the address 0001. Now ignore the eight data l.e.d.'s and look at the address l.e.d.'s only. Press GO and you should see the address change to 0010 (binary 2). Press again, and you should get 0011 (binary 3). Each push of the GO button should increase the binary count by 1 until you reach 1111. The next count will extinguish the four l.e.d.'s because the following number is 10000, and we have no l.e.d. on the next address line, AD4. Yes, I know it's the fifth address line, but both data and address pins are numbered starting from 0, so that the sequence is AD0, AD1, AD2 and so on. It may seem odd but there's a good logical reason – the AD0 line like the data D0 line, represents the zero power of 2, which is 1. The AD1 and D1 lines represent the 1st power of 2, which is 2, the AD2 and D2 lines represent 2 squared (=4) and so on.

We digress. The important thing is to be sure that there are no numbers skipped on the address count. Try resetting at various stages of the count and starting again. Every now and again, you may find that the address doesn't shift. That's not too important so long as it doesn't happen too often, but what we don't want is, for example the address 0010 to jump to 0100 on a single push of the GO button. If this happens the remedy is to reduce the value of the 0.1μF GO button capacitor, so making the pulse on the NHOLD pin a little shorter. (The push button switch itself can also cause multiple triggering, as we found when we used one with a noticeably "rough" mechanical operation – Editor.)

INSTRUCTION

The input byte 00001000 which we've been using is one of the single byte instructions of the INS8060, and it signals NO OPERATION, shortened to NOP. A single byte instruction means one which is not followed by another byte of data, so that the microprocessor will treat this as an instruction *and will also treat the next byte as an instruction.* This is one of the points which worry newcomers to microprocessing, and which never seem to be explained in textbooks, because beginners always ask how the microprocessor "knows" which group of 8 bits is an instruction and which is a number. The answer is that the microprocessor sets up gates and counters to identify the bytes. The first byte in after resetting is *always* treated as an instruction. What happens after that depends on what this first byte was. For example, if the first instruction byte starts with 0, as the NOP instruction does, the microprocessor treats this as a single byte instruction, and the next byte will also be treated as an instruction. If the first byte begins with 1, as we'll see shortly, then the microprocessor treats this as an instruction – but will treat the *next* byte as a number which has to be processed. The next byte after that will be once again treated as an instruction.

The microprocessor is a strict-sequence device – you can't interchange numbers and instructions in the program because everything has to be in the correct order. In this series we'll work through a lot of instructions to see how the microprocessor treats numbers, and you will have to keep exactly to the sequence as shown, resetting as instructed. Just one binary digit out anywhere, and the whole thing "crashes"!

For this reason you need to keep a watch on the address l.e.d.'s to make sure that the address has changed at each press of the GO button. Once you're sure that the address l.e.d.'s step up one bit on each push then you don't need to keep track of the actual address (not until later, at least) but you must be sure that the GO button has operated by checking that there is a change of address when the GO button is pressed. Make a note of this point because one slipped instruction will wreck a program.

The next exercise is designed to rub in this idea of instruction sequence. Reset, and then arrange the data switches to give the binary number 11000100 – switches 1, 2 and 6 up, the rest down. Once again, the led.'s should show the same binary number unless you have a crossed wire somewhere. This instruction starts with 1, so it's a double byte instruction, one which needs a second byte of data to follow it. Press the GO button, once, and the address l.e.d's change to 0010. What has happened? The microprocessor has been instructed to load. Load what? The next byte that you put in right now. To save a lot of switch operation, reset switch 1 only so that the number that is left set up is 01000100 (68 in decimal). Push the GO button again and the address changes to 0011, with this number loaded into the accumulator of the microprocessor.

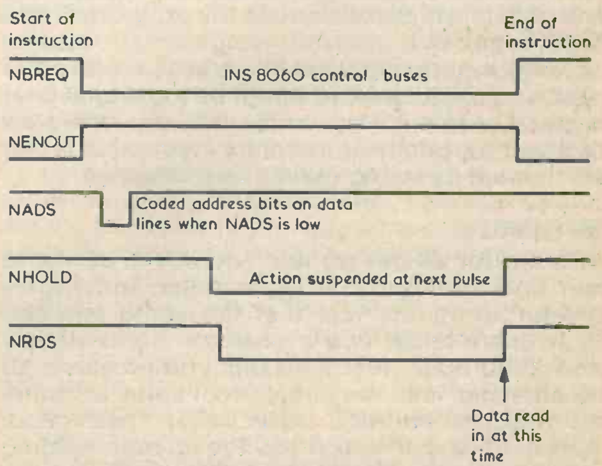


Fig.1. The pulse sequence of outputs from the 8060. This shows only command pulses, not the address pulses nor any data outputs.

The accumulator is, as its name suggests, the main store of the microprocessor, where all numbers that are to be operated on are loaded into or taken from. How do we know that this number is loaded in? We can check by asking the microprocessor to "write" it out again, but we'll need to see what has to be done to write data out first.

Reading, incidentally, ALWAYS means that data is going INTO the microprocessor, and writing ALWAYS means that data is coming out of the microprocessor. Keeping to this convention avoids confusion and we'll use it throughout.

Now, at the moment the data l.e.d.'s are displaying the number 01000100. That's only because the data switches are set up to this number, though. Remember that whenever the microprocessor is *holding* (with the READ l.e.d. on) the data l.e.d.'s will show the same number as the switches are set to. We can check that the number was loaded in by another procedure. Set the data switches to 11001000 and push the GO button *twice.* At the first push the address l.e.d.'s advance to the next address, 100, but at the second push several interesting things happen. For one thing, the READ l.e.d. goes out. That shows that the microprocessor is not reading, and the data l.e.d.'s are displaying a number which is stored in the accumulator, rather than the number set up on the data switch. A quick look at the data l.e.d.'s shows that they are displaying 01000100. That's the number we fed into the accumulator, not the number set up on the switches (which is 11001000). The other odd thing is the address – it's skipped to 1100 on the four low-order l.e.d.'s, and the AD11 l.e.d. is on as well! We'll deal with these address jumps later, but there's nothing wrong when the number skips like this. The important point is that by setting up 11001000 and pressing GO *twice,* we can cause the l.e.d.'s to display a number which was in the accumulator. From now on we will refer to that procedure as DISPLAY, and each time this occurs you'll know that we mean the steps 11001000, GO, GO.

The instruction we started with, 11000100, is called LOAD IMMEDIATE, shortened to LDI, and it has the effect of loading into the accumulator the byte of data which follows it in the program. If you forget to put in a byte following the LDI instruction, the program crashes! There are several other LOAD instructions which we'll be looking at later in part 6, when we deal with memory reference instructions, but the immediate instruction is one which we'll be using mainly in this series.

ARITHMETIC

So far, for all our trouble and effort, all we've been able to do is to load in a number, and display it. Apart from the fact that the same exercise might have taken you a week on some widely advertised units, it's not exactly impressive, so the next step is in the direction of some arithmetic. There is an ADD IMMEDIATE instruction, shortened to ADI, which has the effect of adding the next byte (after the ADI code) to the accumulator. We can demonstrate this by setting up a small number in the accumulator, adding another one to it and then displaying.

The sequence after resetting is shown in Fig.2.

RESET
11000100 LDI
00000100 4
11110100 ADI
00010100 20
11001000
11001000 Display

(PRESS GO AFTER EACH BYTE SHOWN)

Fig.2. A binary addition program.

The byte 11000100 is LDI, instructing the 8060 to load in the *next* number, which is 00000100. That gives us binary 100 (decimal 4) loaded into the accumulator. The next byte 11110100 is ADI, which has to be followed by a number. We've used 00010100 (decimal 20) to minimise switch-juggling, and the press of GO after setting this up performs the addition. To see the answer, use the DISPLAY steps, and the answer which appears on the data l.e.d.'s is 00011000 (decimal 24) which is correct. We'd be a bit worried if it turned out to be wrong, but it's nice to see that it all actually happens.

DECIMAL ADDITION

There's another type of addition on offer in the 8060's instruction set, decimal addition. This is, as the name suggests, addition of decimal numbers but, because the microprocessor can use only binary numbers, the decimal number is BCD coded and the results are not the same as the binary equivalent of the decimal number. The decimal number 36 for example is BCD coded as 0011 (that's 3) 0110 (that's 6), making 00110110 in all. In pure binary, 36 is 00100100 – quite a different byte. Because of this, BCD numbers don't add up in the same way as binary numbers, as Fig.3 shows. The rules for addition are not terribly complicated, but there's no point in going

2	4	Decimal	3	8
0010	0100		0011	1000

So that, in BCD, 24 is 00100100
and 38 is 00111000

Addition: Binary 00100100
00111000
———————
01011100

BCD result is 01100010 (decimal 62).

Fig.3. BCD arithmetic. The answers from a BCD addition are quite different from those of a binary addition, even though the same bits are used.

RESET
11000100 LDI
00100111 BCD27
11101100 DAI
00111000 BCD38
Display

Fig.4. A BCD arithmetic program for the 8060.

	1 1 0 0 0 0 0 0	192
	1 1 1 1 0 0 0 0	240
1	1 0 1 1 0 0 0 0	
Carry bit	Byte in accumulator	

Fig.6. The "carry" illustrated.

through them, because we can do the addition in decimal numbers, and the microprocessor is already programmed to deal with BCD.

A decimal addition program is shown in Fig.4. We start, as usual, by resetting so as to clear the microprocessor of any data in store. The first instruction is LDI, followed by the BCD number, in this example 27 (00100111). Decimal add immediate (DAI) is 11101100, and we've followed it with 38 (00111000). As usual, the answer is worked out when the GO button is pushed after setting up the decimal-add number, and we can display in the usual way, getting 01100101 (decimal 65).

Want to try a few for yourself? Just use the same instruction sequence as has been shown, but substitute your own 8-bit numbers for the data bytes in the examples.

These two immediate instructions cover two important operations, but we haven't learned all the secrets of the INS8060 by a long way. Just to underline this, try the sequence which is shown in Fig.5. This starts off by loading a binary number 11000000 (decimal 192) and then adding to it the number 11110000 (decimal 240). The answer which pops out of the display is 10110000 (decimal 176) which is obviously wrong. Why? We can see why when we try it out on paper (Fig.6). The numbers we are adding are of eight bits each, but the answer to the addition should have nine bits. In arithmetical language, there's a carry to the next place. This carry is not stored in the accumulator, so where is it? The answer comes later. After the NOP step which simply allows the microprocessor to get back to its normal address numbers, we load 00000001

RESET
11000100 LDI
11000000 192
11110100 ADI
11110000 240
Display
00001000 NOP
11000100 LDI
00000001 1
11110100 ADI
00000010 2
Display

Fig.5. More binary addition, using larger numbers.

RESET
11000100 LDI
11000000 192
11110100 ADI
11110000 240
Display
00001000 NOP
00000010 CCL
11000100 LDI
00000001 1
11110100 ADI
00000010 2
Display

Fig.7. The same addition as was done in Fig.5, but with the carry cleared.

(decimal 1) and add (immediate) 00000010 (decimal 2). This should, of course, give 00000011 (decimal 3), but we get 00000100 (decimal 4) when we display this time. That's part of the answer to the question – the carry bit is added into the next addition. It's stored in a flip-flop which forms part of what's called the status register of the 8060, and is automatically added into the next addition.

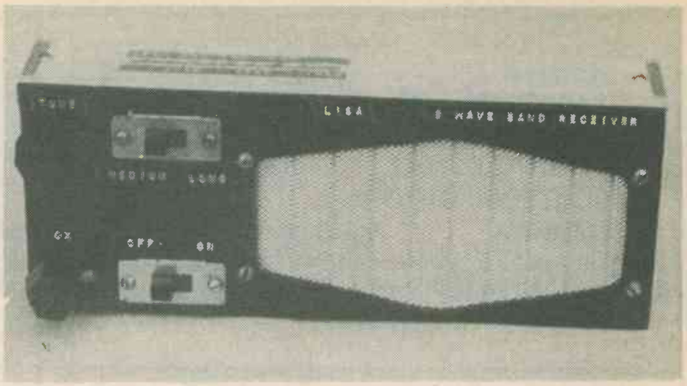
Why should this be done? The reason is simple. If we're adding large numbers which need more than eight bits, we can add only eight bits at a time, because that's all the accumulator can hold. What we do then is to add the lower eight bits, store the carry and then add it into the next addition, which will be of the upper eight bits of a sixteen bit number, We don't have to worry about the carry when we're operating with sixteen bit numbers, then, because the microprocessor attends to all this for us. Suppose we don't want the carry added in? We may not be interested in sixteen bit addition, so that the next sum isn't of the higher eight bits of the first one. In that case, we have an instruction, shortened to CCL, which clears the carry/link. This one is a single byte instruction, coded 00000010. To see it at work, try the instruction set in Fig.7. This repeats the same loadings and additions as we used in Fig.5, but this time with the carry cleared so that the carry is not added into the second sum. Just to complete the set, there's also an instruction which sets the carry link (to 1) – we'll see why in the next Part.

(To be continued)

'LISA' 2-BAND PORTABLE

Part 2 (Conclusion)

By Sir Douglas Hall, Bt., K.C.M.G.



The assembled receiver in its home-constructed case.

Wiring and setting up this ingenious 3 transistor reflex design.

In last month's article we completed the mechanical assembly of the receiver, ending with the construction of the permeability tuning drive. We deal next with the wiring.

WIRING

The wiring is carried out as shown in Fig.6. Note that the end mounting lugs of T1 and T2 are soldered to tags on the 19-way tagstrip and that the transformer mounting clamps complete some of the negative supply rail circuitry. For clarity, many of the tagstrip components are shown spread out. In practice, components should be connected with short direct leads and all parts should be kept within the edges of the Fig.2(a) panel. C9 lies immediately over S2. When VR3 is fitted, make sure that it does not foul the ferrite rod as the tuning control is operated. Connections to the two transformers follow the lead layouts shown inset.

When wiring has been completed, set VC1 to minimum capacitance, VR1 to a central setting and VR3 fully anticlockwise as shown in Fig.6. Switch on. There may be oscillation or distortion which is unaffected by the setting of VR2. Should this occur, reverse the connections to leads 3 and 4 of T1. Put S1(a) (b) to the medium wave position, whereupon it should be possible to receive many stations after

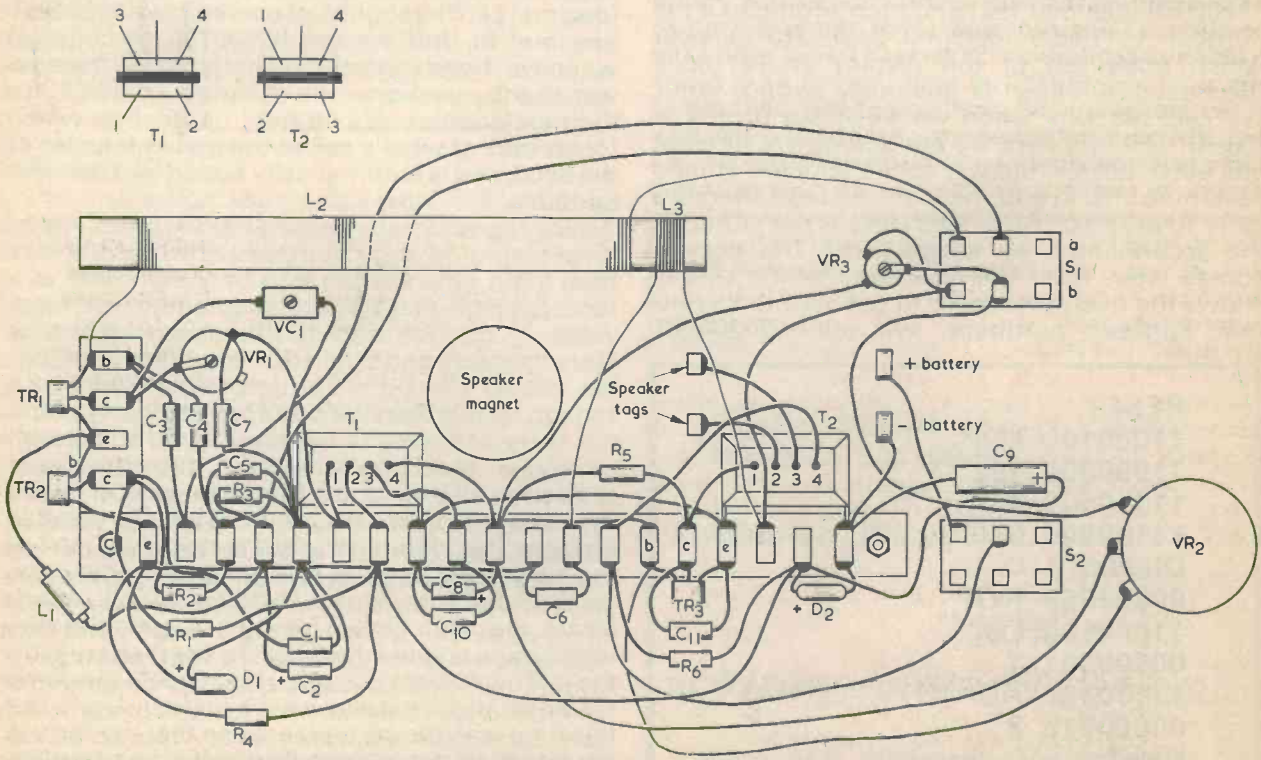
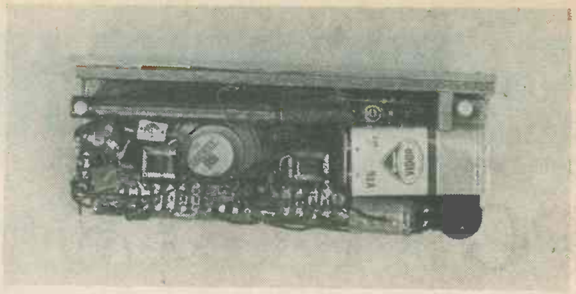


Fig.6. Wiring up the receiver. The cathode end of zener diode D2 is indicated by a plus sign. Components are shown spread out for clarity but in practice should be kept within the outside edges of the receiver front panel.



During wiring, all components should be kept inside the edges of the front panel.

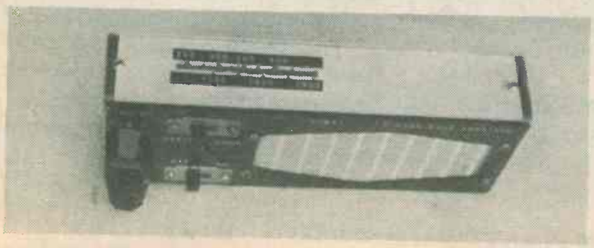
dark, and quite a number during daylight hours, by adjusting the tuning control. The receiver should be kept at full sensitivity, whilst tuning, by setting VR2 so that the receiver is almost, but not quite, oscillating. When all is proved well adjust VR1 until a setting is found where the least possible adjustment is needed in VR2 to maintain maximum sensitivity over the tuning range from about 250 to 450 metres. After this adjustment has been carried out, the need will still arise to set VR2 back for stations of lower wavelength than about 250 metres. Adjust VC1 until the effect disappears. This may necessitate a slight re-adjustment in VR1 to maintain as constant a setting as possible in VR2 for critical reaction over the range, now, of about 200 to 450 metres. When these adjustments are completed it will probably be found that VR2 has to be advanced a little further for stations with wavelengths greater than 450 metres, and that oscillation may tend to occur a little more readily around 350 metres than at other tuning settings. However, in general, very little re-adjustment of VR2 should be necessary for critical reaction throughout the medium wave band.

LONG WAVES

Set S1 to the long wave position and tune in Radio 4 on 1,500 metres. VR2 will need to be well advanced for optimum reaction at this wavelength. Switch back to medium waves and adjust VR3 so that critical reaction is obtained with about the same setting which was employed with the long wave 1,500 metre signal.

Setting up is now complete and the top panel of Fig.2(b) may be secured to the panel of Fig.2(a), using thin countersunk wood screws. The top panel should be positioned so that the 6BA screw tuning pointer appears within, but does not pass through, the slot provided for it. Either long edge of the top panel may be secured to the front panel; choose the edge which allows the most free travel of the 6BA tuning pointer. The front panel will now stand proud of the top panel by a little less that 1/8 in., leaving room for a piece of thin Perspex to cover it later.

Cut out a piece of thin white card to the dimensions shown for the top panel of Fig.2(b) and glue this to the panel. Draw out a tuning scale on this calibrated in wavelength or frequency, using the large number of stations available after dark to facilitate the calibration. Cover the top panel and card with a sheet of thin



A calibrated tuning scale is provided at the slot in the top panel.

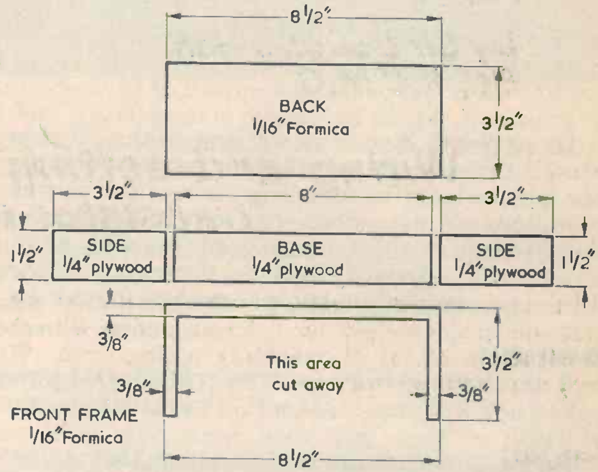


Fig.7. A suitable case for the receiver may be made up with the items shown here.

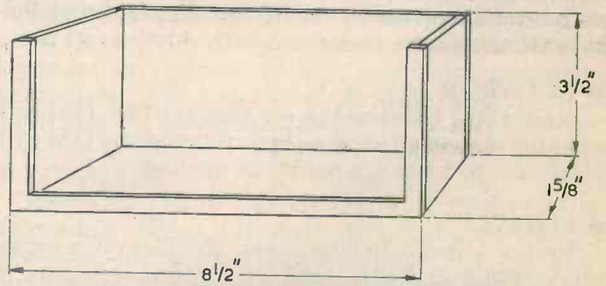


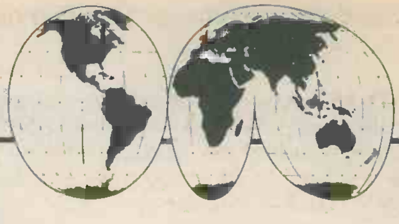
Fig.8. The pieces of Fig.7 made up to form the case, into which the receiver assembly slides. The dimensions shown here and in Fig.7 are for guidance only, and the case should be made, in practice, to take the receiver assembly as constructed.

Perspex measuring 8 in. by 1 3/8 in. Two small woodscrews are used to hold the Perspex in place.

A suitable case with suggested dimensions is illustrated in Figs. 7 and 8. The five pieces of the case are cut out and screwed together as shown, and are then covered with Fablon or Contact of a colour favoured by the constructor. The receiver assembly will then slide in from the top. Note that the dimensions given in Figs. 7 and 8 are for guidance only, and assume that the receiver assembly has been made precisely to the dimensions given last month. In practice the dimensions should be amended to take the receiver assembly as constructed, with small clearances being given where necessary.

(Concluded)

SHORT WAVE NEWS



FOR DX LISTENERS

By Frank A. Baldwin

Times = GMT *Frequencies = kHz*

Dxing South American stations on the 90 metre band is never an easy matter but just now and then one may be lucky by switching the receiver on when conditions are reasonable – or even good – for reception of some of these transmitters. As with all our loggings presented in this article, these are published for the guidance of readers who wish to 'have a go'.

● **BRAZIL**

Radio Riberao Preto on **3205** at 0055, OM with a ballad in Portuguese, OM with station identification at 0100.

Radio Aruana, Barra do Garcas, on **3245** at 0105, OM with announcements in Portuguese, OM with ballad.

Radio Cultura, Araraquara, on **3365** at 0111, OM with songs in Portuguese – rather staid songs at that!

Radio Clube do Dourados on **3375** at 0115, OM with local announcements, light music, OM with ballad in Portuguese.

● **ECUADOR**

Radio Iris, Esmeraldas, on **3380** at 0120, OM with announcements of local interest followed by OM with a talk about local affairs, all in Spanish.

● **BOLIVIA**

Radio Alfonso Padilla Vega, Padilla, on a measured **3480.5** at 0128, OM with announcements in Spanish, military music, more announcements, more military music! Out of band perhaps, but this frequency is occasionally worth a visit.

● **FINLAND**

Helsinki on **21475** at 1449, OM (Old Man = Male Announcer) with station identification followed by a programme of Finnish pops and groups on records in the English transmission for Europe and North America, scheduled from 1430 to 1500 on this channel.

● **TURKEY**

Ankara on **15185** at 1340, local-type music, some with songs by OM in the Turkish programme for Turks living overseas, scheduled from 1300 to 1500 on this frequency.

Ankara on **17860** at 1346, YL (Young Lady = Female Announcer) with a talk about the music of various Turkish localities in an English programme which ended at 1430.

● **ALBANIA**

Tirana on **9500** at 1412, OM with a talk about foreign affairs from the Albanian point of view in the English programme for South East Asia and Australia, scheduled here from 1400 to 1430.

● **SWITZERLAND**

Berne on **9535** at 1335, OM with a talk about Zimbabwe, the present problems and the future aspirations, in an English programme for Europe, Asia and the Far East, scheduled from 1315 to 1345 at the dial reading shown.

● **EAST GERMANY**

Berlin International on **9730** at 1350, YL with a talk about social achievements in the "Socialist World" during an English programme intended for Arabia and scheduled from 1315 to 1400 according to announcements. Off after identification and announcements at 1359.

● **HUNGARY**

Budapest on **9835** at 1415, OM with station identification and announcements at the commencement of the English programme for Dxers intended for Europe, scheduled from 1415 to 1430 on Tuesdays and Fridays only (afternoon sessions).

● **NETHERLANDS**

Hilversum on **9895** at 1445, OM with a programme in French intended for African and European consumption, scheduled from 1430 to 1520.

● **AUSTRIA**

Vienna on **12015** at 1439, OM with identification in several languages, including English, followed by light orchestral music during the German programme for Europe, scheduled here from 1330 to 1500.

● **USSR**

Moscow on **9450** at 1430, OM with a newscast in English in the English-languaged World Service. This service is scheduled almost around the clock on many differing channels and is in itself an unconscious tribute to the English.

● **EGYPT**

Cairo on **9850** at 1435, OM with a political talk during the Arabic-languaged Domestic Service. Also logged in parallel on **12050**.

● **ITALY**

Rome on **15330** at 0535, interval signal, OM with station identification and announcements at the commencement of the Arabic programme for Arabia which ended at 0555.

● **PORTUGAL**
Lisbon on **15125** at 1840, OM with a talk about classical guitar music, Portuguese style, in the Portuguese programme to Europe, scheduled from 1800 to 2000 on this frequency.

● **BULGARIA**
Sofia on **15310** at 1850, YL with a talk about students and the higher grade educational system in Bulgaria in an announced English programme for Africa from 1830 to 1900.

● **CZECHOSLOVAKIA**
Prague on **7345** at 1856, OM with announcements in Spanish, interval signal, OM station identification followed by announcements about the various English transmissions of Radio Prague, this one being to Europe from 1900 to 1930. Another English programme for Europe on this channel is from 2000 to 2030. All this followed by YL with a newcast of both local and world events – the latter from the Czechoslovakian viewpoint.

● **NETHERLANDS – 2**
Hilversum on **17605** at 1904, OM's with a discussion about tea – both the growing and the drinking – in an announced English programme for Africa from 1830 to 1920 on this channel.

● **GREECE**
Athens on **11860** at 1920, OM with station identification followed by a newscast of both Greek and world events. All in English to Europe and scheduled from 1920 to 1930.

● **ROMANIA**
Bucharest on **11940** at 1930, OM with station identification in the "European Service", followed by a newscast in an English programme, scheduled from 1930 to 2030 at this point of the dial.

● **BULGARIA – 2**
Sofia on **11720** at 1930, interval signal then YL with station identification followed by a news reading of both Bulgarian and world events in the English programme for the U.K., scheduled from 1930 to 2000.

● **FINLAND – 2**
Helsinki on **15265** at 1934, OM with news about Finnish affairs in an English programme for Europe, scheduled from 1930 to 2000 on this frequency.

● **SOUTH AFRICA**
Meyerton on **3250** at 1940, YL with a pop song in English in the "Radio Five" programme scheduled from 0300 (Sundays 0400) to 0545 and from 1535 to 2400. The All Night Service is from 0000 to 0300 (Sundays 0400) and the power is 100kW.
Johannesburg on **21535** at 1455, OM with an English programme about South African exports to both the U.K. and Europe in the English transmission to Africa and Europe, scheduled from 1300 to 1550 on this frequency.

● **KUWAIT**
KBS Kuwait on **21545** at 0526, YL with a talk about Islamic Law and its present administration within Kuwait. All in an English transmission.

● **MOROCCO**
VOA (Voice of America) Tangier on **15245** at 0600, OM with station identification followed by a newscast in English. Also logged in parallel on **15160.**

● **SOUTH KOREA**
Seoul on **15570** at 1358, YL in Korean followed by OM with identification and an announced French programme to Africa at 1400.

● **VIETNAM**
Hanoi on **10040** at 1836, YL with songs in Vietnamese, local-style music, all in an English transmission directed to Europe and scheduled from 1800 to 1900. Also logged in parallel on **15010.** According to announcements there is also a further English programme for Europe timed from 2030 to 2130.

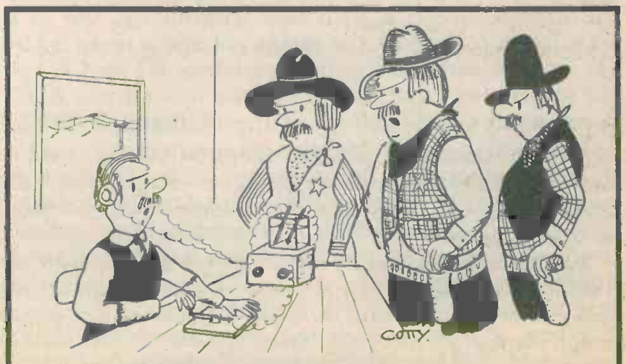
● **NIGERIA**
Kaduna on **4770** at 0504, YL with the news in English, both local and world events, then an interview with a visiting Canadian newspaper reporter. Schedule unknown.

● **EQUATORIAL GUINEA**
Bata, Rio Muni, on **5005** at 0515, OM in vernacular, local type music with folk songs by OM's in chorus. The schedule of this one is from 0430 to 0655, 0955 to 1355 and from 1700 to 2200. The power is thought to be 100kW and this channel would seem to be an alternative to **4926.**

● **COLOMBIA**
Emisora Kennedy ("La Voz de Maria"), Bogata, on **4775** at 0150, OM with local announcements in Spanish then OM and YL with more announcements alternately. This one has a schedule from 1100 to 0400 and the power is 5kW.

● **ECUADOR**
Radio Nacional Progresso, Loja, on **5060** at 0206, light music Palm Court style, OM ballad in Spanish. The schedule is from 1000 to 0415 but has been reported signing on at various times up to 1100 and signing-off as late as 0648. The power is 5kW.

● **BOLIVIA**
Radio Riberalta, Riberalta, on a measured **4697** at 0140, OM's with a discussion in Spanish about local affairs. The schedule is from 1100 to 0400 (Saturdays until 0500) and the power is 3kW.



"Whats it say Luke?"
"Click click-click click click click!"

AIRING CUPBOARD WARMER

By
Owen Bishop

Inexpensive outlay and running costs. Schmitt trigger thermostat switching.

When we decided to economise by reducing the temperature and the length of time for which we ran the central heating, we soon discovered one snag. The airing cupboard became too cool to air the clothes properly. Our airing cupboard measures about 3ft. wide by 2ft. deep and 8ft. high and is heated, when the central heating is on, by three 2in. pipes that pass through the cupboard from top to bottom. These pipes are unlagged and are part of the system which circulates water to the radiators. The cupboard does not contain the hot water tank for the house.

The solution to our problem is the simple thermostat heater which is described in this article. The heater has proved completely successful and has been in constant use for many months.

Another application for the heater will appeal to those who make their own wine or beer at home. The heater can be placed in a large cupboard or wooden crate where it will keep fermenting wine or beer up to the correct temperature during winter months. The fermentation will not then become "stuck" because of low temperature; also wine will be ready at an earlier date. With the popular 2-week and 3-week wines a relatively high temperature is essential, and the thermostat heater will readily supply this.

CIRCUIT OPERATION

The circuit is shown in Fig.1. The heat is provided by two 100 watt mains lamps connected in series and which are turned on and off by the contacts of relay RLA. In keeping with the spirit of economy that led to the development of the heater, the power for the thermostat circuit is provided without the use of a transformer. Instead, the mains voltage is rectified by D1 and passed via dropping resistors R1 and R2 to the smoothing capacitor C1 and the zener diode ZD1. A relatively steady voltage of approximately 6.2 volts appears across these last two components.

The temperature inside the airing cupboard is sensed by the thermistor TH1. This is a disc thermistor type VA1038, which is available from several sources including Maplin Electronic Supplies. It has a nominal resistance of 1.5kΩ at 25deg. C, and this resistance decreases as its temperature rises.

When, due to a high temperature in the airing cupboard, TH1 exhibits a low resistance, sufficient current flows in the base of TR1 to turn this transistor hard on. The low voltage between its emitter and collector keeps TR2 turned off and the relay is de-energised. About 6mA flows through R4 and R6, causing a voltage of about 0.06 volt to appear across R6. As the temperature falls the resistance of TH1 increases, causing the base current for TR1 to decrease, and a point is reached where this transistor begins to turn off. Its collector voltage rises and base current flows into TR2 by way of R4. The emitter current of TR2 passing through R6 causes an increased voltage drop across this resistor with the result that TR1 turns off rapidly whilst TR2 just as rapidly turns fully on and energises the relay. The relay contact arm moves over to the normally open contact and the two lamps are turned on.

The voltage across R6 has now increased to about 0.12 volt and the temperature in the cupboard must

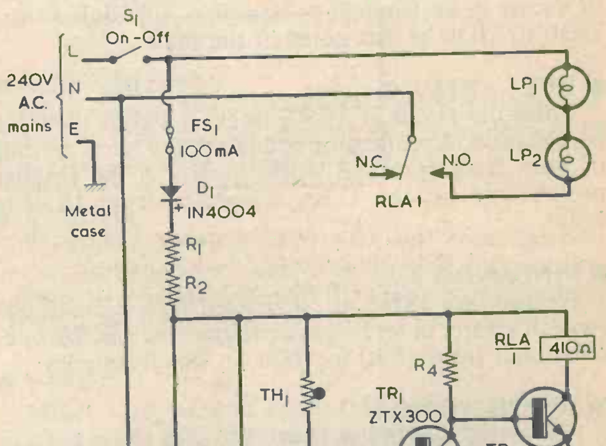


Fig.1. The circuit of the airing cupboard warmer. Thermistor TH1 is the temperature sensor, and the lamps are controlled by the contacts of relay RLA.

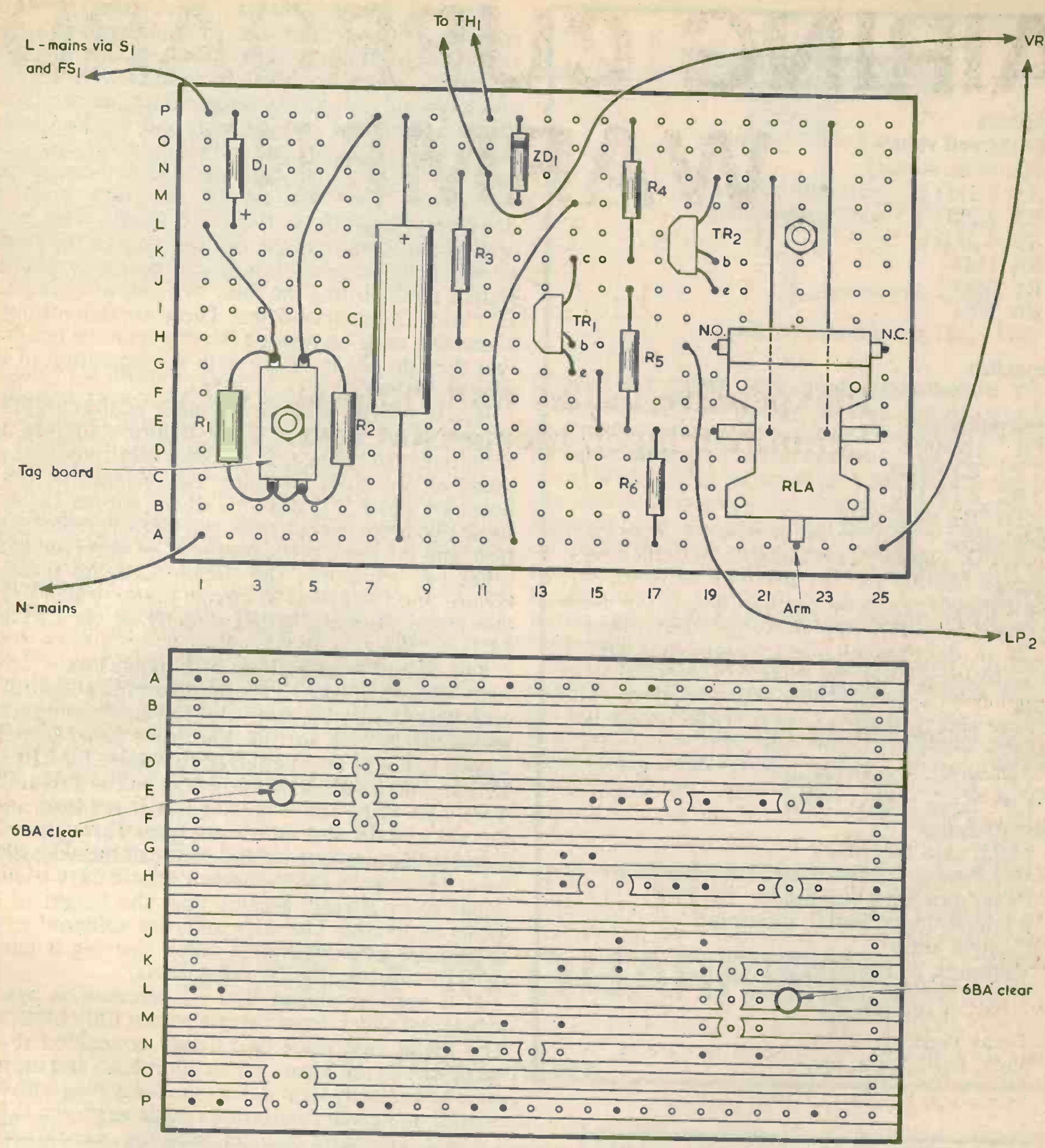


Fig.2. The relay is soldered directly to the Veroboard panel, as also are most of the other components. Veropins suitable for 0.15in. Veroboard are employed at the connection points to parts external to the board. Fig.1 should be followed for circuit details not shown here.

rise appreciably before falling resistance in TH1 causes TR1 to turn on again. The simple Schmitt trigger employed ensures that there is a "snap" action both when the relay energises and when it de-energises, and the resultant hysteresis caters for relatively small changes in temperature without incessant switching on and off around the required level. The average temperature at which the thermostat operates is controlled by adjusting VR1. Increasing the resistance inserted into circuit by this component causes triggering to occur at a lower average temperature.

CONSTRUCTION

Most of the components can be assembled on a piece of 0.15in. Veroboard with the standard size of 3.75 by 2.5in. This has 16 copper strips by 25 holes. The layout is shown in Fig.2. The board has two 6BA clear mounting holes drilled in it and the screw passing through one of these also holds a tagboard which is spaced away from the Veroboard. R1 and R2 are connected to this tagboard. These two resistors dissipate an appreciable amount of heat and they are raised above the board to allow air to circulate around them.

COMPONENTS

Resistors
(All fixed values ¼ watt 5% unless otherwise stated)
R1 2.2kΩ 2.5 watt wire-wound
R2 2.2kΩ 2.5 watt wire-wound
R3 4.7kΩ
R4 1kΩ
R5 68Ω
R6 10Ω
VR1 1kΩ potentiometer, linear

Capacitor
C1 470μF electrolytic, 10V. Wkg.

Semiconductors
D1 1N4004
TR1 ZTX300
TR2 ZTX300
ZD1 BZY88C6V2

Thermistor
TH1 VA1038

Switch
S1 s.p.s.t. toggle, 2A at 250 V.A.C.

Relay
RLA "Open Relay" with 410Ω coil and changeover contacts.

Fuse
FS1 100mA cartridge fuse, 1¼in.

Lamps
LP1 lamp, 240V 100W
LP2 lamp, 240V 100W

Miscellaneous
Metal case (see text)
Veroboard, 0.15in. Matrix, 2.5 x 3.75in.
Panel-mounting fuseholder, for FS1
2 lampholders, batten mounting
Control knob
Veropins, as required
3-core flexible lead
2-core flexible lead
4-way tagboard
Nuts, bolts, wire, etc.

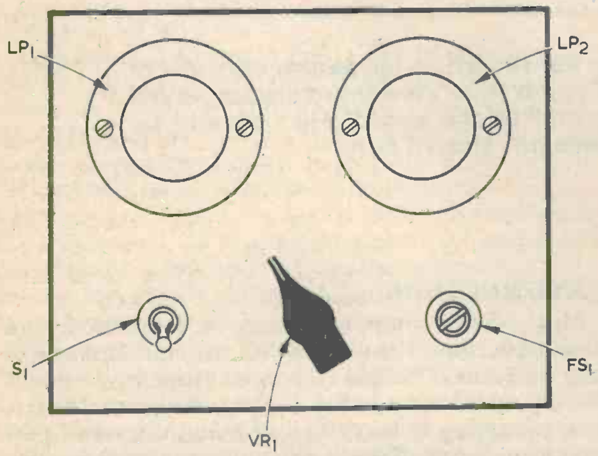


Fig.3. Apart from the thermistor and the lamps, the components are all enclosed in a metal case. The two lampholders, S1, VR1 and the fuseholder are fitted to the top panel.

The relay employed is an "Open" type with 410Ω coil and is intended for direct mounting to a printed circuit board. If it is held over the Veroboard with its armature downwards it will be found that its tags are approximately at the Veroboard holes shown in the diagram. The tags may be bent and the Veroboard holes enlarged as required so that the relay then seats onto the board with its tags soldered to the appropriate strips. The bending of the tags must be done very carefully as these are fragile. This point applies particularly to the two coil tags, as the plastic in which they are anchored can be easily broken. Before finally fitting the relay two link wires to holes E21 and E23 must be fitted. These are thin insulated wires, and must be pressed flat down on the board so that they do not interfere with the operation of the relay armature.

It is, of course, necessary to make all the cuts in the copper strips shown in Fig.2 before soldering any component to the board. At three locations, cuts are made at two adjacent holes. An instance occurs at holes P4 and P5. If desired, all the copper between these two holes may be removed to give greater isolation, and the same procedure may be observed at the other two locations. The double cuts are made to ensure good isolation at circuit points which are at live mains potential either directly or via LP1 and LP2.

The circuit is assembled in a metal box which is large enough to take all the parts comfortably with no crowding. A suitable case would be an aluminium box measuring 8 by 6 by 3in. The front panel layout is shown in Fig.3. Two batten lampholders for LP1 and LP2 are mounted on the top of the box as also are S1, VR1 and FS1. The 3-core mains input lead and a 2-core wire to the thermistor pass through holes, fitted with grommets, drilled in one of the sides of the case. The wire to the thermistor should have a length equal to or slightly greater than the height of the airing cupboard. The wire ends are soldered to the thermistor lead-outs, after which sleeving is passed over the solder joints and lead-outs.

It is very important that all precautions against accidental shock from the mains are fully observed. The metal case *must* be reliably connected to the earth wire of the 3-core mains input lead, and the lead *must* be correctly terminated in a 3-way plug with live, neutral and earth connections made as shown in Figs 1 and 2. The earth connection at the case should be given by a solder tag secured to the case by a nut and bolt. The fuseholder should be wired in the manner shown in Fig.4, so that there is less risk of shock when the fuse is unscrewed. Apart from the thermistor there should be no access to any circuit point which is at mains potential when the lid of the box is in place, and that lid should be secured by at least two screws. All the exposed circuit points at the thermistor must be fully covered with insulating tape.

A further point to remember is that the metal framework of the relay is common with its contact arm and is, therefore, at mains potential. Resistors R1 and R2 run warm and care must be taken to ensure that plastic covered insulated wires are kept well away from these two components when the lid of the box is fitted in place.

INSTALLATION

The two 100 watt lamps in series dissipate roughly 50 watts between them, and this has been found

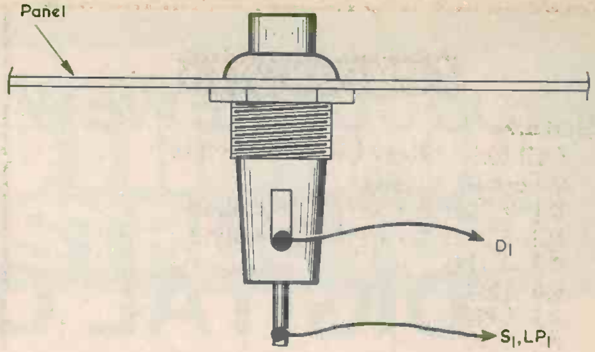


Fig.4. The fuseholder should be wired up in the manner shown here. This reduces the risk of shock when the fuse is removed.

adequate for airing a cupboard of the size already mentioned. Generally, plain glass lamps are cheaper than the pearl types, so these are the type preferred. One reason for using two lamps in series is that they are under-run and their life considerably extended. Also, the heating affect is spread over a larger area.

The unit is placed at the bottom of the cupboard with the lamps uppermost. Take care that nothing can fall on it, especially clothing or other items which might interfere with the thermal feedback between lamps and thermistor and so cause local overheating. People using the cupboard must always ensure that items are stacked so that they cannot fall. The thermistor is positioned at, or near, the top of the cupboard. This, too, should be kept well away from clothing or other items which could interfere with the correct operation of the circuit.

The use of dropper resistors instead of a mains transformer might, in some applications, be considered wasteful of power. In this circuit, which is *designed* to produce heat, the fact that some 3 watts of power is dissipated in the resistors is of no consequence. With a total rating of around 50 watts the unit can run continuously for 20 hours to consume 1 kilowatt-hour. Assuming that the lamps were turned on for all the time, which with VR1 correctly set up they are *not*, the monthly cost of running the heater would only be a little over £1.10. It thus makes a useful and convenient contribution to the "Save It" campaign.

As a final point it may be noted that no protective diode is connected across the relay coil. Such a diode has not been found necessary with the present circuit, with which the relay has been energised and de-energised a considerable number of times during many months of constant use. ■

SAFETY IN QUARRIES

TRADE NOTE

Marconi Avionics Limited state that orders are now being received for a specially developed rearward viewing television system intended for mounting on large capacity dump trucks of the type used in opencast sites and quarries. The company's Electro-Optical Products Division at Basildon, which supplies the system, has developed it as a private venture working in close co-operation with leading companies in the mining and construction industry.

The closed circuit television system, costing approximately £1,400, can be fitted to new vehicles or to existing fleets for greater safety. Systems have been ordered, for instance, by Orenstein and Koppel Limited for installation on their enormous new Giant Wabco 170 ton trucks. These are the largest rear dump trucks used in Europe. The new TV system comprises a rearward pointing television camera, in a rugged weatherproof housing, mounted on the vehicle and connected to a monitor in the driver's cab.

As bigger dumper trucks are introduced into mines and quarries, in the interests of efficiency, the difficulties of rearward vision become increasingly acute. Accidents can occur in which trucks are backed over tips or into high walls, other vehicles and working personnel. The idea of using television as a safety aid originated from H.M. Inspectorate of Mines and Quarries, which has thoroughly analysed the known hazards and various potential solutions.

The camera employed in the system gives a 90 degree rearward viewing angle. A single multi-core cable leaves its housing via a standard quick-realease connector and terminates in the driver's cab at an interface unit coupling to the driver's monitor. The interface unit also provides power to the system from the standard 24 volt battery source and incorporates suppression filters to eliminate interference from the vehicle's electrical systems. ■

PRODUCT REVIEW . . .

DIGITAL OHMMETER

The name "Megger" has, since 1908, marked a series of resistance measuring instruments of very robust construction and high accuracy. Old hands will remember the cranked Megger, with which a handle was turned to actuate an internal generator. The MEGGER Instruments Division (of Evershed & Vignoles Limited, Archcliffe Road, Dover, Kent, CT17 9EN) now announce the introduction of the first digital electronic instrument in the Megger range, this being the D201 DUCTER Digital Ohmmeter.

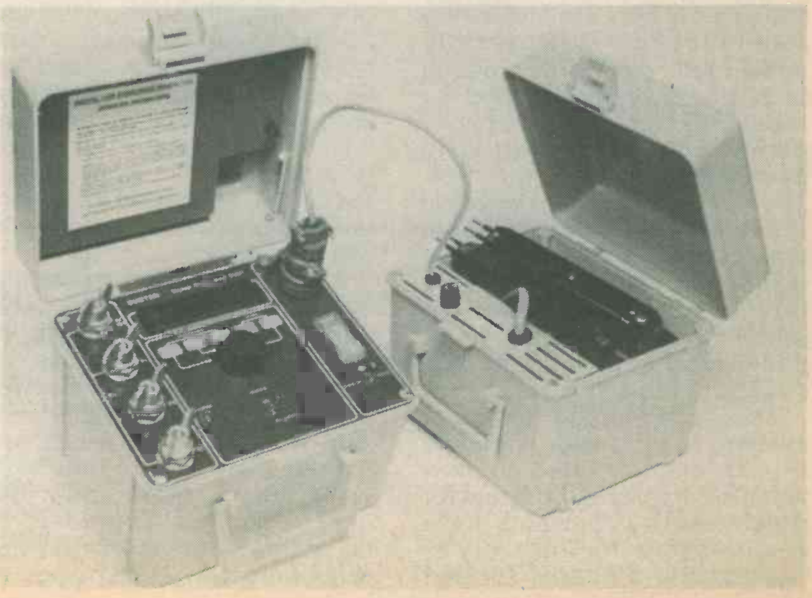
The D201 is a portable battery operated test set with five measuring ranges covering 1 microhm to 20 ohms. Range selection is achieved by a single rotary control on the front panel. Test current is up to 10 amps d.c. depending on the range in use. The instrument is especially useful for measuring earth bonding and continuity, as well as switch and circuit breaker contact resistance. It may be used for resistance measurements of fuses, lightning conductors, transformer windings, armatures, busbar joints, welded connections and rail-bonds.

The instrument employs a 4-terminal measuring system, the sample under test being connected by wing-nut terminals. The measured value is presented as a direct reading on a 3½ digit l.e.d. display. The characters are large and easy to read, being 12mm. high, and there is automatic indication of the decimal point.

Power is given by internal rechargeable batteries. A separate battery charger unit is available, and this operates from a mains supply of 240 volts, 50 or 60Hz. Two battery test positions ensure that a check can be made at any time on the battery powering the digital electronics and also on the batteries which supply the measuring current.

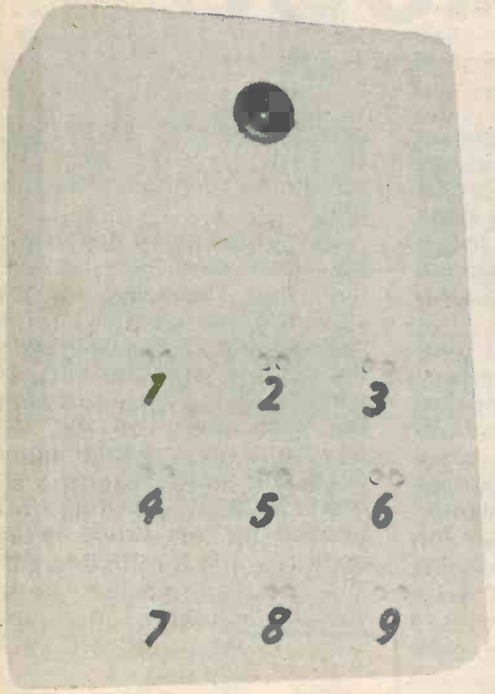
The D201 is housed in a robust ABS plastic case with a carrying handle and a detachable lid, which also acts as a light shield for the digital display under bright sunlight conditions. The charger unit is supplied in a similar case and space is provided for the storage of test leads. Both items are shown in the photograph, the charger unit being on the right.

Possessor of a proud name, the portable instrument on the left is the Megger digital ohmmeter type D201, with a measuring range from 1 microhm to 20 ohms. The internal batteries may be charged at any time from the special mains charger unit, which is shown on the right.



RADIO & ELECTRONICS CONSTRUCTOR

IN NEXT MONTH'S ISSUE



CMOS COMBINATION SWITCH

- Negligbly low standby current
- Automatic inhibit on selection of incorrect contacts
- Finger-tip operation.

LINEAR SCALE OHMMETER

Suggested Circuit

RADIO DISTRIBUTION FAULT

In Your Workshop

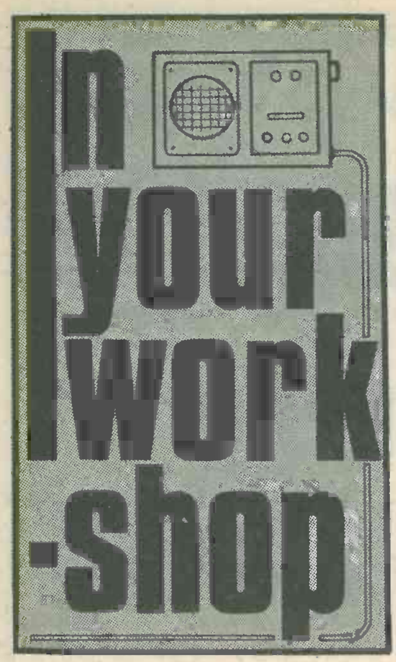
TREMOLO MODULATION UNIT

Easily made circuit adds brilliance to guitars, organs and electronic music. Opto coupling gives smooth modulation.

COIL-COUPLED S.W. CONVERTER

Inductive coupling to M.W. radio – no wires. 19-67 metres. Full Superhet Selectivity

PLUS MANY OTHER ARTICLES



CROWBAR PROTECTION CIRCUIT

"Output power: 30 watts per channel into 8Ω, 40 watts per channel into 4Ω.."

Impressed, Dick raised his eyes from the specification in the service manual. He glanced again at the manual's title, which described the equipment on his bench. "Hi-Fi Stereo Tuner Amplifier and Turntable Unit." The equipment certainly gave every indication of offering what, for domestic purposes, was a more than adequate power output. On its top was the gram turntable and on the front panel were an output meter, a tuning meter, comprehensive bass and treble tone controls, volume and balance controls, a set of function switches, a pilot light and a row of touch tuning contacts. Whoever had brought the unit in for servicing had been thoughtful enough to include the two speakers in their cabinets. And those cabinets were good and large.

Dick set up the speakers on the floor on either side of his bench, ensured that they were plugged into the correct DIN sockets on the rear panel of the unit and connected its mains lead to one of the sockets at the back of his bench. He switched on.

BLOWN FUSE

Nothing happened.

There was no sound from the speakers and the pilot light on the front panel remained extinguished. To all intents and purposes the unit was completely dead. Dick turned to the circuit diagram in the service manual and examined the power supply section. The mains transformer had two secondary windings, one providing high current positive and negative supply rails at 29 volts each for the power amplifiers in both channels, whilst the other provided a lower current single positive supply for the tuner circuits, the audio pre-amplifiers, the touch tuning circuits and the remaining sections of the unit. (Fig.1.)

Dick gazed at the power supply circuit and then his eyes narrowed. There was a 1 amp cartridge fuse in series with the mains input to the primary of the mains transformer. He switched off the unit, located the fuse-holder on the rear panel and unscrewed the fuse. Next, he switched his test-meter to an ohms range and applied its test prods to the ends of the cartridge fuse.

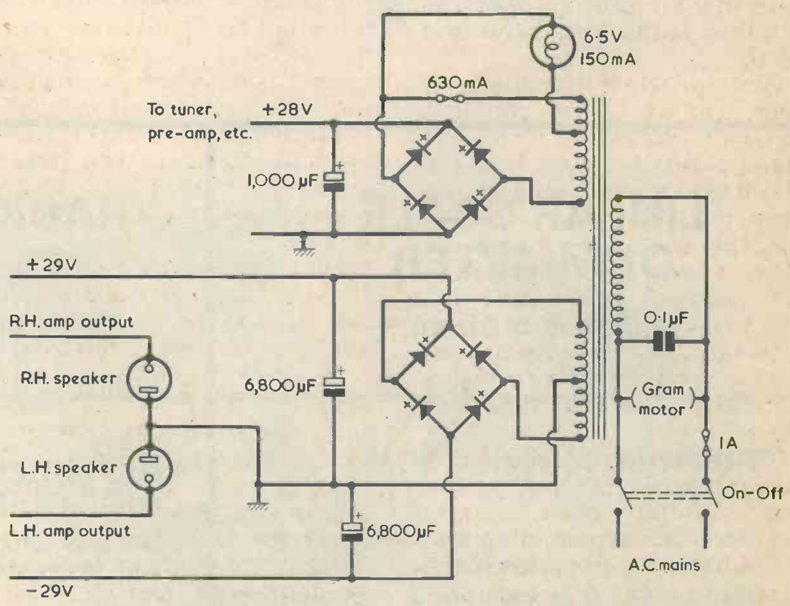


Fig.1. Power supply circuit in the hi-fi unit serviced by Dick. The two 29 volt rails supply the right and left hand power output amplifiers. The pilot lamp connects to a 6 volt tap in the upper mains transformer secondary.

There was no continuity: the fuse had blown. Dick studied the service manual once again.

"Hey, Smithy!"

"Hullo."

"I've got a hi-fi unit here with a blown mains input fuse."

"So?"

"Well, the service manual says you're supposed to replace the fuse only with one which has been approved by the manufacturer of the unit."

"Oh."

Smithy put down his soldering iron and walked over to Dick's bench. Bending over, he looked at the hi-fi unit and then at the service manual circuit.

"We're in luck here," he announced. "I've got a few 1 amp fuses of the recommended type in the spares cupboard. Hang on a jiffy and I'll see if I can find them for you."

After a little searching, Smithy produced a small cardboard box and returned with it to Dick's side.

"You'd better be careful with these fuses," he warned. "I've only got three left. If you blow these you'll have to wait until I can get some more ordered in."

"Well, shall I fit one of them right now and see what happens when I switch the unit on?"

"All right," conceded Smithy. "But if it goes, you'll have to start looking for shorts or other faults inside the unit itself."

Dick quickly fitted the new fuse into its spring cap and screwed the latter into the fuse-holder. He switched on. There was a noticeable thump from the right hand speaker and the pilot lamp came on. Then, after a brief moment, it extinguished again and the unit became dead once more. Dick switched off, unscrewed the fuse and checked it with his testmeter. The new fuse had blown.

"There's another fuse in this power supply circuit," stated Smithy as he looked down at the service manual diagram. "It's a 630mA job and it's in the supply circuit for the pre-amplifier and tuner part of the unit. Check that fuse."

Obediently, Dick located the 630mA fuse and unscrewed it. As he applied the testmeter prods to its ends the meter needle swung over to indicate zero ohms.

"That one's all right."

"Fair enough," said Smithy. "Well, at the expense of one fuse we've already learned enough to make a few inspired guesses as to what's wrong here."

"Already?"

"Of course," retorted Smithy. "For a start that pilot lamp came on. This makes it probable, although not entirely certain I'll admit, that there are no shorts in the mains transformer or the circuits immediately connecting to the mains transformer. If there had been it's doubtful whether the lamp would have lit up, and the fuse would have almost certainly blown as soon as the on-off switch contacts closed. Secondly, the 630mA fuse you've just checked is okay. So that rules out possible shorts in the sections of the unit which that fuse supplies."

"Well, I'll agree with what you've said up to now."

"Good. Let's next look at the supply circuit for the power amplifier section of the unit. The mains transformer secondary is centre-tapped, with the centre-tap connecting to chassis. The result is that it gives two supply rails, one being positive of chassis and the other negative of chassis. The important thing here is that there are no fuses in the rectifier circuit or in either of these supply rails, which means that the unit has almost certainly been designed so that if there are any faults in the power amplifiers it will be the 1 amp mains input fuse which blows. Okay?"

"In other words," said Dick slowly, "We can fully expect the fault to be in the power amplifier section of the unit."

"Everything points that way," replied Smithy cheerfully. "I should start looking for obvious shorts or other faults in the right hand channel power amplifier."

"Come *on*, Smithy! You can't locate the fault as closely as that with just one fuse blowing!"

"That right hand channel idea is only a suggestion," stated Smithy mildly. "I'm almost certain I heard a thump in the right hand channel

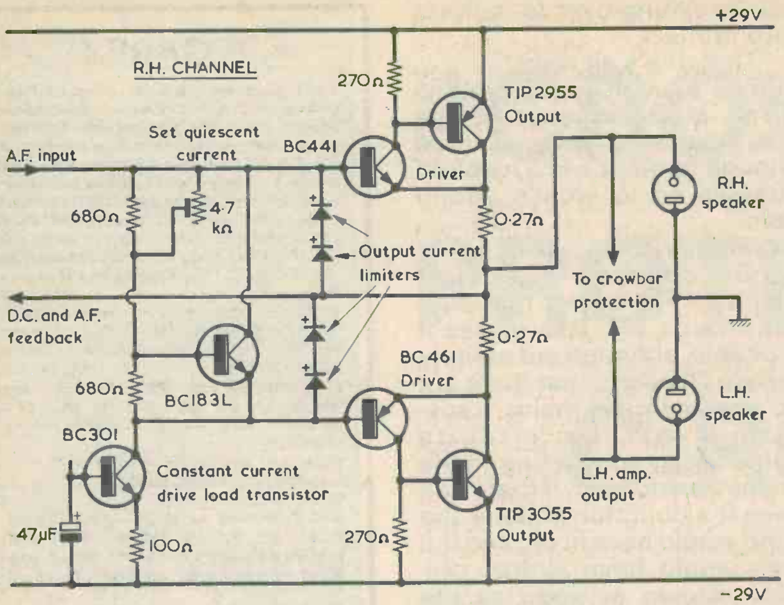


Fig.2. The driver and output transistors of the right hand channel amplifier appear in the circuit shown here, with connection to the right hand speaker being made via a DIN socket. The left hand amplifier stages are identical.

speaker when you switched on the unit just now. If they were working properly, both the left hand and right hand power amplifiers should be giving an output voltage which is midway between the supply rails or, in other words, is at about the same potential as chassis. The two speakers connect between the amplifier outputs and chassis, and it was only the right hand speaker which gave the thump. Start looking for trouble in the right hand section, or for any other thing which could cause the right hand output to be at an incorrect voltage. It could be something quite simple like a short in the output or driver transistors."

CIRCUIT TESTING

With these words, Smithy left his assistant and proceeded to his own bench.

Dick removed the mains plug of the hi-fi unit and turned his attention to the circuit of the power amplifier section as shown in the service manual. It was certainly far more complex than the simple a.f. amplifiers he was used to, but the two output transistors and their driver transistors could be easily identified. His eyes faltered momentarily as he noticed a part of the circuit following the amplifier which was designated "Crowbar Protection". (Fig.2.)

Dick frowned. Crowbar protection? What in heck was crowbar protection? He shrugged his shoulders. He had enough mysteries to contend with as it was without adding crowbar protection to the list. A lunatic image arose in his mind of a circuit which blew out warning puffs of smoke if anyone tried to break into the hi-fi unit with a crowbar, and he dismissed it irritably. Like electronics is getting too involved, man.

He started to dismantle the unit and was soon able to reach the power amplifier board with his test prods. His meter was still switched to the ohms range and he happily started to check through the power amplifier section for obvious short-circuits. Now, this was something he could do any time of the day . . .

"Hey, Smithy!"

"What is it now?"

"You were right. There *was* a short in the right hand power amplifier section."

"Was there?"

Smithy sounded pleased.

"It was in the BC441 driver transistor. There's a 100% dead short between its base and collector." (Fig.3.)

Smithy walked over once more to look at the circuit diagram of the hi-fi unit.

"It's nice," he remarked in a gratified tone, "to know that one of my guesses has turned out right. That short in the driver transistor would certainly cause the output voltage to be well away from its proper potential, which should be midway between the supply rails."

"It will also," remarked Dick, "explain the thump in the right hand speaker when I switched on. But I don't see how the short in the transistor could have caused the 1 amp input fuse to blow."

"That bit's obvious," replied Smithy. "The unbalance at the right hand amplifier output would have triggered off the crowbar protection circuit."

Dick sighed.

"I've been trying to keep that crowbar protection business out of my mind ever since I started looking at the circuit of this power amplifier. What on earth is a crowbar protection circuit?"

"It's a circuit which puts a dead short-circuit across the supply rails when there's a fault condition," explained Smithy. "It acts as though you put an imaginary crowbar across the rails. When the crowbar circuit is triggered the consequent short across the

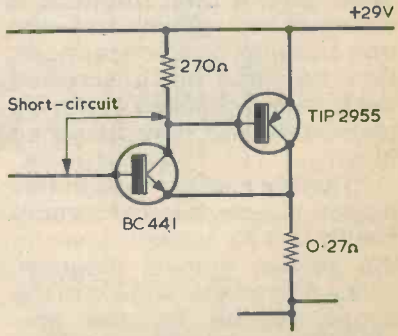


Fig.3. Simple ohmmeter checks led Dick to a base-collector short-circuit in the BC441 driver transistor.

rails causes the mains input fuse to blow."

"But why have a crowbar protection circuit in the first place?"

"Because," said Smithy, "there are a number of faults in the power amplifier circuit which could cause damage to components but which do not result in the supply current consumption rising to a fuse-blowing level. The crowbar protection section detects these faults and then proceeds to blow the fuse for you!"

CROWBAR OPERATION

Dick sat back on his stool.

"This," he said, "you'll have to explain to me."

Smithy glanced at his watch.

"All right," he said equably, "the crowbar protection in this hi-fi unit is very simple and it won't take long to show you how it works. If you look at the circuit in the service manual you'll see that it has four transistors and a silicon controlled rectifier, or thyristor."

Smithy pointed to the circuit in the manual. (Fig.4.)

"Now there's a 22μF electrolytic," he resumed, "which acts as an input reservoir capacitor. The output of the right hand channel amplifier couples to it via an 820kΩ resistor, and the output of the left hand amplifier couples to it via another 820kΩ resistor. Under quiescent conditions, the outputs of both amplifiers should be at, or very close to, chassis potential so that either zero voltage or a very low voltage appears across the capacitor."

"What about when the two amplifiers are handling a signal?"

"In that case the average voltage from each amplifier output should still be zero. Now in our case we had a fault which caused the right hand output to be other than zero with respect to chassis under quiescent conditions. But there are other faults which could make themselves shown when the left and right hand amplifiers are handling a signal, and these could cause an amplifier to give more amplification to positive half-cycles than to negative half-cycles, or more amplification to negative half-cycles than to positive half-cycles. The first of these effects would cause the non-earthy plate of the 22μF capacitor to go slowly positive, and the second would cause it to go slowly negative."

"But," protested Dick, "that 22μF capacitor is an *electrolytic!* It's non-earthy plate *can't* go negative!"

"Yes it can," replied Smithy. "For the moment forget about

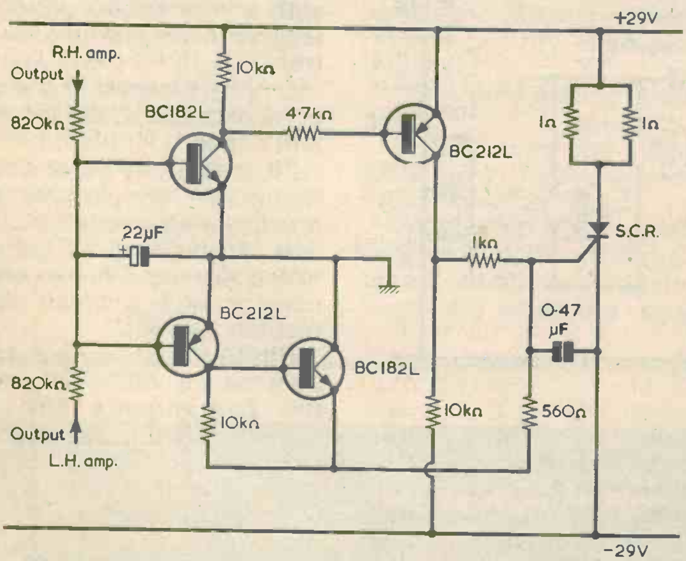


Fig.4. The crowbar protection circuit. The two 1Ω resistors in parallel limit the short-circuit current which flows when the silicon controlled rectifier, or thyristor, is fired. This circuit, and those of Figs.1 and 2, are slightly simplified versions of the corresponding circuits in the Ferguson 3987 Hi-Fi Unit.

it being an electrolytic and assume that it's a non-electrolytic component. Let's next see what happens when the non-earthy plate goes positive. As soon as the voltage across the capacitor reaches about 0.6 volt the upper pair of transistors will be turned on. Base current will flow into the BC182L and its amplified collector current will flow in the base of the BC212L. The BC212L collector current then flows into the gate of the thyristor via a 1kΩ resistor whereupon this thyristor turns on, short circuits the power rails and – wham – there goes the main fuse!" (Fig.5(a).)

"Gosh," spluttered Dick, "this really is something new to me. Let's see if I can trace out what happens when the non-earthy plate of that 22μF capacitor goes negative."

"Go on," said Smithy encouragingly.

"Well," stated Dick, "the voltage on that plate will go more and more negative until it reaches around 0.6 volt. This time it is the two lower transistors which will turn on. There'll be base current in the BC212L and its collector current will then be the base current for the BC182L. The BC182L acts as an emitter follower and its emitter current flows into the gate of the thyristor." (Fig.5(b).)

"Whereupon the thyristor is fired and – wham again – the main fuse blows!"

REVERSE POLARITY

Dick looked pleased with himself.

"This crowbar protection business isn't so difficult after all. Does it turn up in other circuits?"

"Oh yes," confirmed Smithy. "You may find it for instance in some colour TV supply circuits. The transistors and other components coupled to the gate of a thyristor detect fault conditions which, of themselves, would not cause sufficient current to flow to blow an input fuse. When the fault appears the protection circuit triggers on the crowbar thyristor and it is that which blows the fuse."

"There's one thing you haven't explained."

"What's that?"

"How, in the circuit we've got here, the 22μF electrolytic acts as a reservoir capacitor even when its positive plate goes negative."

"Well, to understand that you have to remember how an aluminium electrolytic is made up. One plate is an aluminium sheet, usually etched to increase its surface area, and the other plate is the electrolyte itself which is in intimate contact with all the surface of the aluminium sheet. The dielectric between the sheet and the electrolyte is a film of oxide on the surface of the aluminium sheet. This film is very thin, which explains why electrolytic capacitors have such high values."

"And that film," stated Dick with conviction, "breaks down if you apply a reverse voltage to the electrolytic."

"It doesn't break down," Smithy corrected him, "if the reverse voltage is very low. In the circuit we've been looking at, the reverse voltage is limited to about 0.6 volt by the base-emitter junction of the BC212L."

"This," wailed Dick, "goes against everything I've been taught! Never, but never, I've been told, apply a reverse voltage to an electrolytic capacitor!"

"In general you shouldn't," stated Smithy, "and especially if it's a tantalum electrolytic. However, you can get away with a very small reverse voltage with an aluminium electrolytic."

Smithy glanced at the stubborn expression on his assistant's face.

"It looks," he went on, "as though I'll have to give you a practical demonstration. See if you can hunt up a 22μF electrolytic for me. Oh, and a 4.7kΩ resistor and a small silicon rectifier as well."

Smithy walked over to his own bench whilst Dick found the components and then returned with a few crocodile clip leads and a PP9 battery.

"Here we are, Smithy," said Dick, handing the components over to him.

"Right. Well, I'll start off by wiring up the resistor and rectifier to give us a voltage across the rectifier of 0.6 volt."

Smithy soon connected the two components together and to the battery. (Fig.6(a).)

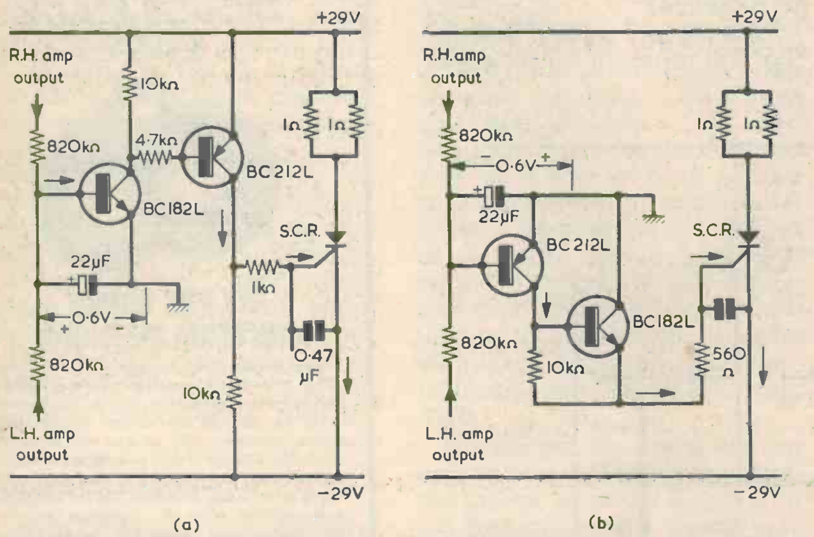


Fig.5(a). If the non-earthy terminal of the 22μF reservoir capacitor is taken about 0.6 volt positive of chassis the upper two transistors turn on and trigger the thyristor. The arrows show current flow (assumed to be from positive to negative).

(b). Taking the non-earthy terminal of the reservoir capacitor about 0.6 volt negative of chassis turns on the lower two transistors. The crowbar protection circuit monitors the outputs of both the right and the left hand amplifiers.

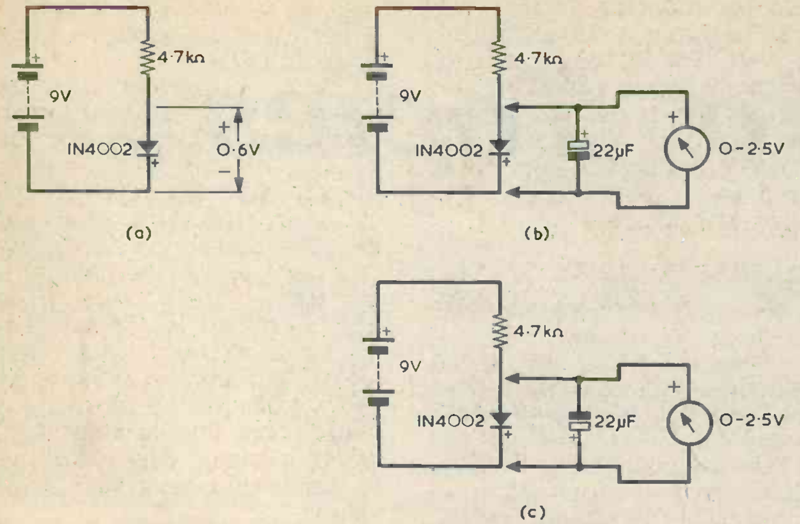


Fig.6(a). A simple circuit which offers about 0.6 volt across the silicon rectifier.

(b). Smithy connected a high resistance voltmeter across a 22μF electrolytic capacitor and temporarily applied its leads across the silicon rectifier.

(c). Smithy then repeated the process with the electrolytic capacitor connected the other way round.

"I next," he said, "want a fairly sensitive voltmeter. An electronic voltmeter would be ideal but a sensitive analogue moving-coil voltmeter will prove my point just as well. Your testmeter has got a resistance of 20,000 ohms per volt and it also has a low d.c. volts range of 2.5 volts, which I'll now select. This means that the resistance between the test leads is 50,000 ohms. I'll clip the leads to the capacitor right way round and I'll then touch the capacitor leads with correct polarity across the silicon rectifier." (Fig.6(b).)

"The meter," said Dick, "is reading 0.6 volt, which of course is what you'd expect."

"Good. I'll now take the capacitor away from the rectifier."

"The voltage reading falls fairly slowly," announced Dick, gazing at the meter, "Until it falls to zero."

"That's fair enough. The time constant of 50,000 ohms and 22μF is about 1 second, and so the fall in voltmeter reading will be slow enough to be observable. I'll now reverse the testmeter connections to the capacitor and also apply it across the silicon rectifier with reverse polarity. Here we go!" (Fig.6(c).)

"We are getting 0.6 volt again."

Smithy took the capacitor leads away from the rectifier. "And now?"

"Why, stap me," exclaimed Dick incredulously, "the voltage is falling slowly again, just like it did when the capacitor was connected with correct polarity!"

"There you are then," said Smithy triumphantly. "Are you now convinced that an aluminium electrolytic will hold a reverse charge provided that the reverse voltage is kept small?"

"Gosh, yes. But I wouldn't have believed it if I hadn't seen it with my own eyes!"

NEW TRANSISTOR

A replacement transistor for the faulty BC441 was not available, even from Smithy's capacious spares cupboard, and so it *had* to be ordered. Smithy took advantage of the situation to include an order for several dozen 1 amp fuses as well, so that he was well stocked up for the future. Cartridge fuses are neat and unobtrusive little components but, during their lifetime, they are only allowed one self-destructive bite at the cherry.

As always with Dick and Smithy, the story has a happy ending. The replacement transistor, when it arrived, completely cured the fault in the hi-fi unit, and this was able to push out all its 40 watts per channel into 4Ω loads without the crowbar thyristor even giving a hint that it intended to bring proceedings to a sudden and cataclysmic conclusion.

EDITOR'S NOTE

Smithy slipped up slightly in his description of the 6MHz sound trap shown in Fig.2 of "In your Workshop" in the April 1980 issue. The trap is a bridged-T filter offering a higher degree of rejection than does an acceptor tuned circuit. We are trying to keep this news away from Dick.

Radio Topics

* * * * *

By Recorder

Some imaginative words are coined in the discipline of electronics and they continue to appear in a truly rich profusion. In the older days, inventors of new electronic devices used to append quite stylish names to their creations, whereupon there were indignant letters to *Wireless World* if these terms happened to derive from a mixture of Latin and Greek. Nowadays, nobody bothers one little bit about the etymology of technical terms, which can so far as anyone cares stem from Latin, Greek, Chaucerian English or Outer Mongolese. Forcefulness in meaning is the essence of technical word production.

PINOUT

Take the 6-letter word "pinout".

To the uninitiated this could be a miniature version of "stake out", conjuring up a scene in which diminutive mineral prospectors mark out their own tiny areas of terrain. But in practice "pinout" merely refers to the manner in which the pins, or "leads", of an integrated circuit appear about its body. It can also apply to the lead-out layout of a transistor, a voltage regulator, a multiple varicap diode unit, or even a multi-pin relay unit intended for p.c.b. mounting. Come to think of it, the word could refer to the pin connections of those marvellously long-running Denco miniature Dual Purpose coils which plug into B9A valveholders. The first Denco Dual Purpose coils to hit the amateur market, incidentally, were designed to plug into much larger 8-pin octal valveholders, and nobody dreamed of employing such a term as "pinout" in those days.

Some conventions have arisen with pinout presentations in drawings and diagrams. So far as *Radio & Electronics Constructor* is concerned we always, with a few exceptions, present transistor pinouts, or lead-out layouts, with the pins pointing towards the reader. The exceptions occur with the occasional device which has to be drawn with its lead-outs pointing sideways, in the plane of the paper on which they are printed.

INTEGRATED CIRCUITS

Integrated circuits, on the other hand, are always presented as a top view, with the pins pointing away from the reader. You then locate pin No. 1, which usually has a dot alongside it on the i.c. housing when this is rectangular, and count the pins in order working in an anti-clockwise direction. With a round i.c. case having a locating lug, the lug normally indicates the pin having the highest number, so that pin No. 1 is the next one to the lug, working in the anti-clockwise direction.

Why should transistor and i.c. lead layouts be presented in completely opposite ways? The only answer to that is that it is one of those things which just happen. When transistors first came on the scene the manufacturers showed them in their literature with pins pointing towards the reader. And when i.c.'s settled down to their current dual-in-line housings, manufacturers' literature showed them with their pins pointing in the other direction.

It must be fun being in at the birth of an electronic device.

"Hey boss, this new device they've dreamed up in the labs is really something."

"What is it, Joe?"

"Well, nobody's quite sure, but the lab boys reckon it simulates human thought."

"Great news, Joe! How do you connect to it?"

"That's one problem to be cleared up. It uses three dimensional instead of lateral logic, and the best we can do is have its connection pins laid out in two counter-directional helices. But we don't know how to identify them."

"That's easy, Joe. Identify the pins in one helix with numbers starting from 1, and the pins in the other helix with letters starting from A."

"Hey boss, you've just created an industrial standard!"

And so is electronic history made.

MICROPROCESSOR-BASED OSCILLOSCOPE

As can be seen in the accompanying photograph, the new Tektronix Model 7854 oscilloscope presents a truly futuristic appearance. And so it should, since it combines the analogue features of a conventional oscilloscope with a microprocessor, the latter providing extensive digital storage and signal processing facilities. The fully programmable Model 7854 allows most waveform measurements to be carried out at the touch of a button, offers improved measurement quality in the presence of noise, and can be combined with a Tektronix desk-top graphics computer to form a complete signal processing system capable of carrying out a wide variety of operations on the basic waveform data.

The conventional analogue features of the oscilloscope include a bandwidth of d.c. to 400MHz at 10mV per division, calibrated sweep rates of up to 500 picasecond per division, and the ability to be used with more than thirty compatible plug-in units in the Tektronix 7000 Series.

The waveform is displayed as on a conventional oscilloscope, but it can also be digitised, stored and recalled for comparison. Digital storage of repetitive waveforms can take place at up to 400MHz, and single-shot events can be stored at sweep speeds of up to 50 microseconds per division. A plug-in unit enables pre-trigger information from zero to 100% of sweep to be displayed, and an optional memory allows up to 40 separate waveforms to be digitised and stored.

The oscilloscope is pre-programmed so that most of the normal waveform measurements (rise time, fall time, pulse width, etc.) and more complex waveform comparisons can be carried out by touching a button on the instrument's calculator-type keyboard, giving faster, more accurate and repeatable measurements. In addition, the Model 7854 can be programmed by the user to calculate specific answers. Key-stroke programs of up to 1,000 lines can be written for repetitive testing requirements, and the instrument can be set to monitor signals in the operator's absence or to automate and organise a long series of measurements.

SIGNAL AVERAGING

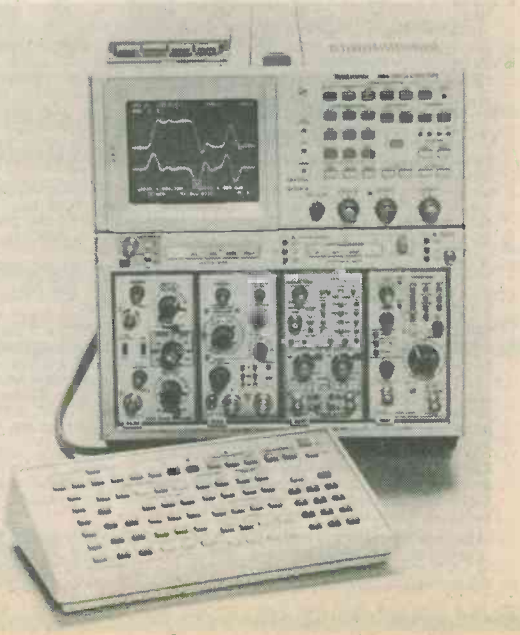
The digital storage system allows signal averaging to be carried out, so that signals buried in noise can be recovered and measurement quality can be improved. The maximum vertical and horizontal resolution of the stored data is 0.01 of a division, and the operator has a choice of 128, 256, 512 or 1,024 horizontal points per waveform. Using the storage system, the operator can make the same measurement on a one-division signal which normally takes six divisions on a conventional oscilloscope.

The Model 7854 has a GPIB (General Purpose Interface Bus) interface for users requiring additional processing, data storage or co-ordination of the oscilloscope with other instruments. Waveform data or measurement results, as well as external programming instructions, can be sent over the interface.

Tektronix also supply a signal processing system, designated WP1310, which is a combination of the Model 7854 oscilloscope and a Model 4052 graphics computing system. The computer provides flexible data communications, an easy-to-learn extended BASIC software language and high resolution graphics capabilities.

The WP1310 includes special signal processing memory packs which tailor the system for waveform processing. Among the features included are extended graphic capability, program storage and control, data storage, a hard-copy option for documentation, and the ability to interface with other computers. Further details on this oscilloscope breakthrough can be obtained from Tektronix U.K. Ltd., Beaverton House, P.O. Box 69, Harpenden, Herts.

The Tektronix Model 7854 oscilloscope system. This combines the features of a high resolution oscilloscope with the special storage facilities and operations provided by a microprocessor.



SMALL ADVERTISEMENTS

Rate: 12p per word. Minimum charge £2.00
Box No. 30p extra

Advertisements must be prepaid and all copy must be received by the 4th of the month for insertion in the following month's issue. The Publishers cannot be held liable in any way for printing errors or omissions, nor can they accept responsibility for the **bona fides** of Advertisers. Where advertisements offer any equipment of a transmitting nature, readers are reminded that a licence is normally required. Replies to Box Numbers should be addressed to: Box No. –, **Radio and Electronics Constructor**, 57 Maida Vale, London, W9 1SN.

BIGGEST RANGE SERVICE SHEETS/MANUALS. Any published sheet £1. plus s.a.e. Repair data any named TV £5.50 (with circuit set £7). S.A.E. newsletter, quotations, bargains. G.T., 76 Church Street, Larkhall, Lanarkshire.

THE BRITISH AMATEUR ELECTRONICS CLUB for all interested in electronics. Four Newsletters a year. Library of technical books and magazines. Help for members by experts. U.K. & Eire £4.50. Europe £6. Airmail £7.50:– Sterling per year. Details from Hon. Sec., J. G. Margetts, 3 Bishopstone Close, Golden Valley, Cheltenham, Glos.

COLLECTORS' ITEMS. Nearly 50 copies of RADIO Society of Great Britain's *Bulletins* covering period 1945 to 1949. In reasonable condition. Offers to: Box No. G377.

25 MIXED I.C.'S £1.50. 100 mixed transistors £3.50. Valves. Early radios. Electronic bargains. Interesting lists 15p. Sole Electronics, REC, 37 Stanley Street, Ormskirk, Lancs, L39 2DH.

£5 OSCILLOSCOPE. Standard junk box components plus approx. another £5 (Total components approx £12). This unit plugs into TV aerial socket and converts TV to oscilloscope. Circuit and plans £3. Kerr, 27 Coles Road, Milton, Cambridge, CB4 4BL.

BOOKS FOR SALE: *Experiments with Operational Amplifiers*, by George B. Clayton. £3.75. *Digital I.C. Equivalents & Pin Connections*, by Adrian Michaels, £1.20. *Experimenting with Electronic Music* by Brown & Olsen. £1.20. *Electric Model Car Racing* by Laidlaw-Dickson. 60p. *Understanding & Using Modern Signal Generators* by Charles Gilmore. £1.20. *Electronics Unravelled* by Kyle, £1. *How to Use your VOM VTVM Oscilloscope*, by Clifford, £1. *Modern Radio Repair Techniques*, by Art Margolis, £1. Box No. 394.

BOOKS AND TECHNICAL MANUALS. Electrical/electronic interest. 1930's to present. About 50. £15 for the lot. Collect Seaford. Telephone: 01-789-1629.

(Continued on page 125)

RADIO & ELECTRONICS
Constructor Projects

80 METRE AMATEUR BAND RECEIVER July	**£21.75**
CAPACITANCE MEASURING ADAPTER July	**£8.75**
REMOTE VOLUME ATTENUATOR August	**£3.00**
WIEN BRIDGE A.F. SIGNAL GENERATOR June 1980	**£8.60**
DUSK-TO-DAWN SWITCH June 1980	**£8.50**
PASSIVE LOGIC PROBE June 1980	**£2.50**
MODULATED ALARM GENERATOR June 1980	**£4.50**
RING OF LEDS PRINT TIMER January 1980	**£7.80**
LOGIC TESTER February 1980	**£3.05**
LABORATORY POWER SUPPLY May 1980	**£12.80**
DUAL POLARITY VOLTMETER May 1980	**£9.60**
STEREO MIXER UNIT March 1980	**£7.60**
INFRA-RED INTRUDER ALARM March 1980 (Relay 2p 2w £3.20 extra).	**£6.10**
TELEPHONE BELL REPEATER February 1980 (Excludes screened cable which is supplied as required).	**£5.80**
GENERAL PURPOSE 8 WATT AMPLIFIER May 1980 (Excludes etched p.c.b.)	**£12.75**

All kits include parts as specified in the article except where indicated. Batteries and solder are not supplied with any kit. Prices include VAT. Postage is 50p per kit. Please allow 10 days for delivery. Send 30p in stamps for our full lists. Mail order only.

T & J ELECTRONIC COMPONENTS
98 Burrow Road, Chigwell, Essex. IG7 4HB

A CAREER IN RADIO

Start training ***today*** and make sure you are qualified to take advantage of the many opportunities open to the trained person. ICS can further your technical knowledge and provide the specialist training so essential to success.

ICS, the world's most experienced home study college, has helped thousands of ambitious men to move up into higher paid jobs — they can do the same for *you*.

Fill in the coupon below and find out how!

There is a wide range of courses to choose from, including:

CITY & GUILDS CERTIFICATES
Telecommunications Technicians'
Radio TV Electronics Technicians'
Electrical Installations Technicians'
Electrical Installation Work
Radio Amateurs'
MPT Radio Communications Cert
EXAMINATION STUDENTS – GUARANTEED COACHING UNTIL SUCCESSFUL

TECHNICAL TRAINING
ICS offer a wide choice of non-exam courses designed to equip you for a better job in your particular branch of electronics, including:
Electronic Engineering & Maintenance
Computer Engineering/Programming
Radio, TV & Audio Engineering & Servicing
Electrical Engineering Installations & Contracting

COLOUR TV SERVICING
Technicians trained in TV Servicing are in constant demand. Learn all the techniques you need to service Colour and Mono TV sets through new home study course approved by leading manufacturer.

POST THIS COUPON OR TELEPHONE FOR FREE PROSPECTUS

I am interested in . . . .

Name . . . . Age . . . .

Address . . . .

. . . . Occupation . . . .

ICS *Accredited by CACC Member of ABCC*

To International Correspondence Schools Dept Z278, Intertext House, LONDON SW8 4UJ or phone 01-622 9911 (anytime)

SMALL ADVERTISEMENTS

(Continued from page 123)

JOIN THE INTERNATIONAL S.W. LEAGUE. Free services to members including Q.S.L. Bureau, Amateur and Broadcast Translation, Technical and Identification Dept. – both Broadcast and Fixed Stations, DX Certificates, contests and activities for the SWL and transmitting members. Monthly magazine, *Monitor*, containing articles of general interest to Broadcast and Amateur SWLs, Transmitter Section and League affairs, etc. League supplies such as badges, headed notepaper and envelopes, QSL cards, etc., are available at reasonable cost. Send for League particulars. Membership including monthly magazines, etc., £6.00 per annum. (U.K. and British Commonwealth), overseas $12.00. Secretary ISWL, 1 Grove Road, Lydney, Glos., GL15 5JE.

PEN TYPE SIGNAL INJECTOR available for £2.50 including air freight. Business Promotion Bureau, 376 Lajpat Rai Market, Delhi 110006, India.

FOR SALE: Wide angle 9.5mm cine equipment: camera, projector, screen, etc. Also several other 9.5mm cine cameras. S.A.E. for details Box No. G388.

WANTED: FAX equipment, manuals, service sheets, etc. G2UK, 21 Romany Road, Oulton Broad, Lowestoft, Suffolk. NR32 3PJ.

WANTED: Service manual – Ekco car-portable type CP 920. To buy or borrow. Box No. G398.

WANTED: Service Manual, circuit diagram of Telequipment Serviscope Type S51A. To buy or borrow copy. Expenses refunded plus small remuneration. 35 Stanhope Road, Swanscombe, Kent, DA10 0AN.

ELECTRICAL/ELECTRONICS WORKSHOP. Remains. Many motors, transformers, variable condensers, meters (including 2 multimeters, large microammeters, CR bridge), switches, relays, etc., etc. Some obsolete and some modern. Offers around £70 for the lot. To be collected from Seaford, Sussex. Telephone 01-789-1629.

AMATEUR REORGANIZING WORKSHOP has the following items for sale in working order. Avo 8 £35. Advance audio signal generator £18. Cossor 1052 D.B. 'scope £20. Cossor 2½ inch miniscope £16. Triplet a.m. signal generator 100kHz – 25MHz £20. BC221 frequency meter £20. Also variacs, auto transformers and meggers. State wants. S.A.E. enquiries. Carriage extra. Box No. G395.

HEATHKIT DIGITAL DISPLAY shelf clock with Westminster chimes. Used one month only. £80. (Cost £160). Telephone:– Southend (0702) 711181.

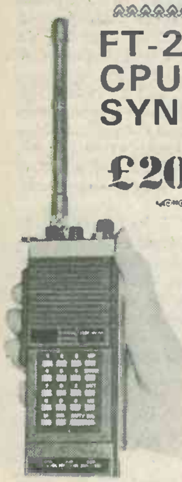
FOR SALE: A number of "D & S" three pin, fused, mains plugs and fuses. S.A.E. for details. Box No. G396.

(Continued on page 126)

AMATEUR RADIO EQUIPMENT & ACCESSORIES

YAESU FT-202R 2 METER HAND-HELD FM TRANSCEIVER "THE HANDIE"

£101 INC. POSTAGE



FT-207R CPU CONTROLLED SYNTHESIZED HANDIE

WITH CHARGER

£209 INC. POSTAGE

SEND CWO OR ACCESS CARD NUMBER

for our latest catalogue plus £3.60 VOUCHER!

SEND 36p IN STAMPS – (STATING INTEREST)

TO: Amateur Electronics
East Ruston
Norfolk. NR12 0RU

YAESU *The radio.*

MARCO TRADING

To obtain a free copy of our 35 page list simply send a 20p postage stamp or a large SAE. This advertisement shows only a part of our range. (Our new list includes Tants, Electrolytics, Disc ceremics, etc.)

400m/w ZENOR DIODES

Low Price

3V6, 3V9, 4V3, 4V7, 5V1, 5V6, 6V2, 6V8, 7V5, 8V2, 9V1, 10V, 11V, 12V, 13V, 13V5, 15V, 16V, 18V, 20V, 22V, 24V, 27V, 30V, 33V

Price: 8p each 100 any mix £6.00

RESISTORS

½W at 40°C 5% tol., 2.2 Ω to 2M2, E12 2p each.
Resistor Pack — 2.2 Ω -2M2, 10 each value (730 resistors) £6.00

1 watt ZENER DIODES

3V3 to 200V Full range
Price 15p each 100 any mix £12.50

8	DIL	10p	22	DIL	23p
14	DIL	13p	24	DIL	24p
16	DIL	15p	28	DIL	28p
18	DIL	18p	40	DIL	40p
20	DIL	22p			

VEROBOARD (Copper Clad)

Size Inch	0-1"	0.15
2.5 x 1	20p	N/A
2.5 x 5	55p	56p
2.5 x 3.75	46p	50p

Vero Wiring Pen (Including spool of wire) £2.84

CONNECTING CABLE

Black. Blue. Green. Grey. Orange. Pink. Red. White. Voilet. Yellow. Brown.
Singles 5p per metre
7/0.2mm 5p per metre
16/0.2mm 8p per metre

TANT. BEAD CAPS

0.1/35v	12p	4.7/35v	12p
0.22/35v	12p	33/6.3v	25p
1.0/35v	12p	47/10v	30p

SUB. MIN. TOGGLE SWITCHES

SPST— 70p
SPDT— 78p
DPDT— 82p
DPDT— (C-OFF) 90p

BRIDGE RECTIFIERS

50V	32p	400V	50p
400V	43p	6.0 Amp 50V	70p
800V	58p	200V	78p
2.0 Amp 50V	35p	400V	85p
100V	42p		

0.1W SUB. MINIATURE PRE-SETS

100 Ω to 1 Meg Vertical or Horizontal
Price: 6p each. 100 any mix £4.50

AC128	20p	BC125	10p	BC184	9p
AD149	58p	BC147	8p	ZN3055	48p
BC107	10p	BC153	10p	BY127	12p
BC108	10p	BC172	8p	IN4007	8p
BC109	10p	BC183	9p	IN4148	2p

Full range of Penel Meters available £6.25 each

SPECIAL OFFERS

BRAND NEW METAL SLIDER POTENTIOMETERS

60mm TRACK	1+	100+
500 ohm Lin. Mono	35p	28p
50K Log. Stereo	40p	30p
100K Lin. Stereo	40p	30p
1 Meg Log. Stereo	40p	30p

BZY96 ZENERS (2½W) – 6vZ
1+ 20p each
100+ 12p each

Other values available in 45mm track – send for list.

Send your orders to:

DEPT DP12, MARCO TRADING, THE OLD SCHOOL, EDSTASTON, Nr. WEM, SHROPSHIRE SY4 5RJ
Tel: Whixall (094872) 464/465

Please add 30p postage and packing to each order and add 15% VAT to your total order. Export add NO VAT but add postage. Air/Sea at cost

SMALL ADVERTISEMENTS

(Continued from page 125)

COMPONENTS, Items, Bargains. Various lists 15p or s.a.e. Sole Electronics (REC), 37 Stanley Street, Ormskirk, Lancs., L39 2DH.

THE RADIO AMATEUR INVALID & BLIND CLUB is a well established Society providing facilities for the physically handicapped to enjoy the hobby of Amateur Radio. Please become a supporter of this worthy cause. Details from the Hon. Secretary, Mrs. F. E. Woolley, 9 Rannoch Court, Adelaide Road, Surbiton, Surrey, KT6 4TE.

INTERESTED IN OSCAR? Then join AMSAT-UK. Newsletters, OSCAR NEWS Journal, prediction charts, etc. Details of membership from: Ron Broadbent, G3AAJ, 94 Herongate Road, Wanstead Park, London, E12 5EQ.

FOR SALE: Photographic enlarging equipment: Vivitar enlarger. Model E.36 with 50mm f. 3.5 and 75mm f.3.5 lenses. Kodak safety light. Kodak contrast filter set. 11 in. x 14 in. printing frame with copying facilities. Measuring flask. Three trays, three tweezers. Three plastic bottles. Clips. Printing paper. Antistatic brush for cleaning negatives. Kodak Photoguide Booklet. Man's protective apron. £75 o.n.o. Pair of Goodman's speakers 8 ohms, 15 watts, £50 o.n.o. R. L. Gee, 3 Longfellow Drive, Hutton, Essex, CM13 2QQ.

BOOKS FOR SALE: *Amateur Radio Antennas* by Harry Hooton, £1. *Ham Antenna Construction Projects* by J. A. Stanley, 75p. *All about Cubical Quad Antennas* by W6SAI, £1. *Radio Astronomy for the Amateur* by Dave Heiserman, £2. *HAM-RTTY* by W2NSD, 50p. All plus postage. Box No. G397.

POSTAL ADVERTISING? This is the Holborn Service. Mailing lists, addressing, enclosing, wrapping, facsimile letters, automatic typing, copy service, campaign planning, design and artwork, printing and stationery. Please ask for price list. – The Holborn Direct Mail Company, Capacity House, 2-6 Rothsay Street, Tower Bridge Road, London, S.E.1. Telephone: 01-407 6444.

INTERESTED IN RTTY? You should find the *"RTTY Journal"* of interest. Published in California, U.S.A., it gives a wide outlook on the current RTTY scene; RTTY-DX; DXCC Honour Roll; VHF RTTY news; and up to date technical articles are included. Specimen copies 35p from: The Subscription Manager, RTTY Journal, 21 Romany Road, Oulton Broad, Lowestoft, Suffolk, NR32 3PJ.

(Continued on page 127)

SMALL ADVERTISEMENTS

(Continued from page 126)

RADIO/RADIO & ELECTRONICS CONSTRUCTOR. 1950 – 1979 bound volumes. Also *Wireless World* 1955-1975 bound and some *Practical Electronics*. Collect Seaford. Telephone: 01-789-1629.

PERSONAL

JANE SCOTT FOR GENUINE FRIENDS. Introductions to opposite sex with sincerity and thoughtfulness. Details free. Stamp to: Jane Scott, 3/Con North St. Quadrant, Brighton, Sussex, BN1 3GJ.

BROADLANDS RESIDENTIAL CLUB for elderly people. Are you recently retired and looking for a home? We have a delightful top floor room overlooking Oulton Broad, facing south. Write to: The Warden, Broadlands Residential Club, Borrow Road, Oulton Broad, Lowestoft, Suffolk.

SPONSORS required for exciting scientific project Norwich Astronomical Society are building a 30" telescope to be housed in a 20" dome of novel design. All labour being given by volunteers. Already supported by Industry and Commerce in Norfolk. Recreational. Educational. You can be involved. Write to: NAS Secretary, 195 White Woman Lane, Old Catton, Norwich, Norfolk.

IF YOU HAVE ENJOYED A HOLIDAY on the Norfolk Broads, why not help to preserve these beautiful waterways. Join the Broads Society and play your part in determining Broadlands future. Further details from: – The Hon. Membership Secretary, The Broads Society, "Icknield," Hilly Plantation, Thorpe St. Andrew, Norwich, NOR 85S.

Give for those who Gave

WINGS APPEAL

During September

COMMUNICATIONS RECEIVERS part of Navy CAS equipment made by Murphy Radio 5 band Rx covers 60 to 550Kc two bands and 1.5Mc/s to 30Mc/s three bands. The Rx uses a total of 13 B7g valves as two RF stages, Sep L.O. 3x IF stages at 800Kc Det, Noise Lim, 2x AF stages, BFO, Crystal Cal at 800Kc, the O/P stage matches to 100 ohm phones and a 600 ohm 2 watt speaker line. Controls main tune, band sel, RF gain, LF gain, Phone gain, AGC on/off, Selectivity at 8,3,1Kc and 200c/s the 1Kc position uses a bandpass crystal filter, the 200c/s uses crystal plus Audio filter, BFO this swt selects upper or lower beat or tune also selects 800Kc crystal cal, their are two O/P jacks for phones and one for speaker on front panel, provision for 75 ohm Ae I/P or long wire. Complete in steel case size 13 x 14" front 14" deep these Rx req ext power supplies of 250v HT and 150v Stab total load 100Ma 6.3v AC at 4 amps. Their is room inside the case to buils internal P.U. Rx supplied Tested with copy of Circuit and 40 page handbook, more details on request. £115. VIDEO RECORDERS Philips type LDL100 portable monochrome 625 line recorder reel to reel ½" tape 75 ohm I/P 1v sig .4v sync 75 ohm O/P ext size 42 x 34 x 20 Cm weight 12Kg we also have a few /2 models these are table case version, both 240v 50c I/P these are supplied in good cond with 80 page handbook and tested, fuller spec on request.- £185.

ARMY RADIO station 128 small low power T/Rx covers 2 to 8Mc/s tunable Rx with crystal controlled Tx normally operates from dry batteries 135v and 1.5v supplied with haversack, battery holder, morse key, aerial wire, headphones and circ. £25.

MAINS INVERTORS small 12v DC I/P 240v O/P at 20 watts square wave at 50c/s in case size 6½ x 4½ x 3" stab freq from UJT, okay for Soldering irons or AC/DC razors with rect O/P tested £15.

PANEL VARIAC small type 200/250v O/P 0 to 240 at 700Ma max ex new equip with knob 9.50.

Above prices include Postage & Vat goods ex equipment unless stated new, 2 x 10p stamps for list 25/1.

A. H. SUPPLIES

122, Handsworth Road, Sheffield. S9.4AE.
Phone 444278 (0742).

BUILD YOUR OWN

P.A., GROUP & DISCO SPEAKERS by R. F. C. Stephens

Save money with this practical guide. Plans for 17 different designs, Line source, I.B., Horn and Reflex types, for 8"-18" drive units. £3.95 post free ($8 overseas).

THE INFRA-BASS LOUDSPEAKER by G. Holliman

(full constructional details for versions using 15", 12" and 10" (drive units). £2.95 post free ($6 overseas).

THE DALESFORD SPEAKER BOOK by R. F. C. Stephens

This books is a must for the keen home constructor. Latest technology DIY designs. Plans for I.B., and Reflex designs for 10-100 watts. Also unusual centre-bass system. £2.20 post free ($5 overseas).

VAN KAREN PUBLISHING
5 Swan Street, Wilmslow, Cheshire

NEW ELECTRONIC BOOKS

Build Your Own Transistor Radio	£2.25
TV Trouble Diagnosis Made Easy	£2.75
Electronic Musical Projects	£2.30
Electronic Gadgets for You	£2.25
Transistor Circuits & Servicing	£2.25
555 Timer & Its Applications	£2.40
Electronic Hobby Circuits	£2.25
Simple Crystal Diode Circuits	£2.25
Fascinating I.C. Projects	£2.30
Transistor Receivers Self-Constructor	£3.10
Build Your Own Digital Clock	£2.75
Cassette Recorders; How They Work; Care & Repair	£5.95
Build a 2-Band Silicon Transistor Radio	£2.30
Pictorial Guide to Colour TV Circuit Problems	£5.95

Books postpaid from:

FINBARR'S LTD.,
16 Turketel Road, Folkestone, Kent.

MAIL ORDER ONLY

"TWO 20dB AMPLIFIERS" – PART 1. **PRINTED CIRCUITS** There is no need to make up and print your own circuit board for this project – we can supply the board fully printed, prepared and ready for use. The board is glass fibre, roller tinned and drilled – just fit components and solder! Price for each board 68p plus 25p post and packing by mail order from BRB PRINTED CIRCUITS, 109 Potter Street, Worksop, Notts., S80 0BY.

RADIO & ELECTRONICS CONSTRUCTOR

Single Copies
Price **60p** each, p&p **18p**
Issue(s) required . . . .

Annual Subscription
Price **£9.50 inland, £10.50 overseas (including Eire)**
post free, commence with . . . . issue

Bound Volumes:

Vol. 27.	August 1973 to July 1974	Price **£3.00**, post & pkg **£1.30**
Vol. 28.	August 1974 to July 1975	Price **£3.20**, post & pkg **£1.30**
Vol. 29.	August 1975 to July 1976	Price **£3.50**, post & pkg **£1.30**
Vol. 30.	August 1976 to July 1977	Price **£3.70**, post & pkg **£1.30**
Vol. 31.	August 1977 to August 1978	Price **£5.20**, post & pkg **£1.30**
Vol. 32.	September 1978 to August 1979	Price **£5.50**, post & pkg **£1.30**

CORDEX SELF-BINDERS

With title, 'RADIO & ELECTRONICS CONSTRUCTOR' on spine, maroon only — Price **£2.25**, post & pkg **50p**
With no title on spine, maroon — Price **£2.25**, post & pkg **50p**
With no title on spine, green — Price **£2.25**, post & pkg **50p**

Prices include V.A.T.

DATA BOOK SERIES

DB5 **TV Fault Finding,** 132 pages — Price **£1.20**, P.&P. **27p**
DB6 **Radio Amateur Operator's Handbook,**
New edition in course of preparation
DB17 **Understanding Television,** 504 pages — Price **£3.95**, P. & P. **£1.00**
DB19 **Simple Short Wave Receivers** 140 pages — Price **80p**, P. & P. **27p**

STRIP-FIX PLASTIC PANEL SIGNS

Set 3: Wording – White – 6 sheets — Price **£1.50**, P. & P. **11p**
Set 4: Wording – Black – 6 sheets — Price **£1.50**, P. & P. **11p**
Set 5: Dials – 6 sheets — Price **£1.50**, P. & P. **11p**

Prices include V.A.T.

I enclose Postal Order/Cheque for . . . . in payment for . . . .

. . . .

NAME . . . .

ADDRESS . . . .

. . . . (BLOCK LETTERS PLEASE)

Postal Orders should be crossed and made payable to Data Publications Ltd.

Overseas customers please pay by International Money Order.
All publications are obtainable through your local bookseller

Data Publications Ltd., 57 Maida Vale, London W9 1SN

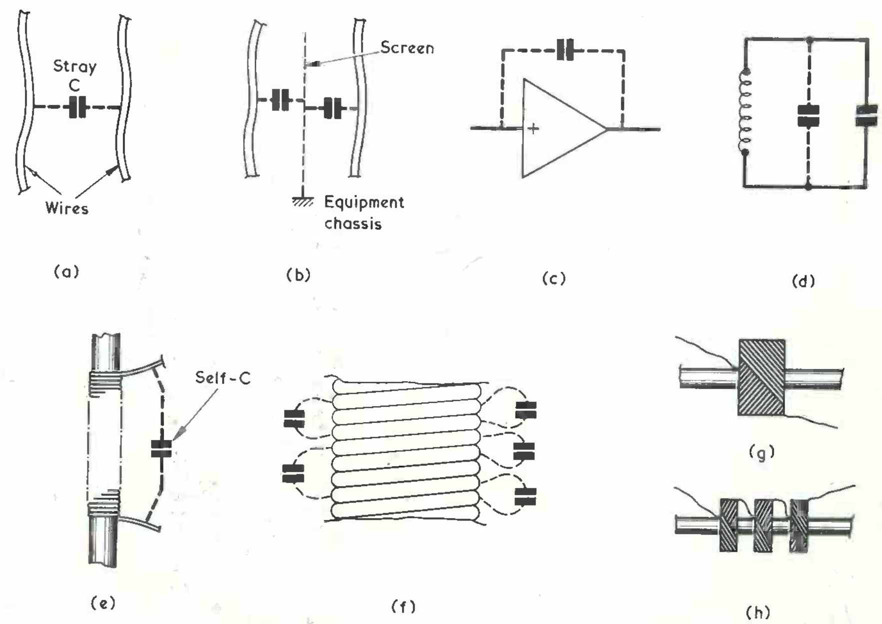
PLEASE MENTION THIS MAGAZINE WHEN WRITING TO ADVERTISERS

STRAY AND SELF-CAPACITANCE

A stray capacitance exists between two adjacent wires, as in (a), this reducing as the spacing between the wires increases and as the diameter of one or both wires reduces. The stray capacitive coupling disappears when an earthed screen is interposed, as in (b), and each wire then has a stray capacitance to the screen.

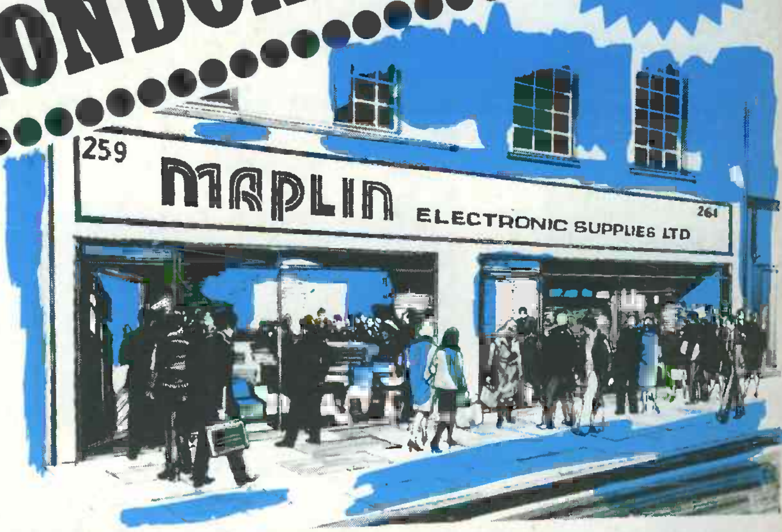
In (c) a stray capacitance appears between an amplifier output and non-inverting input. Should the consequent positive feedback be high enough it can modify the frequency response if there are frequency-conscious components at either terminal or in the amplifier, or cause instability. Feedback problems tend to increase with increasing amplifier gain, bandwidth and input terminal impedance.

Stray capacitance in the tuned circuit wiring of (d) reduces the resonant frequency. To the wiring stray capacitance should be added the self-capacitance of the coil, see (e), which is a summation of all the capacitances between the turns of the coil. It is found that the self-capacitance of a single layer close-wound coil increases almost directly as coil diameter increases, whilst coil length has little effect on self-capacitance. The enlarged section in (f) shows a few of the very many capacitances between coil turns, the most important being those between adjacent turns. Because of the distribution of these capacitances, a coil resonant with its own self-capacitance may not exhibit as sharp a resonant peak as it will if a low value external capacitor is connected across it. The self-capacitance of a coil requiring a large number of turns may be reduced by wave-winding it, (g), and also by winding it, as in (h), with two or three sections connected in series.



MAPLIN announce the opening of their new LONDON shop

259-261 King St. Hammersmith London W6 01·748 0926



- *Excellent metered parking
- *Close to Hammersmith Underground Station for Piccadilly, District & Metropolitan Lines
- *Bus no's 260·266·704·27·91 267·290 stop outside

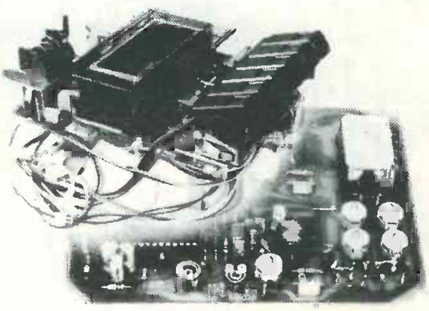
Opens Tuesday 16th September, 1980

Opening Hours 9.45 am to 5.30 pm Tuesday to Saturday (Closed Monday)

- * Up to 8% discount for use with next order
- * All prices include VAT
- * Same day service on in-stock lines
- * Over 95% of our stock lines in stock
- * Large range of all the most useful components
- * First class reply paid envelope with every order
- * Quality components – no rejects – no re-marks
- * Competitive prices
- * Your money is safe with a reputable Company

On price, service, stock, quality and security, it makes sense now more than ever to make **Maplin** – your first choice for components every time!

Stereo Cassette Tape Deck



Utilising the superb JVC deck made for Tandberg and a ready-made pre-aligned, tested and guaranteed module, this cassette deck has a superb sound and a high quality specification. We've got everything you need (except cabinet) including full instruction leaflet for only £39.95. Order as XY36P (Cassette Recorder Kit)

Space Invaders

Fight the space invaders, be a polaris captain or a spaceship commander. Full colour action on your own TV set and over 450 games to play.

Basic console with Combat cartridge (ACOOA) £99.50 + £2.50 carriage

All cartridges available including:

Space Invaders (AC26D)	£29.95	Adventure (AC22Y)	£23.95
Indy 500 (AC24B)	£34.50	Skydiver (AC13P)	£16.95
Chess (8 levels) (AC28F)	£34.50	Breakout (AC05F)	£16.95
Golf (9 holes) (AC18U)	£16.95	Slot Racers (AC19V)	£16.95
Air Sea Battle (AC01B)	£16.95	Programming (AC27E)	£34.50
Space War (AC02C)	£16.95	Olympics (AC04E)	£16.95
Brain Games (AC16S)	£16.95	Street Racer (AC14Q)	£16.95
Outlaw (AC03D)	£16.95	Keyboards per pair (AC29G)	£11.95

All prices include VAT and carriage except where shown.

Post this coupon now for your copy of our 1979-80 Catalogue price 70p

Please send me a copy of your 280 page catalogue. I enclose 70p (plus 46 p&p). If I am not completely satisfied I may return the catalogue to you and have my money refunded. If you live outside the U.K. send £1.35 or ten International Reply Coupons. I enclose £1.16.

Name ____________________

Address ____________________

____________________ REC 10/80

MAPLIN

Maplin Electronic Supplies Ltd

All mail to:- P.O. Box 3, Rayleigh, Essex SS6 8LR.

Telephone: Southend (0702) 554155.

Shop: 284 London Road, Westcliff-on-Sea, Essex. (Closed on Monday)

Telephone: Southend (0702) 554000.

Catalogue now available in all branches of WHSMITH Price £1.00