AUGUST 1978 Australia 85c; Malaysia $2.50; New Zealand 85c 50p

TELEVISION

SERVICING · VIDEO · CONSTRUCTION · DEVELOPMENTS

DIAGNOSTIC PATTERN GENERATOR

ALSO:

SERVICING THORN PORTABLES

VHS VIDEOCASSETTE SYSTEM

ADDING RASTER CORRECTION

PHD COMPONENTS

RADIO & TV COMPONENT DISTRIBUTORS
UNIT 7 CENTENARY ESTATE
JEFFRIES RD ENFIELD MIDDX
MAIL ORDER ONLY TELEX 261295

ALL COMPONENTS PRICED EACH (INCLUSIVE OF VAT AT 12½%)
NO MINIMUM ORDER CHARGE
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CAPACITORS

Description	
DECCA 400-400/350V	3.25
GEC 2000 200-200-150-50/350V	1.90
GEC 1000-2000/35	1.85
GEC/G8 600/300V	1.83
GEC/G8 600/250V	1.55
RRI 600/300V	1.83
PYE 691 200-300/350	2.69
PYE 169 1000-1000/40	0.85
RRI B23 2500-2500/30	1.03
RRI 300-300/300	2.47
ITT/KB 200-200-75-25	2.86
TCE 950 100-300-100-16/275	1.83
TCE 400 150-100-100-100-15	3.51
TCE 1500 150 x 150 x 100	1.99
TCE 3000/3500 175-100-100	2.16
TCE 3000/3500 1000/70V	0.65
TCE 3000/3500 220/100	0.47
TCE B000/8500 2500/2500/63	1.41
TCE B000/8500 700/800	0.93
TCE B000/8500 400/350	0.93
300-300/350	2.82
100-200/275	1.41
100-200-60/275	1.41
200-200-400/350	3.05
200-200-100-32/350	1.41
125-300-100/350	1.41
300-200-100/300	1.41
2000-2000/40	0.70
300-300-100-32	1.41
300-300-100-50	1.41
220-100-47-22/340	1.41
200-100-100-150/350	1.41

DROPPERS

Dropper TCE 1400	1.06
Dropper TCE 1500	0.85
Dropper TCE 1600	0.89
Dropper TCE 3000/3500	0.54
Dropper TCE 8000	0.80
Dropper TCE 8500	0.85
Dropper Philips G8	0.49
Dropper Philips G8	0.25
Dropper Phillps 210	0.83
Philips 210 (Link)	0.54
Dropper RRI 141	0.42
Dropper RRI 161	0.58
Dropper 27840	0.83
Dropper GEC 2000	0.71
Dropper PYE 11062	0.85
Dropper PYE	0.85

DIODES & RECTIFIERS

AA116 Diode	0.11
AA117 Diode	0.11
AA119 Diode	0.11
OA47 Diode	0.08
OA79 Diode	0.08
OA81 Diode	0.08
OA85 Diode	0.08
OA90 Diode	0.08
OA91 Diode	0.08
OA95 Diode	0.08
OA202 Diode	0.12
BA100 Diode	0.12
BA102 Diode	0.07
BA130 Diode	0.10
BA145 Diode	0.20
BA148 Diode	0.20
BA154 Diode	0.06
BA155 Diode	0.09
BA164 Diode	0.09
BAX13 Diode	0.11
BAX16 Diode	0.07
BAY38 Diode	0.11
BY206 Diode	0.20
SK3F/04 Diode	0.20
IN4148 Diode	0.05
IS44 Diode	0.05
BY126 Rectifier	0.10
BY127 Rectifier	0.12
BY133 Rectifier	0.15
BY164 Rectifier	0.50
BY179 Bridge Rectifier	0.96
BY182 Bridge Rectifier	1.27
BY238 Rectifier	0.14
BYX10 Rectifier	0.16
BY187 High Voltage Rectifier	0.30
IN4001 Rectifier	0.08
IN4002 Rectifier	0.08
IN4003 Rectifier	0.09
IN4004 Rectifier	0.09
IN4005 Rectifier	0.10
IN4006 Rectifier	0.10
IN4007 Rectifier	0.11
BY142 Rectifier	0.10
BR100	0.30
BR101	0.35
BRY39	0.35
BT116	1.70
BT119	2.00
BT120	2.00
TV106	1.40
2N4443	1.00
BT100A/02	1.50
OT112	3.50
BYX55/350	0.60
BYX55/600	0.60
BYX71/600	0.60
2N4444 Thyristor	1.27
BT109 Thyristor	1.27

TRANSISTORS

AC107 Transistor	0.20
AC126 Transistor	0.20
AC127 Transistor	0.20
AC127/01 Transistor	0.30
AC128 Transistor	0.20
AC128/01 Transistor	0.30
AC141 Transistor	0.20
AC141K Transistor	0.30
AC142 Transistor	0.27
AC142K Transistor	0.45
AC153 Transistor	0.45
AC176 Transistor	0.30
AC176/01 Transistor	0.45
AC186 Transistor	0.30
AC187 Transistor	0.30
AC187K Transistor	0.45
AC188 Transistor	0.30
AC188K Transistor	0.45
AC193K Transistor	0.45
AC194K Transistor	0.45
AD140 Transistor	1.50
AD142 Transistor	1.50
AD143 Transistor	1.50
AD145 Transistor	1.50
AD149 Transistor	1.00
AD161 Transistor	0.50
AD162 Transistor	0.50
AD262 Transistor	1.20
AF114 Transistor	0.45
AF115 Transistor	0.45
AF116 Transistor	0.45
AF117 Transistor	0.45
AF118 Transistor	0.45
AF121 Transistor	0.45
AF124 Transistor	0.45
AF125 Transistor	0.45
AF126 Transistor	0.45
AF127 Transistor	0.45
AF139 Transistor	0.45
AF239 Transistor	0.60
AL102 Transistor	2.70
AU107 Transistor	2.70
AU110 Transistor	2.70
AU113 Transistor	2.70
BC107 Transistor	0.15
BC108 Transistor	0.15
BC109 Transistor	0.15
BC113 Transistor	0.12
BC114 Transistor	0.12
BC115 Transistor	0.15
BC116 Transistor	0.15
BC117 Transistor	0.15
BC118 Transistor	0.12
BC119 Transistor	0.33
BC125 Transistor	0.15
BC126 Transistor	0.14
BC136 Transistor	0.14
BC137 Transistor	0.14
BC138 Transistor	0.28
BC139 Transistor	0.28
BC140 Transistor	0.28
BC142 Transistor	0.28
BC143 Transistor	0.28
BC147 Transistor	0.10
BC148 Transistor	0.10
BC149 Transistor	0.10
BC153 Transistor	0.10
BC154 Transistor	0.10
BC157 Transistor	0.10
BC158 Transistor	0.10
BC159 Transistor	0.28
BC161 Transistor	0.28
BC170 Transistor	0.10
BC171 Transistor	0.10
BC172 Transistor	0.10
BC177 Transistor	0.17
BC178 Transistor	0.17
BC179 Transistor	0.17
BC1821 Transistor	0.10
BC183 Transistor	0.10
BC183L Transistor	0.10
BC184L Transistor	0.10
BC184LC Transistor	0.12
BC186 Transistor	0.18
BC187 Transistor	0.18
BC203 Transistor	0.10
BC204 Transistor	0.10
BC205 Transistor	0.10
BC206 Transistor	0.10
BC207 Transistor	0.10
BC208 Transistor	0.10
BC209 Transistor	0.10
BC212L Transistor	0.10
BC213L Transistor	0.10
BC214L Transistor	0.10
BC225 Transistor	0.30
BC237 Transistor	0.10
BC238 Transistor	0.10
BC251A Transistor	0.10
BC301 Transistor	0.30
BC303 Transistor	0.30
BC307 Transistor	0.10
BC308 Transistor	0.10
BC327 Transistor	0.11
BC328 Transistor	0.11
BC337 Transistor	0.11
BC338 Transistor	0.11
BC547 Transistor	0.11
BD115 Transistor	0.35
BD116 Transistor	0.80
BD124P Transistor	1.80
BD131 Transistor	0.45
BD132 Transistor	0.45
BD133 Transistor	0.54
BD134 Transistor	0.54
BD135 Transistor	0.54
BD136 Transistor	0.54
BD137 Transistor	0.54
BD138 Transistor	0.54
BD139 Transistor	0.54
BD140 Transistor	0.54
BD144 Transistor	2.50
BD155 Transistor	0.60
BD157 Transistor	0.60
BD159 Transistor	0.60
BD163 Transistor	0.60
BD165 Transistor	0.60
BD175 Transistor	0.60
BD177 Transistor	0.60
BD183 Transistor	0.60
BD187 Transistor	0.60
BD210 Transistor	1.24
BD235 Transistor	0.54
BD236 Transistor	0.54
BD237 Transistor	0.54
BD238 Transistor	0.54
BD239 Transistor	0.54
BD380 Transistor	0.54
BD437 Transistor	0.54
BD439 Transistor	0.54
BD441 Transistor	0.54
BD535 Transistor	0.54
BD536 Transistor	0.54
BD537 Transistor	0.54
BD538 Transistor	0.54
BDX73 Transistor	0.60
BDY201 Transistor	2.10
BF115 Transistor	0.45
BF118 Transistor	0.45
BF121 Transistor	0.60
BF152 Transistor	0.30
BF154 Transistor	0.15
BF157 Transistor	0.50
BF158 Transistor	0.30
BF160 Transistor	2.16
BF163 Transistor	0.45
BF167 Transistor	0.45
BF173 Transistor	0.45
BF177 Transistor	0.45
BF178 Transistor	0.50
BF179 Transistor	0.50
BF180 Transistor	0.50
BF181 Transistor	0.50
BF182 Transistor	0.50
BF183 Transistor	0.50
BF184 Transistor	0.50
BF185 Transistor	0.50
BF194 Transistor	0.10
BF195 Transistor	0.10
BF196 Transistor	0.10
BF197 Transistor	0.10
BF198 Transistor	0.10
BF199 Transistor	0.10
BF200 Transistor	0.10
BF224 Transistor	0.10
BF240 Transistor	0.12
BF241 Transistor	0.12
BF256LC Transistor	0.36
BF257 Transistor	0.36
BF258 Transistor	0.37
BF271 Transistor	0.45
BF273 Transistor	0.15
BF274 Transistor	0.18
BF336 Transistor	0.37
BF337 Transistor	0.37
BF338 Transistor	0.39
BF355 Transistor	0.63
BF458 Transistor	0.15
BF459 Transistor	0.15
BFT43 Transistor	0.39
BFX29 Transistor	0.35
BFX84 Transistor	0.33
BFX85 Transistor	0.33
BFX88 Transistor	0.33
BFX89 Transistor	0.33
BFY50 Transistor	0.33
BFY51 Transistor	0.33
BFY52 Transistor	0.33
BFY90 Transistor	0.90
BDX32 Transistor	2.40
BU105 Transistor	1.50
BU105/01 Transistor	2.40
BU105/02 Transistor	2.40
BU105/04 Transistor	2.40
BU108 Transistor	2.40
BU204 Transistor	1.50
BU205 Transistor	1.50
BU206 Transistor	2.40
BU208 Transistor	2.40
BU208/02 Transistor	2.40
BU326S Transistor	1.98
BU406 Transistor	1.89
BU406D Transistor	2.66
BU407 Transistor	1.59
BU407D Transistor	2.10
2SC1172Y Transistor	2.40
R2008B Transistor	2.25
R2009 Transistor	2.25
R2010B Transistor	2.55
R2540 Transistor	3.00
ME0404 Transistor	0.15
ME0412 Transistor	0.15
ME4003 Transistor	0.10
ME6002 Transistor	0.15
ME8001 Transistor	0.12
MJE340 Transistor	0.15
MJE520 Transistor	0.60
MJE2955 Transistor	0.96
MJE3055 Transistor	0.87
MJ2955 Transistor	1.20
MJ3055 Transistor	1.20
MP8113 Transistor	0.75
MPSU05 Transistor	0.90
MPSU55 Transistor	0.90
TIP31A Transistor	0.48
TIP32A Transistor	0.48
TIP41A Transistor	0.75
TIP42A Transistor	0.75
TIP2995 Transistor	0.96
TIP3055 Transistor	0.96
TIS91M Transistor	0.21
2N2904 Transistor	0.33
2N2905A Transistor	0.36
2N2905 Transistor	0.36
2N3053 Transistor	0.36
2N3055 Transistor	0.88
2N3703 Transistor	0.12
2N3705 Transistor	0.12
2N3710 Transistor	0.12
2N5296 Transistor	0.57
2N5298 Transistor	0.57
2N5496 Transistor	0.63
2N6178 Transistor	0.90
2N6180 Transistor	0.90

INTEGRATED CIRCUITS

TAA550 Int Circuit	0.25
TAA570 Int Circuit	2.10
TAA611 B12 Int Circuit	2.00
TAA630S Int Circuit	2.50
TAA661B Int Circuit	1.60
TAA700 Int Circuit	3.50
TAD100 Int Circuit	1.75
TBA120AS Int Circuit	0.63
TBA231 Int Circuit	1.05
TBA325 Int Circuit	0.50
TBA480Q Int Circuit	1.94
TBA520Q Int Circuit	2.80
TBA530 Int Circuit	2.25
TBA530Q Int Circuit	2.40
TBA540 Int Circuit	2.60
TBA540Q Int Circuit	2.60
TBA550 Int Circuit	3.15
TBA550Q Int Circuit	3.15
TBA560C Int Circuit	3.15
TBA560CQ Int Circuit	3.48
TBA570 Int Circuit	1.62
TBA570Q Int Circuit	1.74
TBA641 BX1 Int Circuit	2.61
TBA641 B11 Int Circuit	3.18
TBA651 Int Circuit	1.75
TBA700Q Int Circuit	1.25
TBA720AQ Int Circuit	2.60
TBA730 Int Circuit	0.50
TBA750 Int Circuit	2.25
TBA750Q Int Circuit	2.40
TBA800 Int Circuit	1.30
TBA810S Int Circuit	1.50
TBA820 Int Circuit	1.05
TBA920 Int Circuit	3.66
TBA920Q Int Circuit	3.75
TBA990 Int Circuit	3.75
TBA990Q Int Circuit	3.66
TCA270Q Int Circuit	2.00
TCA900 Int Circuit	0.87
TCA940 Int Circuit	2.25
TDA1170 Int Circuit	2.60
TDA1200 Int Circuit	2.25
TDA1270 Int Circuit	2.60
TDA1412 Int Circuit	0.90
TDA2020 Int Circuit	3.80
MC1307P Int Circuit	1.60
MC1310P Int Circuit	1.80
MC1327P Int Circuit	2.10
MC1327PQ Int Circuit	2.10
MC1330P Int Circuit	1.35
MC1351P Int Circuit	1.74
MC1352P Int Circuit	1.30
MC1358PQ Int Circuit	1.40
SN76003N Int Circuit	3.10
SN76003ND Int Circuit	2.80
SN76013N Int Circuit	2.20
SN76013N07 Int Circuit	2.20
SN76013ND Int Circuit	2.00
SN76023N Int Circuit	2.20
SN76023ND Int Circuit	2.00
SN76033N Int Circuit	3.00
SN76110N Int Circuit	1.60
SN76131N Int Circuit	1.90
SN76226DN Int Circuit	1.30
SN76227N Int Circuit	0.50
SN76532N Int Circuit	1.50
SN76533N Int Circuit	1.50
SN76544N Int Circuit	1.70
SN76650N Int Circuit	1.50
SN76660N Int Circuit	0.80
SN76665N Int Circuit	1.25
SN76666N Int Circuit	0.60
SL901B Int Circuit	7.50
SL917B Int Circuit	9.90
TBA396Q Int Circuit	0.50
TDA440 Int Circuit	2.50
SN76001N Int Circuit	2.00

VALVES

DY86/87 Valve	1.00
DY802 Valve	1.20
EABC80 Valve	1.50
EB91 Valve	1.10
EBC81 Valve	0.60
EBF80 Valve	0.65
EC86 Valve	1.10
EC88 Valve	1.10
ECC40 Valve	1.20
ECC81 Valve	1.20
ECC82 Valve	1.02
ECC83 Valve	1.02
ECC84 Valve	1.35
ECC85 Valve	1.75
ECC88 Valve	0.75
ECC189 Valve	1.20
ECF80	1.50
ECF82 Valve	0.65
ECF86 Valve	1.10
ECH81 Valve	1.80
ECH83 Valve	0.75
ECH84 Valve	2.10
ECL80 Valve	1.50
ECL82 Valve	1.32
ECL83 Valve	1.10
ECL84 Valve	0.90
ECL86 Valve	1.60
EF80 Valve	1.20
EF83 Valve	1.70
EF83 Valve	1.70
EF85 Valve	1.20
EF86 Valve	2.20
EF89 Valve	2.45
EF91 Valve	0.60
EF95 Valve	0.65
EF183 Valve	1.10
EF184 Valve	1.10
EH90 Valve	1.90
EL34 Valve	3.25
EL36 Valve	0.90
EL41 Valve	1.20
EL81 Valve	0.90
EL84 Valve	1.35
EL86 Valve	0.75
EL95 Valve	1.50
EM84 Valve	1.20
EM87 Valve	1.50
EY51 Valve	0.65
EY86/87 Valve	1.20
EY88 Valve	0.75
EZ80 Valve	1.00
EZ81 Valve	1.00
GY501 Valve	2.40
GZ34 Valve	2.25
PC86 Valve	2.00
PC88 Valve	2.00
PC97 Valve	1.60
PCC84 Valve	1.25
PCC85 Valve	1.50
PCC89 Valve	2.00
PCC189 Valve	2.00
PCC806 Valve	2.50
PC900 Valve	1.70
PCC88 Valve	1.70
PCF80 Valve	1.50
PCF82 Valve	1.90
PCF86 Valve	2.00
PCF200 Valve	1.20
PCF201 Valve	1.25
PCF801 Valve	2.10
PCF802 Valve	1.30
PCF806 Valve	2.10
PCH200 Valve	2.10
PCL82 Valve	1.50
PCL83 Valve	1.80
PCL84 Valve	1.50
PCL85/805 Valve	1.50
PCL86 Valve	1.50
PD500/510 Valve	4.80
PFL200 Valve	2.50
PL36 Valve	1.70
PL81 Valve	1.70
PL81A Valve	1.70
PL82 Valve	0.75
PL83 Valve	1.50
PL84 Valve	1.50
PL95 Valve	1.05
PL504 Valve	1.80
PL508 Valve	2.40
PL509 Valve	4.10
PL519 Valve	5.40
PL802 Valve	4.95
PY33 Valve	1.00
PY82 Valve	0.60
PY83 Valve	0.75
PY88 Valve	1.75
PY500A Valve	2.40
R19 Valve	0.75
U25 Valve	0.75
U26/KY80 Valve	2.20
U49 Valve	0.75
U191 Valve	0.75
UBF89 Valve	0.75
UCC85 Valve	0.75
UCH81 Valve	0.75
UCL82 Valve	1.50
UCL83 Valve	0.75
UF41 Valve	0.75
UL84 Valve	1.80
UY85 Valve	1.50
6BW7 Valve	2.10
6F23 Valve	2.40
6/3012 Valve	2.40
30C15 Valve	2.40
30C17 Valve	2.40
30F5/6F23 Valve	2.40
30FL2/1 Valve	1.70
30FL12/PCEB2 Valve	2.50
30L15/PCC805 Valve	2.50
30L17 Valve	2.50
30P12/PL801 Valve	2.50
30P19/PL36 Valve	1.70
30PL13 Valve	2.50
30PL15 Valve	2.50

EHT TRIPLERS

TCE950 Doubler	2.25
TCE950/1400 Tripler	3.50
TCE1400 (Pied system only)	4.00
TCE1500 Doubler	3.00
TCE500 Tripler	3.50
TCE1600 1/2 Wave	3.50
Decca CS1730/1830 Doubler	3.60
Decca CS1910/2213 Tripler	6.50
Decca 30 Series Tripler	6.50
Decca 80 Series Tripler	6.50
Decca 100 Series Tripler	6.50
GEC Hybrid 2028 Tripler	6.50
GEC2110 Tripler Pre Jan 77	7.00
GEC2110 Tripler Post Jan 77	6.50
ITT CVC5/8/9 Tripler	6.50
ITT VCV20/25/30 Tripler	6.50
Philips 520 Tripler	6.50
Philips 550 Tripler	6.50
Philips G9 Tripler	6.50
PYE 691/693/697 Tripler	6.00
PYE 731/725 Tripler	6.50
Philips 570 Doubler	6.50
PYE 713/CT2001 only/Doubler	6.50
RR1823 Tripler	7.00
RR1Z179/823 Tripler	6.00
TCE3000/3500 Tripler	6.50
TCE4000 Tripler	8.00
TCE8000 Tripler	3.00
TCE8500 Tripler	6.00
TCE9000 Tripler	6.50
TVK52 Continental Sets	6.00
Korting 90% Tripler	6.50
Autovox Tripler	6.50

MISCELLANEOUS PRODUCTS

Sets of Avo Leads	9.50
ELC1043/05 Tuners	6.50
4.443 MHz Crystals	1.30
Cut Out TCE3500	1.20
Cut Out Grundig	1.50
Cut Out GEC	1.50
Cut Out TCE 8500	2.50
TV18 Rectifier Stick	0.50
TV20 Rectifier Stick	1.30
VA1104 Thermistor	0.35
Aerial Isolator	0.65
Solder 18SWG 60/400.5KGM	5.00
Plug 13A	0.36
Super Servisol	0.75
Foam Cleanser	0.75
Silicone Grease	0.75
Plastic Seal	0.75
Aeroklene	0.75
Freezit	0.75
Antistatic	0.75

TELEVISION

August 1978

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Issue 334

CORRESPONDENCE
All correspondence regarding advertisements should be addressed to the Advertisement Manager, "Television", King's Reach Tower, Stamford Street, London SE1 9LS. All other correspondence should be addressed to "Television", IPC Magazines Ltd., King's Reach Tower, Stamford Street, London SE1 9LS.

BINDERS AND INDEXES
Binders (£2.85) and Indexes (45p) can be supplied by the Post Sales Department, IPC Magazines Ltd., Lavington House, 25 Lavington Street, London SE1 0PF. Prices include postage and VAT. In the case of overseas orders add 60p to cover despatch and postage.

BACK NUMBERS
Some back issues, mostly those published during the last two years, are available from our Post Sales Department (address above) at 70p inclusive of postage and packing to both home and overseas destinations.

QUERIES
We regret that we cannot answer technical queries over the telephone nor supply service sheets. We will endeavour to assist readers who have queries relating to articles published in *Television*, but we cannot offer advice on modifications to our published designs nor comment on alternative ways of using them. All correspondents expecting a reply should enclose a stamped addressed envelope.
Requests for advice in dealing with servicing problems should be directed to our Queries Service. For details see our regular feature "Your Problems Solved". Send to the address given above (see "correspondence").

this month

OUR NEXT ISSUE DATED SEPTEMBER WILL BE PUBLISHED ON AUGUST 21

TELEVISION SALE

DISCOUNT FOR QUANTITY

MONO
Rotaries 19" & 23"

	£
GEC	3.00
Thorn 950 etc.	3.00
K.B.	3.00
Pye	3.00
Thorn 1400	4.50

D/S P/B 19" 23"

	£
Thorn 1400	7.00
Bush 161 etc.	7.00
Baird 660 etc.	7.00
Philips 210 etc.	7.00
Pye Olympic etc.	7.00

D/S P/B 20" 24"

	£
Bush	10.00
GEC	10.00
Philips	10.00
Pye	10.00
Thorn	10.00

S/S 20" 24"	£
Bush 313 etc.	12.00
Pye 169 chassis	12.00
Thorn 1500	12.00
GEC series 1 & 2	12.00
Decca MS series	12.00

S/S COLOUR

	19"	20"	22"	25"	26"
	£	£	£	£	£
GEC	40	45	45	45	50
Philips	–	–	45	45	50
Thorn	60	–	65	65	85
Bush	60	–	65	65	75
Kort	–	–	65	–	75

D/S COLOUR

	19"	25"
	£	£
Decca	20.00	25.00
Bush	20.00	25.00
Baird	20.00	25.00
GEC	20.00	25.00
Philips	–	25.00

PLEASE NOTE THERE IS 12½% V.A.T.

Please note all mono sets sold as 100% comp. No broken masks, no broken panels etc.

Colour sets sold with good c.r.t.s and 100% comp.

Working Mono £3.00 extra.

Working Colour £10.00 extra.

Supplied in 1's or 100's

WE DO NOT SELL RUBBISH AT

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TEL: 306018.**

BRIARWOOD TELEVISION LTD.

Legrems Mills, Summerville Road, Bradford, West Yorkshire BD7 1NS. Tel: (0274) 306018.

All transistors, IC's, offered are new and branded. Manufactured by Mullard, I.T.T., Texas, Motorola etc.

Please add 12½% VAT to all items and overseas at cost.

P & P U.K. 25p per order, overseas allow for package and postage. Cash with all orders. All prices subject to alteration without notice.

TYPE	PRICE £
AC107	0.23
AC113	0.17
AC115	0.17
AC117	0.24
AC125	0.20
AC126	0.18
AC127	0.19
AC128	0.17
AC131	0.13
AC141	0.23
AC142	0.19
AC141K	0.29
AC142K	0.29
AC151	0.17
AC165	0.16
AC166	0.16
AC168	0.17
AC176	0.17
AC176K	0.28
AC178	0.16
AC186	0.26
AC187	0.21
AC188	0.20
AC187K	0.34
AC188K	0.34
AD130	0.50
AD140	0.65
AD142	0.73
AD143	0.70
AD145	0.70
AD149	0.64
AD161	0.41
AD162	0.48
AD161 } AD162 }	1.30
AF106	0.42
AF114	0.23
AF115	0.22
AF116	0.22
AF117	0.22
AF118	0.40
AF121	0.43
AF124	0.33
AF125	0.29
AF126	0.29
AF127	0.29
AF139	0.39
AF151	0.24
AF170	0.25
AF172	0.20
AF178	0.49
AF180	0.60
AF181	0.30
AF186	0.29
AF239	0.43
AU113	1.29
BA130	0.08
BA145	0.14
BA148	0.17
BA155	0.10
BAX13	0.05
BAX16	0.08
BC107	0.12
BC108	0.12
BC109	0.12
BC113	0.12
BC114	0.14
BC115	0.12
BC116	0.12
BC117	0.13
BC119	0.24
BC125	0.15
BC126	0.09
BC136	0.14
BC137	0.14
BC138	0.24
BC139	0.21
BC140	0.31
BC141	0.22
BC142	0.19
BC143	0.19
BC147	0.09
BC148	0.09
BC149	0.09
BC153	0.12
BC154	0.12
BC157	0.10
BC158	0.11
BC159	0.11
BC160	0.28
BC161	0.28
BC167	0.13
BC168	0.10
BC169C	0.12

TYPE	PRICE £
BC171	0.12
BC172	0.12
BC173	0.15
BC177	0.14
BC178	0.14
BC179	0.14
BC182L	0.08
BC183L	0.07
BC184L	0.11
BC186	0.18
BC187	0.18
BC209	0.14
BC212	0.13
BC213L	0.09
BC214L	0.14
BC237	0.07
BC240	0.31
BC281	0.24
BC262	0.20
BC263B	0.20
BC267	0.19
BC301	0.26
BC302	0.30
BC307	0.10
BC337	0.13
BC338	0.09
BC307A	0.12
BC308A	0.12
BC309	0.14
BC547	0.09
BC548	0.11
BC549	0.11
BC557	0.11
BD112	0.39
BD113	0.65
BD115	0.40
BD116	0.47
BD124	1.30
BD131	0.32
BD132	0.34
BD133	0.37
BD135	0.26
BD136	0.26
BD137	0.26
BD138	0.26
BD139	0.40
BD140	0.28
BD144	1.39
BD145	0.30
BD222/T1P31A	0.39
BD225/T1P31A	0.39
BD234	0.34
BD222	0.50
BDX22	0.73
BDX32	1.98
BDY18	0.75
BDY60	0.80
BF115	0.24
BF121	0.21
BF154	0.19
BF158	0.19
BF159	0.24
BF160	0.23
BF163	0.23
BF164	0.17
BF167	0.23
BF173	0.21
BF177	0.26
BF178	0.24
BF179	0.28
BF180	0.30
BF181	0.34
BF182	0.30
BF183	0.29
BF184	0.23
BF185	0.29
BF186	0.30
BF194	0.09
BF195	0.09
BF196	0.12
BF197	0.10
BF198	0.15
BF199	0.14
BF200	0.28
BF216	0.12
BF217	0.12
BF218	0.12
BF219	0.12
BF220	0.12
BF222	0.12
BF221	0.21
BF224	0.12
BF256	0.37
BF258	0.27
BF259	0.27

TYPE	PRICE £
BF260	0.24
BF262	0.28
BF263	0.25
BF271	0.20
BF273	0.12
BF336	0.35
BF337	0.24
BF338	0.29
BFT42	0.26
BFT43	0.24
BFX84	0.27
BFX85	0.27
BFX88	0.24
BFY37	0.22
BFY50	0.18
BFY51	0.17
BFY52	0.18
BFY53	0.27
BFY55	0.27
BHA0002	1.90
BR100	0.20
BSX20	0.23
BSX76	0.23
BSY84	0.36
BT106	1.18
BT108	1.23
BT109	1.09
BT116	1.23
BT120	2.08
BU105/02	1.87
BU105/04	2.25
BU126	1.40
BU205	1.97
BU208	2.49
BY126	0.09
BY127	0.10
OC22	1.10
OC23	1.30
OC24	1.30
OC25	1.00
OC26	1.00
OC28	1.00
OC35	1.00
OC36	0.90
OC38	0.90
OC42	0.45
OC44	0.20
OC45	0.20
OC46	0.35
OC70	0.22
OC71	0.28
OC72	0.35
OC74	0.35
OC75	0.35
OC76	0.35
OC77	0.50
OC78	0.13
OC81	0.20
OC810	0.14
OC82	0.20
OC820	0.13
OC83	0.22
OC84	0.28
OC85	0.13
OC123	0.20
OC169	0.20
OC170	0.22
OC171	0.27
OA91	0.05
BRC4443	0.65
R2008B	1.50
R2010B	1.50
R2305	0.38
R2305/BD222	0.37
SCR957	0.81
TIP31A	0.38
TIP32A	0.36
TIP3055	0.53
T1590	0.19
T1591	0.19
TV106	1.09

DIODES

1N4001	0.04
1N4002	0.04
1N4003	0.06
1N4004	0.07
1N4005	0.07
1N4006	0.08
1N4007	0.08
1N4148	0.30
1N4751A	0.11
1N5401	0.10

TYPE	PRICE £
1N5404	0.12
1N5406	0.13
1N5408	0.16

VALVES

DY87	0.52
DY802	0.64
ECC82	0.52
EF80	0.40
EF183	0.60
EF184	0.60
EH90	0.60
PC86	0.76
PC88	0.76
PCC89	0.65
PC189	0.65
PCF80	0.70
PCF86	0.68
PCF801	0.70
PCF802	0.74
PCL82	0.67
PCL84	0.75
PCL86	0.78
PCL805	0.70
PCF200	1.00
PL36	0.90
PL84	0.74
PL504	1.00
PL509	2.45
PY88	0.63
PY500A	1.50
PY81/800	0.57

E.H.T. TRAYS MONO

950 MK2 1400	2.26
1500 18" 19" stick	2.37
1500 24" 5 stick	2.48
Single stick Thorn TV 11.16K 70V	0.75
TV 20 2 MT	0.75
TV20 16K 18V	0.75

IC's

SN76013N	1.48
SN76013ND	1.20
SN76023N	1.50
SN76023ND	1.20
SN76226DN	1.50
SN76227N	1.20
TBA341	0.97
TBA520Q	1.45
TBA530Q	1.20
TBA540Q	1.45
TBA550Q	1.60
TBA560CQ	1.80
TBA570Q	1.00
TBA800	1.00
TBA810	1.50
TBA920Q	1.80
TBA990Q	1.60
TCA270SQ	1.45
TCA270SA	1.45
TCA1327B	1.00

E.H.T. TRAYS COLOUR

Pye 691 693	4.50
Decca (large screen) CS2030/2232/2630/2632/2230/2233/2631	5.67
Philips G8 520/40/50	5.66
Philips G9	5.79
GEC C2110	5.50
GEC Hybrid CTV	5.40
Thorn 3000/3500	5.50
Thorn 800	2.42
Thorn 8500	5.23
Thorn 9000	6.10
GEC TVM 25	2.50
ITT/KB CVC 5/7/8/9	5.50
RRI (RBM) A823	5.89
Bang & Olufsen 4/5000 Grundig 5010/5011/5012/6011/6012/7200/2052/2210/2252R Tandberg (radionette) Autovox	6.60
Grundig 3000/3010 Saba 2705/3715 Telefunken 709/710/717/2000	6.80
Korting	6.80

TRANSISTORS, ETC.

Type	Price (£)	Type	Price (£)	Type	Price (£)	Type	Price (£)	Type	Price (£)	Type	Price (£)	Type	Price (£)	Type	Price (£)	Type	Price (£)	Type	Price (£)
AC107	0.46	AU103	2.40	BC192	0.56	BC377	0.29	BD234	0.68	BF222	†0.51	BPX29	1.62	MPSU05	0.66	ZTX500	†0.18	2N3819	†0.47
AC117	0.38	AU107	2.75	BC204*	†0.39	BC394	0.39	BD235	0.63	BF224 & J	†0.22	BR101	0.53	MPSU06	0.76	ZTX502	†0.22	2N3820	†0.72
AC126	0.36	AU110	2.40	BC205*	†0.39	BC440	0.52	BD236	0.63	BF240	†0.32	BR103	0.64	MPSU55	1.26	ZTX504	†0.28	2N3866	1.08
AC127	0.54	AU113	2.60	BC206*	†0.37	BC441	0.59	BD237	0.68	BF241	†0.31	BR303	1.06	MPSU56	1.32	2N404	1.30	2N3904	†0.20
AC128	0.46	BC107*	0.18	BC207*	†0.35	BC461	0.78	BD238	0.68	BF244*	†0.51	BRC4443	0.96	MPSU60	0.82	2N696	0.46	2N3905	†0.20
AC128K	0.55	BC108*	0.15	BC208*	†0.37	BC477	0.30	BD253	1.58	BF245*	†0.43	BRY39	0.65	MPU131	†0.59	2N697	0.46	2N3906	†0.20
AC141	0.65	BC109*	0.16	BC209*	†0.39	BC478	0.25	BD410	1.65	BF254	†0.48	BRY56	†0.44	OC26	1.90	2N706A	0.33	2N4036	0.94
AC141K	0.70	BC113	†0.22	BC211*	†0.36	BC479	0.33	BD433	0.65	BF255	†0.58	BSS27	0.92	OC28	1.49	2N708	0.29	2N4123	†0.17
AC142	0.60	BC114	†0.22	BC212*	†0.17	BC547*	†0.13	BD435	0.70	BF256L*	†0.49	BT106	1.50	OC29	1.60	2N914	0.32	2N4124	†0.17
AC142K	0.65	BC115	†0.24	BC212L*	†0.17	BC548*	†0.13	BD436	0.71	BF257	†0.47	BT109	1.99	OC35	1.25	2N916	0.46	2N4126	†0.17
AC151	0.31	BC116*	†0.25	BC213*	†0.16	BC549*	†0.15	BD437	0.74	BF258	†0.52	BT116	1.45	OC36	1.25	2N918	0.54	2N4236	2.20
AC152	0.36	BC117	†0.30	BC213L*	†0.16	BC550	†0.24	BD438	0.75	BF259	†0.54	BT119	5.18	OC42	0.90	2N930	0.29	2N4289	†0.32
AC153	0.42	BC118	†0.24	BC214*	†0.18	BC556	†0.23	BD519	0.86	BF262	0.73	BU102	2.85	OC44	0.68	2N1164	8.29	2N4292	†0.32
AC153K	0.52	BC119	†0.34	BC214L*	†0.18	BC557*	†0.16	BD520	0.88	BF263	0.88	BU105	†1.80	OC45	0.63	2N1304	1.40	2N4416	0.85
AC154	0.41	BC125*	†0.30	BC225	†0.42	BC558*	†0.16	BD599	0.87	BF270	0.47	BU105/02	†1.95	OC70	0.65	2N1305	1.29	2N4444	1.90
AC176	0.45	BC126	†0.30	BC237*	†0.16	BC559*	0.17	BD600	1.23	BF271	0.42	BU108	†2.98	OC71	0.73	2N1306	1.49	2N4921	0.80
AC178	0.51	BC132	†0.20	BC238*	†0.15	BCY10	0.30	BD663BR	0.66	BF272A	0.80	BU126	†2.91	OC72	0.73	2N1307	1.32	2N5042	1.65
AC179	0.55	BC134	†0.22	BC239*	†0.22	BCY30A	1.06	BDX18	1.55	BF273	†0.33	BU204	†2.50	OC81	0.63	2N1308	1.53	2N5060	†0.28
AC187	0.56	BC135	†0.21	BC251*	†0.25	BCY32A	1.19	BDX32	2.95	BF274	†0.34	BU205	†2.76	OC81D	0.95	2N1711	0.47	2N5061	†0.30
AC187K	0.65	BC136	†0.22	BC252*	†0.26	BCY34A	1.02	BDY16A	0.43	BF336	0.63	BU206	†3.09	OC139	1.30	2N1893	0.52	2N5064	†0.63
AC188	0.52	BC137	†0.30	BC253*	†0.28	BCY72	0.27	BDY18	1.55	BF337	0.65	BU208	†4.88	OC140	1.35	2N2102	0.71	2N5086	†0.49
AC188K	0.61	BC138	†0.32	BC261A*	†0.28	BD115	1.35	BDY20	2.20	BF338	0.68	BU407	†1.38	OC170	0.80	2N2217	0.55	2N5087	†0.50
AC193K	0.70	BC140	0.36	BC262A*	†0.26	BD123	1.50	BDY38	1.36	BF355	†0.72	BUY77	2.50	OC171	0.62	2N2218	0.38	2N5208	†0.59
AC194K	0.74	BC141	0.44	BC263*	†0.26	BD124	1.85	BF115	0.48	BF362	†0.49	C106D	0.80	OC200	3.90	2N2219	0.42	2N5294	0.66
ACY17	1.20	BC142	0.35	BC267*	0.20	BD130Y	1.58	BF117	0.45	BF363	†0.49	C106F	0.43	OC201	3.95	2N2221A	0.26	2N5296	0.68
ACY19	0.95	BC143	0.38	BC268*	0.28	BD131	0.58	BF120	0.55	BF367	†0.29	C111E	†0.46	OC202	2.40	2N2222A	0.41	2N5298	0.71
ACY28	0.98	BC147*	†0.12	BC286	0.40	BD132	0.68	BF121	0.85	BF451	0.43	D40N1	0.64	OC205	3.95	2N2369A	0.40	2N5322	1.16
ACY39	2.02	BC148*	†0.12	BC287	0.49	BD133	0.70	BF123	0.48	BF457	0.46	E1222	0.47	OCP71	1.98	2N2401	0.80	2N5449	†0.18
AD140	1.79	BC149*	†0.13	BC291	0.27	BD135	†0.37	BF125	0.55	BF458	0.49	E5024	†0.19	ON236A	0.94	2N2484	0.35	2N5457	†0.46
AD142	1.90	BC152	†0.42	BC294	†0.37	BD136	†0.38	BF127	0.51	BF459	0.52	GET872	0.46	R2008B	†2.62	2N2570	0.74	2N5458	†0.40
AD143	1.78	BC153	†0.38	BC297	0.36	BD137	0.40	BF137F	0.78	BF594	†0.16	MC140	†0.36	R2010B	†2.79	2N2646	0.82	2N5459	†0.58
AD149	1.92	BC154	†0.41	BC300	0.62	BD138	0.42	BF152	†0.19	BF596	†0.17	ME0402	†0.18	R2322	†0.75	2N2784	1.15	2N5494	0.85
AD161	0.66	BC157*	†0.13	BC301	0.36	BD139	0.46	BF158	†0.25	BF597	†0.27	ME0404	†0.18	R2323	†0.85	2N2869	2.08	2N5496	1.05
AD161/162	1.22	BC158*	†0.12	BC302	0.86	BD140	0.50	BF159	†0.27	BFR39	†0.39	ME6001	†0.18	ST2110	0.49	2N2894	0.45	2N6027	0.55
AD162	0.71	BC159*	†0.14	BC303	0.64	BD144	2.24	BF160	†0.20	BFR40	†0.29	ME6002	†0.18	ST6120	0.48	2N2904*	0.40	2N6107	0.71
AF114	0.35	BC160	0.52	BC304	0.44	BD145	0.75	BF161	0.84	BFR41	†0.30	MJ2955	1.30	TIC44	†0.25	2N2905*	0.43	2N6122	0.60
AF115	0.35	BC161	†0.58	BC307*	†0.17	BD150A*	†0.41	BF163	†0.65	BFR50	†0.29	MJ3000	1.58	TIC46	†0.35	2N2906*	0.36	2N6178	1.07
AF116	0.41	BC167B	†0.15	BC308*	†0.14	BD155	†0.90	BF164	†0.95	BFR52	†0.33	MJE340	0.68	TIC47	†0.45	2N2926G	†0.15	2N6180	1.39
AF117	0.42	BC168B	†0.15	BC309*	†0.18	BD157	0.51	BF166	0.50	BFR61	†0.29	MJE341	0.72	TIP29A	0.47	2N2926O	†0.14	2N6211	2.74
AF118	0.98	BC169C	†0.15	BC317*	†0.15	BD158	0.75	BF167	0.38	BFR62	†0.28	MJE370	0.74	TIP30A	0.50	2N2926Y	†0.14	2SB337BP	4.28
AF121	0.66	BC170*	†0.15	BC318*	†0.15	BD159	0.68	BF173	0.35	BFR79	†0.30	MJE371	0.79	TIP31A	0.51	2N2955	1.12	2SC458C	0.78
AF124	0.38	BC171*	†0.15	BC319*	†0.19	BD160	2.69	BF177	0.36	BFR80	†0.29	MJE520	0.85	TIP31C	0.67	2N3053	0.48	2SC643A	2.25
AF125	0.38	BC172*	†0.14	BC320	†0.17	BD163	0.67	BF178	0.46	BFR81	†0.30	MJE521	0.95	TIP32A	0.56	2N3054	0.86	2SC930D	1.50
AF126	0.36	BC173*	†0.22	BC321A&B	†0.18	BD165	0.66	BF179	0.58	BFR88	†0.42	MJE2955	1.20	TIP32C	0.72	2N3055	0.72	2SC1061	1.45
AF127	0.86	BC174A & B		BC322	†0.28	BD166	0.88	BF180	0.53	BFT41	0.48	MJE3000	1.95	TIP33A	0.77	2N3250	0.52	2SC1172Y	3.55
AF139	0.58		†0.26	BC323	1.15	BD175	0.90	BF181	0.53	BFT43	0.55	MJE3055	1.22	TIP34A	0.84	2N3254	0.58	2SD234	1.48
AF147	0.52	BC176	0.22	BC327	†0.16	BD177	0.58	BF182	0.44	BFW11	1.02	MPF102	†0.40	TIP41A	0.72	2N3391A	0.38	3N128	1.60
AF149	0.45	BC177*	0.20	BC328	†0.16	BD178	0.92	BF183	0.52	BFW30	2.58	MPS3702	†0.33	TIP42A	0.80	2N3633	12.70	40250	0.98
AF178	1.35	BC178*	0.22	BC337	†0.17	BD181	1.94	BF184	0.44	BFW59	†0.19	MPS3705	†0.30	TIP2955	0.77	2N3703	†0.17	40251	1.14
AF179	1.38	BC179*	0.28	BC338	†0.17	BD182	2.10	BF185	0.42	BFW60	†0.20	MPS6521	†0.36	TIP3055	0.58	2N3704	†0.19	40327	0.87
AF180	1.35	BC182*	†0.15	BC340	0.19	BD183	1.34	BF186	0.42	BFW90	†.65	MPS6523	†0.36	TIS43	†0.44	2N3705	†0.17	40361	0.48
AF181	1.33	BC182L*	†0.15	BC347*	†0.17	BD184	2.30	BF194*	†0.14	BFX29	0.38	MPS6566	†0.44	TIS73	†1.36	2N3706	†0.16	40362	0.50
AF186	1.46	BC183*	†0.14	BC348A & B		BD187	1.20	BF195*	†0.13	BFX84	0.42	MPSA05	†0.30	TIS90	†0.23	2N3707	†0.18	40410	0.94
AF202	0.27	BC183L*	†0.14		†0.17	BD188	1.25	BF196	†0.14	BFY50	0.38	MPSA06	†0.32	TIS91	†0.28	2N3708	†0.17	40429	0.88
AF239	0.73	BC184*	†0.15	BC349B	†0.17	BD189	0.71	BF197	†0.15	BFY51	0.37	MPSA55	†0.43	ZTX108	†0.14	2N3715	1.70	40530	0.79
AF240	1.40	BC184L*	†0.15	BC350*	†0.24	BD222	0.78	BF198	†0.29	BFY52	0.36	MPSA56	†0.45	ZTX109	†0.16	2N3771	2.39	40595	1.39
AF279S	0.91	BC185	0.36	BC351*	†0.22	BD225	0.91	BF199	†0.29	BFY53	0.36	MPSA93	†0.56	ZTX213	†0.20	2N3772	2.58	40603	1.13
AL100	1.30	BC186	0.25	BC352A*	†0.24	BD232	0.91	BF200	†0.25	BFY90	1.98	MPSL01	†0.33	ZTX300	†0.16	2N3773	3.90	40636	1.25
AL103	1.52	BC187	0.27	BC360	0.59	BD233	0.82	BF218	†0.42	BPX25	1.62	MPSU01	0.61	ZTX304	†0.26	2N3794	†0.40	40654	0.89

Alternative gain versions available on items marked*.

For matched pairs add 20p per pair.

LINEAR IC's

Type	Price (£)
BRC1330	†0.93
CA810QM	2.44
CA3005	1.85
CA3012	1.45
CA3014	2.23
CA3018	0.71
CA3020	1.89
CA3028A	0.80
CA3028B	1.09
CA3045	3.75
CA3046	0.70
CA3065	†1.74
CA3068	1.90
CA3130S	1.57
FCH161	†2.40
FCJ101	†3.32
LM309K	1.98
LM380N	1.30
LM1303N	3.08
MC1307P	†1.82
MC1310P*	†1.94
MC1312P	2.34
MC1327P*	†1.86
MC1330P	†0.93
MC1350P	†1.22
MC1351P	†1.42
MC1352P	†1.42
MC1357P	†2.92
MC1358P*	†2.30
MC1458G	1.43
MC1496L	1.15
MC3051P	0.88
MFC4008	0.85
MFC4060A	0.98
MFC6040	1.11
MIC1P	2.58
ML231	†3.57
ML232	†3.57
NE555	0.72
NE556	1.34
NE566	1.95
SAA1024	†5.70
SAA1025	†10.35
SAS560	†2.01
SAS570	†2.01
SC9503P	†1.40
SC9504P	†1.38
SL414A	1.91
SL432A	2.52
SL450	5.10
SL901B	†4.20
SL917B	†5.60
SL918A	†4.95
SN72440N	†2.21
SN76001N	†1.87
SN76003N	2.22

Type	Price (£)
SN76008KE	1.56
SN76013N	1.56
SN76013ND	1.40
SN76018KE	1.56
SN76023N	1.56
SN76023ND	1.40
SN76033N	2.22
SN76110N	1.20
SN76115N	1.62
SN76116N	1.78
SN76131N	1.32
SN76226N	†2.00
SN70227N	†1.61
SN76228N	1.80
SN76502N	†1.92
SN76530P	†0.97
SN76533N	†1.38
SN76544N	†1.65
SN76546N	†1.85
SN76570N	†1.81
SN76620AN	†0.99
SN76650N	†1.48
SN76660N	†0.64
SN76666N	†0.96
TA7073P	†3.51
TAA263	†2.20
TAA300	†2.20
TAA320	1.10
TAA350A	†2.46
TAA370A	3.18
TAA435	†1.70
TAA450	†3.39
TAA521	1.10
TAA522	2.09
TAA550	0.45
TAA560	1.93
TAA570	†2.30
TAA611A	1.20
TAA611B	1.85
TAA621AXI	2.43
TAA630Q	3.91
TAA630S	4.18
TAA661A	1.75
TAA661B	1.75
TAA700*	†2.80
TAA840	†3.36
TAA861A	0.95
TAA930A	1.43
TAA930B	1.43
TAA960	†2.25
TAA970	†2.46
TAD100	†2.66
(Filter)	0.98
TBA120A	†0.90
TBA120S*	†0.99
TBA120SA	†1.02
TBA231	1.32

Type	Price (£)
TBA240A	†3.98
TBA281	†2.07
TBA395*	†2.58
TBA396	†2.40
TBA400	†2.20
TBA480Q	†1.84
TBA500*	†2.21
TBA510*	†2.21
TBA520P*	†3.40
TBA530*	†2.24
TBA540*	†2.88
TBA550*	†3.13
TBA560C*	†3.18
TBA570*	†1.29
TBA611B	2.68
TBA641	2.55
TBA641A12	2.55
TBA641B11	2.90
TBA651	†2.42
TBA673	†2.19
TBA700*	†2.50
TBA720AQ	†2.38
TBA720Q	†2.38
TBA750*	†2.18
TBA800	2.05
TBA810AS	2.00
TBA920*	†3.80
TBA940	†3.52
TBA950	†2.78
TBA990*	†2.90
TCA270A*	†3.55
TCA280A	1.43
TCA290A	3.46
TCA420A	1.98
TCA440	1.67
TCA640	2.76
TCA650	2.76
TCA660	2.76
TCA730	3.54
TCA740	3.04
TCA750	2.53
TCA760	1.52
TCA820	3.29
TDA440	†4.36
TDA1003	1.52
TDA1004	2.73
TDA1005	3.04
TDA1022	6.89
TDA1024	0.97
TDA1034	1.98
TDA2610	2.86
TDA2640	2.86
ZN414	1.45

* Indicates Q version is also available.

DIODES

Type	Price (£)	Type	Price (£)
AA113	0.17	BY114	0.60
AA119	0.21	BY118	1.10
AA129	0.28	BY126	0.20
AA143	0.18	BY127	0.24
AAY30	0.28	BY133	0.35
AAZ13	0.42	BY140	1.40
AAZ15	0.35	BY164	0.75
AAZ17	0.28	BY176	2.80
AY102	2.55	BY179	0.83
BA100	0.24	BY182	1.14
BA102	0.36	BY184	0.44
BA110	0.80	BY189	5.30
BA111	0.70	BY190	4.90
BA115	0.17	BY206	0.26
BA116	0.56	BY238	0.25
BA121	0.85	BYX10	0.30
BA129	0.45	BYX38/600	0.70
BA145	0.19	BYX70/500	0.53
BA148	0.19	ITT44	0.08
BA154	0.06	ITT210	0.63
BA155	0.17	ITT827	0.80
BA156	0.12	MCR101	0.43
BA157	0.25	MR854	1.10
BA156	0.28	OA5	0.88
BA159	0.40	OA10	0.58
BA164	0.14	OA47	0.20
BA170	0.18	OA81	0.19
BA182	0.27	OA90	0.13
BA201	0.13	OA91	0.15
BA202	0.14	OA95	0.20
BA203	0.14	OA200	0.11
BA216	0.08	OA202	0.13
BA219	0.11	OA210	0.89
BA243	0.45	TIL209	0.16
BA317	0.06	TIL211	0.20
BA316	0.07	TV20	2.25
BAV10	0.10	IN914	0.08
BAV21	0.18	IN916	0.09
BAW62	0.06	IN4001	0.06
BAX13	0.07	IN4002	0.07
BAX16	0.10	IN4003	0.08
BAX17	0.19	IN4004	0.08
BAY72	0.16	IN4005	0.09
BB104B	0.52	IN4006	0.10
BB105B	0.33	IN4007	0.12
BB105G	0.30	IN5400	0.15
BR100	0.40	IN5401	0.17
BY100	0.35	IN5402	0.20
BY103	0.35	IS920	0.09
		IS921	0.11

ZENER DIODES

400mW plastic	3.0-33V	14p each
1/1.3W plastic	3.3-180V	18p each
1.5W flange	4.7-75V	£1.08 each
2.5W plastic	7.5-75V	67p each
20W stud	7.5-75V	92p each
75W stud	7.5-75V	£6.88 each

VDR's, etc. (†)

Type	Price (£)
E295ZZ	
/01	0.28
/02	0.28
E298CD	
/A258	0.25
E298ED	
/A258	0.22
/A260	0.22
/A262	0.22
/A265	0.22
/P268	0.22
E298ZZ	
/05	0.25
/06	0.22
E299DD/P116-P354	all 0.23
E299DH	
/P230	0.72
R53	1.75
VA1015	0.92
VA1026	0.79
VA1033/34/38/39/40/53	all 0.20
VA1055s/56s/66s/67s	all 0.23
VA1074	0.20
VA1077	0.31
VA1091	0.29
1096/97/98	all 0.20
VA1103	0.32
VA1104	0.46
VA1108/09/10/11/12	all 0.24
VA8650	1.20
2322 554 02221	0.59
2322 662 98003	0.88

VALVES (†)

Type	Price (£)
DY86/87	0.75
DY802	0.75
ECC81	0.78
ECC82	0.95
ECC83	0.78
ECH81	0.83
ECL80	0.82
EF80	0.60
EF183	0.75
EF184	0.75
EH90	0.94
EL34	1.68
EY51	1.20
EY86/87	0.67
PCC84	0.61
PCC85	0.79
PCC89	0.74
PCC189	0.94
PCF80	1.20
PCF86	0.87
PCF200	2.32
PCF801	0.74
PCF802	1.20
PCF805	3.37
PCF808	2.00
PCL82	0.93
PCL83	1.12
PCL84	0.65
PCL86	0.74
PCL805/85	1.00
PD500	3.75
PFL200	1.40
PL36	1.20
PL81	0.94
PL84	0.79
PL504	1.05
PL508	1.85
PL509	3.10
PL519	3.10
PL802	3.25
PY81/P810	0.60

BRIDGES

Rating		Price (£)	Rating		Price (£)
1½A	50V	0.27	2A	100V	0.36
	100V	0.28		200V	0.40
	200V	0.32		400V	0.47
	400V	0.40		600V	0.53
	600V	0.50		800V	0.60
	800V	0.58		1000V	0.87
3A	100V	0.52	6A	100V	0.86
	200V	0.55		200V	0.68
	400V	0.61		400V	0.74
	600V	0.67		600V	0.80
	800V	0.80		800V	0.86
	1000V	1.20		1000V	0.95

10A and 25A ranges also stocked.

RESISTORS

Mixes of a minimum of 10pcs of any value:

Carbon Film (5%) (†)	Ea	10 of one value	50pc	100pc	500pc
⅓W 5.6Ω-330kΩ (E12)	3p	25p	98p	£1.40	£6.40
½W 10Ω-10MΩ (E24)	3p	25p	98p	£1.40	£6.40
1W 10Ω-10MΩ (E12)	5p	45p	£1.96	£3.40	£15.25
2W 10Ω-10MΩ (E6)	9p	80p	£3.60	£6.40	£28.90

Wirewound (5%)

2½W	0.22Ω-270Ω	18p
4W	1.0Ω-10kΩ	22p
7W	1.0Ω-22kΩ	24p
11W	1.0Ω-22kΩ	28p
17W	1.0Ω-22kΩ	33p
Vertical mounting pillars		3p

Presets (†)

0.1W (Vertical and Horizontal) 100, 220, 470Ω, 1, 2.2, 4.7, 10, 22, 47, 100, 220, 470kΩ, 1, 2.5, 5MΩ all 14p each

0.2W (Vertical and Horizontal) Values as 0.1W all 14p each

FUSES (all packs of 10)

20mm Time Delay (BEAB)

40mA	£3.68
50, 63mA	£2.56
100mA	£1.86
160, 200, 250mA	£1.44
315, 500, 800mA, 1, 1.25, 1.6, 2, 2.5, 3.15, 5A	all £1.19

20mm quick-blow (BEAB)

100mA	68p
200, 250, 315, 500, 630, 800mA, 1, 1.25, 1.6, 2, 2.5, 3.15, 5A	all 56p

2A circuit breakers metal £1.52, plastic £1.48

LABGEAR (Details of full range on request)

COLOURTEXT ADAPTOR 7026

Full facility Colourtext decoder to place between aerial and receiver. All you would expect of a quality ready-made unit. Leaflet on request. †£340.20

COLOUR BAR GENERATOR

CM6052/DB. VHF/UHF gives standard 8 band colour bars + variable tuning + front panel on/off switch + sync trigger output + blank raster + red raster + crosshatch + greyscale stepwedge + colour bar + centre cross + dot pattern + centre dot. £182.25

AMPLIFIERS (†)

CM6001/PU	Power unit for those marked* below	£9.42
CM6017	Set-back, battery op., single u.h.f. group	£9.21
CM6019/WB	Masthead, wideband u.h.f., with companion CM6020 power unit	£14.69
CM6030/W8*	Masthead, ultra wideband ch. 1-68	£17.88
CM6040/W8*	Masthead, wideband u.h.f.	£17.88
CM6051*	Masthead pre-amp, single group u.h.f.	£9.42

Please state which group required, if appropriate.

P. & P. UK: £0.12 per order. **Overseas:** At cost.
Please add VAT at 8% and 12½% on items marked†.
It is only possible to show part of our range here. Our catalogue (30p refundable) shows Service Aids, 7400 series, CMOS, op amps, SCRs etc., hardware, capacitors, special TV items and many more transistors, diodes, i.c.'s and valves.
Giro A/c 23 532 400. *A/c facilities available*

CAPACITORS

Metallised Paper (†)

2n2F	1500V DC	60p	10nF	500V AC	60p
2n2F	600V AC	24p	15nF	300V AC	30p
3n6F	1700V DC	60p	22nF	300V AC	32p
4n7F	1500V DC	60p	100nF	1000V DC	20p
10nF	1000V DC	22p	470nF	1000V DC	60p

Reversible Electrolytics (†)

33V	6μF	42p	50V	25μF	53p
50V	4μF	30p		32μF	55p
	6μF	30p		50μF	58p
	8μF	34p	150V	4μF	60p
	12μF	36p	250V	1μF	63p
	16μF	38p		2μ2F	86p

CONVERGENCE POTENTIOMETERS
5, 7, 10, 15, 20, 50, 100, 200, 500Ω †38p each
Spindles for above 5p each

VHF to UHF CONVERTER CM6022/RA. "Televerta" for DX-ing or uhf receiver use on relay systems, Eire etc. †£24.40

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TELEVISION

Where's the Profit?

We can produce the sets, and we can sell them. But can we make a profit out of it? It's well known that many manufacturers have been running their TV setmaking operations at a loss over the past couple of years or so. Others can hardly have made much at it. The retailers have been bemoaning their low profits – but then like farmers they probably always will. The savage discounting that's been going on does however mean that profitability has been low. Does it all matter, you may say? Unfortunately, events can hardly have taken a worse course. Take VCRs. A recent letter in one of the trade magazines commented that no UK firm had developed one from scratch. But you can't without the money to do so, and in the absence of profits and in an era of high interest rates the money isn't there. So no UK VCR system – even if yet another system would have been a desirable thing, which is debatable. More to the point however is the other development that could mean a bright future for the TV industry – teletext/Viewdata, or Prestel as we must now learn to call the latter (see page 511). These systems originated and have been developed in the UK, but is the industry in its present profitless state in a position to be able to seize the opportunities they represent? And quite apart from the limitations which lack of funds place on the development of new products, restraint is also placed on investment in improving existing products – ensuring, that is, that the TV sets themselves remain competitive in terms of reliability, performance and value.

What can be done? We don't think there are any easy solutions, though there always seem to be plenty of suggestions on offer. Ray Cope, Grundig's sales director, puts the blame for the situation on TV rental. Addressing the recent Scottish RIC congress, he commented: "Our manufacturers strive to design and to manufacture television receivers to the lowest possible price they can get down to, trying to prove to successive Governments that the television industry is far more efficient at providing a social service, and that we provide the finest occupational therapy product in the form of colour television receivers and charge peanuts for the service ... Rental is unique to Great Britain. Some 65 per cent of all sets distributed are rented ... The greater proportion go through rental groups owned or in direct association with manufacturers. Much of the profits from rentals is going out of this industry into the profit boxes of the finance companies. It's my view that insufficient money is ploughed back into the industry for technical development of the products."

Heady stuff, and indeed not enough is ploughed back, but what was that about rental groups owned or in association with setmakers? The problem is rather more complex. First, rental organisations are successful only because they provide a service which the public clearly wants and is prepared to pay for. Then, the high profitability is to some extent because the sets don't automatically fall to pieces at the end of the time the accountants decide is their life span, contributing extra profits once they've been written off. It's hard to see how the profit coming from the rental of aged sets can be diverted to current research and development. Perhaps a higher charge could be made for initial rentals, with larger reductions as the sets age. But who's going to be first to put up initial rental charges? The rental side is highly competitive – and is about to be investigated yet again by the Price Commission. Somehow, placing the blame on rental doesn't quite add up.

What else had Ray Cope to suggest? If we can summarise briefly, the argument ran that a more imaginative approach to sets and retailing was desirable. Make the sets more exciting – remote control and so on – and aim to go after a larger slice of total consumer expenditure. Sell the goods by pushing new technology, encouraging viewers to change sets more often. This sounds good, and no doubt goes down well amongst sales people. But it seems to us that the British public has become largely immune to the hard sell, and doesn't regard a couple of extra knobs or an infra-red remote control system as contributing all that much to what we nowadays call the quality of life. Maybe in fact the much referred to British disease is simply that we are quite happy with old bangers and ancient tellys, and don't consider a glowing new with-in wonder all that worthwhile striving for. Perhaps Ray can persuade us otherwise?

On one point we are largely in agreement with Ray Cope however – when he comments that "the rented set offers the finest value for money in this country today. In fact it's grossly undervalued and would still be a very good family investment if the price of the rented set doubled. Let us compare it with renting a car, or television rental ten, fifteen or twenty years ago."

Pass us another PL36, and did yours get through its MoT this time?

Teletopics

THE TRADE SHOWS

While setmakers were expressing satisfaction at the level of orders taken during the May 1978 trade shows, there was plenty of interest to visitors by way of new sets and video equipment. In particular, VCR activity has burgeoned. Toshiba and Sanyo have both announced the introduction of machines using the Sony Betamax system, while ITT have announced that they will be marketing machines to the Grundig four-hour standard. Grundig's four-hour machine is the SVR4004 incidentally (incorrectly referred to as the SVR4404 in our last issue). It's interesting to compare the tape speeds and track widths of the various VCR systems now available:

System	*Tape speed*	*Track width*
Philips N1700	6·56cm/sec	85μm
Grundig SVR4004	3·95cm/sec	51μm
JVC VHS	2·339cm/sec	49μm
Sony Betamax	1·873cm/sec	30μm

From these figures one sees why Sony make a point about their cassette being the smallest: they've certainly got the business of information storage density down to a fine art. The more you can get on to a tape, the cheaper the programme material becomes in pence per minute terms of course. There must inevitably be some trade-off between programme cost and picture quality however, and it remains to be seen which way the market will go. Grundig express great confidence in their four-hour system, which includes innovations such as a mono-crystal ferrite video head with glass-filled flux gap to give improved frequency response and less danger of picture break-up due to dirt on the head.

While on the subject of video, MCA in California have announced that they are equipping plant for the production of consumer optical videodiscs – the laser scanned discs developed by Philips. The player is to be produced by Philips' US subsidiary Magnavox, and the system is likely to come on the US market later this year.

Philips have introduced a hand-held monochrome TV camera for use with their N1500 and N1700 series of VCRs. The V100/15 camera is aimed at the VCR owner wishing to produce "home movies". It comes complete with a lightweight integrated power supply/modulator pack and ten metres of cable, and plugs into the VCR directly. The camera has a built-in microphone and electronic viewfinder, socket for an extension microphone, and an f 1·8 12·5-75mm zoom lens. The 2/3in. vidicon tube gives a picture resolution of 500 lines at the centre of the screen. Light control is automatic, but there's also a manual black-level control. A retail price of around £400 is suggested.

On the receiver side, Pye were showing their model CT483, a 26in. colour set with built-in teletext decoder. An interesting feature here is the facility to preprogramme a selected teletext page to appear at a set time without interference to normal viewing. Shown for the first time by Rank was the Bush Model BN6520 which combines a 4½in. monochrome TV set, an a.m./f.m. radio and a digital clock with liquid-crystal display. A new National Panasonic 22in. colour receiver, claimed to be the first of its kind in the world, features a built-in microcomputer which gives automatic programme selection for "as far in advance as broadcast schedules will allow". It's due to be launched in the UK early next year. Up to twenty on-off sequences can be preset for as much as a year in advance, with an accuracy of one minute. The complete list of dates, times and channels selected can be displayed on demand. The set switches itself off automatically an hour after the end of each selected programme. The Saba Model T6794 colour set is unique on the UK market in featuring PIP – picture in a picture. A reduced version of a second channel's picture can be added in the corner of the main display, enabling a second channel to be monitored while viewing another channel. The PIP feature can also be used to display a reduced monochrome picture from a remote-controlled closed-circuit TV camera which can be set up to monitor the front door or a child's bedroom etc. Various small-screen TV sets shown by Sony include the TV511UK whose 5in. c.r.t. can be rotated for viewing from different angles.

Of the eleven companies taking part in the Post Office's Prestel market trials only one has produced an adaptor for use with existing monochrome receivers. Labgear's commercial manager Bill Shepherd commented "we see tremendous market potential in this, because of the enormous number of TV sets in use with no internal facilities for the new services". The Labgear Prestel (Viewdata) adaptor was on display at the Pye trade show.

CONFIDENCE FROM ITT

While most UK setmakers are talking of closures and lay-offs (GEC is the latest), ITT are challenging the Japanese domination of the small-screen colour TV set market by setting up an assembly line at their new Basildon plant to produce their new 16in. colour set, announced last month. Model CP340, as it's known, is fitted with the CVC40 chassis and uses a 90° PIL black-matrix tube. The assembly line will be able to turn out 2,000 sets a week for the home and export markets. A suggested price of around £270 has been mentioned for the set.

The CVC40 chassis has some interesting technical features. The discrete component switch-mode power supply is of the series variety, using a BU126 chopper transistor. The power consumption is a lowly 65W under normal operating conditions, rising to 75W at maximum beam current. The i.f. strip consists of a TDA2540 i.c., with a surface-wave filter at the input to form the bandpass response. The BU208 line output transistor drives a diode-split line output transformer, with a transductor used for EW raster correction. The rest of the circuitry follows established lines, with a class B field output stage, single-transistor class A RGB output stages and a Mullard three-chip decoder.

VIDEODISC BREAKTHROUGH?

The great advantage of tape over discs as an information storage medium is that with tape the user can make his own recordings. Or so it has been up to now. In the June issue of *Video* (previously known as *Video and Audio-Visual Review*) there's reported a hint from the French firm Thomson-CSF that they have succeeded in modifying their laser-scanned videodisc system in such a manner that home recordings can be made. The recordings would be "one-off", i.e. you can't wipe them out and re-record something different on the disc. Nevertheless if this development reaches the production stage it would mean a radical change in the video scene.

PRESTEL LAUNCHED

Snags have attended the start of the market trials of the PO's Prestel information-via-TV service, and in fact only a single London household was linked to the system at the official start – via a Radio Rentals installation. There appears to have been some disagreement between the PO and setmakers as to the full technical specification for linking sets to the PO's lines for the service, with the setmakers claiming that the PO changed its specification and is being unduly fussy. There have also been troubles with the PO's computer – and over the name itself, with the original Viewdata being dropped because the PO had difficulties in registering such a general term. The PO comments that the "teething troubles" will be easily solved, and point out that a two month delay is a small matter for a service "which will grow into the next century".

Radio Rentals at any rate seem to be pleased to have got a foot in the door first. Their Prestel set, a 26in. colour one also incorporating teletext, is initially being rented out at £2·10 a month more than the standard rental charge of £12·90 for the receiver. It's anticipated that the charge will rise to £18 a month in six months' time when the Prestel service is able to provide customers with a more comprehensive range of information. Radio Rentals view the Prestel service as mainly rental, estimating that non-rental sets could retail at anything up to £1,000. On top of this of course the PO's charges have to be paid, just as with an ordinary telephone.

SERVICE ADVICE

There are a couple of points of general interest in the latest issue of the Philips Service publication *Link*. First it's been found that some receivers fitted with the latest Hi-Bri types of colour tube (types A56-510X and A66-510X) exhibit a degree of impurity after initial installation. The automatic degaussing circuit in the set will improve this to some extent, but it's recommended that an external degaussing coil is used to clear impurity. Secondly, emphasis is placed on ensuring that the condition of the aerial isolating panel remains in good condition. This is a safety item, and a manufacturer-approved replacement should be used, fitted in exactly the same way as the original. The problem arises because of the increased use of external items, such as TV games, that have to be plugged into the aerial socket. According to Philips, inspection has shown that repairs to aerial isolating panels are generally carried out with great care but there have been some cases where sockets have been repaired unsafely.

STATION OPENINGS

The following relay stations are now in operation:

Bampton (Devon) BBC-1 channel 39, ITV (Westward Television) channel 45, BBC-2 channel 49. Receiving aerial group B.

Cheadle (Staffs) BBC-1 channel 48, ITV (ATV) channel 56, BBC-2 channel 66. Receiving aerial group C/D.

Chinley (Derbyshire) BBC-1 channel 57, ITV (Granada Television) channel 61, BBC-2 channel 64. Receiving aerial group C/D.

Grasmere (Cumbria) BBC-1 channel 57, ITV (Granada Television) channel 60, BBC-2 channel 63. Receiving aerial group C/D.

Moel-Y-Sant (Powys) ITV (HTV Wales) channel 24, BBC-2 channel 27, BBC-Wales channel 34. Receiving aerial group A.

All the above transmissions are vertically polarised.

LATEST BREMA FIGURES

The latest TV set distribution figures released by the British Radio Equipment Manufacturers' Association provide some heartening news for UK setmakers. BREMA comments that the early months of 1978 (up to the end of April) have seen much lower volumes of imports than the corresponding period of 1977. In fact UK setmakers were responsible for 83 per cent of colour set and 60 per cent of monochrome receiver deliveries during the period.

MORE TV ICs

SGS/ATES have announced three new i.c.s for use in TV receivers. The TDA1180 is claimed to be the most advanced of its type, providing sync separation and the line oscillator function – there are different versions to drive a thyristor or transistor line output stage. Good sync separator performance is ensured by the use of independent line and field sync pulse separators with variable external time-constants.

The TDA2190 is a complete sound channel, incorporating the 6MHz amplifier/demodulator sections and the audio circuits – the output is 5·5W.

The TDA1370 is a development of the earlier TDA1270, comprising field oscillator/driver circuits.

ITT have announced two i.c.s which together provide an infra-red remote control system. The SAA1050 transmitter i.c. uses CMOS technology while the SAA1051 receiver i.c. uses silicon-gate technology. Several receiver units can be controlled by the same transmitter, making it possible to use a single transmitter to control say the TV set, a high-fidelity installation, and other applications such as a model railway.

INDEPENDENT TUBE REBUILDER GETS BSI CERTIFICATION

NGT Electronics Ltd., 120 Selhurst Road, London SE25 6LL tell us that they have become the first independent tube rebuilder to win BSI certification for their range of sizes of rebuilt colour tubes.

TEXAS PRESTEL/TELETEXT DECODER

A combined Prestel/teletext decoder, type VDP11, has been put into production by Texas Instruments. It provides for all Prestel functions including autodialling and terminal identification. Options include interfacing with different types of circuitry, even (UK) or odd (Germany) parity, and for use with wired keyboards or ultrasonic remote control. The VDP11 is an extension of Texas Instruments' XM11 teletext decoder which has been in production for over eighteen months. The decoder is built on a 300 × 165mm PCB, and the price is understood to be in the region of £250 to original equipment manufacturers.

RENTAMOVIE

Intervision is the first UK company to offer feature films for rent on all types of videocassette. The charge is £5·95 per day, including VAT, and some 200 films are already available. Copyright on additional films is being obtained, and a stock of 5,000 videocassettes is envisaged. Enquiries to Intervision Video Ltd., 4th Floor, 25-26 Poland Street, London W1V 3DB.

Bubble, Bubble, Audio Trouble

Les Lawry-Johns

WHEN Mr Fortune smiled at me I knew I was in for an awkward one. He's an engaging Scot with a very dry sense of humour that leaves you wondering where the leg pull ends and the fact begins. You may remember his brother Dick (the Scot from New Zealand) who did so well at last year's sheep dog trials.

Anyway, Mr Fortune had a friend who had a Decca colour set which had been giving trouble with the sound, first going faint and then disappearing altogether.

"No bother" we said. "Bring it in and you'll be taking it out before you can say Hootsman".

A Decca 20 Series

It came in all right. But it wasn't at all what we thought it would be. In the first place the model number didn't ring any bells. It was a CS2227 and was the first of these fairly old sets to come our way. We were quite unprepared for the audio output stage – a small panel up on the left side, containing the driver and output pair of transistors.

As there was no response at all from the loudspeaker we checked this first since it was freely accessible. A meter across the tags on the low ohms range showed no reading. With a smile matching that of Mr Fortune we removed the tags and connected them to a test speaker of some 15Ω. Still nothing, and the smile faded.

Recheck the speaker in the set. It now read 25Ω. Oh dear, I couldn't have connected the prods properly in the first place. Reconnecting the clips to their original place we turned our attention to the audio panel (Fig. 1).

It was easily removed. Still with the meter on the low ohms range we checked the npn output transistor Tr251. Base to collector about 30Ω, base to emitter the same. This one was o.k. then (bad mistake). The pnp transistor Tr252 was open-circuit base to emitter. This was it then.

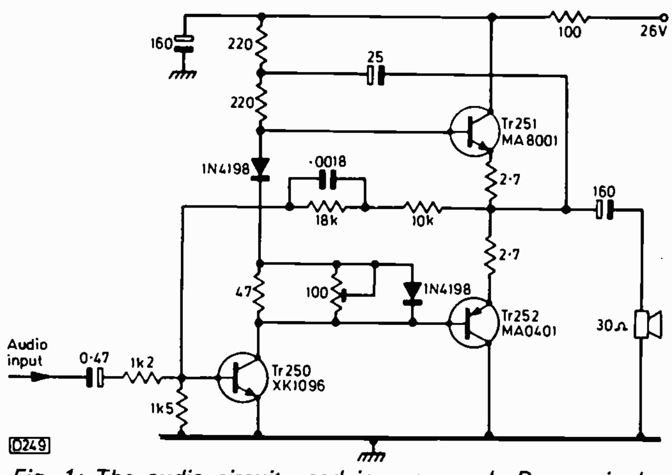

Fig. 1: The audio circuit used in some early Decca single-standard colour sets (20 series chassis). Most of the rest of the circuitry is similar to later versions of the Decca CTV25 series, though a different set of component reference numbers was used. Sets using this chassis are the CS2225, CS2227 and CS2520. Another difference is the use of an MC1351P intercarrier sound i.c.

Remove it from its heatsink and look up a likely replacement, which appeared to be a BC143. Fit this and switch on, having replaced the plug and flylead. Low, distorted sound. BC143 getting hot.

Check voltages. Full supply across BC143, no drop across the npn transistor Tr251. Penny dropped. Idiot. Failed to check it for shorts. Dead short emitter to collector. Remove and fit BC142. Check carefully, driver and diodes, small preset etc. All o.k. Refit and switch on. Burst of sound, then nothing. Oh dear (again).

Check voltages, all o.k. Still no sound. Connect test speaker. Lovely sound. Recheck set's speaker. Reads 50Ω and needle wanders up to infinity. Fit new speaker in cabinet. Sound now perfect. "All right?" we enquired.

Mr Fortune's friend shook his head sadly and said "Grrulley brunnesal yiggle frungle".

Mr Fortune interpreted for his friend. "The sound sounds fine but if you were round here you would appreciate that it's also helpful to have a picture to go with it. It was there but went when the sound came back, I suppose we mustn't expect too much. . . ."

With a heavy heart I became aware of a smell from the right side of the set. Tripler. Oh no.

"We'll leave it with you and call back later" said Mr Fortune. "My friend is getting impatient."

So saying, off went the jovial Scot with his friend now happily wagging his tail, leaving me with a smoking tripler which did little to sweeten the atmosphere of the shop.

A Music Centre

Having finally cleared up the Decca, we thought we would tackle what appeared to be a straightforward job on a Ferguson music centre fitted with a Thorn 78S main deck. The complaint was no sound from either channel, though one side failed before the other. True to form, we did all the wrong things and reached (jumped to) conclusions and what have you which we had no right to reach or jump to.

Standing the thing up on its end, we released the necessary screws to enable the main panel to be removed for a quick look. Seeing a couple of burnt out resistors in one of the output stages we removed the supply plug and strip connector, plus the f.m. aerial plug to enable the unit to be separated completely.

The 315mA mains fuse had of course failed, and the burnt out resistors were the usual 2·2Ω (or thereabouts) ones which in this case join the collectors (see Fig. 2) of the output pair of pnp and npn transistors in one channel (four separate heatsinks). We assumed that there was a collector to emitter short and confirmed this with a meter check. Stupid to the last, and being distracted by the phone and enquiries about other jobs, we studiously fitted another pair of output transistors and collector resistors, stuck in a new fuse and coupled up. Smoke from the resistors, pop went the fuse. "You bloody fool, you forgot to check the drivers etc."

The same collector to emitter short was still there, but on removing the associated driver the short had gone and in fact the output transistors were not at fault, neither were the

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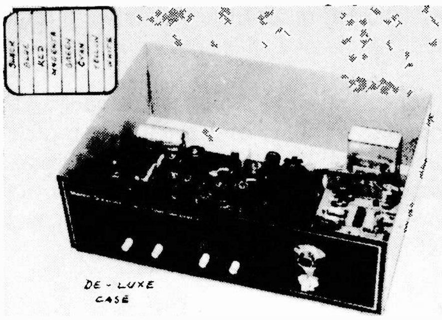

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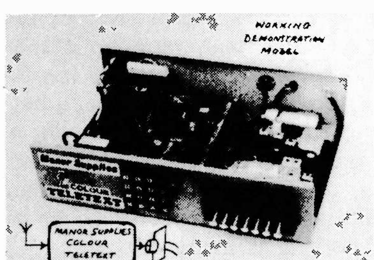

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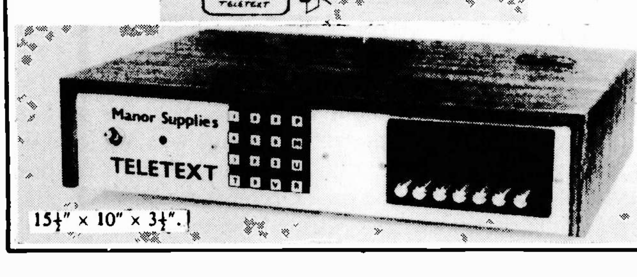

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two previously removed. Looking at the circuit didn't really show how the resistors had cooked up as the result of one faulty driver, but a close check of the whole audio channel revealed that of all the six transistors and two diodes involved only the output pair and one diode were in fact in order.

Four new transistors and one diode were fitted and the channel then functioned fine (new resistors as well of course).

Turning our attention to the other channel we found that here only the a.f. amplifier and pre-driver transistors were defective, the effect of this being to turn the rest off (no burn ups). All this can be told in next to no time. In fact it took several hours, such is my blundering incompetence. I'll learn one day, you'll see.

Back to More Familiar Ground

You would think that after that repairing an Ultra colour set with a Thorn 3500 chassis in it would be a picnic. I thought so too, so I am barmy as well. Not half as barmy as the chap who introduced me to it however.

He came in and said "would you have time to come out to the car and have a look at my set so that you can give me an estimate for its repair?"

I replied of course "what sort of car radio is it?"

"It's not a car radio, it's an Ultra Bermuda colour television and it only wants an aerial socket. I've just brought it and don't want to spend too much on it. The people I got it from said it only wanted a socket, you see."

Here we go again, here we go again.

Reason prevailed and he and his dad got the set out of the car and on to the bench it went. It appeared to be in good condition generally, but I was not inclined to believe that the original owner would have parted with it simply because the aerial socket had broken. This however precluded it being demonstrated.

So while they stood there I fitted the required aerial socket. We then tried the set. Somewhat to my surprise, a picture of sorts appeared, but with very poor convergence. This partially responded to adjustment, but I was aware of some overheating from the convergence board. This sort of thing is usually associated with defective diodes, and it didn't take long to find that W571 was short-circuit. With this replaced and the controls reset, the picture was very reasonable and the tube seemed to have plenty of emission.

In Search of the Sound

We then went in search of the sound, of which there was no trace. The loudspeaker proved to be in order, but the voltages in the output stage were way out, as were those in the driver and audio amplifier stages (see Fig. 3). All four transistors appeared to read right in situ, but just to be sure each was removed and tested. The only one at all suspicious was the pnp output one VT404 which seemed to have very slight base to collector leakage though hardly enough to cause the wild voltage inaccuracy. To be certain this was replaced, but nothing seemed to change.

The trouble seemed to be that there was no turn-on voltage at the collector of VT401. This should be 0·5V in order to coax the driver VT402 into passing current. This meant that VT401 was shut off, either because its base voltage was too high or its emitter voltage was too low. We pointed an accusing finger at C402, which could have been short-circuit. It wasn't. The base circuit components seemed to be in order, so we concentrated on the emitter circuit.

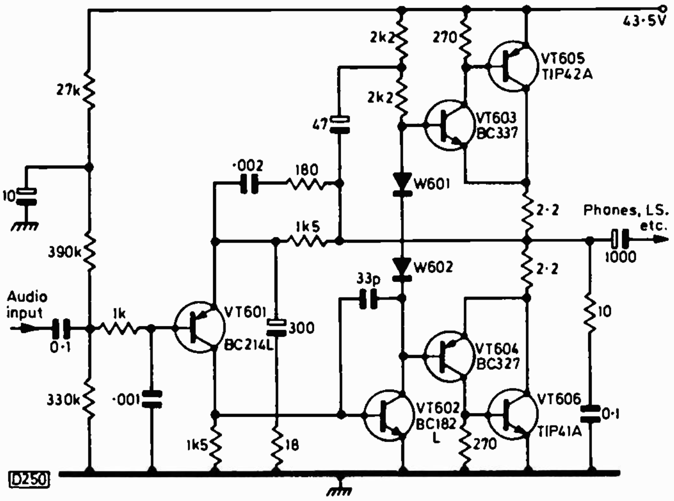


Fig. 2: Some contrasting audio circuitry, used in a Thorn music centre. One channel only of this stereo unit shown. Both channels were dead, for different reasons.

The voltage here wasn't too far out but on close inspection was somewhat lower than it should have been. This could have been due to leakage through C407. It wasn't.

Now stop and think. If VT401 wasn't passing current, there should be no voltage across R409 and there should be the same voltage at the emitter of VT401 as at the emitters of the output transistors. This latter voltage was not the correct 26V but more like 60V since VT404 was turned off. So the voltage at the emitter of VT401 should have been 60V instead of the nearly correct 26V or so! This could be explained if R409 was way up from its rated value of 4·7kΩ: it wasn't.

Panic started to creep in. The voltage at both ends of R409 was only about 26V and was varying slowly. Now this resistor is near the top of the board and quite suddenly the meter jumped and the sound returned only to fail as the prods were removed. Belatedly the penny dropped and panic was replaced by bitter hatred. Once again we'd missed the obvious. Very careful examination revealed a hair crack on the panel passing through two tracks. Scrape, clean and bridge with wire. Normal sound and correct voltages. At last.

The Lot Went Off

Moving the set to make a final check on the picture there was a sparking noise and the lot went off, only to come back on immediately. What next?

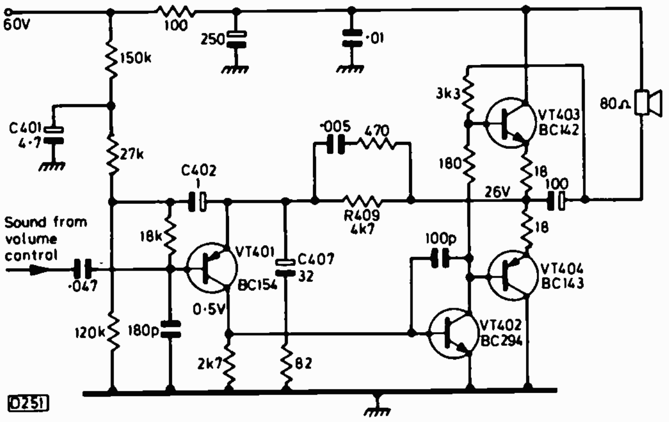


Fig. 3: Another collection of d.c.-coupled audio stages, this time the circuit used in the Thorn 3000/3500 colour chassis. Odd voltages were caused by printed panel defects rather than component failures.

We wearily turned our attention to this new problem. It turned out to be nothing more than a poor contact on the on/off switch, where the live mains lead had never been properly soldered to its tag.

Now the thing functioned properly. Now we knew why the set had been sold. All it wanted was an aerial socket.

A Visit to Oaktree Drive

"Would you call to look at my set, it's the HMV, the picture's gone fuzzy? You know where we are, Oaktree Drive. Anytime". It was Dr Elmtree. So we wrote in the book Dr Oaktree, Elmtree Drive. Another 3500 chassis. Fuzzy picture. Probably means it's out of focus. Make sure we have a tripler in the outside service box. Yes. After tidying up a couple of loose ends we set off to attend to Dr er-who?

Now once the old computer has an address fed into it we are not really conscious of where we are driving until we get there, because thinking (as you may have gathered by now) is not one of our strong points. Arriving at our destination we were quite surprised to find it marked Oaktree Drive. Must have changed the name, we thought. Bashing on the solid oak door we were vaguely aware that there were too many oaks around to be true.

I was ushered into the room where the TV set lived by the elderly lady who had answered the door, but when I looked round she had vanished and in her place stood a stocky man who seemed to find something interesting in the ceiling. I thought I'd better attract his attention. "Dr Oaktree, I presume?"

He spoke. "Dr Elmtree is not here at present, I'm Dr Sideshaw".

He said this still looking upward. I too looked up, in case there was something I was missing. He swivelled his eyes down to look at me, with his chin still held high.

"There's nothing to look at up there. I've only got my head up like this because there are two points sticking out of my collar which impale themselves in my neck if I lower my head. My wife has a habit of not taking the bones out of my collars before they're washed and ironed. Then when she finds the bones in a mess she takes them out and puts in cherry sticks. I wouldn't mind this but she forgets to break the points off and through the collar they go you see."

And off he went, struggling to undo the collar. What was that he'd said, Dr Elmtree? Could have sworn it was Oaktree. Perhaps I'm in the wrong house. No, there's the HMV. Oh well, there are some funny people about. Better have a look at the TV set.

Picture o.k. Suddenly bright blue and hazy. Not the tripler then. Just another one of those "reliable" thick-film resistor units crumbling up again (RGB output stage load resistors). Rummage in spares box and find three 8·2kΩ 7W wirewounds which are near enough. Use with three 47kΩ carbon resistors (to chassis) to replace the thick-film colour drive output load resistive unit. Remove panel and spread out nearby Girlie magazine to catch any drops of solder. Easy job really, but some care is needed to insert the new resistors into the correct positions.

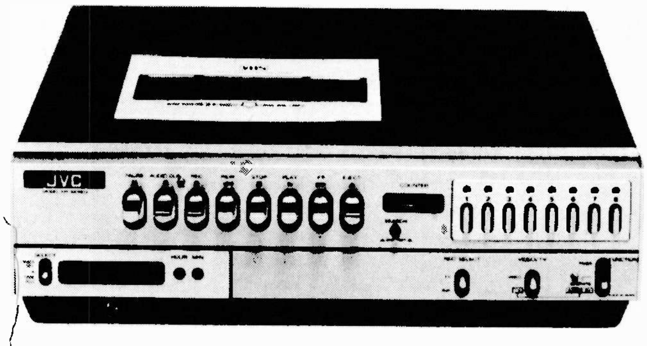
Ten minutes on panel, another ten studying Girlie magazine.

Not a bit like *Homes and Gardens*.

Wrap up job. No one at all around now. Let myself out having called out a few "hallos" up the stairs and into the kitchen. All the same if I'd been taken bad or electrocuted myself or something. Don't forget to send bill in, and try to get name and address right, Sideshaw, eh?

The VHS VCR System

Steve Beeching, T.Eng. (C.E.I.)



The JVC HR3300EK VCR.

THE VHS system is one of the latest domestic videocassette systems to be launched in the UK, initially by JVC and Akai who are both well known for their audio equipment. The format and basic electronics were designed by JVC, who carried out the research and development work. JVC's HR3300EK videocassette recorder and Akai's VS9300EK are identical inside, only the covers being different. Both companies have marketed industrial and educational video equipment: JVC have produced many machines using the U-Matic format, while Akai have done well in marketing a portable video unit using ¼in. tape.

At a first glance the VHS VCR looks like a large audio cassette recorder – see the accompanying photograph. A closer look reveals a very compact videocassette machine however.

Signal connections follow an established pattern. The TV aerial is plugged into the VHS machine's aerial input socket, and a lead that's supplied connects the output, at r.f., to the TV set. Thus the VCR and the TV set can be tuned to separate channels simultaneously. In addition, there are standard video input and output connections. Most domestic users would not require a video output, but the video input is ready to accept the output from any standard monochrome or colour camera without the need for a u.h.f. modulator as an extra. Line audio input and output are via a single DIN socket, with a microphone socket at the front. This is useful in giving the facility to dub audio, allowing the user to record audio on top of the video as say a commentary track. It'll erase any existing audio though.

The tuner unit is a standard one covering channels 21-69, with the u.h.f. output on channels 43-47. So watch it if you are in the Emley Moor area.

The r.f. output is adjustable to avoid co-channel problems. The way I do it is as follows. Insert the test tape and replay. Tune the TV set to around channel 50, then tune *down* to the signal. Stop the machine and plug the aerial into the TV set directly. Check whether any signals from TV transmitters are present. If not, all is o.k. If signals are present, readjust the TV set until there is no signal. Reconnect the VHS machine in the playback mode and, using a trimming tool inserted through a hole in the side, tune the machine's modulator for correct replay. After doing this recheck the tuning by adjusting the TV set back to a higher channel, then down again. The reason for this is that the modulators are double-sideband, and you can tune the TV set to either sideband: the lower, unwanted sideband is slightly noisier, and TV sets with a.f.c. do not appreciate it. So always tune to the upper sideband by tuning downwards from a higher channel till you reach it.

Resolution and Bandwidth

The resolution of the VHS system is given as 240 lines on colour and 290 lines on monochrome. The relationship between lines and bandwidth is rather vague: a given resolution is possible with a given bandwidth, but this does not take into account either the depth of modulation of the video signal or the dB fall off in high-frequency amplitude. There's an approximation however, a factor of 80. So 240 lines divided by 80 suggests a bandwidth of 3MHz.

The selection of auto, colour or monochrome is by means of a three-position switch at the rear, auto being the usual position. In the monochrome position various colour filters are switched out giving increased bandwidth. The audio bandwidth is significant because of the very low tape speed: it's 70Hz-8kHz at the speed of 2·339cm/sec (0·92in./sec).

Controls

There is the standard range of controls for a tape recorder: pause, record, rewind, stop, play, fast forward, eject and audio dub. There's also a search control tied to the 000 position of the tape counter – useful when there is more than one programme on a three-hour cassette.

A switch on the front has the two positions TV and video (see Fig. 1). In the video position the input to the TV set will be the channel tuned in via the VCR during record or the off-tape signal during playback. For normal TV viewing the switch is left in the TV position. To go from normal TV viewing to replay the switch has to be moved to the video position. On other VCRs this function is paralleled to the playback switch. This was annoying after using the Philips VCR, but I found that I got used to it.

Another front panel switch enables an external input such as a camera output to be recorded. Again care is needed, since if the switch is in the auxiliary position you can't record off-air transmissions.

A third switch selects standby, operate, or timer. In the standby position the machine is off though the clock is on; the operate position gives record or replay; the third position gives remote recording at a time set by the clock. The main power on/off switch is at the rear.

The clock is a twenty-four hour one and the machine can be preset to start at any time during twenty-four hours. There is no preset switch-off, so with a three-hour tape inserted the recording will continue right to the end of the tape before switching off. I found that the figures are a bit patchy, making them difficult to read across the room in daylight.

Tapes

There are four standard tapes, E30, E60, E120 and E180 – indicating recording times from half an hour to three hours. Each cassette is the size of a paperback book. This makes them easy to store, and they handle well during insertion and extraction from the machine. A colleague pointed out that when you have more than one cassette you have to be careful about not mixing them up, since they are

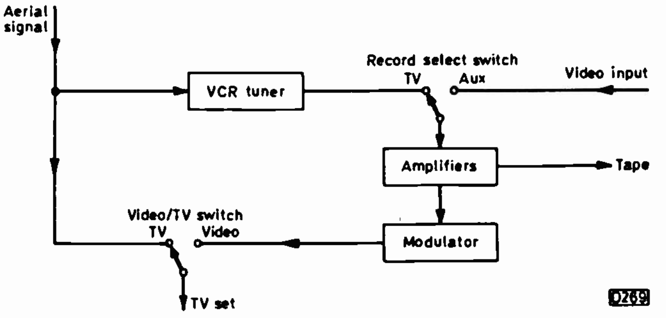


Fig. 1: Input/output switching.

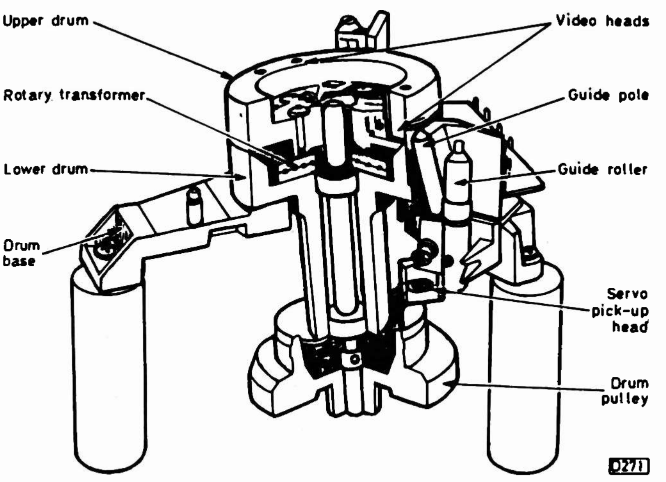


Fig. 2: Cut-away view of the head drum assembly.

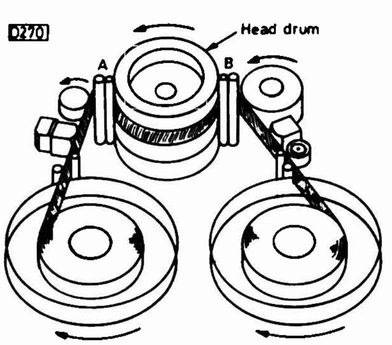


Fig. 3: The M wrap tape path system.

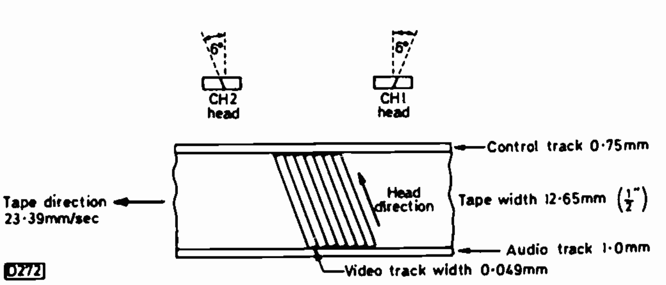


Fig. 4: Head/tape format details.

not marked (only the box covers are marked). The tapes are not easily damaged except when inserted into a cold machine that has been brought into a hot room. Condensation will then occur, but this problem is common to other VCRs.

Mechanical Details

Fig. 2 shows a cut-away view of the head drum and Fig. 3 the M wrap tape path system. Guide posts A and B travel across from the cassette to the head drum, carrying the tape with them and wrapping it around the head drum by just over 180°. It's simple and effective, operates very quickly, and the servos give a rapid lock-up and picture, with the video muted until the servos become stable. This speedy operation is useful, providing fast searching for the beginning of the programme – the machine dethreads for fast forward and rewind in order to avoid unnecessary head wear.

A rotary transformer is used to pass the signals between the video heads and the record and replay amplifiers. This is used in preference to slip-ring connections. The drum servo pick-up head is linked to the drum pulley instead of the drum itself. This means that a small amount of setting up is required after replacing the upper drum containing the video heads in order to phase relate the head crossover points.

Signal Processing

As in the Philips N1700 VCR described in the April issue, to maximise the amount of information on the tape there is no guard band between the adjacent tracks and the heads are tilted with respect to each other. As Fig. 4 shows, the tilt in the VHS system is 6°. The azimuth difference is 12° therefore, giving well over 60dB of attenuation to crosstalk between the tracks. This is well below the limiting capability.

As in all VCRs of this type, f.m. is used for the luminance signal. The tips of the sync pulses are d.c. clamped at a fixed level corresponding to 3·8MHz, peak white being set at 4·8MHz with clipping to avoid severe over modulation. The chroma signal is on a lower carrier at 626·9kHz.

As with the other slanted-head systems, the azimuth tilt rejects only the f.m. luminance carrier and not the lower frequency colour carrier. Steps have to be taken therefore to reject colour crosstalk between adjacent tracks. In the Philips' system it's arranged that the crosstalk is in phase so that it adds to the required signal rather than interferes with it. JVC however have devised a complex system which shifts the phase of the colour signal fed to one head by –90° per line. Thus the "channel 1" head records the colour in its normal PAL mode while the "channel 2" head records a rotating vector as a result of the sequential line-by-line 90° signal phase delay. On replay the reverse occurs. The "channel 1" head replays normally while the "channel 2" head produces an output which is phase advanced by 90° per line on a line-by-line basis. The object of the exercise is to lay down a track pattern which when replayed avoids crosstalk by addition and subtraction of the phase shifted signals, a technique not a million miles removed from the PAL delay line technique. It's hoped to explain the colour signal processing and the double limiting of the f.m. luminance carrier during replay in a more detailed article later.

Conclusion

All in all the VHS system is a good design which I expect will become popular on the domestic video scene.

Finally, as I meet more and more dealers who are handling VCRs for the first time I become increasingly aware of the need for widespread technical support – not because the machines are unreliable, but because of the need to be able to recognise the complex symptoms that can arise due to simple causes. The best advice I can give is that the nearest specialist video dealer is located. A list can be obtained from: The Association of Video Dealers Ltd., 317 High Holborn, London EC2.

Many thanks to JVC and Rank Audio Visual who provided advanced information and photographs. ■

Servicing Thorn Portables

– the 1590/1591/1593 Series

John Coombes

THE Thorn 1590/1591/1593 series of mains/battery monochrome portables first appeared in 1972 and large quantities have been produced and sold. The 1590 chassis is the 12in. version used in the Ferguson 3816, Marconiphone 4816 and Ultra 6816. The 1591 is a 14in. version used in the HMV 2818, Ultra 6818 and Alba T14. The 1593 is a slightly different 14in. presentation used in the HMV 2841.

There have been several important modifications worth noting, including the change in later production from a germanium to a silicon line output transistor. Later still the l.t. regulator transistor was changed from a germanium to a silicon device. Most sets encountered will be found to have germanium transistors in these positions however. At an earlier stage the audio driver and output stages received the same treatment, changing from the use of germanium to silicon transistors (see Fig. 2).

As you would expect, there are two main trouble spots, the power supply circuit and the line output stage. We'll start off with the power supply.

Power Supply Faults

On mains operation a double-wound transformer with centre-tapped secondary (see Fig. 1) feeds a pair of rectifiers in a full-wave circuit. The mains fuse is rated at 250mA. The l.t. rectifier or battery outputs pass via a 2·5A fuse to a two-transistor series regulator circuit which provides a stabilised 11·6V output. The reservoir capacitor prior to the regulator is C85 (4,700μF) while the smoothing electrolytic which follows the regulator is C87 (1,000μF). The supply for the audio output stage is taken directly from C85, not passing via the regulator.

The series regulator transistor VT21 and its driver/error detector VT22 can both go either short- or open-circuit. In either case the result is a dead set, though in the case of a short F2 blows. Both transistors can also become leaky. When this happens to the regulator VT21 the output voltage rises, which amongst other things is nasty for the tube whose heater is connected across the 11·6V line. If VT22 becomes leaky the regulation is impaired, with symptoms such as bent verticals.

Other causes of incorrect output voltage from the regulator circuit are R103/6 changing value or, more often, the reference zener diode W17 going open- or sometimes short-circuit. The result of an open-circuit zener is a small picture, lacking in width and height. If the regulator output does not vary between 9-15V when the "set HT" control R104 is adjusted, the zener diode is suspect.

The mains rectifiers W7/8 can and often do go short-circuit, blowing fuse F2 since the reverse battery protection diode W6 will then conduct on the negative supply half-cycles. Another possibility is a short-circuit rectifier protection capacitor (C88/C89) though this is rare. A short-circuit protection diode W6 will blow F2 of course.

When the reservoir capacitor C85 loses capacitance the smoothing is poor, i.e. loud hum and a distorted picture. When the smoothing capacitor C87 goes open-circuit the result is usually a hum bar on the screen. C86 can also be responsible for poor smoothing, e.g. wavy verticals.

Line Timebase Faults

An important difference between the 12 and 14in. models is that there is a separate e.h.t. reservoir capacitor (C115, 0·001μF) in earlier versions of the 12in. 1590 chassis. This regularly goes short-circuit, burning up and giving the no e.h.t./no raster symptom. The e.h.t. rectifier stick W12 can also be responsible for no or low e.h.t.

There are several other causes of no e.h.t. The boost diode W11 can go short-circuit to cause this symptom, or the line output transistor VT26 can go short- or, occasionally, open-circuit. When it goes short-circuit one or other of the fuses blows of course. Two other supply lines are obtained from the line output transformer (see Fig. 1), a 300V supply for the c.r.t. first anode and focus electrodes, and a 95V line which supplies the video output transistor and the brightness control. The rectifiers and reservoir capacitors concerned are W13/C110 and W14/C111 respectively. Any of these four components can go short-circuit to give no e.h.t. with fuse blowing. Check them in pairs since a short-circuit capacitor will overload the associated rectifier and vice versa. The rectifiers can also go open-circuit, with opposite results – a bright raster should W14 go open-circuit, a blanked out screen should W13 go open-circuit, since in the former case the c.r.t. is without bias while in the latter case its first anode supply is missing. The boost reservoir capacitor is C107 (220μF). This occasionally goes short-circuit with the result no e.h.t. Should W11 go open-circuit, there'll be no e.h.t. and excessive HT1 voltage.

The line oscillator transistor VT24 often goes short-circuit, and when this happens the line driver transistor VT25 is often found to be open-circuit. If the oscillator transistor is found short-circuit the driver transistor should also be checked therefore, also the oscillator transistor's emitter load resistor R123 (18Ω). Line oscillator failure in early models was sometimes due to the supply feed resistor R119 (22Ω) failing. In later versions this resistor is up-rated to 1W. These faults all result in no e.h.t. of course.

Defective line sync can be due to the flywheel line sync discriminator diodes W9 and W10 or the electrolytic C96 (10μF) in the reactance stage associated with the line oscillator. There are two electrolytics in the flywheel sync filter circuit, C93 (0·22μF) and C94 (2·2μF). These should be checked in difficult cases of poor line sync. Bent verticals can also be due to power supply faults as we have seen.

Striations across the screen are experienced with some sets. Where this trouble is encountered, add a 560Ω damping resistor across the line linearity coil L15.

A vertical white line means e.h.t. but no line deflection. Check for a dry-joint at point 15 on the board or the scan-correction capacitor C108.

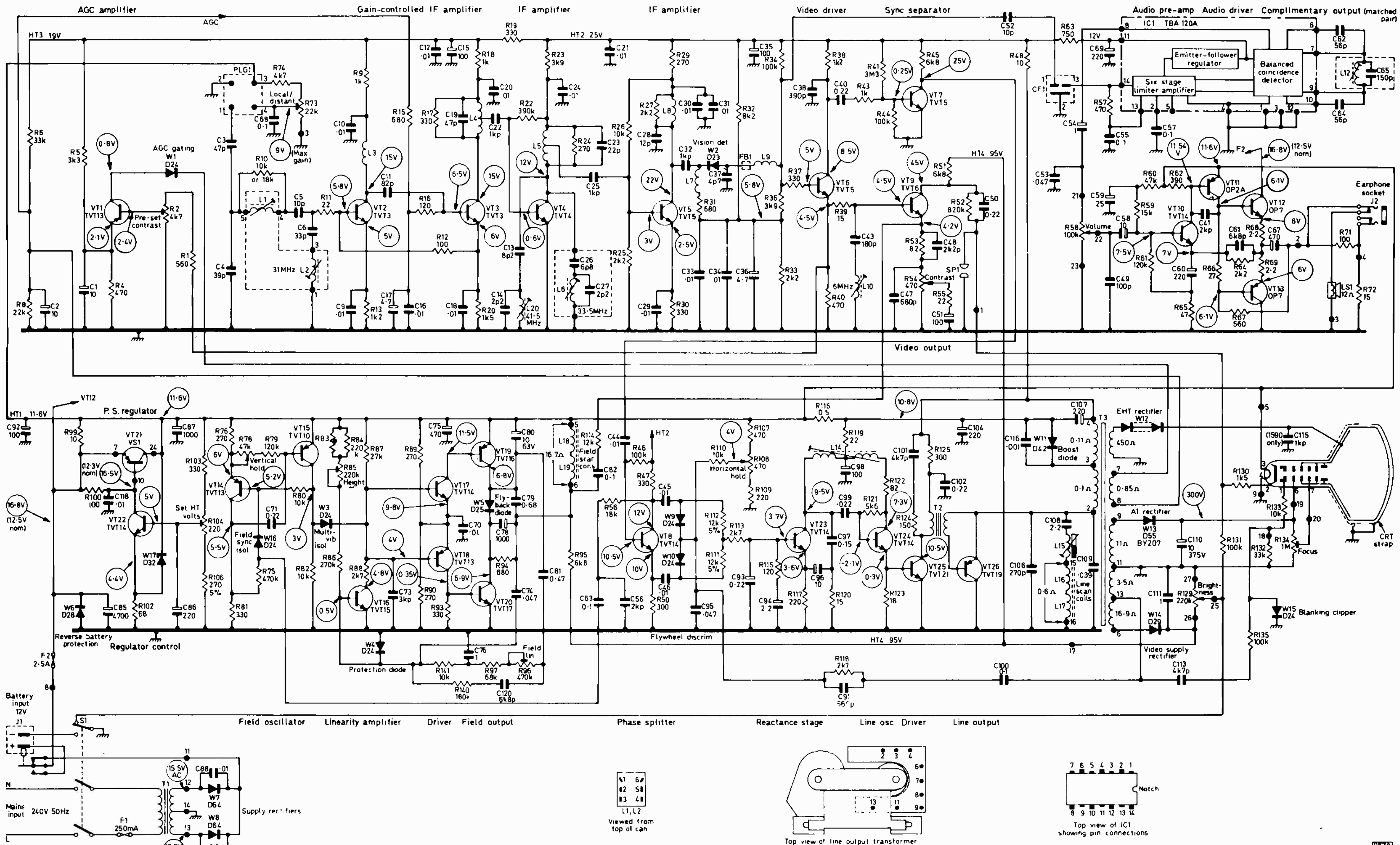


Fig. 1: Circuit diagram, including minor component value changes. In the 12in. chassis (1590) R131 is 150kΩ and C106 0·0039μF. C115 was fitted on earlier 12in. models only. In later production R48 is a safety resistor – see modifications over page. The 560Ω resistor added across L15 in later production is R126. See Fig. 2 for later audio circuitry.

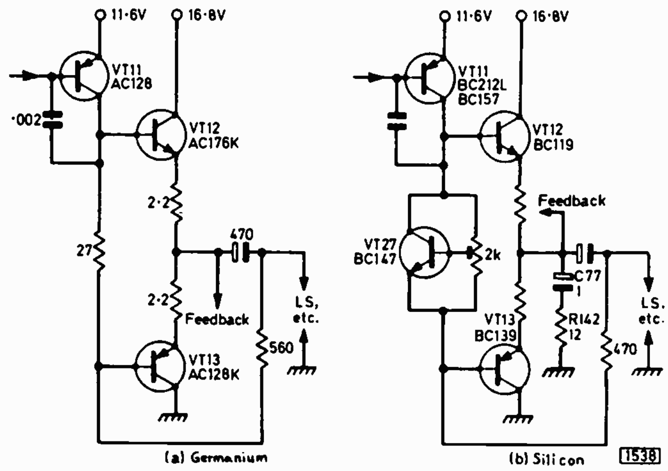


Fig. 2: Audio circuit modifications when silicon devices are used in the output and driver stages. The network C77, R142 was added to improve the audio stability.

Loss of sync occurs when the sync separator transistor VT7 goes short- or open-circuit. In cases of weak field sync, check the 3·3MΩ resistor R41 from the base of the sync separator transistor to the supply line and if necessary the transistor itself and the following sync pulse amplifier/phase-splitter transistor VT8.

The Field Timebase

The most common cause of field collapse is failure of the complementary field output pair of transistors VT19/VT20. The driver transistors VT17/18 can also be responsible for this however, as can either of the oscillator (multivibrator) transistors VT14/15. Other causes of field collapse are an open-circuit flyback diode W5, since this removes the d.c. continuity in the field output stage, and an open-circuit field scan coupling capacitor C78 (1,000μF). A defective field linearity amplifier transistor (VT16) more often causes poor field linearity.

D.C. coupling is used throughout the field timebase, so failure of an early stage will affect the voltages in the later stages. When fault-finding therefore work back to the first stage that gives incorrect voltage readings and suspect whichever transistor is concerned. The decoupling capacitor C70 in the driver stage was changed from 0·002μF to 0·01μF: the latter value avoids instability when a high-gain transistor is used as the npn device in the field output stage, i.e. VT20.

It's quite common to find that the height control R85

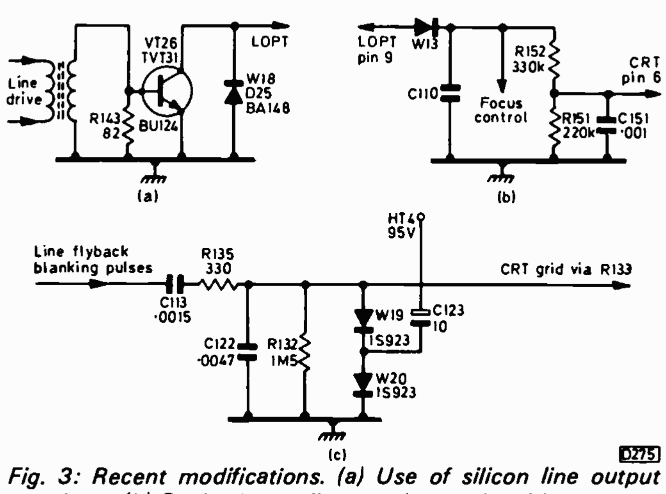


Fig. 3: Recent modifications. (a) Use of silicon line output transistor. (b) Revised c.r.t. first anode supply with c.r.t. type TMT31-102. (c) Spot-quench circuit.

(220kΩ) has a faulty track, with the result that the height jumps. A similar problem arises with the field linearity control R96 (470kΩ), the top then flickering in or out.

Video Faults

Loss of contrast or no picture at all, just a blank raster, is commonly due to a defective video output transistor VT9 (see Fig. 1). It can go open- or short-circuit, but the effect is the same since its output is a.c. coupled to the c.r.t. cathode. Weak or no vision can also be due to the contrast control going open-circuit – it's connected in the video output transistor's emitter circuit to vary the gain. There's also a preset contrast control R2, but this should be adjusted only if components around the control or the a.g.c. amplifier VT1 have been changed.

No vision can also be due to the video driver transistor VT6, or to C36 (4·7μF) which smooths its base bias being leaky.

I've also on several occasions traced lack of signals to the detector diode W2. It usually goes open-circuit but I've also found it short-circuit. The latter condition is not so easy to trace unless a very careful check is made. The i.f. signal is capacitively coupled to the detector diode by C32 (0·001μF) and I've also traced failure of the i.f. signal to get through to this capacitor being defective.

The IF Strip

The i.f. strip is quite reliable with few faults. The most common defect is simply the third or fourth i.f. amplifier transistor VT4 or VT5 going open- or occasionally short-circuit. The result is very grainy reception or a weak picture. One of the other culprits for a grainy picture is the local/distant control R73 (22kΩ) which goes open-circuit. Mounted on the main board, it controls the gain of the tuner.

The a.g.c. amplifier forward biases the second i.f. amplifier transistor VT3 which in turn biases the first i.f. amplifier transistor VT2. If you can't get the voltages right in this area, check the a.g.c. amplifier transistor VT1 and the various electrolytics present – C1 (10μF), C2 (10μF) and C17 (4·7μF).

An occasional i.f. strip fault is intermittent loss of signals. In this case the disc ceramic decouplers C9, C18 and C29 (all 0·01μF) in the emitter circuits of the first, second and fourth i.f. amplifier transistors should be suspected of being intermittently leaky.

Flyback Lines

Complaints of field flyback lines on the screen are occasionally encountered. The usual cause is that the field flyback blanking pulse coupling capacitor C82 (0·1μF) is dry-jointed.

Sound Faults

The intercarrier sound channel consists of a TBA120A i.c., though sometimes a TBA120B is fitted. Because of the tolerance limits of this latter device, a ¼W 12kΩ resistor is fitted on the print side of the board between pins eight and eleven. Distortion can be present if this resistor is not fitted. It should not be used with the TBA120A and should be removed if a TBA120A is used to replace a TBA120B. The 6MHz quadrature coil is L12 and the tuning of this is fairly critical. The 56pF capacitors C62 and C64 which drive this coil can be responsible for weak, distorted sound.

No sound can be due to several things, mainly the complementary symmetry output pair of transistors VT12/13. These can go short- or open-circuit. In the former case there will be fuse blowing of course. The driver transistor VT11 can also be responsible for no sound, and can damage the output pair when defective. All three transistors can be responsible for sound distortion, while VT11 sometimes causes intermittent loss of volume – check by applying freezer. In the case of short-circuits in the output stage the emitter bias resistors R68 and R69 (2·2Ω) should be checked as they will probably have been damaged.

C54 (1μF) couples the output from the intercarrier sound i.c. to the volume control from which it's coupled to the audio amplifier circuit by C58 (10μF). These capacitors can be responsible for weak or no sound when they dry up, while should C58 go short-circuit or leaky the result will be no sound or weak, distorted sound respectively due to the bias conditions being incorrect.

The loudspeaker can go open-circuit to cause no sound, and can also be responsible for distortion due to cone displacement.

No sound can also be due to the earphone socket J2. There's a potential divider R71 (100Ω) and R72 (15Ω) across the output to protect the amplifier in the event of the earphones being shorted. This can also give trouble.

The Tuner Unit

The u.h.f. tuner used is a standard Thorn one and is very reliable. There are two transistors, a grounded-base r.f. amplifier (VT351) which is suspect in the event of a very weak, grainy picture, and the mixer VT352 which can be responsible for absence of the lower channels. The r.f. gain control R73 on the main panel should be adjusted to remove cross-modulation under very strong signal conditions. The usual Thorn push-button tuner mechanical troubles are sometimes experienced.

Later Modifications

Important later modifications are as follows.

The series regulator transistor VT21 has been changed to a silicon device, type T6017V initially, later type T6018V. Modifications associated with this change are: R116 replaced by coil L13, R86 changed to 330kΩ, and different deflection coils used. With a silicon regulator transistor the HT1 rail is 11·1V.

With a silicon line output transistor the line output stage is altered as shown in Fig. 3(a). An R2461 transistor was used initially, with R143 180Ω. Associated modifications in the driver stage are: R125 220Ω, C101 0·01μF, C102 4·7μF electrolytic.

Some 12in. models are fitted with a TMT31-102 c.r.t. which requires a lower first anode voltage. The modification shown in Fig. 3(b) applies in this case. Another modification applicable to the 1590 chassis is the addition of a spot-quench circuit in the c.r.t. grid circuit to prevent c.r.t. spot burns with some batches of tubes. See Fig. 3(c). This applies to sets in which the lead from R129 (tag 25) to S1 is omitted.

The mains rectifiers W7/8 have been uprated to 3A types, classification D64. Type 1N5401 is suitable. The boost diode is now classified type D42, e.g. BY298 or MR854.

R48 was a 3W fusible resistor in some sets. In latest production it's a ¼W carbon film type. The latter type should be used for replacement purposes, mounted clear of the board to allow air to circulate around it. ■

Adding Raster Correction

to the Thorn 2000 chassis

Keith Cummins

THE Thorn 2000 chassis was introduced at the start of the UK colour service in 1967. It was a dual-standard colour chassis and was either loved or hated by engineers – no one seemed indifferent to it. Two things are sure. It was the first all solid-state colour chassis to be introduced anywhere, and it has stood the test of time. In the writer's family there are two of them still running quite happily, and one can be sure that their contemporary hybrid chassis rivals have not done so well.

Unfortunately this early chassis was not fitted with raster correction. Many customers complained that the top of the picture was bowed downwards, and this was indeed the case. The base lines of tennis courts, edges of swimming baths etc. were all decidedly bent. Inspection of the convergence panel reveals that raster correction had been considered, but omitted. Indeed a space exists on the board for a transductor and its associated components.

The writer decided to investigate the possibility of fitting raster correction retrospectively. As it was not known exactly what Thorn had in mind originally, the existing printed circuit was carefully examined and was found to lend itself, as one might expect, to the addition of a transductor. A certain amount of experimenting was necessary however, and some decidedly odd raster shapes emerged during these efforts. The final result was well worthwhile however, and this article should enable anyone owning one of these chassis to instal the appropriate components and set up the receiver on a test card without great difficulty.

Principle of Operation

First, for those unfamiliar with the process of raster-correction, we must go through the principles involved. The key component in early raster-correction systems – i.e. for 90° deflection tubes – is the transductor. It's an inductor with a saturable core, the saturation being controlled by windings arranged to operate in antiphase. The antiphase action prevents the device behaving exactly like a transformer. (It can easily be mistaken for one in appearance though.)

Current flowing through either set of windings will vary the core saturation and hence the apparent impedance of the other windings. This two-way process is used to advantage in raster correction systems so that the line and field scans can be used to modulate each other. The line deflection circuits are connected to one set of windings and the field deflection circuits to the other.

Without correction the raster is not rectangular. It's more like a pincushion in shape, hence the term "pincushion distortion". The amplitude of the line and field scans has to be increased across the centre axes of the tube therefore and reduced at the corners. This will straighten out the pincushion distortion and produce a rectangular raster.

In order to produce precise correction it's necessary to modulate the line-scanning current with a parabola at field frequency and the field scanning current with a parabola at line frequency. The transductor is designed so that its saturation characteristic is approximately parabolic, and it's this which provides the basic waveform shape required.

The final circuit adopted for use with the Thorn 2000 chassis is shown in Fig. 1. It will be seen that one feed is taken from the line output transformer. The other half of the circuit is connected in series with the field scan coils (details to follow), so that all the field scan current flows through windings (c) and (d) of the transductor.

EW Correction

When the field scan is at the centre of the screen, the current is zero. At the top and bottom of the screen, the scan current is at a maximum. The sense of current flow is not important: the transductor saturates progressively in either direction. Consequently the line circuits "see" a high reactance when the field scan current is zero, and a lower reactance as the scan reaches the top or bottom of the screen. This reduction in reactance loads the line circuits more heavily and reduces the width at the top and bottom of the screen, so straightening out the pincushion distortion at the sides of the picture. This is referred to as East-West (E-W) correction, and follows the approximately parabolic law referred to above.

NS Correction

The correction of the raster vertically is likewise called North-South (N-S) correction. The way the transductor achieves this is more involved than the E-W correction described above however. Windings (c) and (d) operate in conjunction with L2 and C1 to produce a phase shift. Windings (c) and (d) produce differential saturation of the transductor's core. The amplitude of the line frequency pulses induced in windings (c) and (d) is dependent upon the amplitude and polarity of the field current. A parabola at line rate is thus superimposed on the field scan current, with its maximum amplitude at the top and bottom of the picture where the field current is greatest. The N-S phase inductor L2 is used to set up the phase of the line parabola so that it is symmetrical about the N-S axis of the tube. The control adjusts the N-S correction, so that the maximum correction occurs along the N-S axis. If the correction is excessive and the picture is bowed outwards (barrel distortion) C1 can be shunted by a resistor. A value of 1kΩ is suggested.

Trapezium Distortion

It was found that when the above adjustments were optimised a degree of trapezium distortion remained, so that

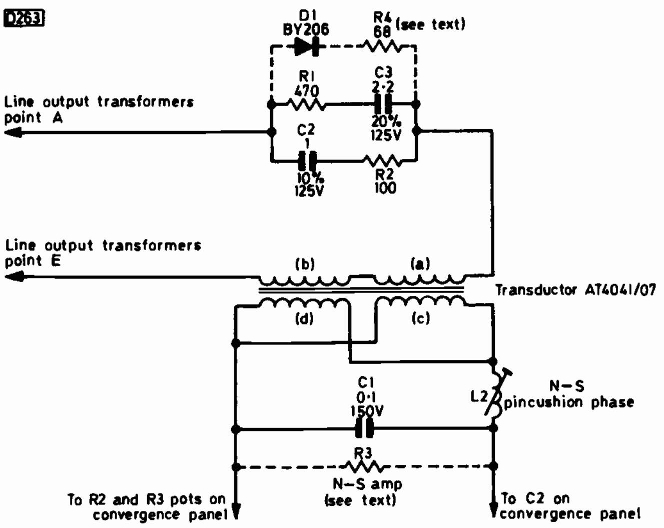


Fig. 1 Raster correction circuit.

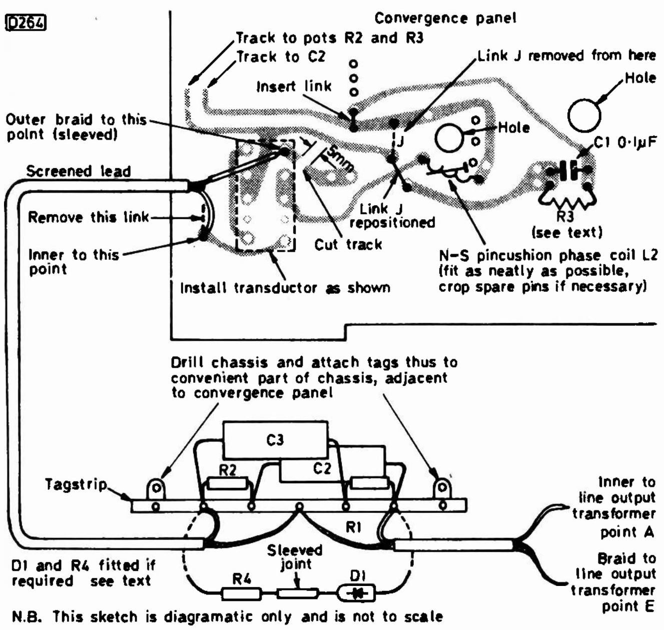


Fig. 2: Physical layout of the modification.

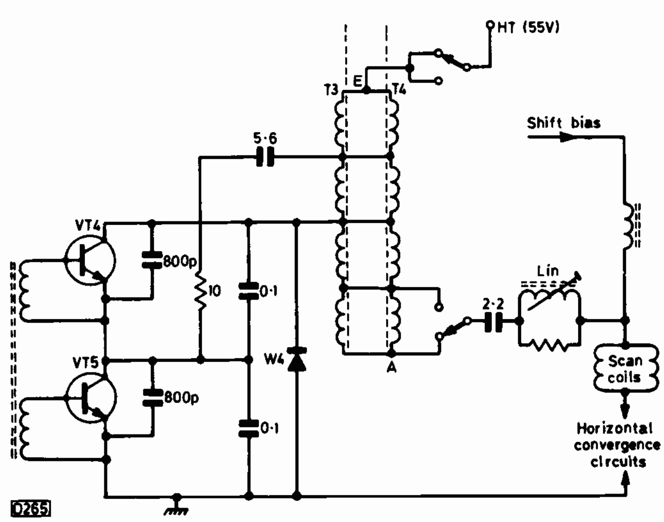


Fig. 3: Line output stage circuit (simplified) used in the Thorn 2000 chassis. The raster correction circuit is connected across points E and A. Note that there are three "LOPTs" in all in the 2000 chassis. One is used in the separate e.h.t. generator circuit. The other two (T3/4) are connected in parallel in the line output stage.

while the top and bottom edges of the picture were straight they were not parallel. Bending of the verticals also occurred at the top of the picture.

This effect is corrected by the introduction of a phase-shift network at the input to the transductor – components C2 and R2. The parallel resistor R1 forms part of the total load across the line circuits and introduces a loss as the transductor progessively saturates. C3 is a d.c. blocking capacitor (a d.c. voltage drop occurs across the line output transformers).With these adjustments to optimise the raster correction it's been found that a very good compromise can be reached, any residual errors being small enough to go unnoticed during normal viewing.

Making the Modifications

The transductor used is a Mullard type AT4041/07. The phase coil L2 is the type used in the early RRI A823 colour chassis, and needs to have two layers of turns removed in order that the core adjustment comes in the centre.

Fig. 2 shows the layout of the convergence panel, with details of how the additional components are incorporated. The transductor will fit into its position only one way round. The earth link should be cut as shown. Link J is removed and repositioned. An additional link is placed across the system switch to link C1 and R2 to the rest of the circuit. Note – this modification presupposes that 405-line working is not required!

The phase coil L2 can be persuaded to fit across the points shown. Components R1, R2, C2 and C3 are on a small tagstrip which can be mounted on the chassis frame adjacent to the convergence panel.

Connection to the Line Output Stage

A screened lead is taken off the board to the line output transformers (there are two on this chassis, connected in parallel) points A and E (see Fig. 3). Make sure these connections are not reversed. The screened lead should have adequate insulation, since the inner has line flyback pulses applied to it. The outer is at 55V. This lead can be fitted with a plug and socket if desired, in order to facilitate removal of the plug-in boards.

Setting Up

When setting up, choose a time during which the test card is available, or alternatively use a crosshatch generator. Push the core of L2 fully in. Switch on, adjust for a normal picture, then move the core of L2 out while watching the top of the picture. Adjust until the edge is as straight as possible. If no great change occurs, remove more turns from L2 until the correct result is obtained. If the inductance of L2 is too small however, distortion and lines across the upper part of the picture will result.

If barrel distortion is present, fit a 1kΩ resistor across C1. Some experimentation may be necessary to take into account tolerance differences between various sets.

Residual Trapezium Distortion

Any residual trapezium distortion can be corrected by including the network D1, R4 in parallel with R1, C3 and C2, R2. Optimise the value of R4 on test. This circuit introduces a d.c. flow through the transductor, thus altering the symmetry of the core's saturation. The effect of these components is normally noticeable only on the test card. ■

Letters

NON-TRADE REPAIRS

I'd like to add some comments to the letters from R. A. Fisher and K. Blower in the April and June issues.

I spent ten years in the trade as a service manager before moving on to a job in industry. It's obvious that Mr Fisher is familiar with the trade and Mr Blower is not. As it is lamentably true that service expertise is lacking in some organisations however I have sympathy with both correspondents. Good service departments do exist fortunately, and generally succeed in retaining their customers' goodwill.

While Mr Blower is right in criticising incompetence within the trade, Mr Fisher is equally correct in condemning the cowboys. Mr Blower is in an ideal position: he does not have to recover such overheads as rent, rates, telephone, fuel bills, wages and so on. He presumably declares his income for tax purposes, but does not have to collect VAT. Furthermore he sets his own pace and does not touch jobs he considers to be outside his capability. He's not presented with a list of ten or more calls to make in a day, involving a round trip of say fifty miles. And if he considers this too high a workload, would he agree that service charges be increased to cover the overheads of more staff?

The hard facts revealed by an accountant during a symposium I attented about three years ago would surprise many people outside the trade.

A dedicated casual serviceman doing repairs as a hobby is an undoubted gem to his customers. Now that I have left the trade I may myself if I choose help people in this way. The point however is that this idyllic way of conducting service is *not* viable commercially and will not work on the grand scale, as Mr Fisher will testify. It's worse still when the cowboys are stealing their employers' components and "borrowing" facilities such as test gear and company cars! Fire them, I say, for they are making the legitimate organisation's burden heavier still.

Trade servicing can be difficult and demanding. It requires a particular combination of skill, tact and patience which under trying conditions cannot always endure to the end of the day in an ideal manner.

Leader columns in *Television* have often stated that the public gets good value in terms of expertise and charges rendered. One comment made about my last employers was that they were "expensive but good". Most people do not mind paying for honest, efficient service – what they do object to are the antics of both cowboys and bent traders, as the two previous correspondents obviously agree.

So thank goodness for all the stoics like Les Lawry-Johns, supported by his most beautiful girl in the world, who do a good job of getting the sets fixed and making the rest of us smile with both appreciation and sympathy (how's your groin, Les). – **Keith Cummins,** *Southampton.*

HOBBYISTS WILL ATTACK ANYTHING

I would like to comment on K. Blower's letter on non-trade repairs in the June issue. As a professional video engineer, servicing radio and television receivers, v.t.r.s, etc., I've on a number of occasions been called upon to service equipment that's been through the hands of the hobbyist. The sort of things I mean are 5W mains droppers, fusible resistors made non-fusible, and so on. I and others in my position are then called in when the hobbyist refuses to take any further interest. It truly amazes me how anyone can even think of taking the back off something like a videocassette recorder, but in my area the hobbyists do just that, without any formal instruction.

I've nothing against anyone earning extra money, especially if he enjoys himself in the process – provided he knows his limitations, which Mr Blower clearly does. He says he won't touch anything if he can't carry out a safe and lasting repair, which in my estimation is fair enough. In my area and no doubt many others however the hobbyists don't adopt this attitude and attack anything and everything.

There's a lot to be said for shops refusing to service sets they've not themselves sold, but what does the owner do then? The answer is to contact a qualified person who only services and does not sell equipment. In the meantime if hobbyists think they can cope they should, like Mr Blower, obtain their work via recommendation only.

Finally, I'd like to comment on J. Pierce's letter regarding renovations etc. He's quite right, the Pye 691/3/9 chassis are prone to line output transformer trouble, but if the set to be bought is checked in the fashion I suggested originally you should find yourself with a set with a good line output transformer. If you're unfortunate enough to purchase a set with a faulty line output transformer, or one fails in a reconditioned set you've sold, then ex-equipment, guaranteed ones are readily available from advertisers in this magazine for as little as £5. – **P. G. Dixon,** *Crawley, Sussex.*

USE OF ELECTROLYTIC CAPACITORS

With reference to the informative article by S. Simon on capacitors, may I amplify one or two points mentioned to prevent any misunderstanding of electrolytic capacitors?

The forming process is the oxidation of the aluminium (anode) foil under controlled conditions at a specified voltage, usually 20% in excess of the proposed capacitor working voltage. Many capacitor manufacturers purchase the anode foil ready formed from specialist processors.

During the manufacture of the capacitor a polarising voltage is applied to the component in order to reduce the leakage current to an acceptably low value, and this "reforming" process is an essential part of production. During the reforming, slit edges of the foil are anodised and mechanical defects introduced by handling, winding and assembly are repaired. Coincidentally, the capacitance and power factor values are stabilised.

It's possible to measure the capacitance and power factor with only a low a.c. signal applied, without the presence of a d.c. polarising voltage. A small difference will be observed

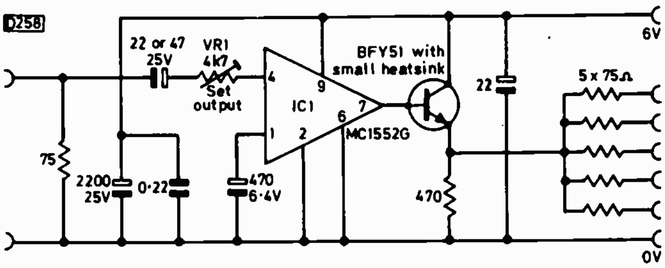


Fig. 1: Steve Beeching's video distribution amplifier circuit. Adding a 22kΩ resistor between pin 1 of IC1 and chassis alters the output as shown in Fig. 3(b).

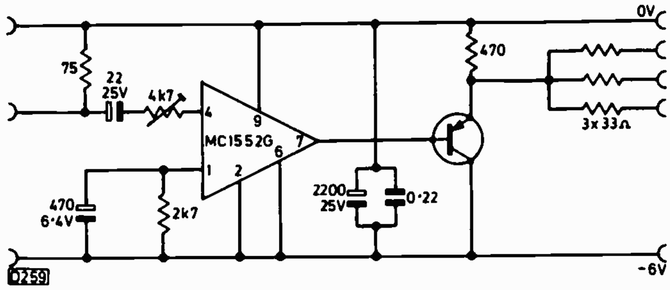


Fig. 2: Alternative version of the circuit for use as a pulse distribution amplifier.

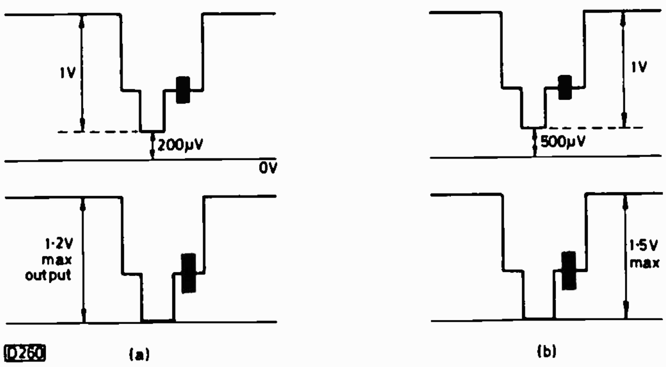


Fig. 3: Output waveforms obtained from the video distribution amplifier circuit. (a) Standard 6V circuit. (b) Circuit with 6V supply and 22kΩ resistor added between pin 1 of IC1 and chassis (across the 470μF capacitor).

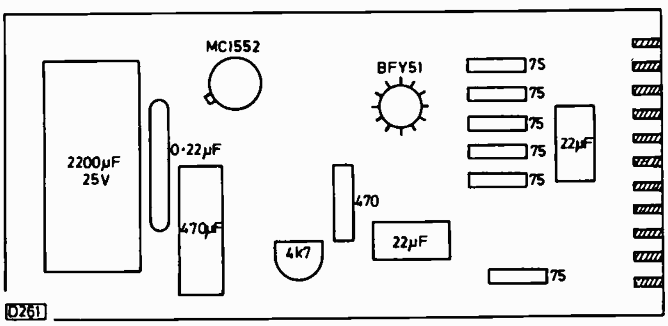


Fig. 4: Board component layout.

however if comparative measurements are taken with and without the polarising voltage present.

With modern electrolytics there is no disadvantage in operating below the true working voltage, although in the long term there may be some capacitance instability. Operating a capacitor rated at 100V at say 10V in a warm environment (as is the case in most TV receivers) may lead to a slight increase in capacitance during life, as the dielectric film (produced by the forming process) is not being fully supported. The film becomes apparently thinner, and the capacitance therefore rises.

The same effect may be noticed in normal storage, but the essential requirement of an electrolytic is that its leakage current capability, which deteriorates during storage, remains at a sufficiently low level to permit immediate use when repair and replacement work is undertaken. – **P. E. White,** *Camberley, Surrey.*

VIDEO DISTRIBUTION AMPLIFIERS

I read with interest the video distribution amplifier article in the June issue. Two points however. First the high cost of the thick-film unit: more on this below. Secondly the value of the output capacitor C3. This needs to be more like 10,000μF if tilting of the field waveform and level shifting of the field sync pulses are to be avoided. The original module was obviously designed to run off 8·5V and −4·5V in order to make the output standing voltage 0V.

Fig. 1 shows the circuit of a VDA I designed some years ago. It fulfills the function of a buffer as well as a distribution amplifier. The standing d.c. is about 1V, but as nearly all video monitors have an input isolating capacitor between the termination resistor and the input electronics this makes little difference. The cost of the printed circuit board and components is £16-18, and these can be obtained from myself. – **Steve Beeching, B & B Electronics,** *64 Manners Road, Balderton, Newark, Notts.*

SIMPLE TEST CARD GENERATOR

I appreciate the time and trouble Peter Stonard took in commenting on the simple test card generator circuit published in the May issue. There are some points I should clarify.

The unit was initially designed to work from an external sync pulse generator, and one or two components used for coupling unfortunately found their way into the final design. R30 for example, which was part of an *RC* network to prevent shading at the top of the picture following field blanking. This resistor can in fact be replaced by a link. Similarly C5 can be replaced by a link and R2 removed. Including these components does not seem to upset the operation of the circuit at all however. A lot depends on whether one is coupling positive- or negative-going pulses to TTL i.c.s. Where an isolating capacitor is used, the associated chassis connected resistor should normally be between 4·7kΩ and 33kΩ for negative-going pulses and up to 1kΩ for positive-going pulses. Diode protection is desirable in theory, but in practice I have had no failures with the i.c. types used in the generator except for about 0·5% initial failure of new devices. TTL devices are very robust, more so almost than ordinary transistors, and only extreme misuse, such as connecting to a live TV chassis, seems to damage them.

On the subject of connecting the outputs of the 7400, with particular reference to IC24, this was overlooked in the interests of simplicity. Constructors are welcome to try the suggestion made, though the unit certainly works as published.

Of particular concern is the possibility of overloading the ZNA134, since this is a very expensive device. I've used two of them in this circuit without any signs of distress, but it would probably be wise to err on the side of caution. Taking a line drive feed from pin 3 of IC10 won't work properly however because of the pulses from pin 1 of IC8. Better to take a positive-going line pulse from pin 6 of IC10 and feed it to one of the unused inverters in IC26, e.g. pin 1, distributing the negative-going inverted pulses from pin 2. This involves minor alterations to the printed board, with a couple of wire links on the underside. It's suggested that before this is done the circuit is got going in the form published – to avoid constructional faults being confused with any introduced during modification.

I agree that decoupling can be important. It was only found necessary on IC22 (C30, 10μF) however, and surprisingly no problems with false triggering were experienced except on a prototype built on Veroboard where some wiring caused trouble. If an external sync pulse generator is used, not only may some *RC* coupling be needed but screened input leads should be used.

Although very simple in concept the unit as published has worked very well and reliably. Peter Stonard clearly works with this type of circuitry much of the time, and his views are to be respected. I must emphasise however that a great deal of work went into producing a unit which I as an engineer thought necessary to replace the broadcast test card. I've built three of these generators, and all have performed as described. A few component value variations may be needed due to tolerances, but fibreglass p.c.b. construction is very easy and results in a professional finish. There should be no reason why a competent constructor should not get similar results to the picture on the front cover of the May issue. This was obtained from a tried and tested unit.

One or two readers may wonder why there's no circle or colour information. I've seen amateur built units incorporating these, but they don't fall into the "simple" category – in fact they resemble a small computer. Careful observation of the crosshatch pattern obviates the need for a circle, while a cheap source of colour is now available from Manor Supplies. The possibility of developing suitable circuitry is being considered, but if all you need is a monochrome test card then this is the circuit for you! – **Malcolm Burrell,** *Halstead, Essex.*

1500/1700 VCR CONVERSION

You may be interested to hear of my experiences in coverting a Philips N1500 VCR to the new N1700 VLP standard.

Merely to change the speed to half the original was not thought to be worthwhile, as the tapes would be incompatible with other machines. It was necessary therefore to compare the two systems and decide what course of action to take.

First, the tape speed had to be changed from 14·29cm/sec to 6·56cm/sec. This was done by machining the tape drive motor pulley to half diameter, fitting an extra servo head, and reducing the diameter of the capstan from 0·142in. to 0·131in. Secondly the non-preferred (top) audio track on the 1500 is used as the sync track on the 1700, so conversion necessitated replacing the sync head. The third difference is that the angle at which the tape traverses the head drum is changed from 3° 41′ 5″ in the 1500 to 3° 42′ 52″ in the 1700. A small change, but enough to cause a track error of about 70μm from the start to finish of one field, and as the video track is only 85μm wide a 1700 tape would not replay correctly. It was thought that adjusting the tape guides would overcome this problem.

Since everything seemed feasible we decided to go ahead. A 1700 head drum was fitted, along with a half-size motor pulley and second servo head. The machine then performed very well on its own recorded tapes, but there was some chrominance disturbance, particularly with a fully saturated red picture. The 1700 head drum is designed to displace alternate fields by one line in order to minimise chroma disturbance, and it was hoped that when the tape was transported at the correct speed (6·56cm/sec instead of 7·145cm/sec) this would be the case and the picture quality would be improved.

The new audio/sync head was next fitted, and the capstan turned down to 0·131in. diameter. The real moment of truth came when a tape recorded on a 1700 machine was replayed. The audio/sync head was aligned to the sync pulses and its azimuth set for optimum sound, but there was interference and disturbance at the top of the picture, obviously due to the different angle at which the video tracks were recorded and were now being replayed, as had been feared. The machine was tried on its own recording and gave excellent results.

As stated earlier, the angle at which the tape passes over the head drum is greater on the 1700 than the 1500, so it seemed likely that if the tape was made to begin its traverse across the head about 70μm lower the angle should be correct. We decided therefore to adjust the tape input guide while replaying the prerecorded 1700 tape. Lowering the guide by turning it clockwise through 270° produced a perfect picture with excellent tracking.

Finally, a tape recorded on the converted machine was replayed on a 1700 VCR to confirm complete compatibility. The results were very good. The only noticeable difference between the converted 1500 and the 1700 is a slight disturbance in fully saturated areas of the picture. The 1700 has an additional chrominance a.g.c. circuit to overcome this problem, so this will be our next area of investigation.

All in all the results obtained have been well worth the effort, and it's nice to know that all recordings made in future will be fully compatible with the new VLP standard. – **K. A. Paget, Goodwins TV,** *Wigan, Lancashire.*

SERIES HEATER CHAIN ORDER

Robin D. Smith got it wrong when he observed in *Faults Analysed* (May) that "the boost diode is always the first or second valve in a series heater chain in order to keep the potential difference between the heater and cathode as low as possible".

In an a.c. heater chain the heater potential of the first or second valve in the chain will be oscillating between voltages of the order of ± 300V during each cycle of the mains supply. As a result, a 50Hz potential is capacitively induced on the cathodes of these valves. This "hum" would be a menance in signal-handling stages, so the signal-handling valves are kept low down in the heater chain, near chassis potential. Stages such as the sync separator, timebase generators and the field and sound output valves are placed midway in the chain, while the designers choose valves whose performance is least likely to be impaired by this effect for the top end of the chain – the line output valve and the boost diode. These stages deal with such large amplitude waveforms that capacitively introduced hum has little or no effect on the line scan and e.h.t.

Even where a heater dropper diode is used to reduce the value of mains dropper resistor required, the heater hum problem is still present. The heater voltage is then derived from a half-wave rectifier without smoothing, so that judicious arrangement of the valves within the chain is still necessary.

If the boost diode was last in the chain incidentally and developed a heater-cathode short-circuit, the h.t. or mains fuse would blow. – **B. C. Alabaster, Tech. (C.E.I.), M.S.E.R.T.,** *Haverfordwest, Dyfed.*

Miller's Miscellany

Chas. E. Miller

A Tale of Two Fuses

I recently had two rather odd experiences with fuses which were "gone" but not "blown". The first was on a Dynatron stereo record player with the complaint that one channel had never worked properly. The original supplier had changed the loudspeakers and fitted a new and expensive cartridge, all to no avail. In this model there are twin amplifier panels fed from a common power supply via two fuses. Both the latter appeared to be o.k., and it was purely by force of habit that I checked the voltage on each. To my surprise, one had only about 11V on one side, instead of the usual 24V. This was just sufficient to give the inferior results complained of on that channel. Even on very close inspection the fuse appeared to be perfectly in order – no sign of the wire having heated up at some time or having corroded. But the ohmmeter said it was high resistance. Why was it acting as a resistor and passing only 11V? A replacement brought the channel back to normal, and as yet there have been no further complaints.

The second incident involved a Korting colour receiver. The initial fault was no picture, and on removing the back I noticed that the c.r.t. heater was not lit. This caused panic stations until I remembered that in this particular set it's fed from a winding on the line output transformer. In fact, the PY500 had gone, a new one restoring things to normal. Not long after the customer reported that the picture was sometimes "fuzzy", though I found nothing unusual when I called to look at it. Eventually the complaint was no picture once more, so I went to see the set armed with a handful of line output bottles. To my dismay this stage was functioning well – according to my neon tester – but the c.r.t. heaters weren't lit! They were not open-circuit on the meter, and neither was the winding on the line output transformer, so there seemed to be no reason for their not lighting up – unless the tube had gone soft. After a lot of anguish I found that there was a fuse in series with the heater winding, and that it read some 30Ω. Again a replacement did the trick. It seems that the old fuse had previously gone high-resistance to produce the fuzzy picture, though not so high as to extinguish the heaters altogether.

In cases like these one regrets bitterly the passing of the good old-fashioned brass-shafted volume control, a section of which has been known to make a robust replacement for a fuse!

More Jumping to Conclusions

The owner of a set fitted with the Thorn 1500 chassis rang up to say that her picture had gone and that there was a "nasty smell". So I gathered up an e.h.t. tray and went out to do a swift repair. That wasn't the result of course! The original tray was perfectly o.k., but the line output stage wasn't functioning. The safety resistor had opened up, so I checked the PL504 and PY800 and the high-voltage capacitor from the latter's cathode to earth. All were o.k., so I admitted temporary defeat and took the set into the workshop. I then found that although the line oscillator was functioning correctly there was a small positive bias on the PL504's control grid. The coupling capacitor was not leaking, and the boost capacitor was likewise in order. Touch wood, I've been very lucky with the line output transformers in the 1500 chassis, and I was loathe to believe that this one had gone. It took a very close inspection indeed to find (surprisingly) that the top cap lead to the PL504 had been dressed too close to one of the other pins on the transformer, and had eventually developed a pin-hole failure of the insulation. I fitted in its place a stiffer piece of wire, which would be unlikely to repeat the performance!

First Things First

I make no excuse for returning to a subject I've mentioned before. Always check the obvious things when starting a repair job: then double-check them! Recently a trade customer gave me a 20in. GEC monochrome set to repair, the symptoms being no raster or sound. The first suspect was the h.t. section of the mains dropper, but this proved to be o.k. I then touched my neon tester on the top cap of the PL504 line output valve to see if it was performing correctly, and got no response at all. Confident that I'd found the fault, I put in a new valve and awaited results. Nothing. Not a sausage.

The neon showed that there was still no line timebase operation (my old ears won't respond to 16kHz), so I checked for volts on the PY801 boost diode top cap. Surprisingly, the reading was nearly 300V, which indicated virtually no load on the h.t. line. The line output transformer hadn't gone open-circuit, as the PL504 had the same voltage at its top cap, so the next basic check was its screen grid feed resistor. It was not open, but to be on the safe side I put the meter directly on to the valve base in case of a break along the print. Voltage o.k. again. Perhaps the control grid would furnish a clue?

In place of the usual negative reading, I found nearly 60V positive, which made for some interesting speculation. Why, with such a large positive bias, wasn't the PL504 drawing heavy anode current and glowing red hot? And where was the positive voltage coming from? The coupling capacitor from the PCF802 anode wasn't leaking, as might be suspected. I played about for some time, even changing the PY801 and PCF802 for good luck, until I finally did what I should have done in the first place, try another PL504. This time the set burst into life: the previous new valve had been faulty. As I returned it to its box in disgust, I noticed a minute crack between two of the pins. Not enough air had leaked in to stop the heater from lighting, but sufficient to prevent the cathode emitting, I presumed. As I said earlier, it's much better to check the easy things first . . . I wonder how long it will be before I get caught again like this?

Backs to the Wall

Backs are a fact of life as regards TV sets, and unfortunately, like the poor, they are always with us. A television back is a stupid object. You can't lie it down on the bench because it takes up too much room, and you can't stand it up because it falls over and trips you up as you stagger into the workshop with a 26in. colour set. It either needs screws to hold it on – these get lost – or has footling little plastic clips which break off. Sometimes the whole perishing thing is made of plastic, which warps when you leave it near the electric fire and has even been known to burst into flames and drip blazing globules on to the Axminster.

I regard most backs with a jaundiced eye, but my personal non-favourite has to be the Indesit 24in. monochrome one, followed closely by the Thorn 1500 plastic cabinet variety. Both require considerable physical strength, combined with a fine disregard for personal danger, if they are to be fitted into their clips successfully! Maybe one day we shall again see a back like that fitted to the bow-fronted Deccas in the late fifties. Flat, apart from a very small "bowler hat" for the tube, it was held on by captive sliding screws and clips. Meanwhile, it's on with the mighty heave, crack! Oh, hell where's the glue technique . . .

Curing the Bends

I'm indebted to our friends at RRI for the following tip. A Murphy Model 2211 (A823 chassis) came into the workshop in a butchered condition. After various repairs, such as fitting a new tuner unit, it produced a picture with a pronounced bend near the top of the screen. It looked like h.t. ripple, but wasn't. The Man with the Gong said to bend the scan drive panel away from the main chassis, and if this did the trick to turn the aforementioned panel upside down. This was 100% successful, another example of how a five minute phone call can save hours of toil. Thank you, gentlemen! (But see our note about the matchbox visible on the November 1977 cover, on page 7 of that issue – *Editor.*)

He's Heard (At Last!)

Due to certain pressing engagements last autumn I missed Les Lawry-Johns' "Visit to the Cinema" in the October issue. One or two people mentioned the article, and the quote "are you listening, Chas. E. Miller?", which whetted my curiosity considerably. At last, thanks to the editor, I've had a chance to read the piece in question, and very fascinating it was! In my innocence, I'd never imagined that the projection of films had become so sophisticated. (I also never imagined that I'd read about "tit and bum" in *Television*. What would F. J. Camm have said?!)

Now I suppose it's possible I've given the impression that I'm pretty long in the tooth, but honestly, I mean honestly, I only know as much as I've read about sound-on-disc recording. My introduction to cinema projection was on a tiny RAF radar station in Suffolk, by way of 16mm. sound-on-film. The cinema, by the way, must have been one of the smallest on record, with just seven seats (armchairs) in the station NAAFI, which was a room about as big as the average living room. In fact the projection "booth" was just as big, if not bigger! The projector was an even then venerable Gaumont-British one, with a separate, massive valve amplifier for the sound. This sat beneath it. The output never had to be fully used in the tiny auditorium, and in fact a pair of headphones were provided for the operator to monitor what was going on, because the whirring of the mechanism drowned the sound from the speaker next to the screen.

According to demand, the film shows took place on perhaps two or three evenings a week, and should the projectionist have seen the current offering enough times to bore him he might set the projector to work, throw down the earphones, and settle to reading a book. This was made possible by the film being wound on extra-large reels, with few changes being called for. (In contrast, in conventional cinemas, even in the '70s, one didn't have time to really see the film, being too occupied in focusing the first projector, lacing up the second, checking the arcs, watching for the reel dots, and so on.)

Anyway, one night I found myself replaying, for the second or third time, a piece called "The Night has a Thousand Eyes", starring Edward G. Robinson and Gail Russell – and not a t. or b. in sight. I elected not to watch it again. As I said earlier, the projector was aged, and one of its foibles was to impart a pronounced jitter to the image on the screen. This could be cured only by inserting a matchstick into the film gate. I made sure that this had been done as I laced up the film, started the machine going, and relaxed.

Some time later I became conscious of foot-stamping and jeering from the audience, the normal reaction to the dreaded jittering. I peered through the projection window, but saw nothing wrong. Nevertheless the stamping persisted. It struck me that the sound might have failed, so I slipped on the earphones. It was coming through loud and clear, and it was not until I'd watched the screen again that I realised that Mr. Robinson was speaking with Miss Russell's voice, and v(o)ice versa!

This baffled me completely, because such a thing just shouldn't have been possible with sound-on-film. Then I glanced down at the amplifier, and found that during my lacing up I'd allowed a loop of film to drop down into its works. The loop went right around one of the valves, which acted as a pulley, and was running smoothly enough up into the sound head, but Lord knows how many frames out of sync. The fault was soon rectified, but I was not allowed to forget it for a long time. I always kept the earphones on thereafter, no matter how often I'd seen the film!

Vintage Spot: Band III Converters

When it became known in 1954 that independent television was on its way most setmakers paid at least lip service to the idea of making their products easily convertible to receive the new Band III transmissions. In some cases this amounted to little more than fitting a mains socket, controlled by the on-off switch, at the rear of the set.

As time passed and it became obvious that ITV was going to be a big money-spinner however converters began to be produced in earnest. Some makers opted for turret tuners (and occasionally incrementals) which could be mounted inside the cabinet, whilst others, probably the majority, housed their converters in little boxes which either stood on top of the set or were screwed on to the back. One thing they nearly all had in common was the principle of replacing the existing r.f. amplifier/frequency changer with those in the new tuner unit, sometimes rewiring the set's frequency changer as an extra i.f. amplifier. From this you will appreciate that conversion was at first limited to superhet type receivers, though there were still plenty of t.r.f. sets about.

To cater for these, the "universal" converter was developed. Its principle was to change the incoming Band III signal to an i.f. which was that of the local Band I station. Thus the output could be fed directly to the aerial socket of either a superhet or a t.r.f. receiver. In the former case the result would be a "double superhet" receiver, whilst in the latter case the receiver stages would become an i.f. strip operating at Band I frequencies. This sounds perfectly simple in theory, but in practice some unexpected drawbacks occurred, as we shall see. First however a glance at the various "universal" converters which appeared on the market.

Initially by far and away the most numerous model was the one produced by Plessey and sold under a dozen well known brand names. Whilst researching for this article I looked through a book devoted to Band III conversion. It dealt with each type of converter by name, and I was amused to find the same Plessey unit described over and over again . . . Soon however hordes of small firms jumped on the bandwagon with cheap (and often nasty) converters designed around r.f. pentodes of the EF80 type. Since these were being called upon to operate at frequencies way above those envisaged by their manufacturers, it is hardly surprising that gain and grain were not all that could be desired!

Then along came a unit which for ingenuity of design, performance and compactness could not be bettered. This was the "Sterling", which to outward appearances was a small metal case about 4 × 6 × 2in., with a control panel having an on/off switch, a Band I/III switch, and a Band III fine tuner. At the rear were two coaxial sockets for the aerials, and an r.f. gain control for Band III. Inside was a single valve – a Mullard ECC85, which had been developed primarily as a combined r.f. amplifier/self-oscillating mixer for f.m. receivers at Band II frequencies. The performance at the much higher Band III frequencies was very creditable: in reasonable conditions the Sterling could produce excellent ITV pictures – at least whilst the BBC wasn't transmitting.

I had to add that proviso because now we come to the snags which beset all universal converters. First, in areas of high Band I signal strength enough signal could be picked up on the short length of coaxial cable linking the converter to the receiver for the latter to produce anything from severe patterning to an actual picture floating in the background. Secondly (as if to return the compliment) a t.r.f. receiver operating with a converter would have several volts of r.f. at the BBC frequency, but carrying an ITV picture, at its detector stage. In some cases the radiation was sufficient to transmit a viewable picture to nearby Band I only sets. This was fine if the owners wished to watch ITV, but rather annoying if they didn't!

Converted sets lingered on for a number of years after the introduction of ITV, but now appear to be quite extinct (someone is bound to write in to contradict me!) while presumably all those countless thousands of converters have disappeared without trace. Perhaps somewhere there's a giant junkyard where they, along with other temporary crazes of the 50s such as clip-on bicycle engines, plastic bug-deflectors for cars, hula-hoops and stereoscopic movies lie waiting to be rediscovered!

Information Wanted

Has any reader knowledge of the Toshiba power pack type TH9013P? Toshiba themselves can't even tell me what it is, let alone supply technical gen. Meanwhile I have two intriguing little units (which were acquired with some bankrupt stock) staring at me from a shelf!

Diagnostic Pattern Generator

Malcolm Burrell

A specific pattern which enables a fault condition to be simulated can be a great help in diagnosing faults. For example, the set being tested might lose sync on dark scenes, or the picture may pull to the right on bright scenes. These symptoms may not be produced by a test card pattern, while the programme transmissions will probably be too inconsistent to provide a reliable guide.

The simple patterns provided by this generator are produced using very few components. In addition to their usefulness in checking receivers, they can be used for display purposes or perhaps even be adapted to give special effects. The output can be at video frequency or via an r.f. modulator to provide a u.h.f. signal for feeding to the aerial input socket of a receiver. Alternatively, the video could be taken by a switch to the modulator in the test card generator featured in the May issue so that the patterns complement its output.

Sync Pulse Generator

As featured, the ZNA134 sync pulse generator i.c. is again used to drive the circuitry. Alternatively an external sync pulse generator such as the one featured in the June issue could be used to provide the drive waveforms required. Only the mixed sync and blanking outputs from the ZNA134 are used, the line and field drive waveforms being generated separately – by IC1 and IC2 respectively. This makes it simple to use an external sync pulse generator in conjunction with the PCB.

The number of i.c.s used could have been reduced, but this would have complicated switching between patterns. Since the i.c.s are relatively cheap it was considered better to use a few extra ones.

Patterns Provided

The four basic patterns provided are: chequerboard, 50Hz squarewave (screen half white, half blank), negative- and positive-streak charts. It's easy to add switch positions for blank raster and bright raster if these are required. In addition to these outputs, this is probably the first pattern generator to feature a simulated teletext option. This is handy in preventing those hidden dots resulting in a call-back because they weren't noticed during a transmission. They won't operate a teletext decoder of course, but should make any cases of slow field flyback obvious.

We'll describe each pattern in turn, giving the reason for its use and explaining the method of generating it. The aim was not to obtain absolute perfection in the reproduction given by TV sets, but to make possible a professional approach to servicing, avoiding the hit and miss business of waiting for a suitable pattern to appear. It was interesting to observe the results when the output signals were, as a trial, piped around the workshop signal distribution system. An elderly dual-standard GEC monochrome receiver developed a false lock on the 50Hz waveform for example, while a Philips colour set fitted with the G8 chassis displayed a great deal of flaring on its ailing tube when presented with the negative streak chart.

Line and Field Drive Waveforms

The mixed sync output from pin 3 of the ZNA134 sync pulse generator i.c. is fed to the two monostables IC1 and IC2. Due to the fast time-constant of the components used with IC1, it's sensitive to the line pulses only, from which it's triggered to produce a short pulse output at pin 1.

IC2 is similarly triggered, but the time-constant here is long in order to give a long field pulse. It could be triggered at irregular intervals by the line pulses, giving erratic operation with several output pulses per field: to prevent this, positive-going line pulses from pin 6 if IC1 are fed in at pin 4, switching IC2 off except during the field sync period. This works very effectively.

Chequerboard Pattern

IC5 and IC7 form a multivibrator operating at line rate. Opposite polarity squarewave outputs are obtained at pins 1 and 6 of IC7. The output from pin 1 and the output from pin 6 of the second multivibrator IC6/8 are fed to pins 12 and 13 of one of the AND gates in IC18, giving vertical rows of squares with blank bars between as shown in Fig. 1(a). Feeding the opposite polarity outputs from both multivibrators to pins 1 and 2 of another AND gate in IC18 provides a second row of squares, displaced so that they occupy the blank space period of the previous set. Simply connecting together the outputs from the AND gates will not work, so two of the NAND gates in IC19 are interposed. Fig. 1(c) shows the final result.

Due to the large time-constants employed in the field rate multivibrator there was a tendency for instability and slow pull-in from switch on to occur. C5 introduces a little positive sync information into IC5 to correct this.

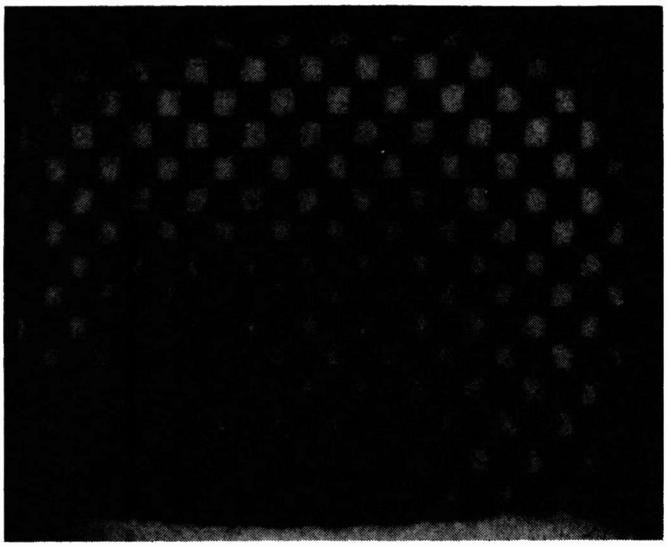
Both multivibrators also provide pulse feeds for the streak chart and simulated teletext signal generators.

Due to the sudden sharp transitions from black to white, the chequerboard pattern is useful as a test for sync separators and video circuits. It can also make a pleasant showroom display, and provides a guide to scanning linearity.

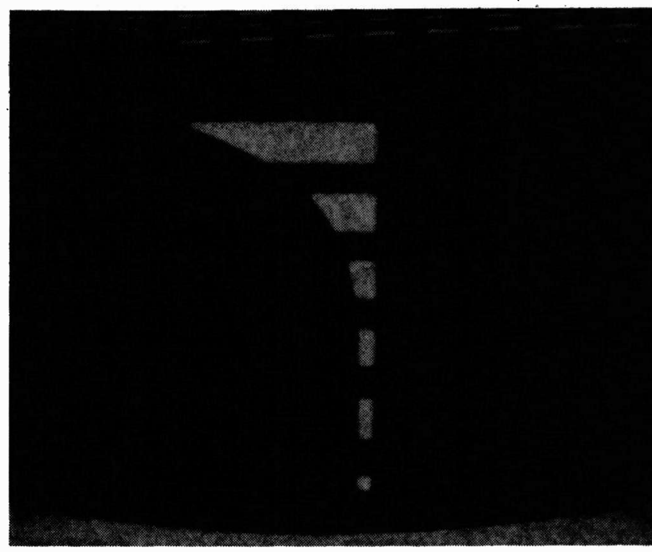
R4/7 and R5/9 may need a little adjustment to compensate for component tolerances and give a regular pattern of squares.

Streak Charts

A pattern used for adjusting afterglow correction with flying-spot scanners is a streak chart. This consists of a number of horizontal stripes which enable the h.f. response or clamping performance on varying pulse widths to be assessed. In this form it simulates the effects of captions or



Off-screen photograph of the chequerboard pattern.



Simulated teletext and negative streak chart shown on a set with slow field flyback.

★ Components List

Resistors:

R1	18k
R2	1k
R3	22k
R4	6·8k
R5	1·5k
R6	6·8k
R7	AOT
R8	1k5
R9	AOT
R10	1·2k
R11	3·9k
R12	18k
R13	120Ω
R14	2·2k
R15	22Ω
R16	3·9k
R17	AOT
R18	3·9k
R19	33k
R20	390Ω
R21	820Ω
R22	56Ω
R23	68k
R24	560Ω
R25	560Ω

All ¼W, 5%

VR1 4·7k
Subminiature horizontal preset.

Capacitors:

C1	22pF	ceramic plate
C2	270pF	ceramic plate
C3	0·22	polyester
C4	470pF	ceramic plate
C5	0·47	polyester
C6	0·22	polyester
C7	0·001	ceramic plate
C8	0·22	polyester
C9	0·001	ceramic plate
C10	4·7 35V	tantalum bead
C11	0·0047	ceramic plate
C12	0·47	polyester
C13	0·22	polyester
C14	0·047	polyester
C15	0·0047	ceramic plate
C16	0·0047	ceramic plate
C17	0·33	polyester
C18	0·47	polyester
C19	2,200 16V	Electrolytic
C20	100 6V	tantalum bead
C21	180pF	ceramic plate

Miscellaneous:

BY164 Bridge rectifier
FS1 1A anti-surge
LP1 Mains neon
T1 9V, 2A RS 207-510
XTL1 2·5625MHz crystal
Redpoint TV4 heatsink required for IC21
UHF modulator – Manor Supplies
UHF coaxial socket

Integrated circuits

IC1	74121
IC2	74121
IC3	ZNA134
IC4	7400
IC5-13	74121
IC14	7400
IC15-17	74121
IC18	7408
IC19	7400
IC20	7400
IC21	7805

Availability:

The crystal can be obtained from AEL Crystals Ltd., Gatwick House, Horley, Surrey RH6 9SU. The ZNA134 i.c. can be obtained from Semicomps, Wellington Road, London Colney, St. Albans, Herts.

end of programme credits, where streaking or poor clamping is most noticeable. It also emphasises the effects of flaring often apparent on failing colour tubes or due to faulty video output stage operation. It's useful when confronted with a picture which simply doesn't "look" right but casts doubt as to whether a video fault is actually present. Most receivers naturally exhibit a little ringing or streaking, especially at high contrast control settings or where mean-level a.g.c. or a.c. coupling are used. Experience must be the judge here.

ICs10/11/16/17 form a "window" generator, with IC10 providing the horizontal spacing and IC11 the vertical spacing. It's similar to the mating waveform generators used in the simple test card generator. IC16 is responsible

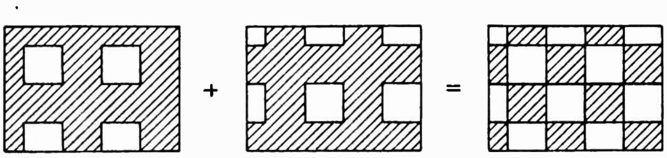


Fig. 1: Building up the chequerboard pattern.

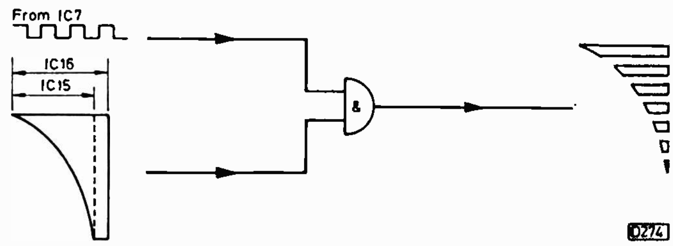


Fig. 2: Generating the streak chart.

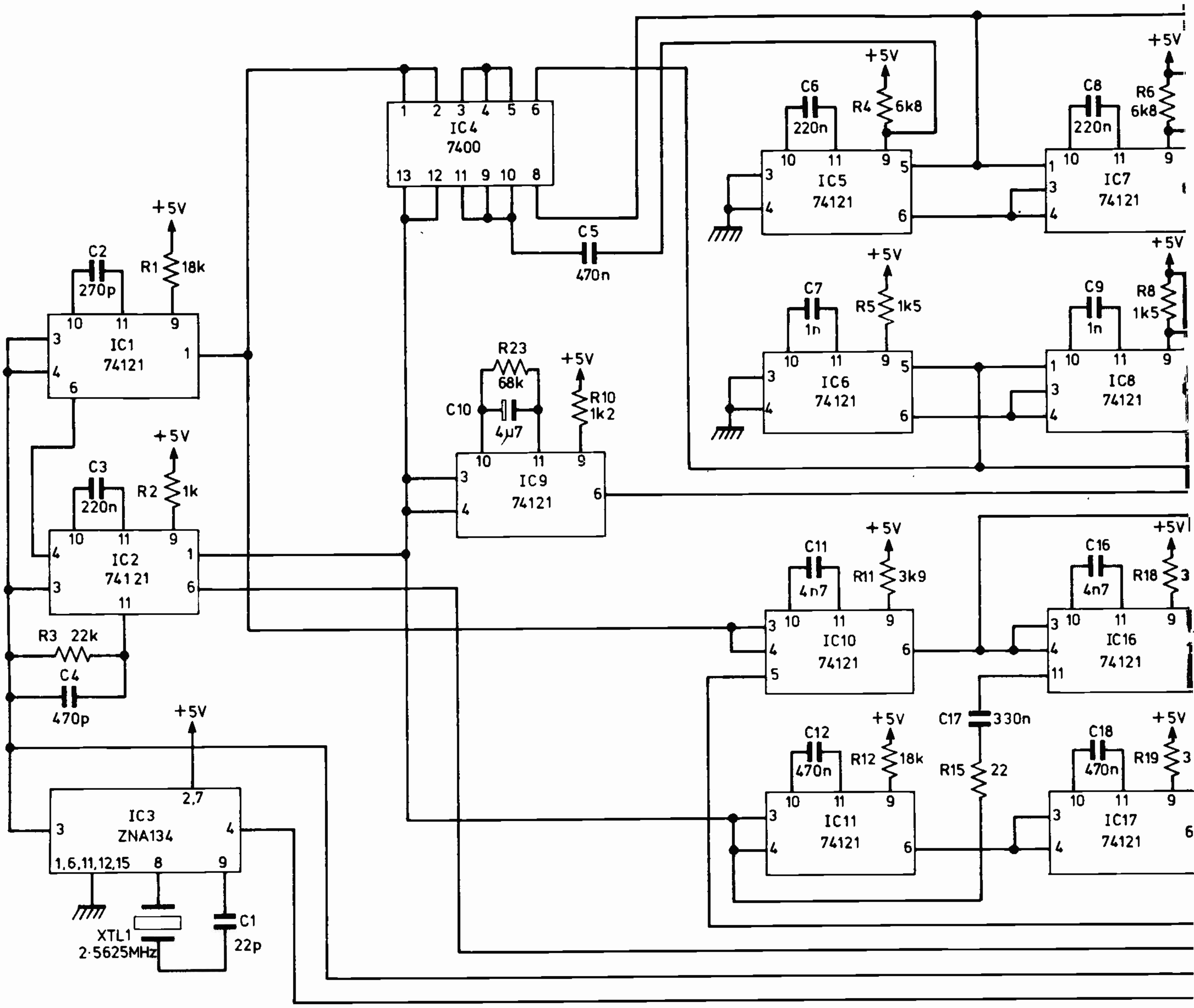


Fig. 3: Circuit of the diagnostic pattern generator. With exte
compatible source or via CR network

for the start of the streak pattern and, despite the apparently similar time-constant, IC15 ends the pattern (due to R15/C17, which mix a little of the field waveform in to give the curved leading edge, the time-constant of IC16 is shortened slightly). The value of R17 is selected to make the tip of the pattern as narrow as possible.

The output from IC16 is fed to one of the NAND gates in IC20 (pin 1) along with the output from IC15 (fed into pin 2). The following gate inverts the signal. The whole shape is then sliced into segments in the AND gate behind pin 9 of IC18 by means of the squarewave input from pin 6 of IC7 fed in at pin 10. The following NAND gate in IC19 acts as an inverter to give the negative streak chart, the positive one being taken directly from pin 8 of IC18.

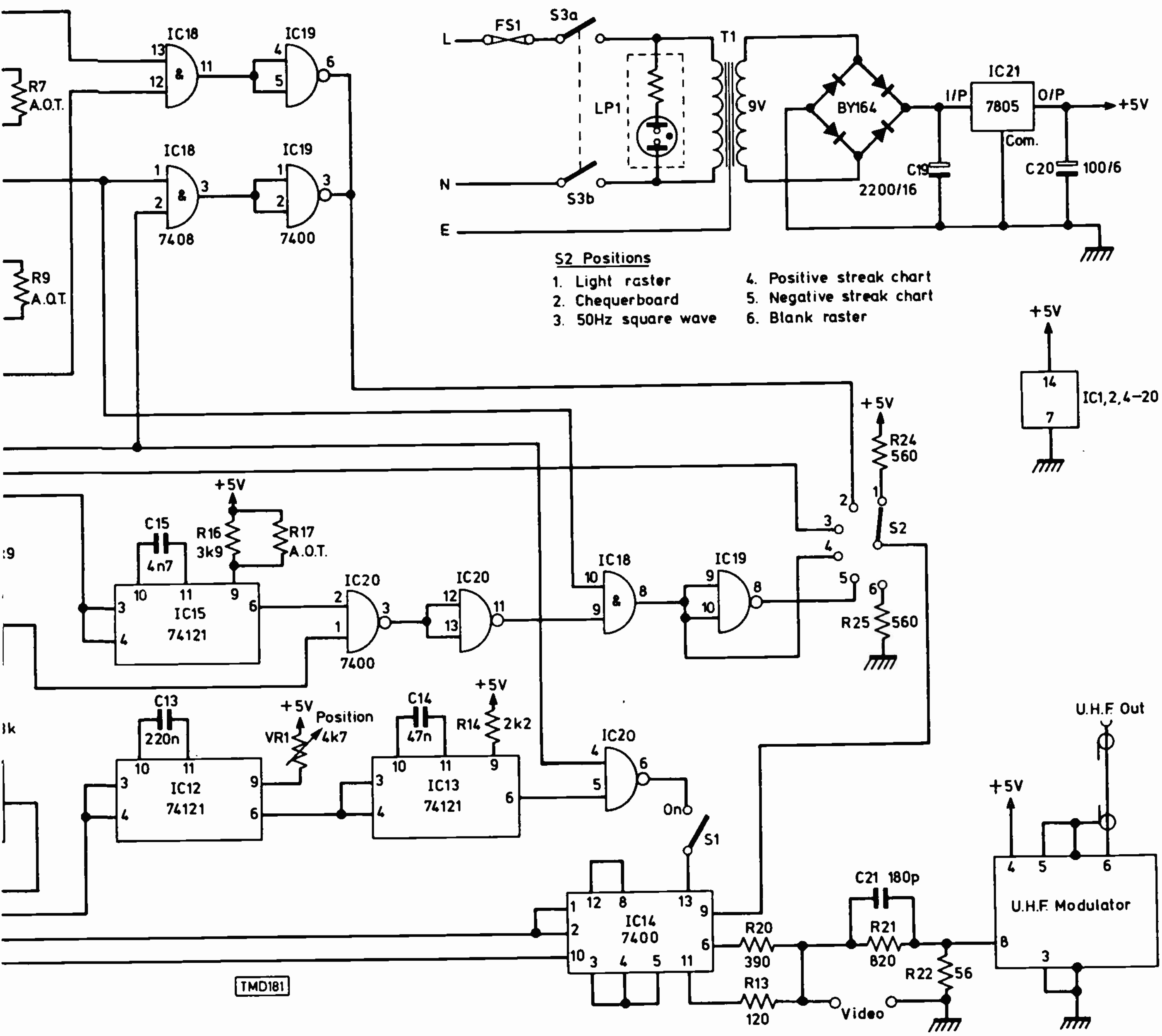
50Hz Squarewave

The BBC broadcast a 50Hz squarewave prior to the test transmissions as an l.f. response check on the transmission lines. Whilst it can be used for similar checks on video equipment, it's more useful to the service engineer for checking for false triggering of the field timebase by large areas of light or dark video information.

The circuit consists of the monostable IC9 which is triggered by the field pulses. The time-constant is provided by C10/R10, with R23 preventing jitter. Due to the tolerance of C10, the values of R10 and R23 may need to be adjusted to give a 1:1 mark-space ratio output.

Simulated Teletext

Test signals have been transmitted during the field flyback blanking period for many years. More recently, lines 17, 18, 330 and 331 of these periods have come to be used for the teletext service – with the prospect of some others being used at a later date. The result is the appearance of twinkling dots at the top of the picture. In cases of maladjustment, or where a fault in the field timebase results in slow flyback, these dots can appear superimposed on the picture. This is particularly noticeable on dark scenes, but can escape the service engineer's attention due to the continuously varying picture content of a normal transmission. There are also cases where picture height varies with beam current, with the result



nal sync omit IC3 and connect direct to pins 3 and 4 from TTL s (10μF, 5·6kΩ) from 75Ω source.

that the dots become visible on dark scenes. If these fault conditions are missed, the result can be repeated call-backs after a set has been returned.

To simulate the teletext transmissions a pattern of black and white dashes with a duration of about four-six lines is generated and inserted in the field flyback blanking period. VR1 enables the exact position to be set during construction to coincide approximately with the teletext information, S1 enabling the facility to be switched in or out as desired. The pattern is particularly noticeable on a blank raster or the negative streak chart.

IC12 is triggered by the field pulses, giving the spacing, set by VR1, from the top of the raster. Adjust by slipping the field hold control on a set receiving an off-air transmission, noting the position of the teletext signal within the field flyback blanking period. Connect the signal from the pattern generator in place of the off-air picture transmission and set VR1 for a pattern in approximately the same position.

IC13, triggered by IC12, produces a pulse duration of a few lines. Its output is modulated in IC20 by the squarewave output from IC8 in the chequerboard generator circuit, the resultant signal being fed to IC14 where it's inserted into the blanked video.

Output Stage

IC14 is the common output stage, S2 selecting whichever pattern is required. The i.c. simply blanks the video and adds the sync waveform.

Conclusion

The purpose of this unit, with the previously published test card generator, is to enable the modern workshop to be independent of the broadcaster, whose main obligation of course is to provide programmes. It's hoped that as well as providing a constant source of particular patterns for fault-finding it will also be used to give an additional five-point check on the performance of sets at extreme levels of operation, thus improving the standard of repaired TV receiver performance. ■

PCB DETAILS NEXT MONTH

TV Servicing: Beginners Start Here. . .

Part 11

S. Simon

LAST month we followed the path of the signal from the receiving aerial through to the detector. The latter demodulates the received signal, leaving the original video signal which includes the sync pulses, the chrominance (colour) signal on its 4·43MHz subcarrier, and the sound signal on its 6MHz frequency-modulated "intercarrier". We saw that these three basic signals can be separated by means of filters. In some designs more than one detector is used, and in this case there will be no 6MHz signal in the video path at all. It's logical next to trace the path of the video signal from the detector to the c.r.t. As in previous instalments, we'll take as our main example the Thorn 1500 chassis.

The Video Channel

The circuit of the video channel is shown in Fig. 1 and consists of two stages centred around transistors VT8 and VT9. VT9 is the output stage, generating the high-voltage swings required to drive the c.r.t.'s cathode. VT8 is a buffer stage, isolating the detector from the low input impedance of the output stage. It also provides a convenient means of separating some of the signals: thus the intercarrier sound signal is extracted at its collector, via C36, whilst the signal at its emitter drives VT9 and also provides, tapped off via R34, a feed for the a.g.c. detector. Since a monochrome set is not designed to process the chrominance signal this is simply ignored: the most it can do by way of interference on the monochrome display is to introduce slight patterning on parts of the picture where the colour is particularly strong. The whole transmission system is designed so that the colour signal generates minimum disturbance on a black-and-white picture.

Separating the Sound and Vision Signals

The 6MHz sound signal occupies a very narrow bandwidth and can be simply developed across a selective tuned circuit (L12, C34 and R31 in Fig. 1). In order to provide reasonable picture detail however the video signal occupies a very wide bandwidth – from 0-5·5MHz. It can't be developed across a tuned circuit therefore. To ensure that the response is even over the bandwidth (otherwise the picture will be degraded) the video signal must be developed across resistors of quite low value. This sets a limit to the amplification which can be obtained from any one stage.

Let's clarify this a little. The human ear has a restricted frequency range, as any dog will tell you. Give or take a bit, anything over 15kHz (fifteen thousand cycles per second) is pretty well lost to human ears. Thus even if we add a stereo phasing signal at say 39kHz, a bandwidth of 100kHz is more than adequate for the intercarrier signal. A tuned circuit tuned to 6MHz will neatly select this signal and requires very little damping (parallel resistance – R31 in Fig. 1) to flatten the tuning peak sufficiently to provide a flat, narrow bandwidth. Similarly a tuned circuit (L13, C35) can be used to delete the 6MHz signal from the video signal path. The colour signal is also of comparatively narrow bandwidth (in comparison to the basic video signal that is) and can likewise be selected, in a colour set, by means of a tuned circuit.

Bandwidth

The video (luminance) bandwidth has to extend up to 5·5MHz however in order to modulate the rapidly moving c.r.t. beam which produces the picture, i.e. vary the beam current between the extremes of black and white sufficiently rapidly for fine picture detail to be present on the face of the tube. This means that the design of video circuits demands careful attention so that all the frequencies involved are amplified evenly and passed on without peaks and troughs in the response.

Despite the apparent simplicity of the video amplifier circuit (VT9) in Fig. 1 the component values have been carefully chosen to provide this even amplification of all frequencies. There is inevitably some fall in gain towards the top end of the video bandwidth, due to the presence of stray capacitance which tends to short out the higher frequencies. Compensation for this is provided by C39 in series with R42. This capacitor is not of large enough value to decouple the emitter resistor R43 at the lower end of the frequency range. The result is the introduction of negative feedback at the lower frequencies, thus reducing the l.f. gain to compensate for the loss of h.f. gain due to stray capacitance, i.e. provide even overall gain.

Other factors play a part in determining the bandwidth. The signal is coupled to the c.r.t. cathode via capacitor C40. This means that the d.c. component of the signal is removed, the d.c. level at the c.r.t. cathode being set by the brightness control, which also affects the frequency response. For several reasons this arrangement is not ideal: for practical purposes however it's effective.

Tube Drive

The large voltage swings required to drive the tube cathode are developed across resistors R40 and R41, and as a result the c.r.t. cathode swings negatively from the preset voltage set by the brightness control. Remember that the greater the difference between the grid and cathode voltages, the greater the beam current and the brighter the screen illumination: the c.r.t. cathode is driven negatively therefore from the level corresponding to black which is set by the brightness control. This is because the grid is returned to chassis by means of a couple of resistors (R113 and R114) and is thus at chassis potential during the

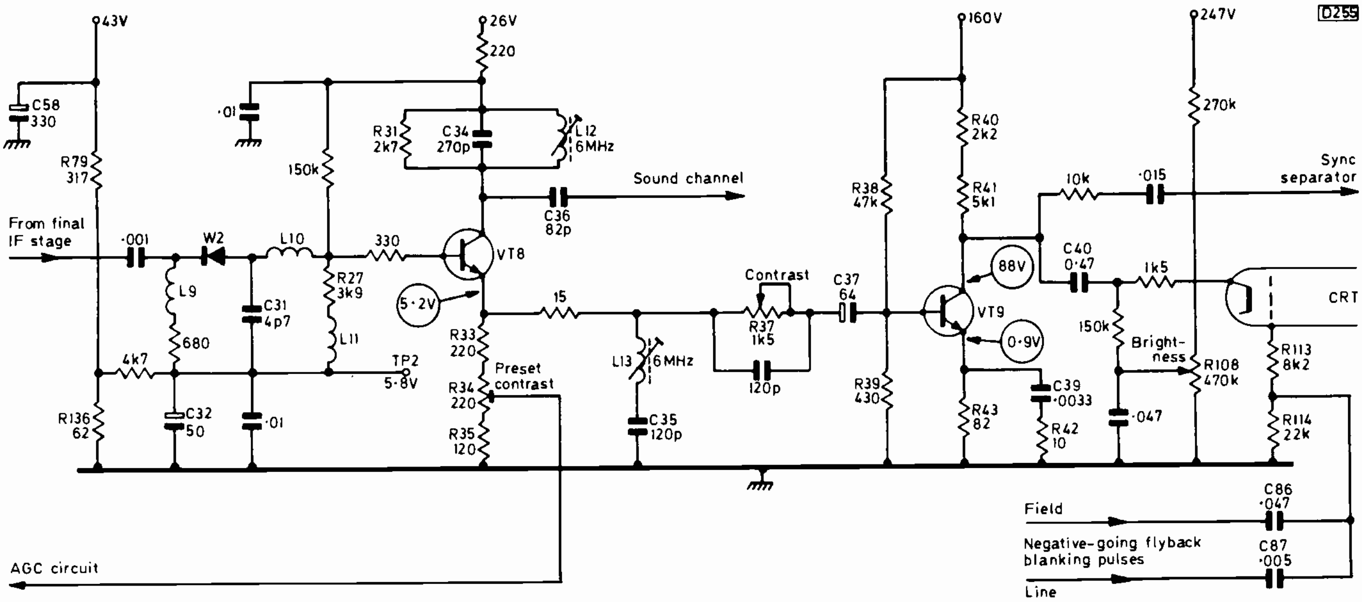


Fig. 1: Video circuitry used in the Thorn 1500 chassis.

forward line and field scan periods. If we were driving the c.r.t.'s grid instead of its cathode (this is done in a few chassis) the drive voltage would have to be positive-going to increase the screen illumination. Returning to the 1500 chassis however, it will be seen that negative voltage pulses are applied to the grid to black out the screen during the line and field flyback periods – the field flyback blanking pulse is fed via C86 and the line flyback blanking pulse via C87.

For further information on c.r.t. drive techniques refer back to Fig. 2, Part 3.

Video Output Stage Faults

Now what goes wrong with this type of circuitry? A very basic rule of thumb that doesn't always apply is that things which run warm fail quicker than things which don't (loud applause). To swing a c.r.t. from peak white (maximum tube emission) to black (no emission) requires a fairly hefty voltage difference to be applied to the tube's cathode or its grid. Because the first anode voltage is held at a steady positive voltage, applying the swing to the cathode is more effective than applying it to the grid, i.e. if you swing the cathode voltage negatively this is the same as swinging both the grid and the first anode voltages positively, whereas swinging the grid voltage positively does only that, the cathode-first anode potential remaining constant.

This hefty signal voltage swing can be developed in one of two ways, either by passing a small current through a large value resistor or by passing a higher current through a lower value resistor. We have seen that in order to keep an even response over a large range of frequencies we have to keep the load resistor(s) fairly low in value. This means that a fairly high current is required, with consequently warm running. The video stage must be considered a high-risk area therefore.

The answer is to use a massive device that dissipates heat easily, plus large wirewound resistors. This is not economic however. Large valves or large transistors obviously have a better chance of survival than small transistors, while wirewound resistors are better able to stand up to warm running than carbon types. We have to be cost conscious however and we find small transistors with heat dissipating fancy hats on them working with carbon resistors.

Lots of colour sets use a similar arrangement multiplied by three, one for each primary-colour (red/green/blue) drive (three tube guns, therefore three cathodes etc.), but the load resistors are usually wirewound for better reliability – except in certain cases where a multiple thick-film resistor unit is employed combining the three load resistors with three bleed resistors to chassis. Generally speaking, separate resistors seem to be more reliable.

We are digressing again, however, so back to our specimen monochrome circuit. Carbon resistors which run warm run the risk of changing value. R40 and R41 do run warm and do change value, usually decreasing in value so that the full voltage swing to drive the tube cannot be developed across them. This leads to an overall grey picture lacking "attack". The fact that the video output transistor's collector voltage is higher than it should be does not affect the mean brightness level since this is set by the brightness control, capacitor C40 blocking the d.c. In receivers with direct coupling to the tube cathode a higher than normal video output transistor collector voltage (little voltage drop across the load resistors) would tend to bias the tube back, thus darkening the picture. Many a tube has been condemned because of this fault, but there is no excuse for making this incorrect diagnosis since the fact that the brightness control still operates normally clears the tube of suspicion – if the tube was at fault, advancing the brightness would tend to invert the whites to a pearly grey. So it's necessary to keep an eye on the load resistors and ensure that they have not lost value.

The video output transistor also runs warm and is a likely source of trouble if the picture is lacking contrast or if there is no picture at all. There are two ways of checking a transistor, as we have outlined in previous articles. It does no harm to repeat essentials however and we can add a couple of points which are relevant to this type of circuit.

The first method of checking consists of taking voltage readings with the set working. The collector should be at something under 100V (depending upon the signal input), thus proving a voltage drop across the load resistors of some 60V (h.t. line about 160V). This check alone proves that the transistor is drawing current in this circuit (1500 chassis), as there is no other d.c. path through the load resistors to chassis. In some designs however there's a bleed resistor which does provide such a path and which has a value of some 10kΩ (e.g. Pye 169 chassis, see Fig. 2). In this case therefore there will be a voltage drop across the load resistor whether or not the output transistor (VT5) is passing current.

So a check can next be made at the emitter of the transistor. In the case of the 1500 chassis the reading should be something like 1V or a little under. This reading means that the transistor is functioning, because there is no other current path through the emitter resistor (R43).

Fine. In the case of the 1500. Other designs may have a stabilising circuit from the l.t. line to the emitter resistor to keep the bias level steady, and this may include a preset control as in the case of the Pye design (RV3A). In this case a voltage reading across the emitter resistor does not necessarily indicate that the transistor is drawing current.

Transistor Testing

It's here that the second method of checking proves of worth. First identify the type of transistor (npn usually). Then, with the set switched off of course, carry out the previously outlined transistor check using a multimeter on the low ohms range (R×, ×R, R1 or whatever the marking is for the times one ohms range). With the negative prod (positive supply) to the base, the reading should be about 30Ω with the positive prod to the emitter or the collector. With the leads reversed, only the resistance of the external circuitry should be read.

If the transistor is defective due to a collector-emitter short, the previous voltage readings would have been so low as to call attention to this condition.

Misleading Results

A word of warning however. Testing a transistor can often seal up an open-circuit, so that the readings are apparently right. Indeed the transistor may then function for a brief period afterwards, thereby adding to the general confusion. If in doubt, replace it – not forgetting to put the heatsink on the new one (hot headed little horrors don't last long).

Valve Video Circuits

Video or luminance output valves do not differ too much. They usually lose emission (remember the cathode has an emitting surface which releases lots of electrons when heated) and the resultant reduced current means that the anode voltage rises. If the tube's cathode is directly coupled to the output valve's anode, as is usually the case, the result will be a dark picture since the tube's cathode voltage rises further above the grid voltage thereby increasing the bias and decreasing the tube emission. Elementary? Yes, but think of all those hybrid colour sets still in use. One of the most common complaints is a dark picture with the brightness fully up and only a replacement PL802 (say) will restore normal conditions.

Excessive current through the valve will have the opposite effect, because the voltage across the load resistor(s) will increase. The reduced anode voltage pulls down the tube's cathode voltage, increasing the brightness. This condition may perhaps bring into operation a beam limiter circuit in a colour set, adding to the mayhem.

Excessive current can arise in several ways. The valve could be defective; the cathode bias could be shorted out by a defective capacitor; the grid could be positive, again due to a leaky capacitor. All sorts of things can happen: it's your job to find out, using your multimeter and your logical mind (and your stock of spares). Remember the hints given in the articles (May and June) on the habits of resistors and capacitors.

Lack of Input Signal

A perfect video output stage can deliver only the goods which are supplied to it. When one suspects a fault in the circuitry between the detector and the video stage, it's prudent to see how the sound is faring. If it's good, the chances are that the fault is occurring after the point of sound/vision signal separation. A quick check on the circuit diagram will show where this crossroads occurs in a particular model. This presents no problem where the set uses discrete components (separate transistors etc.), but gets a little confusing when an integrated circuit such as the TBA550 or a similar chip is used. We musn't get too complicated at this stage, however, or we'll defeat the whole object of the series.

Assuming that the sound is in order, a fault which results in the vision signal being lost or severely impaired directs attention to that part of the circuitry between the sound pick-off point and the tube. Having already checked the video output stage, we next have to look at the components that precede it – capacitors, chokes etc.

Choke Faults

We haven't said much about chokes so far, mainly because of their relative simplicity. We know that if we wind a coil of wire it becomes an inductance, due to the magnetic field building up and collapsing as the current passing through the coil varies. Depending upon the number of turns and the nature of the former the coil is wound upon, it will pass low-frequency signals with little loss but offer much opposition (reluctance) to signals of higher frequency. Hence its use.

Not much to go wrong here you may think. But if the wire of the coil is fine, it can hardly be used as a point of connection. It's wound round a soldering post therefore, and soldered at either end. Here lies its weak point. The coil is made of coated wire, so that the turns do not short together. The coating does not allow proper contact at either end of the coil, so it has to be cleaned off before a good soldered connection can be made. It's at these terminations that we often find a contact that's less than perfect.

Such coils can be found at various points between the video detector and the video output stage. In the case of the 1500 chassis there are L10 and L11, but these are not after the sound pick off point and so are not suspect unless the

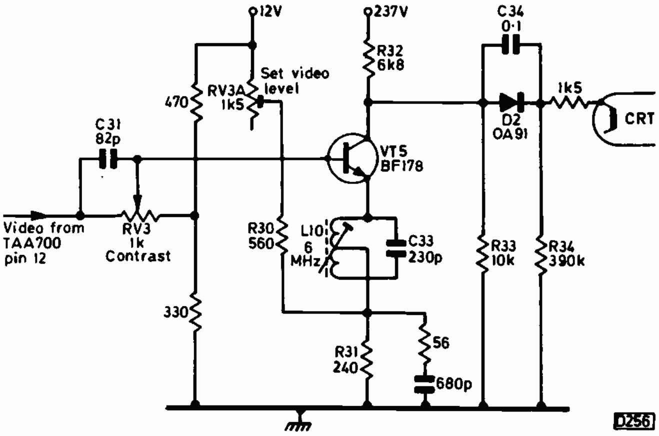


Fig. 2: Video circuit used in the Pye 169/569/173 chassis.

sound too is affected. In any case we've not worked our way back to this part as yet, we're still lingering around the base of the video output transistor as it were.

Defective Coupling Capacitor

Whilst there is no choke (coil) here, there most certainly is a capacitor. C37 is a 64μF, low-voltage electrolytic. It can suffer from one of two fault conditions. Most often it loses its capacitance, leaving the picture looking decidedly washed out. The check for this is quite simple. Select another capacitor of approximately the same type and shunt it across the suspect, ensuring that the polarity (+ or –) is the right way round.

The other fault condition is that the capacitor is leaky. In this case shunting another across it is of no help at all, because the leakage will still be there. If it's leaky, the video output transistor's base voltage will be higher than it should be, as will be the emitter voltage. The collector voltage will be much lower however as the transistor is passing too much current. Removing the suspect capacitor should restore normal voltages but will also remove the picture information of course.

Contrast Control Faults

If the capacitor is in order, the next item is the contrast control R37. It's simply a variable resistor, the wiper determining the amount of resistance in series with the capacitor. The usual trouble here is rough handling by the user, resulting in the wiper not wiping the surface of the track.

Pye Video Circuit

A slightly different system is used in the Pye circuit (Fig. 2). Maximum signal is obtained when the wiper of the contrast control is at the i.c. (pin 12) end of the track. There is no blocking capacitor in this circuit, the d.c. voltage at the base of the video output transistor being determined by the values of the various resistors in the circuit (C31 is there to bypass the contrast control at the higher frequencies, maintaining the h.f. response).

It's of interest to see how the 6MHz sound signal is removed from the vision signal path. Still with the Pye circuit, a rejector circuit (L10, C33) tuned to 6MHz is connected in series with the emitter of the video output transistor. When correctly set, this forms a high-impedance at the tuned frequency, cutting off the transistor just as if a high value resistor had been placed in series with R31 at this frequency only and no other. The method used in the 1500 chassis is to provide a low-impedance path to chassis at this frequency, i.e. the acceptor circuit formed by L13, C35.

The Emitter-follower Stage

We have already mentioned the role of VT8, whose base is driven by the detected signal filtered by L10, C31 and developed across R27. Maximum signal at 6MHz is developed across L12, C34 (damped by R31 to broaden the response) in the collector circuit, whilst the vision signal is developed across R33-34-35 in the emitter circuit and passed to the contrast control.

AGC Circuit Operation

R34 sets the level at which the a.g.c. circuit (see Fig. 3) operates. The key to the a.g.c. circuit is the a.g.c. detector diode W1. The anode of this is reverse biased by the potential divider R1, R2 so that it conducts only when its cathode is driven below the voltage at the junction R1, R2. The signal at the emitter of VT8 consists of positive-going video information and negative-going sync pulses. W1 conducts on the tips of the sync pulses therefore, to a degree depending on the setting of R34. This is a convenient system, since the sync pulses are at a fixed level (the video information is constantly varying of course) and represent an accurate measure of received signal strength. The output from W1 is smoothed by the filter circuit C3, R3, C6, varying the bias applied to the base of the a.g.c. amplifier transistor VT3. If its base voltage falls (increased a.g.c.) it passes less current and the voltage *across* R9 in its collector circuit is reduced. This means *increased* voltage at the junction of R9, R5 which provide the forward bias/a.g.c. for the controlled transistors in the i.f. strip (VT5 and VT4, see Fig. 5 last month).

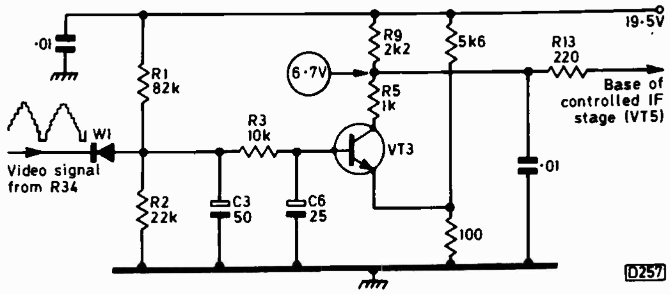


Fig. 3: A.G.C. circuit used in the Thorn 1500 chassis.

Biasing VT8

VT8 is a maid of all work therefore and should be looked upon as a maid worth dallying with. The voltage at test point 2 (TP2) is vital for correct operation. This should be 5·8V, derived from the transistor supply line at the junction of R79 and R136 (at the end of the valve heater chain). The worst thing that can happen is for resistor R136 to become open-circuit. This causes a dramatic rise in voltage, the result of which is difficult to foretell. It obviously drives VT8 fully on, cutting off the sound and picture and probably damaging this transistor. At the same time the main transistor supply line rises to a high level, exceeding the voltage rating of the smoothing electrolytics C58 and C56. One of these is likely to fail, possibly shorting and thus bringing the voltage once more to a low level – or to zero if C58 shorts – adding further to the confusion. Fortunately this is not a very frequent happening. Another possibility is that the increased supply line voltage will destroy one of the i.f. transistors, VT7 being particularly vulnerable.

The easiest preliminary check on VT8 is to measure its emitter voltage. This should be about 5V, i.e. about 0·6V lower than its base voltage, which is normal for a silicon transistor when it's conducting.

Wirewound Resistor Failure

Earlier on we stressed the greater reliability of wirewound resistors in video output stage load circuits. Since we've been mentioning here and there the Pye 169/569/173 chassis it's only fair to say that one of the most common faults on these sets is failure of the wirewound load resistor R32 (Fig. 2). It goes open-circuit, leaving a very low voltage at the collector of VT5 (the same voltage as at its emitter). The result is a bright raster with only the faintest trace of video information present. Only this afternoon . . .

Recent Faults

Andy Denham

Problems with Portables

A monochrome portable fitted with the Thorn 1590 chassis was producing a familiar symptom, a hum bar, but only after an hour or so. The smoothing was checked and found to be o.k., but on feeling the case of the regulator transistor this was found to be very warm. I noticed that its mounting bolts were loose: tightening these cured the fault completely!

Another of these sets exhibited the same fault, but very much more severely – a black-to-white hum bar after ten minutes or so (not what it came in for either!). After much head scratching and component checking in the regulator circuit one of the two mains rectifier diodes was removed and checked on the meter. 10kΩ both ways! Suspicious. Replacement cured the fault.

The trouble with a Bush monochrome portable, Model TV300, was low gain. A very weak, snowy picture was the complaint. Even our strongest signal (10mV, Emley Moor) produced only a faint show. Remove back and think of Teleton look. Check tuner transistors. Look reasonable, 0·7V base-to-emitter on both. Next notice small box sweated to end of tuner. Out of curiosity, check for active components inside. One with strange markings. Well, it must be an r.f. or i.f. type: look through stock, find and fit BF241, perfect picture. Not end of story. Reassemble, no sound or picture. Remove tin can and note that small p.c.b. has to be sweated to can for earthing. Refix to tuner and return to customer.

Some Colour Sets

The fault on a Pye hybrid colour set looked simple enough: no B–Y on the screen, with blue shading from left to right. Obviously the B–Y output pentode's 12kΩ anode load resistor was open-circuit, proved correct by a meter check. Rummaging in the car also proved that we'd left the resistors at the shop. Took panel back and replaced 12kΩ resistor, partner in crime returning panel to set as he lives nearby. Arrived at my front door at 8 p.m. stating no picture. Help! Found that the leads of the flyback blanking transistor in the luminance output pentode's cathode circuit appeared to have left the print (note for diary: ensure that all transistor leads are short when partner has to handle panels in future). Resolder, picture returns. Next morning, woeful greeting: no line or field sync, set in car. Transfer set to bench. Check with scope at collector of sync separator reveals very low amplitude sync pulses. Peculiar looking video at base. Go back to preceding phase splitter stage: video at collector same as at base! Replacement phase splitter produces good picture, but all profit spent on petrol.

Next a solid-state Pye colour receiver with 90° tube. Impossible to set up the grey scale: blue cast. Minimum voltage at c.r.t. first anode about 700V. Blue first anode preset and its 470kΩ series resistor decomposing. In fact all three presets reduced to less than 200kΩ from 470kΩ, and the boost voltage feed resistor (hides near line output transformer) down to about 10kΩ. Replace all potentiometers and associated feed resistors and grey scale can be set up. The h.t. line was correctly set up incidentally.

The trouble with a set fitted with the Philips G8 chassis was no red. Possibly no colour. That's what the man said. Anyway, check the red output transistor. Open-circuit base-to-collector. Simple. Replace. Still no red. Check voltages, collector 200V, base and emitter 0V. Check voltages at preceding TBA530 matrix i.c. Voltage at pin 11 low due to external 39kΩ load resistor for internal red output stage open-circuit. Replace. Good black-and-white, no colour, Bring scope into action. Reference output from TBA540 o.k. U and V outputs from delay line o.k. TBA990 demodulator i.c. suspect. Replacement restores colour. Incidentally about a year ago the set came in as one of about six during a fortnight all with line output transformers with shorted turns. Why that sudden rush I don't know: every G8 we handled for a while was a line output transformer job.

Here's one we didn't solve. A G8 chassis (early model) with intermittent no sound or picture, c.r.t. heater remaining alight. Obviously line timebase trouble. Drive waveform correct at collector of BD144 driver transistor. During space of two weeks replace driver transformer, damping network, output transistor balancing coil, both BU105s, and the flyback tuning capacitors. Set always starts up following any disturbance to the heatsinks. Phone CES who say they've never had it. Phone TV magazine editor who says the same. Phone irate customer and try to pacify. Give up and fit replacement panel. Comments welcome! Output transistors were obviously not turning on hard enough – in fact the highest potential output transistor had only 200V peak-to-peak at its collector under the fault condition.

Trouble with a Skantic

Next set is partner's, a 22in. Skantic hybrid colour model. Problem no picture (no heaters). Continuity check proves PC92 open-circuit. It's a valve, not a connector! A triode in the width/e.h.t. stabilising circuit. Find local Skantic dealer, acquire valve and fit. Result, postage stamp picture in centre of screen. Check around PC92 and find no cathode voltage. Notice diode between the cathode and chassis. Short-circuit. No marking, so replace with BA154. Result, very wide picture with field foldover, cathode voltage now 160V. Phone dealer for circuit. Service manager out, no one knows where manual is. Ask about diode. Proves to be a zener, about 12V. Fit BZX88/C12. Set works. Relief.

Rank A774 Chassis

The picture on a Bush large-screen single-standard monochrome set (A774 chassis) tended to be of very low contrast with no snow under no-signal conditions. There was an occasional improvement when hot. All attempts to set up in accordance with the manual failed. Even with the gain at maximum there was no snow visible on the screen. On checking, the voltage at the base of the r.f. amplifier transistor was found to be about 20% higher than it should be. The set was one of the ones with an extra preset in the a.g.c. circuit. This item had fallen from its correct value of 4·7kΩ to about 200Ω. A replacement cured the fault. I've come across this preset being faulty on two or three other occasions: usually however it goes intermittent.

Transistors in TV Circuits

Part 4

S.W. Amos, C.Eng., B.Sc., M.I.E.E.

In this survey of the applications of transistors in television receivers, arranged in order of frequency, line frequency was reached in Part 3. In this article we shall deal with video amplifiers and associated circuits in both monochrome and colour receivers.

Video Amplifier Circuits

There are two basic ways in which video signals can be used to drive a colour picture tube. One method is to generate the red, green and blue signals in a matrix and to apply these signals to the three cathodes of the tube. The alternative method is to apply the luminance signal Y to the three tube cathodes and the colour-difference signals – R–Y, B–Y and G–Y – to the control grids so that matrixing occurs within the tube itself. We will first consider the way in which transistors can be used to amplify the colour-difference signals so that they are of sufficient amplitude to drive the c.r.t. grids.

The output stages must operate in class A in order to be able to cope with the positive and negative excursions of the colour-difference signals, and must be able to supply voltage swings of up to 100V in amplitude at up to a frequency of about 1MHz. The capacitance of the c.r.t.'s control grid limits the value of collector load resistance that can be used to about 10kΩ. Thus a supply voltage of at least 200V and a mean collector current of 10mA are required so that adequate output voltage variations are obtained. Transistors capable of operating with a 280V supply and with collector dissipations of 3W are available for this purpose. A heat-sink is desirable to enable the collector power to be dissipated safely.

A simplified circuit of a suitable amplifier is shown in Fig. 1. It's a simple class-A stage, with stabilisation of the mean collector current by means of the potential divider R1R2 and the emitter resistor R4. The direct-coupled emitter-follower Tr1 is interposed between the potential divider and the amplifier to raise the effective input impedance and thus minimise loading of the source of the colour-difference signal.

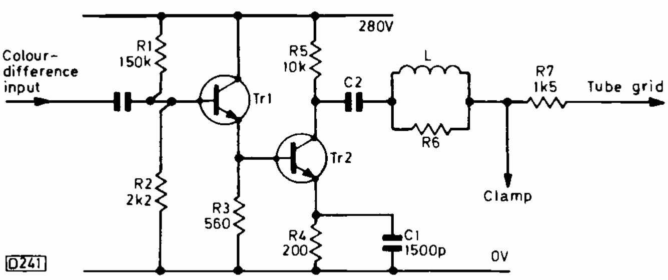


Fig. 1: Essentials of a colour-difference signal amplifier.

Inductor L is included in series with the feed to the tube grid to help attain the required passband: it resonates with the tube's input capacitance near the upper limit of the band. Resistor R6 introduces sufficient damping to prevent ringing at the resonant frequency.

The value of the emitter decoupling capacitor C1 can also be chosen to help maintain the response at the upper end of the passband: it should decouple at frequencies above 1MHz but not below. A useful guide to the value required can be obtained by equating the emitter and collector time-constants. For example, if the total capacitance shunting the collector circuit is 30pF and the emitter resistor is 200Ω we have:

$$200 \times C1 = 10{,}000 \times 30\text{pF},$$

giving a value of 1500pF for C1.

The video output transistor in a monochrome receiver has to supply a voltage swing of about 100V at frequencies up to 5·5MHz. A single common-emitter stage could do this from the vision detector output, but a buffer stage is required between the two to minimise damping of the detector stage by the lower input resistance of the video amplifier. The usual technique, as shown in the previous section, is to use an emitter-follower as buffer. A practical example is shown in Fig. 2 – taken from a monochrome portable receiver.

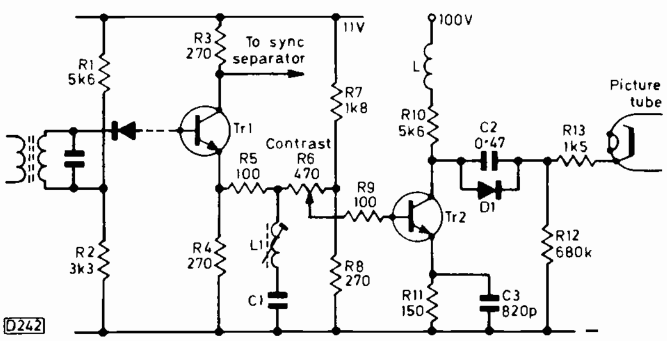


Fig. 2: Video driver and output stage circuits for a monochrome portable set.

The video output stage has much in common with the colour-difference output stage just described, but the wider bandwidth means that a lower value collector load resistor R10 (5·6kΩ) is required. Inductor L and frequency-dependent negative feedback in the emitter circuit (R11,C3) enable the frequency response to be extended to 5·5MHz.

It's particularly important to stabilise the no-signal collector current of the video stage, because the black level of the picture depends on this. The potential divider R7,R8 in conjunction with R11 ensure a measure of stability but, to avoid disturbance of the black level when the contrast control R6 is operated, the standing voltage at Tr1's emitter must be made equal to that at the junction of R7,R8. Tr2 is a class-A amplifier which is biased to near cut off by R7,R8 and R11 in the absence of an input signal, being driven into conduction by the positive-going picture signal applied to its base. At peak white, the collector current approaches 20mA to generate the necessary drive to the tube. Thus the transistor requires a supply of at least 100V.

Tr1 is a typical example of an emitter-follower circuit: it, too, uses the base potential divider and emitter resistor technique to ensure stability of emitter current. The emitter resistor is R4 and the potential divider R1,R2. The latter applies a standing bias to the vision detector circuit which is direct coupled to Tr1's base.

A common technique is to include a resistor R3 in the collector circuit of Tr1 to generate a video signal for feeding

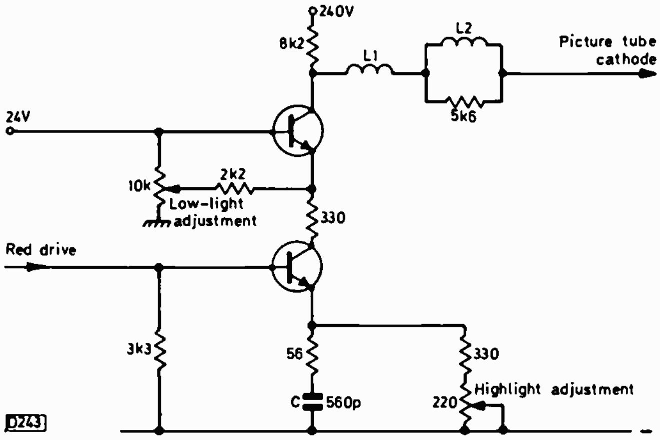


Fig. 3: Simplified circuit of a cascode RGB output stage for a colour receiver using a PIL tube.

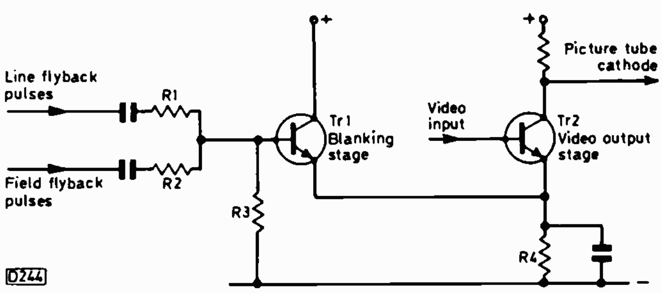


Fig. 4: One method of achieving flyback blanking.

the sync separator. Thus Tr1 behaves as an emitter-follower for driving Tr2 but as a common-emitter amplifier to feed the sync separator. This is a convenient method of obtaining a signal with negative-going sync pulses to feed the video stage and positive-going sync pulses for the sync separator. The acceptor circuit L1,C1 is tuned to 6MHz and ensures that the intercarrier sound signal does not pass through the video channel.

D1 provides beam limiting. At high beam currents the voltage across R12 will rise sufficiently to reverse bias D1. The signal is then a.c. coupled by C2, removing the d.c. component of the signal and in this way reducing the brightness.

Cascode RGB Output Stage

We've already mentioned that a colour picture tube can be driven by three separate video amplifiers which feed the three cathodes with red, green and blue signals. It's essential for good black-and-white reproduction over the whole range of reproduced brightnesses that the relative amplitudes of the red, green and blue signals should be accurately maintained. Provision is therefore made for adjusting the R, G and B proportions at low amplitudes (low-light areas) and at high amplitudes (highlight areas). Preset controls are required for this purpose, and in one form of video amplifier a cascode circuit is adopted as a convenient means of incorporating the six preset controls necessary to ensure good grey-scale tracking. This particular circuit is suitable for driving the PIL tube which has common control grids and first anodes.

The cascode behaves as a single transistor with properties similar to those of the upper transistor, but there are two bases into which signals can be injected to control the current. Fig. 3 shows a simplified circuit of one of the three channels (red). The input signal is applied to the base of the lower transistor, and a preset positive bias from a 24V supply is applied to the base of the upper transistor. The gain is controlled by a preset resistor in the emitter circuit of the lower transistor – this determines the degree of negative feedback employed. The three bias controls are adjusted to give correct R, G, B proportions near tube cut off, i.e. in low-light areas. The negative feedback controls are adjusted to give the correct proportions for larger signal inputs (highlight areas). In practice the three preset resistors in the lower emitter circuits may be returned not to chassis as shown in the simplified circuit diagram but to a common low-impedance source of controllable voltage (an emitter-follower) which acts as a brightness control, while for highlight adjustment drive controls operating on the same principle as the previously described contrast control may be employed.

RGB amplifiers require a bandwidth of 5·5MHz. This is achieved by use of the compensating inductors L1 and L2 in conjunction with the emitter capacitor C which gives frequency-dependent negative feedback as in the two previous circuits.

Flyback Blanking

It's normal practice in television receiver design to suppress the electron beam in the picture tube during the line and field flyback periods so that there is no possibility of flyback lines becoming visible even when the receiver is badly adjusted. There are many ways of achieving flyback blanking, and a simplified circuit of one approach is shown in Fig. 4.

Tr2 is the video output stage and Tr1 the flyback blanking stage. These two transistors have a common emitter resistor R4 and, during the forward scans, Tr1 is cut off by the positive emitter bias received from Tr2. During reproduction of the picture signal therefore Tr1 is effectively not present in the circuit. During the line or field flyback periods however positive-going pulses at both frequencies are applied to Tr1's base from the respective timebases. These pulses are of sufficient amplitude to turn Tr1 hard on and its emitter current, in flowing through R4, biases off Tr2, thus cutting off the picture tube and blanking out the flyback traces. Tr1 is at all times either cut off or fully conducting: this is another example of a bipolar transistor being used as a switch.

Decoder APC Loop

A simple field-effect transistor application is shown in Fig. 5. It's used in the reference oscillator circuit of a colour receiver, between the burst detector and the oscillator itself. The discriminator circuit (D1, D2 etc.) compares the phase of the transmitted burst with that of the reference oscillator signal. The discriminator output indicates by its polarity the sign of any phase difference and by its magnitude the extent of the difference. This output voltage is applied to the field-effect transistor Tr2 whose output is used to control the current flowing through the capacitance diode D3 and hence its effective capacitance. The diode is included in the base circuit of the reference oscillator, capacitance changes in D3 bringing the phase of the reference oscillator signal into step with that of the burst. The current in the field-effect transistor (and hence the phase of the reference oscillator) can be adjusted manually by the potentiometer R5 in the source circuit.

The output resistance of the discriminator circuit is high because of the two 470kΩ resistors R1 and R2, and to minimise reduction of the output voltage the following transistor must have a very high input resistance – preferably several megohms. The field-effect transistor is

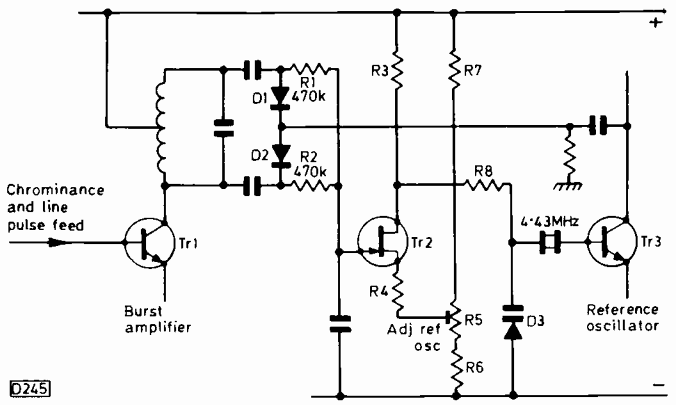


Fig. 5: Field-effect transistor used as a d.c. amplifier in a decoder reference oscillator phase-control loop.

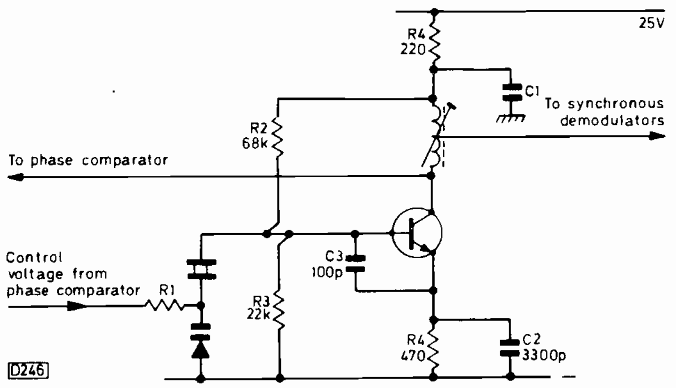


Fig. 6: Typical decoder reference oscillator circuit.

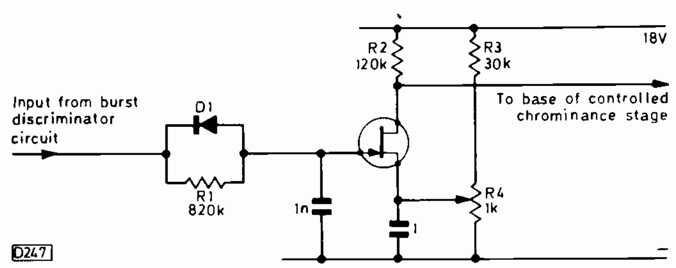


Fig. 7: Field-effect transistor used as an a.c.c. amplifier.

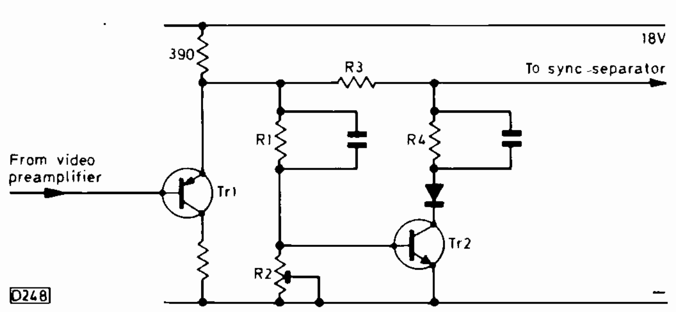


Fig. 8: Noise-cancelling circuit.

thus ideally suited to this d.c. amplifier application. An alternative possibility would be a bipolar transistor as an emitter follower.

Decoder Reference Oscillator

Most colour television receivers incorporate an oscillator which must operate in phase with the transmitter's colour subcarrier: the previous section gave one circuit for ensuring phase synchronism. We shall now consider the circuit of the oscillator itself. Those sets which don't employ a separate 4·43MHz oscillator make use of the transmitted bursts directly.

A crystal is used to provide frequency stability of the oscillator, and the small frequency variations required to secure phase synchronism are obtained by connecting a capacitance diode in series with the crystal as shown in Fig. 6. The basic problem is that of making the transistor oscillate at approximately 4·43MHz. The circuit shown is typical, with use being made of the internal collector-base capacitance of the transistor. By virtue of this capacitance, the input resistance of the transistor becomes negative if the collector circuit is made inductive. Thus if the crystal is connected across the input circuit, the circuit oscillates at the resonant frequency of the crystal. Oscillation amplitude must be kept low to minimise excitation of the crystal, and the transistor is therefore constrained to operate in class A, stability of mean collector current being assured by the base potential divider R2,R3 and the emitter resistor R4.

The interesting and significant feature of this circuit is that it depends for its operation on the internal collector-base capacitance of the transistor. It's the first transistor application so far encountered in this series to make use of this capacitance which, as we shall see in applications to be described later, is often a hindrance to the designer of radio-frequency circuits.

Automatic Chrominance Control

It's important in a colour television receiver that the correct relative amplitudes of the chrominance and luminance signals are maintained, and to this end the chrominance amplifier has an a.g.c. system known as automatic chrominance control. The control signal is derived from the colour burst amplitude or from the 7·8kHz component of the burst and is applied to the base of one of the chrominance amplifiers to control its gain.

Fig. 7 shows the circuit of a field-effect transistor used as an amplifier of the a.c.c. voltage. It's basically a common-source amplifier, the source being returned to a preset resistor which enables the source potential to be set at any value between certain limits. Diode D1 generates a negative voltage from the colour burst. This biases the transistor back, thus raising the drain potential which controls the gain of the chrominance stage. R4 is adjusted so that the transistor can respond to all the variations in burst level that are likely to be experienced.

A field-effect transistor is ideal for this application. Its high input resistance enables D1 to be given a load resistor of nearly one megohm so that there is negligible loading on the source of burst signal. The field-effect transistor gives high voltage gain, so making the a.c.c. effective. The non-linearity of the input-output voltage relationship of the field-effect transistor is of no importance in this application.

Noise-cancelling Circuit

A circuit which makes use of the polarity-inverting characteristic of a common-emitter amplifier is the noise-cancelling circuit shown in simplified form in Fig. 8. The source of video signal, with positive-going sync pulses, is the emitter-follower Tr1 which has a mean emitter voltage of 11V. This signal is applied to the noise-inverting stage Tr2 via a preset potential divider R1,R2 which is adjusted so that Tr2 conducts only on signals of amplitude greater than the sync pulse tips. The resulting amplified, inverted signals at the collector are mixed with those from the emitter-follower at the junction of R3 and R4, with the result that the noise pulses are cancelled. In this way the sync separator is prevented from receiving any spurious pulses with an amplitude greater than that of the sync pulses.

Servicing the Philips G8 Chassis

Part 3

M. Phelan

THE following description of the decoder panel applies to the later type with two i.c.s. It will be followed by mention of the earlier type.

Chrominance Signal Path

The chroma signal from the i.f. panel goes to T7238, whose collector current is controlled by a.c.c. The low values of C7229 and R7235 provide isolation of the changing input impedance. The colour control provides varying forward bias to the back-to-back diodes D7251 and D7255 between this and the next stage, which is an emitter-follower. The base bias for this transistor, T7268, is provided by the colour killer. T7268 drives the PAL delay line driver T7271, whose collector load is the delay line input coil. In this circuit the direct signal path gain and phase are fixed, the delayed signal amplitude being adjustable by R7267 and its phase by L7003. The U and V signals from the delay line are then fed to the TBA520 demodulator i.c.

Burst/Reference Oscillator Circuits

The chroma signal at the collector of T7238 is also applied to the base of T7112. It undergoes further amplification here before being fed to the base of burst gate T7121. The base of this stage is normally without forward bias. The tuned circuit consisting of L7134 plus C7125 and C7127 in series is made to ring by applying a positive-going line flyback pulse through the internal capacitance of D7145. The negative overshoot applied to its emitter turns T7121 on – this is arranged to occur during the burst period by selection of the *L* and *C* values. After a few cycles of operation C7125 charges slightly, holding T7121 cut off between burst periods. During the scan D7145 is forward biased, loaded by R7138 and L7134; when the diode is reverse biased by the flyback pulse, the tuned circuit is isolated.

The burst signal appearing at the secondary of the burst transformer L7007 is fed to the phase detector R7141, R7142, D7147, D7146. C7132 and C7133 provide d.c. blocking. The reference carrier is fed to the junction of D7147 and D7146. When this is in +(R – Y) phase, the output at the junction of the resistors is zero. In practice, a small positive voltage is added to the reference carrier by R7148, R7151 and R7152 to give a correspondingly positive output, which biases the d.c. amplifier T7154 to about the middle of its operating range. To keep the bridge balanced, a positive voltage derived from R7135, R7136 and R7137 is fed to the base of the d.c. amplifier. C7162 and R7163 remove the 7.8kHz component of the control voltage caused by the swinging burst.

The reference oscillator T7173 has the crystal in the feedback path from collector to base. R7178 damps the transformer, so its timing has little effect upon phase. The output is tapped down by the capacitive divider C7008a and b and applied to the buffer transistor T7182. This stage has a load resistor R7188 in its collector circuit, and a signal in –(R–Y) phase is taken from this to feed the R–Y demodulator in the TBA520Q i.c. An adjustable phase-shift network R7187, R7186, C7185 is connected between the collector and emitter to extract a signal in –(B–Y) phase to apply to the B–Y demodulator in the TBA520Q i.c., via emitter-follower T7192.

The +(R–Y) carrier at the emitter of T7182 is used as the reference feedback for the burst phase detector.

The 7·8kHz squarewave at the collector of the d.c. amplifier T7154 is stepped up by the tuned amplifier T7197 to give a 30V p-p sinewave. This is fed to the TBA520 (pin 1) as ident, and is rectified by D7202 to turn on T7268, the second chrominance amplifier, when a burst signal is present.

Signal Matrixing

Matrixing to derive the G–Y signal takes place in the TBA520Q i.c., and the residual subcarrier is removed from the three outputs by *LC* filters before feeding to the TBA530Q. The TBA530Q adds the luminance information to the colour-difference signals to give primary-colour signals which are amplified by the output transistors T7332, T7348 and T7367 to a level suitable for driving the c.r.t. cathodes. A.C. and d.c. feedback is taken from the collectors and returned to the TBA530Q to ensure good frequency response and stability of the grey-scale.

Luminance Signal Path

The luminance signal from the i.f. panel goes through the delay line L7208 to one end of the contrast control. The other end of this is connected to the junction of R7218 and R7217 so that at black level the same voltage exists at both ends of the control. C7213 inserts a blanking pulse into the luminance waveform, which from the slider of the contrast control goes to the emitter-follower T7221. It's then a.c. coupled to pin 5 of the TBA530Q via C7224. The d.c. component is thus lost, and has to be reinserted by a driven clamp T7220. This is operated by the negative burst gate pulse developed across L7134. The pulse is inverted by T7227 before application to the base of T7220.

Earlier RGB Subpanel

Earlier panels had a subpanel with discrete components to carry out the functions of the TBA530, and the other i.c. was then a TAA630. C7169 was omitted. Some later panels omit L7003, delay phase adjustment being carried out through the hole in the front of the delay line. The latest panels have a 4.43MHz notch filter in the feed to pin 5 of the TBA530Q.

Intermittent or No Chroma

Most of the faults on this panel give rise to intermittent or no chroma. If there is no chroma, first check the voltage at TP41 – it should be 25V with the colour control at maximum. No voltage here probably means that the wiper of the colour control has fallen off.

Next check at TP26. If there is more than 11V the fault must lie *after* T7238, possibly in T7268 or T7271. If the voltage is less than 11V, connect TP26 to TP80 to override the colour-killer. Very weak unlocked chroma means that T7238 is open-circuit – this is a favourite cause of intermittent chroma. No chroma usually means that the oscillator has stopped, probably due to a faulty crystal or to one of the two capacitors inside the reference oscillator can going open-circuit. The transistors in the burst channel seldom give trouble, but if the chroma will not lock C7132 or C7133 is likely to be open-circuit if of the polystyrene type.

If the chroma is apparently normal with the killer disabled (no ident of course) the cause will be either failure of the ident amplifier, usually because of an open-circuit C7204 (replacement must be of the exact value), or due to low output from the reference oscillator. This can be a faulty crystal or simply L7008 off tune. Tune for maximum output with a scope or diode probe on pin 8 of the TBA520Q.

Decoder Fault Summary

L7159 and C7164 occasionally give trouble, causing the oscillator to go unstable. C7285 or C7284 leaky will give a band of Hanover bars down one side of the raster.

The two i.c.s are quite reliable, but the TBA530 can give rise to smearing and loss of one primary colour on half the screen.

The output transistors suffer as a result of c.r.t. flash-overs, and can also leak when hot due to thermal runaway. R7344, R7357 and R7375 can go high or dry-jointed giving variations in grey scale. Bright flashes of one primary colour are due to one of the subcarrier filter chokes going open-circuit.

L7312 open-circuit will give an uncontrollably bright raster, as will R7316 open-circuit, but also check that the front control panel goes to earth, as there is a piece of print under the socket on the i.f. panel – this sometimes disappears. T7220 and D7315 can cause variations in brightness, while a short circuit T7227 gives a band down the left-hand side of the screen with flyback lines showing. The contrast control is prone to being noisy and dry-jointed. Intermittent loss of luminance can be a faulty delay line or one of its termination chokes (L7320 or L7240).

RGB Subpanel Faults

The RGB subpanel fitted to earlier panels is extremely difficult to work on, but one fault which seems to recur is caused by D7544 (a 62V zener) going short-circuit and burning up R7503 and R7531. This causes a patterning of vertical lines all over the screen. These subpanels are prone to giving drift in brightness level, and are not very easy to set up satisfactorily.

Setting Up the Decoder

Setting up the G8 decoder is relatively simple. The first thing to do, assuming that the various adjustments are not so far out as to give no chroma, is to peak L7008 for maximum reference carrier at the emitter of T7192, using a scope or diode probe. Then override the killer, remove link "A" (behind T7154) and adjust R7136 for 5V at TP33 (using a 20kΩ/V meter). Adjust C7169 for almost stationary colour. On earlier panels adjust R7136 for almost stationary colour. Recheck L7008; if readjustment is necessary, reset C7169 and R7136. Refit link "A", disable the burst gate by earthing the base of T7121, and adjust R7151 for almost locked colour. Remove the short and killer link.

Align the delay line matrix either by X–Y display, or by shorting TP27 and TP28 (to convert to simple PAL), adjusting L7003 for minimum hanover bars on R–Y, R7186 for minimum bars on B—Y, then after removing the short R7267 for minimum bars overall.

L7007, the burst phase detector transformer, is best left undisturbed.

Adjust R7103 for 3V p-p burst at T7121 collector on a normal transmission.

To adjust the d.c. levels at the TBA520Q, remove the luminance/chroma input plug, adjust the brightness for 1·2V at pin 7 of the edge connector, then adjust R7297, R7288 and R7286 *in that order* for 140V at the collectors of the blue, green and red output transistors respectively. Remove any tint from the highlights by adjusting the drive controls R7354 and R7372.

Combined Signal Panel

Later receivers combined the previous separate i.f. and chroma panels in a single "signal panel". The i.f. circuitry is the same, except that the chroma module is no longer fitted, the sound i.f. strip is now a TBA750Q, which includes the driver stage, and a series regulator T3401 (BD131) supplies all the 12V rails. The decoder has been replaced with the Mullard four-chip circuit, and as several descriptions of this have appeared in the magazine no further explanation will be given.

The decoder section is very reliable, but the older type has the edge on performance in our opinion. I.F. faults are much the same as those which occur on the older panel, except that the driver stage in the TBA750Q gives intermittent sound. No luminance is usually a faulty TBA560Q, but a fault in the blanking circuit on the timebase panel will give the same effect. R3398 (fusible in series with the BD131 12V regulator transistor) springing open for no apparent reason will almost certainly be due to

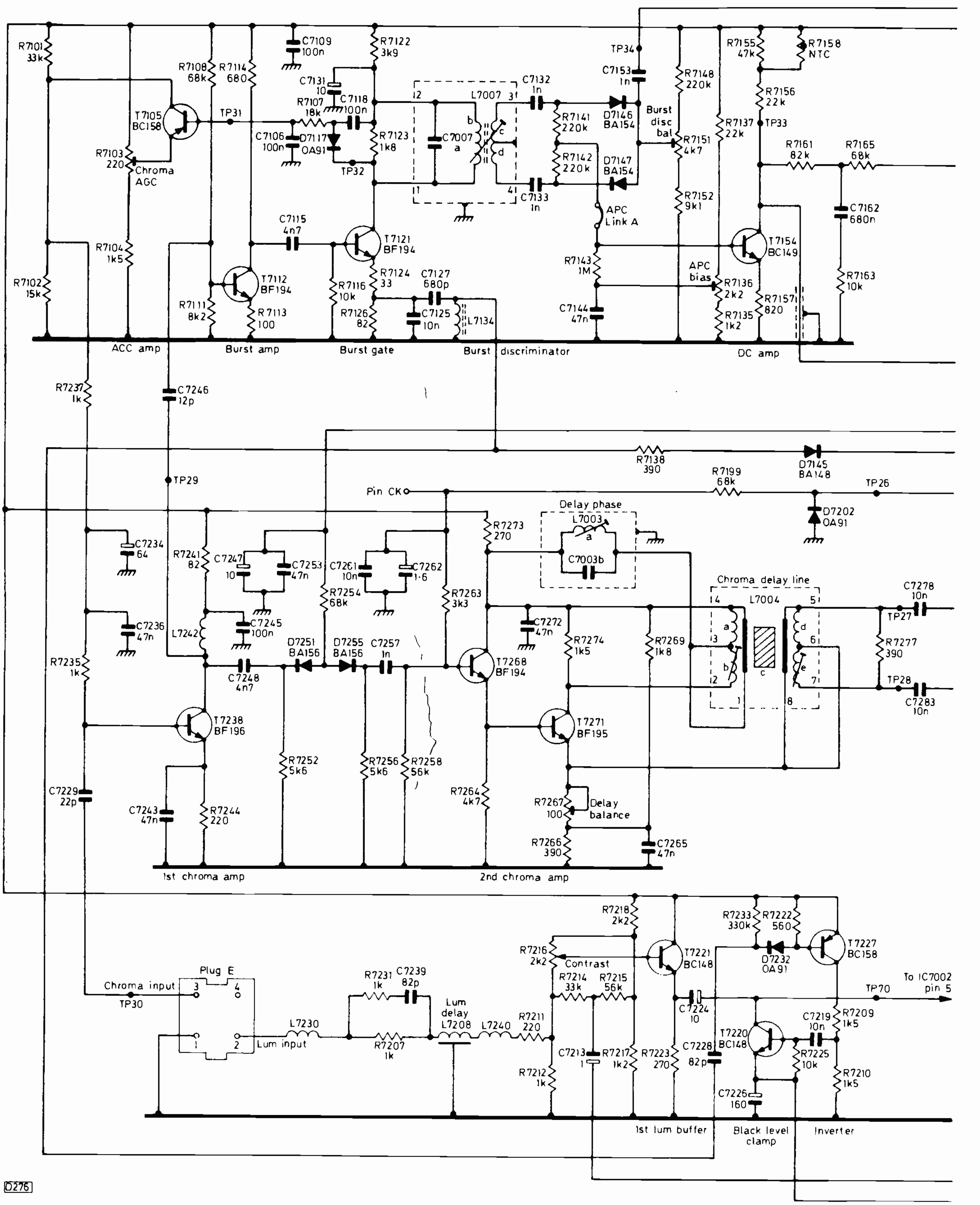
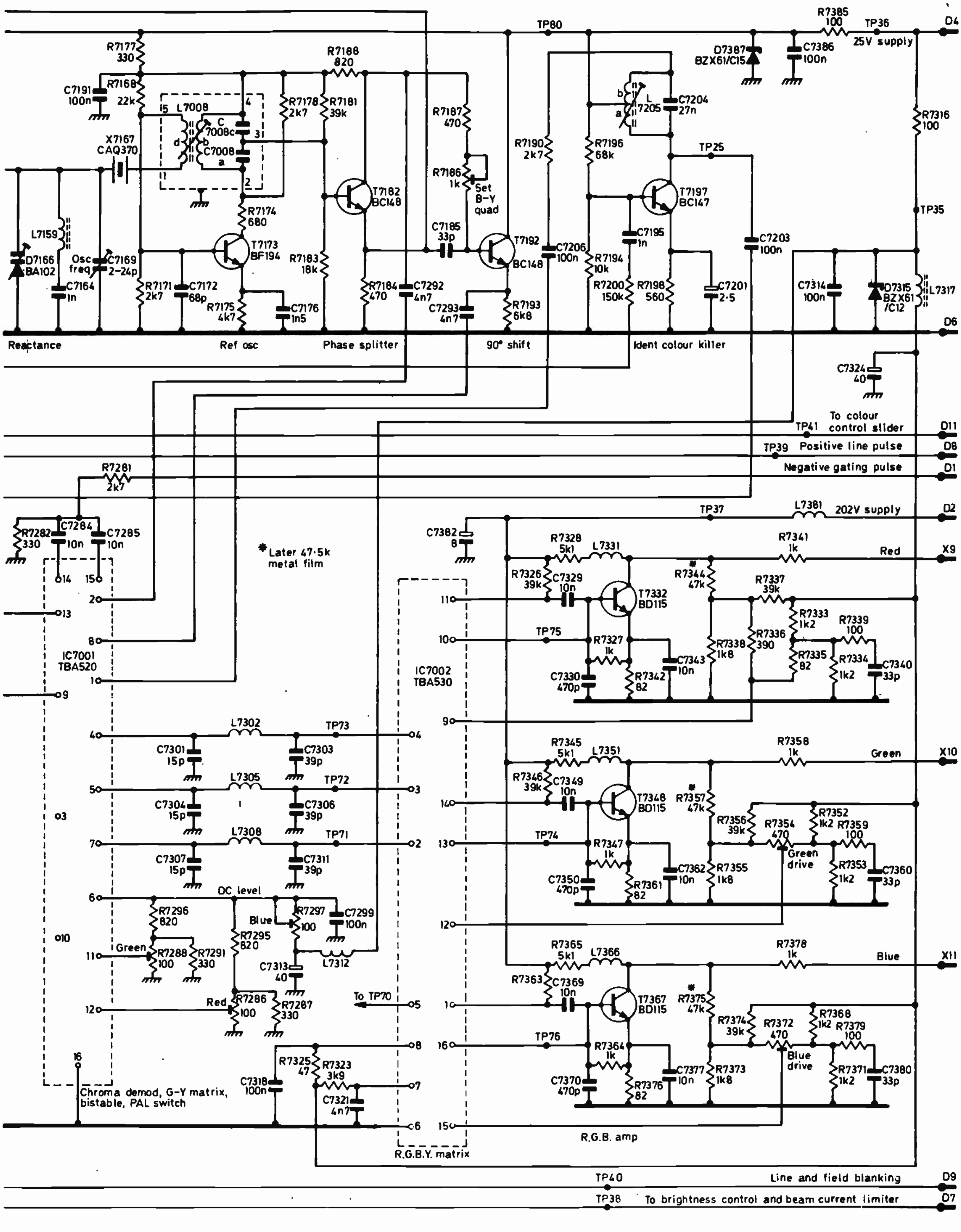


Fig. 9: Circuit of the two-i.c. decoder

a leaky thyristor in the power supply. Failure of the RGB output transistors is fairly common, particularly if they are type BF258P. To override the colour killer, unplug flying lead PC5. Connect to pin "b" to remove the chroma.

For no chroma faults, check the voltage on TP90. If around 4V, the reference channel and bistable are working so the TBA560 is probably faulty. If around 1V, override the colour-killer. No chroma means that the reference oscillator has probably stopped due to the crystal or the TBA540Q. If unlocked chroma appears, check pin 7 of TBA560Q. If 8V, TBA540 is probably faulty. If the voltage is incorrect, the burst gate in the TBA560 is inoperative.



used in the Philips G8 chassis.

Failure of the bistable in the TBA990 i.c. will cause the killer to operate; also the voltage on TBA990 pin 3 will be incorrect (it should be 3·2V). On the whole however this decoder gives very little trouble.

To adjust the RGB d.c. levels, unplug flying lead X20, set the brightness control to give 1·2V at TP99, and set the three potentiometers in the same order as on the older type panel to give RGB output transistor collector voltages of 145V.

This completes our summary of the G8 chassis. In conclusion it must be said that the chassis is very easy to work on, is reliable, and produces good results. ■

Long-Distance Television

Roger Bunney

RECEPTION of distant television signals via all propagation modes occured during May, at v.h.f. or u.h.f., though the start of the Sporadic E season turned out to be rather a damp squib. Up to May 30th there were numerous Sp.E openings, but few have been good, mostly being rather selective and of medium to short duration. May 1st produced an opening into Eastern Europe, with good signals from Poland on channels R1 and R2. There were extremely strong signals from Norway on ch. E2 at the same time – mid morning. Sp.E signals were also received on the 2nd and 3rd

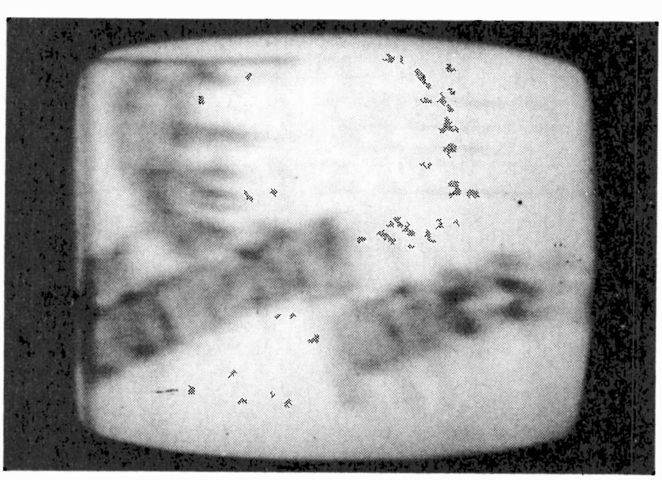
Solar activity produced a strong Aurora which was noted by those in more northerly locations. The Auroral activity seems to have lasted for some days, being noted up to the 9th. Kevin Jackson (Leeds) reports that the Aurora gave him many signals from the more northerly BBC-1 transmitters, also NRK (Norway) on the 9th. According to the *Daily Telegraph*, the solar flare on May 3rd was the strongest ever recorded. Whilst Kevin was logging the Scottish BBC-1 stations all that Huge Cocks in the south could receive were the characteristic "rumbling" noises.

The May Aquarids meteor shower peaked on the 5th/6th, giving an active Band I with several strong signal pings in Band III as well. Kevin Jackson reports more than fifteen pings per hour.

The tropospherics lifted on the 7th/8th, giving u.h.f. reception over several hundreds of miles. David Martin (Shaftesbury) received West Germany at u.h.f. on the morning of the 8th.

Further good Sp.E openings occurred on the 9th and 13th, the latter lasting most of the day. There was then a further lull until the 17th, when another good opening produced signals from Russia, Poland, Hungary, Austria and Czechoslovakia.

There were signs of F2 reception from the south on May 18th, when Clive Athowe (Norwich) received a weak, smeary chequerboard pattern on ch. E2 followed by programme material suspected as being from Rhodesia!



"Barnaby Jones" caption received at 1843 BST on May 29th from Rhodesian TV on channel E2. Photographed by Hugh Cocks in South Devon. The accompanying sound indicated that this was a trailer for the next day's episode.

Hugh Cocks noted similar reception on the 24th in the early morning.

Sp.E then appeared to stabilise, with openings on the 24th into Eastern Europe, on the 25th into Sweden and on the 27th into Eastern Europe and Scandinavia – YLE (Finland) ch. E3 was particularly strong here at Romsey at 1100. Later in the day reception moved to the south, with good signals from Spain. There was a reasonable Sp.E opening towards the south east on the 30th, the most confusing signal being a long-duration weak line sawtooth on ch. E4 from 2035-2105.

Towards the end of the month a very settled high-pressure system produced very hot days with clear, cloudless skies – the classic conditions for tropospheric reception. At the time of writing however only slight lifts have been noted. One hopes that the drop in pressure at the end of the current warm spell will give enhanced reception.

Kevin Jackson noted lightning flash scatter on the 4th incidentally, with short signal pings from Belgium ch. E43 (Egem) and Holland ch. E32 (Goes). I've left the most significant reception here till last. From 1810-1835 BST on the 29th I logged programme material from the south on ch. E2. I had to switch off at 1835, but at 1840 this same signal was observed by Hugh Cocks, producing English language captions with English dialogue to match. The participants in the programme were all of light complexion. The signals faded at about 1930. For about twenty minutes during this period, dark skinned programme participants were seen on ch. E3. We must assume therefore that the ch. E2 signals came from the Gwelo, Rhodesia transmitter! The signal was quite strong and could well have passed as one from Madrid via Sp.E.

In retrospect therefore May was an active month, though for my part Sp.E was lacking.

News Items

Holland: The new Lopik NOS ch. E4 transmitter is being tested, initially "with wide bandwidth". Transmissions cease at times for technical reasons. I've noticed an improved signal here in Hampshire. NOS has been carrying out stereo sound tests, while Harold Peters reports reception at the Pye plant in Lowestoft of the first DX teletext signals – both NOS-1 and -2 were transmitting an 18-page magazine. Harold feels that even better results could have been achieved by realigning the sound traps to 5·5MHz.

France: Closure of the 819-line v.h.f. service is to start in 1981, with the Lille ch. F8a transmitter ceasing operations during the year.

UK: The BBC has started a series of test transmissions from Pontop Pike to evaluate the potential of a public service using digitally coded audio signals. The transmissions are at 47MHz and the bit rate is 704kbits/sec. It's rumoured that the BBC's v.h.f. transmissions are to close in 1982.

The French are to assist in setting up a colour service (SECAM) in the Congo ... The Swiss parliament has passed legislation allowing Liechenstein to start its own radio/TV service, but no commencement date has been announced ... It's assumed that TV transmissions have started in Afghanistan, since the overseas Radio Afghanistan service now includes "Television" in its call sign.

New EBU Listings

France:

Clermont Ferrand	TF1	ch.E22	700kW (directional)
Marseilles	TF1	ch.E29	1000kW
Vittel	FR3/A2	chs.E32/35	50kW
Ussel	FR3		60kW
Argenton	FR3	ch.E43	80kW
Neufchatel	TF1	ch.E51	80kW
Corte Antisanti	FR3	ch.E54	70kW
Parthenay	FR3	ch.E55	300kW
Chaumont	FR3	ch.E55	50kW
Gueret	FR3	ch.E61	80kW
Cherbourg	FR3	ch.E62	100kW

All transmissions horizontally polarised.

Sunspot Cycle 21

An article in the May issue of *Radio Communication* predicts a high sunspot count for the current cycle. The prediction is based on a theory originally put forward by the Soviet scientist A. I. Ohl and subsequently modified by H. H. Sargent (Boulder, Colorado). Using this, it has been possible to assess the potential of the present cycle, in which counts approaching 100 have already been recorded, up to the maximum which is due in February 1980. It's suggested that a smoothed, weekly count at maximum will be 153·4. The article, by O. Okleshen (W9RX), comments that "cycle 21 will be a whopper", with an impact similar to the record peak reached during cycle 19 in 1957. The accuracy of the Ohl/Sargent method of prediction, tested during cycle 20, approached 95%. We can expect a considerable increase in F2 layer reception over the next three-four years therefore.

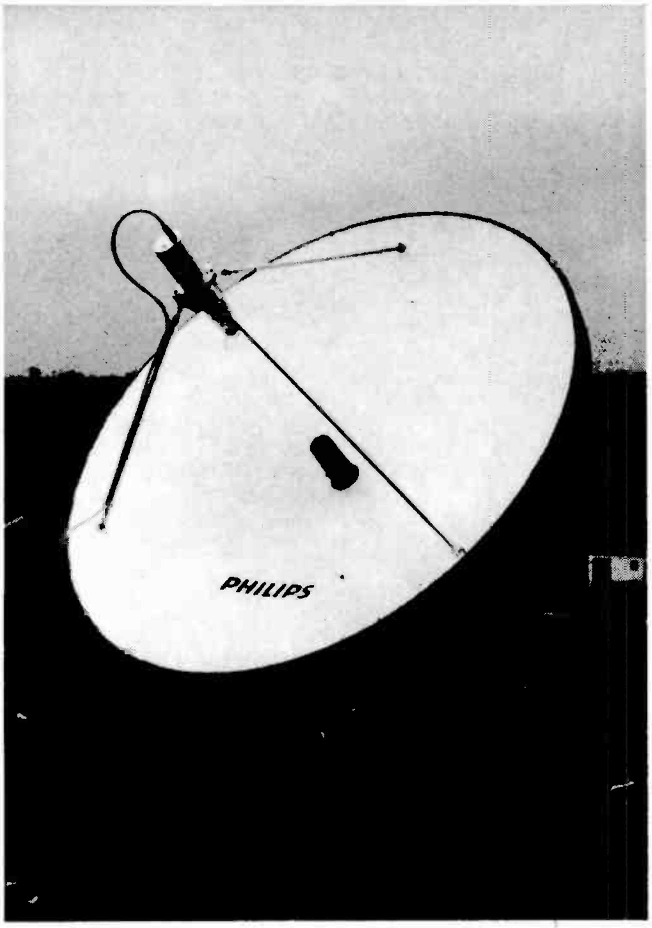
From Our Correspondents . . .

Alan Latham, at present in Abu Dhabi, tells us that up to May 13th Sp.E conditions there were good, with reception from Jordan, Syria, Iran, Russia, Pakistan and India – there were 100% identifications of Russian signals from Baku and Tashkent. He's also seen F2 reception from the south east, suspected of being from China, and a PM5544 pattern with Chinese writing on it! A weak test card C that could have been from the Forest Side transmitter in Mauritius was seen on ch. E4.

In a long letter Bernard Kirk (Germersheim, West Germany) tells us that the caption "ARD STERN" originates in Frankfurt and is the name of the centre through which all programmes are distributed. Bernard has also noted AFN (the American Forces Network) using the RETMA card.

Anthony Mann, writing from near Perth in Australia, reports that F2 propagation gave maximum usable frequencies of over 50MHz during March and April. The m.u.f. reached 56·2MHz on April 16th, with both Russian and ch. E2 information. Conversations between some amateurs at Darwen were overheard, during which mention was made that southern Japan had been worked at 144MHz via evening TE openings, also Hawaii at 52MHz. A further report says that TV sound from New Zealand has been heard in Costa Rica, Central America.

Finally a letter from Mike Dalby who is now in Australia. Mike is working for a small company which installs and operates small TV stations in the outback. He's



Philips 1.2m dish/head end used for the Canadian CTS satellite experiments.

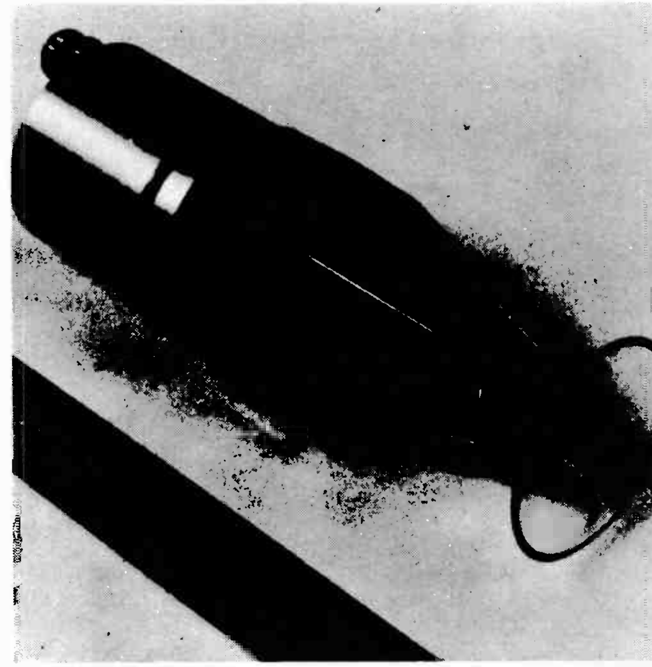
at present at the mining town of Gove, NT, some 400 miles east of Darwin. The transmitter powers involved are 1-250W, the transmitters being made by Aerodyne in the US. There's a u.h.f. link at Gove to a translator with a 100W output on ch. 11, and also a 1W relay on ch. 9 at the Aboriginal mission at Yarrakla. All programme material is on ¾in. U-matic tape, recorded by ABC at Perth or GTS4 in S. Australia. Programmes usually run for six hours daily.

On the DX side, Mike has received various Malaysian and Indonesian stations on chs. E2 and 3. The 27MHz citizens band is extremely active, with reception throughout the 24 hours from most parts of the world including at times Italy and Germany. The power limit in Australia is 12W s.s.b. and 4W a.m., though illegal linear amplifiers and high-gain aerials are popular. As Mike comments, "there is a large number of pirates and clowns . . . and in a country this size it's impossible to trace all the offenders".

Corrections

In the June column I mentioned a new wideband Fuba aerial being distributed by Audio Workshops. Unfortunately it was referred to as the DOU45 instead of the CLOU45.

In the March column the gain characteristics of the wideband Antiference XG21 aerial were discussed – in particular the dimensions of the director elements. Antiference comment that all the directors are tuned towards the h.f. end of the bandwidth, since any attempt to tune any of the directors towards the l.f. end would result in complete cut-off just above the frequency to which they were tuned due to the resulting reflector action. The fact that all the directors are tuned to the h.f. end accounts for



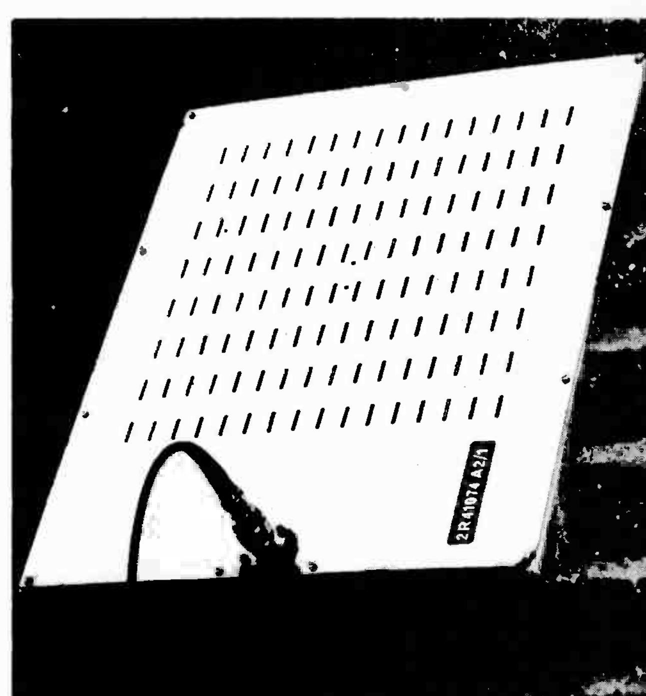
The Philips head end converter unit.

the rising gain at this end of the bandwidth. Our thanks to Antiference for their guidance.

Satellite TV

At present there is little practical experience of satellite TV reception at 12GHz. Those experiments that have been carried out have enabled many of the problems to be overcome however, and quite a lot has been written on the subject.

Aerials with parabolic reflector dishes are preferred. With diameters of 0·6 to 1·6m, gains of 36 to 44dBi are achieved. To maintain the gain the surface accuracy has to be to a very close tolerance: a variation of 1mm gives a loss of 1dB



Prototype planar array developed by the BBC. The half-wave slots are spaced approximately one wavelength in the H plane and one half wavelength in the E plane.

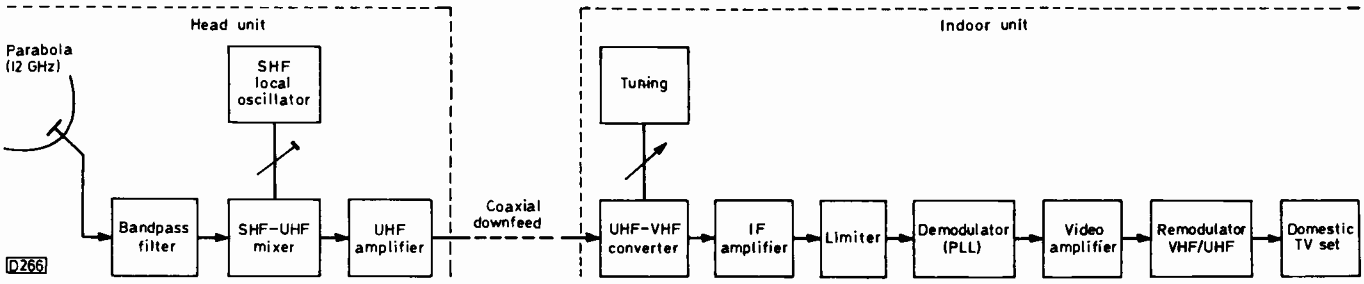


Fig. 1: Block diagram of a double-superhet receiving system developed by Mullard.

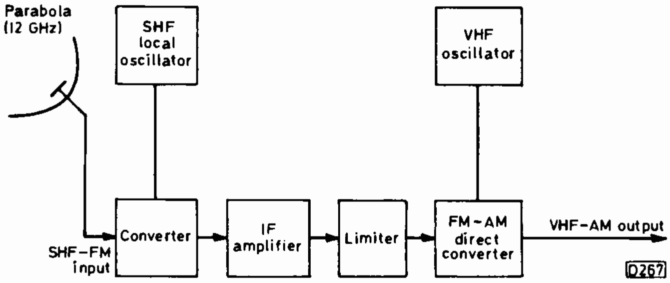


Fig. 2: Block diagram of an s.h.f./f.m. video receiver developed by NKH, Tokyo.

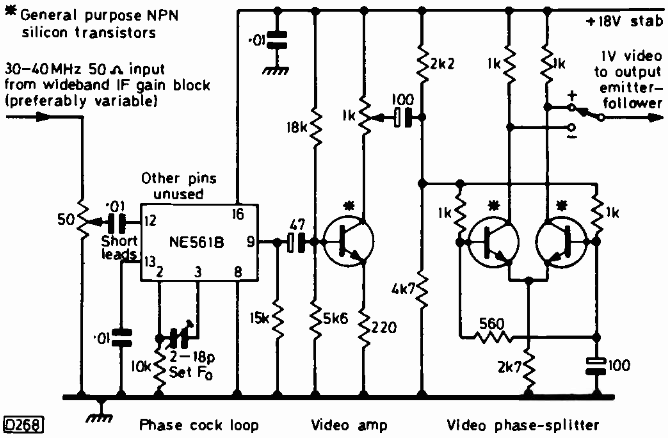


Fig. 3: Steve Birkill's improved f.m. video demodulator.

at 12GHz. Materials suggested are pressed steel or reinforced glassfibre polyester with a metallised layer. Typical beamwidths between the −3dB points are 1·1° for a 1·6m dish and 2° for an 0·6m dish. It follows that the aerial has to be orientated very carefully, and that the mounting has to be strong enough to withstand gusts of wind without misalignment. The BBC have suggested as an alternative a planar array of half-wavelength slots printed on copper-clad laminate with the slots connected together. At the present time the substrate material is extremely expensive, but increased demand could reduce the cost so as to become comparable to a standard parabola.

Due to the high losses at s.h.f., frequency conversion at the aerial is essential. The receiver system may use single or double conversion, but the latter seems to have advantages in terms of tuning stability, image frequency rejection and reduced local oscillator radiation. With double conversion, the signal is converted to u.h.f./f.m. at the aerial, with signal connection to the receiver via conventional low-loss coaxial cable. Fig. 1 shows a block diagram of the system. At the receiver the signal is converted to v.h.f., amplified, limited and demodulated, then remodulated at v.h.f. or u.h.f., a.m., for feeding to a standard TV receiver. This technique avoids the hum and isolation problems that could arise with direct connection of the video to an a.c./d.c. receiver chassis. One alternative suggestion that has been made is to use the receiver's local oscillator to feed a frequency multiplier at the masthead. This would add further complication however and call for a.f.c. from the modified receiver.

The construction of 12GHz equipment by the amateur enthusiast without the necessary measuring equipment is tricky to say the least. An accuracy of less than a millimetre is required, and this is unlikely to be possible for the average reader.

An accompanying photograph shows a Philips head unit (aerial/converter) which has been used with the Canadian CTS experiment. Certain details were given in the 1977 *EBU Technical Review*. The feed horn and waveguide couple the 12GHz signal into the mixer, which consists of an alumina microwave i.c. with two balanced Schottky diodes mounted together on a printed hybrid ring so that the diodes are coupled to the oscillator in the correct phase. The local oscillator consists of a Gunn diode stabilised by an invar cavity. The temperature stability is within 1·5MHz at 12GHz over a temperature range of 90°. An integral low-noise (1·5dB) u.h.f. amplifier operating at a mid-frequency of 410MHz gives the frequency converter a noise figure of 7dB. Power for the unit is fed up the coaxial cable. The system shown is for plane polarised signals: modification would be required for circularly polarised signals. The indoor unit follows more conventional lines.

It's possible that the Japanese will enter the market with a low-cost head unit (see Fig. 2) that gives direct conversion to v.h.f./a.m. at the head itself. The Japanese BSE experimental satellite transmissions, now in operation, are giving the electronics industry there practical experience and as early as September 1974 the Japanese broadcasting authorities published a paper describing a low-cost converter with low noise and simple f.m./a.m. conversion. The noise figure was quoted as 4·5dB, with bandwidths of 180MHz and 500MHz respectively for i.f.s of 360MHz and 1,250MHz. The highly sensitive converter uses a planar circuit mounted within a waveguide. Down conversion uses a v.h.f. oscillator, with direct conversion from f.m. to a.m. achieved by exploiting the non-linear characteristics of a diode. Measurements are quoted as ±0·5mm. For further details refer to the NHK, Tokyo paper serial number 180.

Meanwhile, Steve Birkill has provided details of an improved f.m. video demodulator (see Fig. 3). This is the second half of a double-conversion system consisting of a standard u.h.f. tuner/i.f. amplifier feeding a phase-locked loop demodulator, with up to 1V video to feed a monitor or remodulate back to r.f. The front end at 12GHz is the missing bit of course . . .! If any surplus s.h.f. units become available however we should be able to use Steve's circuit.

My thanks to K. G. Freeman, B.Sc., of the Mullard Research Laboratory, Ir. Ewens of Philips, Eindhoven, the EBU, the BBC and Steve Birkill for their help in preparing the above notes.

The IBA has just issued an information folder on "The Crawley Court Earth Station". This gives details of their projected experiments with the OTS satellite and information on their equipment.

Your PROBLEMS solved

Requests for advice in dealing with servicing problems must be accompanied by a 50p postal order (made out to IPC Magazines Ltd.), the query coupon from page 552 and a stamped addressed envelope. We can deal with only one query at a time. We regret that we cannot supply service sheets nor answer queries over the telephone.

RANK A823A CHASSIS

Blue does not appear for anything from ten minutes to an hour and a half after the set is switched on. Under the fault condition the collector of the blue output transistor is at 135V while the collectors of the other two output transistors are at 100V. Both the output transistor and its driver are o.k., as is the 1μF bias electrolytic. When the blue does appear, application of freezer to the SL901B demodulator/matrix i.c. results in it going for another hour or so. Is the SL901B faulty or is there anything else to check?

The signal is a.c. coupled from the SL901B to the blue channel by 3C44, which is 6·4μF on earlier panels, 10μF on later ones. It's this coupling electrolytic that's noted for causing intermittent faults. Check all three output transistor collector voltages under no signal conditions (pull the i.f. input out). If they are the same, within say 10V, the fault is in the a.c. signal path, either the SL901B or 3C44. If the blue output transistor's collector voltage is still wrong, take a look at the output stage clamp circuit – 3R52, 3D7, 3C56.

THORN 1600 CHASSIS

The report on this set was that the picture began to distort, rather like a trick mirror, after which smoke accompanied by an acrid smell appeared. On investigation I discovered that a one-eighth inch hole had burnt through the printed board at the junction of the width coil L23 and the coil in series with it (L24) – these coils are in series with the line scan coils. L23 was not marked, but L24 was quite scorched at the end connected to L23. Both coils and their associated damping resistors are intact however.

The scan correction capacitor C136 could be faulty, but we feel it's much more likely that there was a dry-joint at this point and that it had heated due to arcing (a surprisingly large current flows in the scan coils, even in a small receiver like this). Resolder the junction firmly. Hopefully the line output transistor VT16 was not damaged.

TELEFUNKEN 709 CHASSIS

On switching the set on there's instant sound but instead of a presentable picture appearing within the usual twenty seconds or so it takes ten minutes for a stabilised, but quite good, picture to develop. Another point is that when the colour control is turned fully to the left the picture is not completely monochrome. The stabilised voltage lines, the boost voltage and the transistor voltages on the signal board are all correct.

Since these sets were produced some years ago now it's quite possible that the tube is getting a little sluggish in warming up. We've found that the Telefunken tubes fitted to these sets often take five or ten minutes to reach full emission. Unfortunately when this problem occurs the only real cure is the costly one of fitting a new tube. A by-product of this effect is often noticeable as a shift in the grey scale towards one colour when the brightness or colour controls are varied, and because of this it's quite possible that a colour cast is present when the colour control is turned down. It should be impossible for any chroma signal to reach the decoder with the colour control set at minimum since one end of the slider is connected to chassis. The control could be faulty to cause the fault mentioned: it can be checked with an ohmmeter.

THORN 1590 CHASSIS

The audio output transistors have gone short-circuit, blowing the 2·5A fuse. It's the later circuit using silicon transistors (BFR52 and BFR62) in the output stage and a 2N3703 driver. The latter checks o.k. on a multimeter. Are there any alternative output transistors, and are there any checks that should be made as I don't want to switch on and see new ones go up in smoke?

There are alternative transistors that work in this circuit. A much more reliable replacement pair is the BC142/BC143 set as used in the Thorn 3000 colour chassis. The output transistors normally self-destruct, but it's as well to replace the driver transistor and check the output coupling capacitor (C67, 470μF). When the circuit is restored to life, adjust the 2kΩ bias potentiometer just to clear crossover distortion – best heard at low volume levels, but make sure that the loudspeaker is in order as it's hard to tell a rubbing cone from crossover distortion. Don't forget the BC147 transistor across the bias control: if it's open-circuit the output pair turn hard on and may be damaged. The BC143 is the pnp transistor incidentally, with its collector connected to chassis.

GEC C2110 SERIES

A rather loud ripple can be heard through the speaker on this set. The frequency varies when the field hold control setting is changed, so a new field timebase panel was tried, though without success. I've come across other sets in this series with the same fault. Rerouting various leads has been tried but the fault persisted.

We suggest you try connecting a 470μF 16V electrolytic across the decoupling capacitor C187 (0·1μF) on the sound panel. You will probably find it advisable to transfer C187 to the underside of the panel and wire the electrolytic on the components side, with the positive tag to the print which goes to pin 4 of plug PL11. The problem was present on a number of earlier production models.

THORN 1500 CHASSIS

When the set is first switched on there's a gap of about two inches at the bottom of the screen. The screen gradually fills after ten to fifteen minutes and the picture is then perfect. A new PCL805 field timebase valve has been tried without success. The gap has been getting gradually larger over a period of several weeks.

There are several possibilities, as follows, listed in order of likelihood: the output pentode's cathode bias components C79 (160μF, use 250μF) and R103 (300Ω), the coupling capacitor C73 (0·1μF) from the triode to the pentode, R105/6 in the linearity network, and C101 (100μF) which smoothes the HT4 supply to the field timebase.

MURPHY DUAL-STANDARD COLOUR

The problem with this elderly colour set is that the left-hand side of the screen is sometimes shaded purple for a width of around four to five inches while the rest of the picture has a greenish cast. This colour unbalance usually occurs after the set has warmed up, and will sometimes correct itself after a quarter of an hour or so. At other times it either takes longer or does not improve. I've replaced the three PCL84 colour-difference output valves and checked the resistors feeding the c.r.t. first anode potentiometers.

The display described suggests that there's a line-rate sawtooth waveform on one of the green gun's electrodes. Start by checking 9C10 (0·01μF) which decouples the first anode supply. If it turns out to be o.k., turn to the clamp circuit components in the G – Y output stage, particularly the coupling capacitor 6C15 (4,700pF) and the anode resistor 6R36 (10MΩ). Make sure that there are no dry-joints here, and that the panel is properly earthed to the main chassis frame.

GEC SERIES ONE CHASSIS

When the set is first switched on the field takes some time to lock. Subsequently it often goes out of lock on a camera change, but will right itself after a time. A new PCL805 field timebase valve has been fitted.

Try replacing the sync separator's screen grid feed resistor. This is R141 (47kΩ). Other possibilities are the field sync pulse integrating capacitor C208 and the field charging capacitor C238. The value of both these capacitors is 0·047μF.

ITT CVC8 CHASSIS

The problem with this set is intermittent field slip – the setting of the field hold control is very critical. There's also a lightish bar which moves up and down the picture, verticals within this bar being wavy. There's a sudden increase in colour intensity when the fault appears. The PCL805 field timebase valve has been replaced without making any improvement.

This sort of effect is often caused by excessive hum ripple on the 20V l.t. line. The usual causes of this are the AD161 (on the heatsink at left-hand side) regulator transistor T46 or the bridge rectifier D52 (by the chrominance delay line). Less frequent causes are the reservoir capacitor C262 (500μF), the BC170 regulator driver transistor T45 or the filtering capacitor C263 (10μF) in its base circuit. If the field hold problem persists when the hum has been dealt with, check by substitution D46 (OA91) beside the PCL805 and the a.g.c. gating diode D45 (BA145) on the right-hand side of the decoder panel.

DECCA 30 SERIES CHASSIS

When the set is first switched on the picture appears broken up into narrow horizontal bars, though there's no loss of colour. After fifteen minutes the picture settles down and the set operates normally. The line timebase and sync separator valves have been replaced and the line oscillator coil reset, but the fault is still present. The voltage at R37 (beam limiting) is satisfactory.

The fault is fairly common on these sets. We generally replace the two flywheel sync discriminator diodes, the two electrolytics C425 and C419 in the line oscillator circuit, and the 470pF feedback capacitor C427 – the latter must be a silver mica or polystyrene type – then reset the oscillator coil L401.

PHILIPS G6 D/S

There's a weak raster on this set. The sound is o.k. until the line output stage comes into operation, then the sound cuts out due to the heavy current being taken by the line output stage. Switching the three beams off removes the loading, and the same thing happens when the luminance is switched off. Under the fault condition the voltage at the grid of the PD500 shunt stabiliser triode rises to –150V and there's no voltage at its cathode. The picture was excellent before this fault condition arose.

The shunt stabilser is being driven to cut off, so there is excessive beam current. Take a look in the neck of the c.r.t. as the line output stage comes into operation. A green glow suggests that the PFL200 luminance output pentode's anode load resistor R2115 is open-circuit or the c.r.t. cathode voltage is low for some other reason. Since the symptoms go when the luminance is switched off, this is the likely area of trouble, but it's also possible that the c.r.t. is faulty. If the c.r.t. cathode voltage is low, check the voltages in the luminance output stage. Another possibility is that the h.t. may be dropping when the line output stage comes on as a result of the reservoir/smoothing electrolytics ageing.

ITT CVC 5/8 CHASSIS

There's an intermittent fault at switch on. A few minutes after switching on the colour goes, leaving a perfect monochrome picture. After a further ten to twenty minutes the colour returns, sometimes with a slight flicker, at other times imperceptably. There's been no other trouble except a fuse blowing early on, due I was told to an unsatisfactory batch of fuses.

Apart from dry-joints – check for these if you have not already done so – there are two common areas in which this trouble occurs. The first is drift of the subcarrier oscillator, as a result of which the colour-killer comes into operation. This is usually due to the burst discriminator assembly, the reference oscillator transistor T38d, the filter capacitor C208d (6·8μF) or the 1·5V zener diode D36d in the control loop, or the crystal. Alternatively the trouble could be due to failure of the chrominance amplifiers or one of the tantalum capacitors in these stages. Use of an oscilloscope after overriding the colour-killer (connect a 12-18kΩ resistor from the 20V line to TP18) should enable the fault area to be tracked down quickly.

PHILIPS G8 CHASSIS

A year after this set was purchased the red and green convergence on the right-hand side shifted out of alignment. On inspection, I found that the horizontal R/G parabola control R1934 was well cooked and difficult to adjust. An exchange panel was fitted and all went well with the minimum of adjustment. A year later however the same fault occurred. This time the control was so cooked that the knob broke off. I bypassed the slider with a wire link and the picture is now reasonable. Is there anything that can be done to prevent this trouble recurring? The control is a wirewound potentiometer rated at 3W.

Burning of wirewound potentiometers on convergence panels over a period of time is not unusual. It would help to use a component rated at more than 3W. Alternatively, as the rotor shorts out a portion of the winding to reach the operating position, you could parallel the potentiometer with a 5W low-value resistor and then reset the control for good convergence. This would bypass some of the current, reducing the dissipation in the potentiometer. Make sure that the set is positioned so that the air circulation around it is good.

SONY KV1800UB

On ITV the colour is perfect until the adverts come on. The picture then takes on a greenish hue. Perfect colour is restored by tuning off and then back on to channel once or twice – until the next lot of adverts appear. On the BBC channels there is similar trouble, usually on a change of camera. I've checked around the preset hue control VR303 without success.

We've known this sort of thing to be due to wrong phase conditions around the multivibrator Q161/Q162. This circuit controls the line-by-line switching in the decoder. Check around the gate circuit Q324/D316 which controls the multivibrator. This circuit depends in turn on the burst circuit, where T311 (BAT-3) may be incorrectly aligned. Misalignment elsewhere in the decoder could also be responsible, but a scope, bar generator and the full manual would be required to check it.

GRUNDIG 6011

The problem with this set is wavy verticals over the top two thirds of the screen. There's no pulling, and the main smoothing capacitors and the electrolytics on the vertical and horizontal modules have been replaced.

This effect is usually due to failure of Di504 (1N4004), or R504 (39Ω) in the line output stage. These components, connected in parallel, are in series with the secondary of the width control transductor.

TEST CASE

188

Each month we provide an interesting case of television servicing to exercise your ingenuity. These are not trick questions but are based on actual practical faults.

The red hue on the screen of a Bush Model CTV1126 was far above the intensity of the green and blue hues, and with the brightness control set in the position that would normally give a correct picture the display was predominantly red. It was discovered that by advancing the brightness control the hue imbalance decreased, but the picture was then far too bright.

Enquiries established that the symptom had occurred suddenly, and that previously the receiver had been operating normally with good colour balance. The sound was unaffected, and even when the colour control was retarded the display still had a red tinge.

It was clear in the technician's mind that the fault was caused by excessive red gun beam current. Experimental adjustments were made to the three preset drive controls but there was no change in the fault condition itself. The c.r.t. first anode presets were also adjusted, and although the red tinge could be reduced by turning down the red preset the basic symptom still remained.

Attention was then directed to the biasing of the c.r.t. guns, starting at the grids. These are connected together and used for beam limiting and for line and field flyback blanking. All appeared to be normal here, the common grid potential being about right. Each RGB channel consists of two npn transistors, the emitter of the driver being directly connected to the base of the output transistor whose collector is in turn directly coupled to the appropriate picture tube cathode. The two transistors are biased by a resistive potential divider at the base of the driver transistor: this operates in conjunction with a feedback clamp.

Voltage checks indicated that both transistors were receiving excessive forward bias, the abnormally high collector current flowing in the second transistor resulting in a lower than normal collector voltage which made the nominal bias on the c.r.t.'s red gun lower than that on the other two guns. The resistors in the offending circuit had correct values, and no capacitor trouble could be detected.

Which important aspect of the symptom had been overlooked by the technician, and what part of the circuit had been left unchecked? See next month for the solution and for a further item in the series.

SOLUTION TO TEST CASE 187
– Page 496 last month –

The low-level sound distortion experienced with a Grundig Model 717 colour receiver was obviously not being caused by amplifier trouble otherwise the effect would have been present on the external speaker as well. Since the internal speakers also seemed to be in order, the cause of the trouble was most likely to be in the coupling between the audio output transformer's secondary winding and the internal speakers. The DIN switched socket was thus the prime suspect and was in fact proved to be responsible.

Since the switch had been in the open position for a long period, the contacts had become tarnished and the spring pressure had diminished. When the internal speakers were brought back into service the contacts appeared in series with them. The tarnish and the light pressure resulted in a "semiconductor" junction action which partially rectified and hence badly distorted the signal. At higher audio current the rectifier action collapsed, as also did the distortion. Replacing the socket cleared the fault completely.

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TELEVISION AUG 1978

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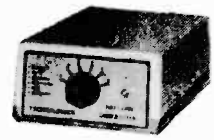

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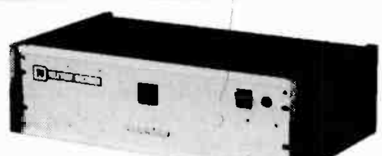

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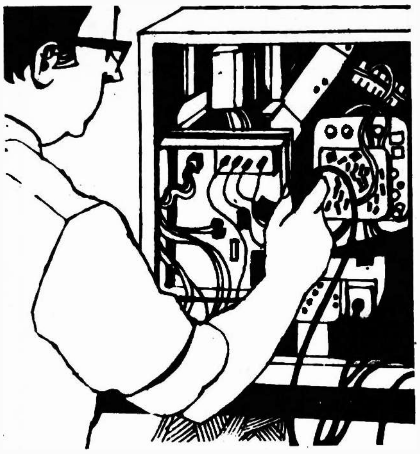

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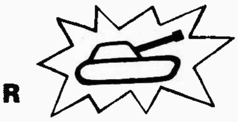

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3300/40v, 680/40v, 680/50v, 220/63v, 2200/10v — 12½p EACH

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·0047 MFD 1000v
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} 8p EACH

200+200+100M 325v	40p
470+470M 250v	40p
100+200M 325v	30p
200+200+100+32M 350v	70p
150+200+200M 300v	50p
800M 250v	20p
600M 300v	£1.00
400M 400v	£1.00
800+800M 250v	60p
300+300+100+32+32 300v	£1
200+100+100M 350v	70p
100M 450v	25p
33/450v	25p
47M 450v	25p
680M 100v	25p
6800M 40v	35p
100M 350v	20p
22M 350v	20p
33000 10v	30p
15000 40v	50p

2·2/63v, 10M 40v, 220M 10v, 2·2M 100v, 22M 100v, 4·7M 63v — 5p EACH

Plessey Green Condensers

2200M 16v	1000M 50v
1000M 10v	1500M 25v
4700M 25v	1000M 10v
680M 63v	1500M 40v
1000M 63v	1000M 25v
3000M 16v	1500M 50v
330M 100v	4700M 16v
4700M 10v	1000M 16v
1000M 63v	100M 63v
3300M 25v	12½p
1000M 40v	EACH

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BT106	95p
BT116	95p
BY212	15p
12 Kv Diodes 2 M/A	30p
18 Kv BYF3123 Silicone	30p

160PF 8Kv	100M 50v
270PF 8Kv	330M 10v
1000PF 10Kv	330M 25v
1200PF 10Kv	330M 35v
1000PF 12Kv	330M 50v
160M 25v	330M 63v
220M 25v	470M 25v
1000M 16v	470M 35v
220M 35v	470M 40v
220M 40v	47/63
220M 50v	300PF 6Kv
470M 25v	8M/350v
22M 315v	10p EACH

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