SERVICING · VIDEO · CONSTRUCTION · COLOUR · DEVELOPMENTS

Television

AUGUST 1975

40p

VIDEO-TAPE RECORDING

Part 1

PLUS:
OVER-VOLTAGE PROTECTION TECHNIQUES
THE THORN 9000 COLOUR CHASSIS
INTRODUCTION TO ELECTRONIC LOGIC

TRANSISTORS, ETC.

Type	Price (£)
AC107	0.35
AC117	0.24
AC126	0.25
AC127	0.25
AC128	0.25
AC141	0.26
AC141K	0.27
AC142	0.20
AC142K	0.19
AC151	0.24
AC152	0.25
AC153K	0.28
AC154	0.20
AC176	0.25
AC178	0.27
AC187	0.25
AC187K	0.26
AC188	0.25
AC188K	0.26
AC193K	0.30
AC194K	0.32
ACY28	0.25
ACY39	0.68
AD140	0.50
AD142	0.52
AD143	0.51
AD149	0.50
AD161	0.48
AD162	0.48
AF114	0.25
AF115	0.25
AF116	0.25
AF117	0.20
AF118	0.50
AF121	0.32
AF124	0.25
AF125	0.25
AF126	0.25
AF127	0.25
AF139	0.35
AF147	0.35
AF149	0.45
AF178	0.55
AF179	0.60
AF180	0.55
AF181	0.50
AF186	0.40
AF239	0.40
AF279	0.84
AL100	1.10
AL102	1.10
AL103	1.10
AL113	0.95
AU103	2.10
AU110	1.90
AU113	2.40
BC107	0.12
BC107A	0.13
BC107B	0.14
BC108	0.12
BC108B	0.13
BC109	0.13
BC109C	0.14
BC113	0.13
BC114	0.20
BC115	0.20
BC116	0.20
BC117	0.20
BC119	0.29
BC125	0.22
BC126	0.20
BC132	0.15
BC134	0.20
BC135	0.19
BC136	0.20
BC137	0.20
BC138	0.20
BC142	0.30
BC143	0.35
BC147	0.13
BC148	0.12
BC149	0.14
BC152	0.25
BC153	0.20
BC154	0.20
BC157	0.15
BC158	0.13
BC159	0.15
BC161	0.48
BC167B	0.15
BC168B	0.13
BC169C	0.13
BC170	0.15
BC171	0.15
BC172	0.14
BC173	0.20
BC174B	0.26
BC176	0.22

Type	Price (£)
BC177	0.20
BC178	0.22
BC178B	0.22
BC179	0.20
BC179B	0.21
BC182L	0.11
BC183	0.11
BC183K	0.12
BC183L	0.11
BC184L	0.13
BC186	0.25
BC187	0.27
BC208	0.12
BC212L	0.12
BC213L	0.12
BC214L	0.15
BC238	0.12
BC261A	0.28
BC262A	0.18
BC263B	0.25
BC267	0.16
BC268C	0.14
BC294	0.37
BC300	0.60
BC301	0.35
BC303	0.60
BC307B	0.12
BC308A	0.10
BC309	0.15
BC323	0.68
BC377	0.22
BC441	1.10
BC461	1.58
BCY33	0.36
BCY42	0.16
BCY71	0.22
BCY88	2.42
BD115	0.65
BD123	0.98
BD124	0.80
BD130Y	1.42
BD131	0.45
BD132	0.50
BD135	0.40
BD136	0.46
BD137	0.48
BD138	0.50
BD139	0.55
BD140	0.62
BD144	2.19
BD145	0.75
BD163	0.67
BD183	0.56
BD222	0.78
BD234	0.75
BD410	1.65
BD519	0.76
BD520	0.76
BD599	0.75
BDX18	1.45
BDX32	2.55
BDY18	1.78
BDY20	0.99
BF115	0.20
BF117	0.45
BF120	0.55
BF121	0.25
BF123	0.28
BF125	0.25
BF127	0.30
BF158	0.25
BF159	0.27
BF160	0.22
BF161	0.45
BF162	0.45
BF163	0.45
BF167	0.25
BF173	0.25
BF177	0.30
BF178	0.33
BF179	0.33
BF180	0.35
BF181	0.33
BF182	0.44
BF183	0.44
BF184	0.26
BF185	0.26
BF194	0.15
BF195	0.15
BF196	0.15
BF197	0.17
BF198	0.20
BF199	0.25
BF200	0.35
BF218	0.35
BF222	1.08
BF224J	0.15
BF240	0.20

Type	Price (£)
BF241	0.22
BF244	0.18
BF254	0.45
BF255	0.45
BF256	0.45
8F257	0.49
BF258	0.66
BF259	0.93
BF262	0.70
BF263	0.70
BF273	0.16
BF336	0.35
BF337	0.35
BF458	0.60
BF459	0.63
BF596	0.70
BF597	0.15
BFR39	0.24
BFR41	0.30
BFR61	0.30
BFR79	0.24
BFT43	0.55
BFW10	0.55
BFW11	0.55
BFW16A	1.70
BFW30	1.38
BFW59	0.19
BFW60	0.20
BFW90	0.28
BFX16	2.25
BFX29	0.30
BFX30	0.35
BFX84	0.25
BFX85	0.26
BFX86	0.26
BFX87	0.28
BFX88	0.24
BFY18	0.53
BFY40	0.40
BFY41	0.43
BFY50	0.25
BFY51	0.23
BFY52	0.23
BFY57	0.32
BFY64	0.42
BFY72	0.31
BFY90	0.70
BLY15A	0.79
BPX25	1.90
BPX29	1.70
BPX52	1.90
BRC4443	0.68
BRY39	0.47
BRY56	0.40
BR101	0.47
BSX19	0.13
BSX20	0.19
BSX76	0.15
BSX82	0.52
BSY19	0.52
BSY41	0.22
BSY54	0.50
BSY56	0.80
BSY65	0.15
BSY78	0.40
8SY91	0.28
BSY95A	0.27
BT106	1.24
BT116	1.20
BU105/02	1.95
BU108	3.25
BU126	2.99
BU204	1.98
BU205	1.98
BU207	3.00
BU208	3.15
BU209	2.55
BUY77	2.50
BUY78	2.55
BUY79	2.85
D40NI	0.45
E1222	0.55
E5024	0.20
ME6001	0.16
ME6002	0.17
ME8001	0.18
MJE340	0.68
MJE341	0.72
MJE370	0.65
MJE520	0.85
MJE521	0.95
MJE2955	1.20
MJE3000	1.85
MJE3055	0.74
MPF102	0.40
MPS6566	0.21
MPSA05	0.47
MPSA55	0.50
MPSU05	0.66
MPSU06	0.76

Type	Price (£)
MPSU56	1.26
MPSU55	1.26
OC26	0.38
OC28	0.65
OC35	0.59
OC36	0.64
OC42	0.55
OC44	0.25
OC45	0.32
OC70	0.32
OC71	0.32
OC72	0.32
OC73	0.51
OC75	0.25
OC76	0.35
OC81	0.53
OC81D	0.57
OC139	0.76
OC140	0.80
OC170	0.25
OC171	0.30
OC200	1.30
OCP71	0.92
ON236A	0.65
ORP12	0.55
R2008B	2.05
R2010B	2.95
TIC44	0.29
TIC46	0.44
TIC47	0.58
TIP29A	0.49
TIP30A	0.58
TIP31A	0.65
TIP32A	0.67
TIP33A	0.99
TIP34A	1.73
TIP41A	0.80
TIP42A	0.91
TIS43	0.30
TIS73	1.36
TIS90	0.23
TIS91	0.23
ZTX109	0.12
ZTX300	0.16
ZTX304	0.22
ZTX310	0.10
ZTX313	0.12
ZTX500	0.17
ZTX502	0.17
ZTX504	0.42
ZTX602	0.24
2N525	0.86
2N696	0.23
2N697	0.15
2N706	0.12
2N706A	0.15
2N708	0.35
2N744	0.30
2N914	0.19
2N916	0.20
2N918	0.42
2N930	0.35
2N1164	3.60
2N1304	0.21
2N1305	0.21
2N1306	0.31
2N1307	0.22
2N1308	0.26
2N1309	0.36
2N1613	0.34
2N1711	0.45
2N1890	0.45
2N1893	0.48
2N2102	0.51
2N2217	0.36
2N2218	0.60
2N2219	0.50
2N2221A	0.41
2N2222A	0.50
2N2270	0.41
2N2369A	0.42
2N2401	0.60
2N2484	0.41
2N2570	0.18
2N2646	0.53
2N2712	0.12
2N2894	0.77
2N2904	0.22
2N2904A	0.26
2N2905	0.26
2N2905A	0.28
2N2926G	0.13
2N2926Y	0.12
2N29260	0.12
2N2955	1.12
2N3012	0.91
2N3019	0.75
2N3053	0.21
2N3054	0.55
2N3055	0.60

Type	Price (£)
2N3133	0.54
2N3134	0.60
2N3232	1.32
2N3235	1.10
2N3250	1.02
2N3254	0.28
2N3323	0.48
2N3391A	0.23
2N3501	6.99
2N3702	0.13
2N3703	0.15
2N3704	0.15
2N3705	0.11
2N3706	0.10
2N3707	0.13
2N3715	2.30
2N3724	0.72
2N3739	1.18
2N3766	0.99
2N3771	1.70
2N3772	1.90
2N3773	2.90
2N3790	4.15
2N3794	0.20
2N3819	0.35
2N3820	0.49
2N3823	1.45
2N3866	1.70
2N3877	0.25
2N3904	0.16
2N3905	0.18
2N3906	0.15
2N4032	0.43
2N4033	0.54
2N4036	0.52
2N4046	0.35
2N4058	0.17
2N4123	0.13
2N4124	0.15
2N4126	0.20
2N4236	1.90
2N4248	0.12
2N4284	0.19
2N4286	0.19
2N4288	0.13
2N4289	0.20
2N4290	0.14
2N4291	0.18
2N4292	0.20
2N4392	2.84
2N4871	0.24
2N4902	1.30
2N5042	1.05
2N5060	0.32
2N5061	0.35
2N5064	0.45
2N5087	0.32
2N5294	0.35
2N5296	0.57
2N5298	0.58
2N5322	0.85
2N5449	1.90
2N5457	0.30
2N5458	0.35
2N5494	0.85
2N5496	1.05
2N6027	0.65
2N6178	0.71
2N6180	0.92
2SC643A	1.36
2SC1172Y	2.80
3N140	1.21
40250	0.60
40327	0.67
40361	0.48
40362	0.50
40429	0.80
40439	2.67

MATCHED PAIRS

Type	Price (£)
AC128/AC176	0.52
AC141K/AC142K	0.56
AC187/AC188	0.60
AC187K/AC188K	0.61
AC193K/AC194K	0.71
AD161/AD162	0.95
BC142/BC143	0.70
TIS90M/TIS91M	0.50

Any other transistors can be matched at a supplement of 20p per pair.

Tel: Stoke Climsland (05797) 439

Telex: 45457 (A/B Mercury Calgton)

DIODES

Type	Price (£)
AA113	0.15
AA119	0.09
AA129	0.20
AA143	0.10
AAZ13	0.30
AAZ17	0.12
BA100	0.15
BA102	0.25
BA110U	0.30
BA115	0.12
BA141	0.17
BA145	0.17
BA148	0.17
BA154	0.13
BA155	0.16
BA156	0.15
BA157	0.25
BAX13	0.06
BAX16	0.07
BAY72	0.11
BB104	0.52
BB105B	0.52
BB105G	0.45
BB110B	0.45
BR100	0.50
BY100	0.22
BY103	0.22
BY126	0.16
BY127	0.17
BY133	0.23
BY140	1.40
BY164	0.55
BY176	1.68
BY179	0.70
BY206	0.31
BYX10	0.15
BYZ12	0.30
FSY11A	0.45
FSY41A	0.40
OA10	0.20
OA47	0.07
OA81	0.12
OA90	0.08
OA91	0.07
OA95	0.07
OA200	0.10
OA202	0.10
OA210	0.29
OAZ237	0.78
S2M1	0.22
TV20	1.85
IN914	0.07
IN914E	0.06
IN916	0.10
IN1184	0.92
IN1185	1.10
IN4001	0.05
IN4002	0.06
IN4003	0.07
IN4004	0.08
IN4005	0.09
IN4006	0.11
IN4007	0.14
IN4148	0.05
IN4448	0.10
IN5400	0.15
IN5401	0.17
IN5402	0.20
IN5403	0.22
IN5404	0.25
IN5405	0.27
IN5406	0.30
IN5407	0.34
IS44	0.07
IS310	0.45
IS920	0.07
IS923	0.12

Diodes can be supplied balanced at a supplement of **5p** per device – e.g. four balanced OA91 would be **£0.48** per set.

Variable capacitance diodes can be supplied matched at a supplement of **3p** per device.

LINEAR INTEGRATED CIRCUITS

Type	Price (£)
CA3045	1.35
CA3046	0.70
CA3065	1.90
MC1307P	1.19
MC1310P	2.94
MC1327PQ	1.01
MC1330P	0.76
MC1351P	0.75
MC1352P	0.82
MC1358PQ	1.85
MC1496L	0.87
MC3051P	0.58
MFC4000B	0.43
MFC4060A	0.70
MFC6040	0.91
NE555	0.72
NE556	1.34
PA263	1.90
SL414A	1.91
SL901B	3.84
SL917B	5.12
SN76001N	1.45
SN76003N	2.92
SN76013N	1.95
SN76013ND	1.72
SN76023N	1.95
SN76023ND	1.72
SN76033N	2.92
SN76227N	1.46
SN76530P	1.05
SN76533N	1.20
SN76666N	0.90
TAA300	1.76
TAA320	0.94
TAA350A	2.02
TAA435	0.85
TAA450	2.70
TAA550	0.55
TAA570	2.02
TAA611A	1.70
TAA611B	1.85
TAA630Q	4.18
TAA630S	4.18
TAA661B	1.32
TAA700	4.18
TAA840	2.02
TAA861A	0.49
TAD100	2.66
TBA120S	0.99
TBA240A	2.97
TBA281	2.28
TBA480Q	1.90
TBA500	1.99
TBA500Q	2.00
TBA510	1.99
TBA520Q	3.34
TBA530	2.71
TBA530Q	2.71
TBA540	3.21
TBA540Q	3.21
TBA550Q	4.10
TBA560C	4.09
TBA560CQ	4.10
TBA570	1.17
TBA641	0.76
TBA673	2.28
TBA700	2.59
TBA720Q	2.45
TBA750Q	2.33
TBA800	1.75
TBA810AS	1.75
TBA920Q	4.23
TBA990	4.10
TBA990Q	4.10
TCA270Q	4.18
ZN414	1.25

Please enquire for linear op. amps, 709, 710, etc.

DIGITAL INTEGRATED CIRCUITS

Type	Price (£)
7400	0.20
7401	0.20
7402	0.20
7404	0.24
7406	0.45
7408	0.25
7410	0.20
7411	0.25
7412	0.28
7413	0.50
7416	0.45
7417	0.30
7420	0.20
7425	0.37
7430	0.20
7440	0.20
7441	0.85
7445	1.95
7447	1.30
7450	0.20
7451	0.20
7454	0.20
7460	0.20
7470	0.33
7472	0.38
7473	0.44
7474	0.48
7475	0.59
74B9	4.32
7490	0.65
7491	1.10
7492	0.75
7493	0.65
7494	0.85
7495	0.85
7496	1.00
74100	2.16
74121	0.60
74122	0.80
74150	1.44
74151	1.15
74154	1.66
74164	2.01
74192	2.05
74193	2.30

HARDWARE BASES

Type	Price (£)
DIL8	0.16
DIL14	0.16
DIL16	0.18

MOUNTING KITS

Type	Price (£)
TO-3	0.06
TO-66	0.06

VALVES

Type	Price (£)
DY87	0.39
EB91	0.30
ECC82	0.41
EF80	0.41
EF183	0.53
EF184	0.53
EH90	0.55
PC86	0.67
PC88	0.76
PCC89	0.58
PCF80	0.47
PCF86	0.58
PCF801	0.58
PCF802	0.63
PCL82	0.50
PCL84	0.54
PCL805/85	0.58
PCL86	0.58
PFL200	0.74
PL36	0.80
PL84	0.61
PL504	0.80
PL508	0.95
PL509	1.44
PY81/800	0.45
PY88	0.52

ZENER DIODES

400mW 3.0-33V **12p each**
1.3W 3.3-100V **18p each**

VDR'S, PTC & NTC RESISTORS

Type	Price (£)	Type	Price (£)
E295ZZ/01	14	E299DD/P116-P354	all 8
E295ZZ/02	14	VA1015	50
E298CD/A258	7	VA1026	41
E298ED/A258	6	VA1033	8
/A260	6	VA1034	8
/A262	6	VA1040	8
/A265	6	VA1053	8
/P268	6	VA1055S	10
E298ZZ/05	7	VA1077	12
/06	6	VA1104	35
		VA8650	110

RESISTORS

Carbon Film (5%)	ea
¼W 5.6 Ω-330k Ω (E12)	1.5p
½W 10 Ω-10M Ω (E24)	1.5p
1W 10 Ω-19M Ω (E12)	3p
2W 10 Ω-10M Ω (E6)	5p

WIREWOUND (5%)

2½W	0.22 Ω-270 Ω	15p ea
5W	10 Ω-8.2k Ω	13p ea
10W	10 Ω-25k Ω	18p ea

CAPACITORS

Full range of C280, C296, tubular ceramic, pin-up ceramic, miniature electrolytics, mica, mixed dielectric and TV electrolytics stocked. – Please see catalogue.

MASTHEAD AMPLIFIERS

Labgear uhf group amplifier complete with mains power unit CM6001/PU.
Groups A, B, cr C/D please specify **£11.00**

Labgear CM6030 WB vhf/uhf ultra wideband amplifier (channels 1-68). Complete with mains power unit CM6001/PU **£16.71**

Labgear CM6019 WB uhf wideband amplifier (channels 21-68). Complete with mains power unit CM6020/PU **£8.19**

PATTERN GENERATORS

Labgear CM6004/PG giving crosshatch dots, greyscale and blank raster on 625-lines. Tuning can be preset for anywhere in Bands IV and V as well as Band III (for relays) **£49.95**

Labgear CM6038 DB Pocket size vhf/uhf generator. Outputs as CM6004 PG above but can be used either on mains or battery **£39.60**

COLOUR/BAR GENERATORS

Labgear CM6037/DB: Dual standard band generator gives standard 8 band colour bars + greyscale step wedge + red raster + centre cross + centre dot + crosshatch + dot pattern + blank raster. Sync output also provided **£111.00**

VHF/UHF CONVERTERS

Labgear "Televertas" for DX-ing or single-standard receiver use on relay systems. Type 6022/RA **£13.80**

OUR NEW CATALOGUE IS AVAILABLE AT 30p (refundable).

P. & P.: UK £0.12 per order.
Overseas: At cost.
Please add VAT at 25% on all items except test generators which are at 8%.
All prices subject to availability.
Giro A/c 23 532 4000.

EAST CORNWALL COMPONENTS
CALLINGTON - CORNWALL

Television

SERVICING
VIDEO
CONSTRUCTION
COLOUR
DEVELOPMENTS

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All correspondence regarding advertisements should be addressed to the Advertisement Manager, "Television", Fleetway House, Farringdon Street, London EC4A 4AD. All other correspondence should be addressed to the Editor, "Television", at the same address.

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this month

OUR NEXT ISSUE DATED SEPTEMBER WILL BE PUBLISHED ON AUGUST 18

Television

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EXPORT SCENARIO

Now that the referendum has come and gone, with a decisive vote in favour of commitment to Europe, it is very much the time for our radio and TV industry to be thinking increasingly in terms of exports – particularly since the home market is in such a depressed state and is likely to remain that way for some months. Fortunately there is evidence that this is indeed the way the industry is thinking, and there is no doubt now that the European market is the important one to go for – it's rich, has a large population, and uses the same basic transmission standards.

A favourable trading balance has at last been achieved in one section of the TV market. During the first quarter of the year exports of 26in colour receivers reached £7·72 million while imports were down to £4·77 million. If that can be done, what else can be achieved? Colour TV exports for the first quarter of 1975 were in fact 424% higher than the equivalent quarter of 1974. This is a massive percentage increase, but as the starting point in real terms was so low it should be treated as just a beginning.

At the last BREMA annual meeting Fidelity Radio's managing director Jack Dickman commented that the government does not take the industry seriously "because our export record is not very good – though our import record is excellent"! The figures above show that the situation is changing. To take some examples of what is happening, Rank Radio now has offshoots on the continent in France, West Germany, Belgium, Holland, Sweden and Denmark. GEC (Radio and Television) has formed a subsidiary company, GEC Fernseh und Phototechnik GmbH, Dusseldorf, to sell models tailored specially to the needs of the West German market. Thorn has been active on the continent for some time – the 4000 colour chassis for example is mainly an export model aimed at the requirements of continental markets. The company has moved large quantities of both colour and monochrome portable sets abroad and with its modern plant – the colour TV factory at Bradford is said to be the largest and most up to date in Europe – has every chance of seizing a substantial chunk of the market. Pye and Decca also have export models in production.

Inevitably something of a question mark hangs over the role which the multinationals will play in all this. After all, if Philips and ITT, the firms concerned, export to Europe they are simply competing with their own local companies and plants there. And there seems little doubt that ultimate control of these companies is very definitely exercised from abroad.

With the signs pointing in the right direction, the industry is more than ever justified in claiming that it is not receiving the encouragement it should from the government. We commented on this – in connection with VAT – last month. The point is that you cannot compete successfully if, due to a hammered home market, your plants are working way below capacity.

The economics of modern large-scale manufacturing mean that plant has to be operated at a high level of production if its costs are to be covered and a profit produced. It's no answer to say that plant should be set up to cater mainly for export markets: one has only to think of Volkswagen to appreciate the dire consequences that can stem from this policy. A degree of stability in the home market is essential for profitable operations, without which there is no incentive to invest in modern plant. Successive governments over the last twenty years have offended in this respect, and many firms have gone under during these years through no fault of their own but simply because they have brought new capacity into operation just when the government of the day has decided to introduce a harsh economic squeeze. A government decision to clobber the industry takes a matter of days: financing, designing, building and bringing modern plant into production takes a matter of years.

It is high time the industry had a fair deal from the government now it has shown that it can contribute to the UK's vital export effort.

teletopics

TRADE SHOWS REPORT

The most significant technical aspect of this year's radio and TV trade shows was the increasing number of new models fitted with the various types of in-line gun, slotted shadowmask tubes now becoming available. The Japanese setmakers are going over to them fast, the Mitsubishi SSS (see our December 1974 issue, pages 68-9), Matsushita (National Panasonic) Quitrix and Toshiba RIS tubes being featured in a number of their latest sets. This is not surprising really, since the Japanese setmakers tend to concentrate on the smaller screen sizes and it is at this end of the range of tube sizes that the initial production of in-line gun c.r.t.s is taking place. Amongst the UK setmakers, Thorn have now introduced models fitted with the PIL tube (9000 chassis). This chassis was first shown last year but has only recently gone into full production. Models fitted with it include the Ferguson 3722 and Marconiphone 4722. Nordmende also showed a 20in model fitted with the PIL tube and Korting have gone a stage further, with a complete range of models – 16, 20, 22 and 26in – featuring this tube. The Philips/Mullard 20AX tube has not been seen so far in sets produced on this side of the channel, though we understand that it is being used in a few new chassis now in production on the continent.

An interesting technical innovation is the various monitoring devices introduced by several continental setmakers to provide rapid fault diagnosis in particular chassis. The fault indication checkers produced by Grundig and Korting make use of light-emitting diodes to show up the presence of fault conditions: the failure of one or more of the l.e.d.s to light, or a substantial deviation from the normal intensity of illumination, indicates either an incorrect supply voltage or absence of signal at a particular point in the set. The Nordmende fault diagnosis checker consists of a meter which monitors critical voltages around the chassis. The testers mentioned so far connect to a special outlet socket on the chassis. A rather more complicated system has been devised by Telefunken. This consists of a number of templates for the various printed boards in their chassis: each template is colour coded and when used with a meter enables faults to be rapidly traced.

All this may help towards the aim of speedy, economic fault finding, but we tend to have our reservations. After all, TV sets themselves give a very good indication of what ails them, and the simple use of a meter in nine cases out of ten enables the fault to be tracked down. Where a set uses novel circuitry however, with unusual power supply arrangements and lots of trips and safety mechanisms, such testers could well save a lot of unnecessary head-scratching: provided the user has carefully studied the often elaborate instructions that accompany them!

A number of the latest models from UK manufacturers feature a new programme selector switch mechanism. Terms used by various setmakers in their literature include mini-throw programme selectors, pressure-sensitive panels and micro-touch programme selection. To operate the switches, no more pressure is required than when placing the finger on a touch-sensitive arrangement, but the electronic complexity of the latter approach is avoided. The switch movement is only about $\frac{1}{32}$in but the action is very positive. Models in the Pye, Ekco, GEC and ITT ranges use this new type of programme selector switch.

A number of new sets have been introduced by Pye – with equivalents in the wholesale Ekco range. The 22in Pye Model CT222/Ekco Model CT822 is fitted with a new chassis, the 725, which is derived from the 731 110° chassis: it uses the same signal and power supply panels, but since a 90° tube is used the line and field timebase and convergence panels are different. The field timebase panels can be interchanged however simply by altering the values of three components. These and several other new sets in the Pye/Ekco range are fitted with the programme selector mechanism mentioned in the previous paragraph. The Pye Group's chassis numbering is getting rather complex incidentally: it seems that a new chassis number is given with each change in the tuning arrangements – resulting in almost as many chassis numbers as models.

Philips have introduced three 26in 110° models (553, 554 and 555) fitted with their new G9 chassis. The chassis has been developed from the well known G8: it shares the same signal panel as the latest version of the G8, but incorporates Mullard Phase II 110° timebase/convergence/pincushion distortion correction circuitry (for a description of most of this see our October 1973 and November 1974 issues, pages 536-9 and 10-3 respectively).

A surprise was presented by Dynatron – a 26in colour set combined with a videocassette recorder, in a Queen Anne style walnut cabinet. Basically this is a combination of the Pye group's 110° colour chassis and the Philips VCR. The model is the Sandringham CTV25VCR and the recommended retail price is £1,672.41.

ITT announced that they will be reintroducing the name RGD as their wholesale brand. The number of times this venerable name – which started out as Radiogramophone Developments, remember ? – has come and gone over the years leaves us somewhat agog.

Along with the sets fitted with their new colour chassis, the Thorn group were showing a new range of mains/battery monochrome portables. They were also demonstrating Ceefax/Oracle reception. The latest models from Alba continue to be fitted with Thorn chassis.

Nordmende demonstrated their Colourvision CCS system for the first time in the UK. This product employs an electronic film scanner to enable Super-8mm cine film cassettes to be viewed on a TV set – the signal is fed in via the aerial socket. No price has been decided so far for this equipment but it is expected to be close to that of a VCR.

All in all despite the difficult economic background it is clear that technical development in domestic TV is not standing still. We seem in fact to be at something of an interim stage, awaiting the final takeover of the colour market by in-line gun c.r.t.s as these are developed in all sizes and production is stepped up.

Pye's commercial training manager Don Pinchbeck has estimated that sales of colour TV sets in the UK this year will top 1·7 million, with sales of monochrome sets at three-quarters of a million. This would compare with 2·2m and 821,000 respectively in 1974 and 2·775m and 1·412m respectively in the record year of 1973. We shall see: contacts in the trade say that set disposals have virtually dried up following the April pre-VAT increase spending spree.

MORE RELAY STATIONS OPEN

The following relay transmitters are now in operation:
Milburn Muir (Strathclyde) BBC-1 channel 39, ITV channel 42 (Scottish Television programmes), BBC-2 channel 52. Receiving aerial group B.
Oakenhead (Lancashire) ITV channel 41 (Granada Television programmes), BBC-2 channel 44, BBC-1 channel 51. Receiving aerial group B.
Peebles (Borders, Scotland) BBC-1 channel 22, ITV channel 25 (Border Television programmes), BBC-2 channel 28. Receiving aerial group A.
Porth (Glamorgan) BBC-Wales channel 40, BBC-2 channel 46. Receiving aerial group B.
Shatton Edge (Derbyshire) ITV channel 48 (Yorkshire Television programmes), BBC-1 channel 52, BBC-2 channel 58. Receiving aerial group C/D.
Stroud (Gloucestershire) ITV channel 42 (HTV West programmes), BBC-2 channel 45, BBC-1 channel 48. Receiving aerial group B.

All these relay transmissions are vertically polarised.

THORN 4000 CHASSIS

Our brief note on the 4000 chassis when commenting (see June *Teletopics*) on the latest Thorn colour chassis contained an error which we hasten to correct. The fact is that in our rather hasty look at the circuit diagram we described the line output transistor as a BU126, failing to observe that in fact there are separate line output (BU208 transistor) and e.h.t. generator (BU126 transistor) stages. Since the chassis employs yet another approach to line output/e.h.t. generation it is worth a close look. The system used is shown in simplified form in Fig. 1. The chassis is based around a 26in, 110° deflection delta-gun shadowmask tube, and a toroidal scanning yoke is used. The line coils have an inductance of 1·25mH, a d.c. resistance of 1·7Ω and require approximately 6A peak-peak for full deflection at 25kV e.h.t. Since the pulse voltage between the line and field coils on the yoke must not exceed 700V, a balanced line output stage is used: the primary winding of the line output transformer T303 is split between the collector and emitter circuits of the line output transistor VT305 and in consequence instead of a 1·2kV flyback pulse a 600V positive pulse appears at VT305 collector and a 600V negative pulse appears at its emitter during the flyback period. The balanced arrangement also helps minimise electromagnetic radiation from the deflection assembly. The shift circuit produces a d.c. component which flows through the coils and can be varied to provide horizontal picture displacement.

A relatively simple (i.e. none of your diode modulators etc.) EW pincushion distortion correction system is used. Briefly, field frequency parabolic and sawtooth waveforms are mixed, amplified and applied to the base of VT306 which is in series with the line output stage, on the chassis side. VT306 is a power device of course, carrying the line output stage current. In effect VT306 is a variable impedance in series with the line output stage: it passes maximum current at the centre of the field scan and proportionally less current at the beginning and end of the field, so that the width increases at the centre and is reduced at the top and bottom of the raster. Since VT306 is driven by a primarily parabolic waveform the width variation is progressive from top to centre and from centre to bottom of the picture, compensating for the tube's EW pincushion distortion characteristic. The width control is incorporated in the preamplifier circuit.

Separate secondary windings on the driver transformer T302 drive the line output transistor VT305 and the e.h.t. output transistor VT307. This latter device is a fast turn-off transistor which can pass currents of 3A and operate with up to 750V

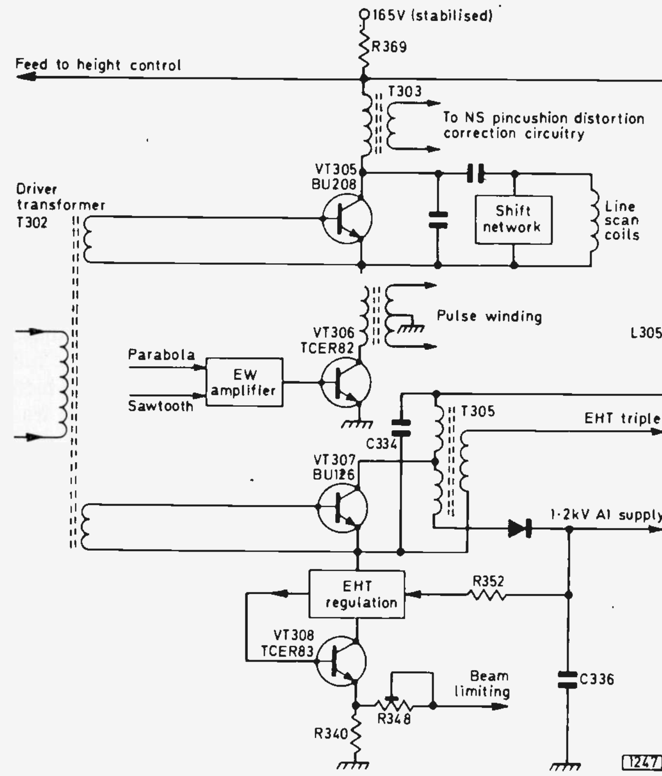


Fig. 1: Simplified circuit of the line output and e.h.t. generator stages used in the Thorn 4000 110° colour chassis. Both are driven from the same driver transformer T302, and being fed from a common resistor (R369) the width and e.h.t., also the height, track together. VT306 returns the line output stage to chassis and, being driven by a field frequency parabolic waveform, provides EW (side-to-side) pincushion distortion correction, i.e. it modulates the line output at field frequency. The width control (not shown) sets the bias applied to the d.c.-coupled EW amplifier. The voltage across C336 is fed via R352 to the e.h.t. regulation circuit which also regulates the width due to the voltage developed across the common feed resistor R369.

between its collector and emitter. The e.h.t. transformer T305 and the line output transformer T303 are fed from the h.t. line via a common resistor R369. This provides automatic width correction: if the e.h.t. voltage falls due to increased loading, VT307 will be conducting more heavily and the voltage across R369 will increase, reducing the supply to the line output stage so that the width decreases. Since the height control is also fed from R369, the height will track with the width and the e.h.t. L305 and C334 filter the supply to the e.h.t. generator stage. A 1·2kV supply for the c.r.t. first anodes is also obtained from the e.h.t. generator stage. VT308 acts as a variable impedance in series with VT307. If the c.r.t. first anode supply increases, due to increased flyback pulses across T305, feedback via R352 and the regulator circuit reduces the conduction of VT308 and vice versa, thus stabilising the e.h.t. Since the voltage across R340 is proportional to the e.h.t. it is taken via the preset control R348 to the luminance/chrominance amplifier i.c. to provide beam current limiting.

All the convergence controls – both static and dynamic – are housed, along with the convergence waveform shaping components, in a hand-held unit which can be unclipped from the side of the chassis frame to enable adjustments to be carried out from the front of the receiver. This, together with the fact that the function of each control is indicated pictorially, makes convergence adjustments a relatively simple matter. As this implies, static convergence adjustments are carried out electronically rather than by means of permanent magnets. Thick-film resistor bridge networks are used to adjust the static convergence control currents: two arms of each bridge consist of a specially designed thick-film potentiometer which has a low-resistance, high-wattage rating at the track ends, tapering to a high-resistance, low-wattage section at the centre. With the slider at the centre the bridge is balanced and no current flows via the slider to the static convergence coil: as the slider is moved away from track centre increased current flows through the coil.

VIDEO DEVELOPMENTS

Two new videodisc systems were on show at the ninth Montreux International Television Symposium and Technical Exhibition (a report on this will appear in our next issue). The videodisc system shown by Bosch Fernseh is designed to give results equal to those obtained using a broadcast standard videotape recorder: the full 5MHz bandwidth signal is recorded on a rigid Perspex disc which is optically scanned by a laser beam. The other disc system was shown by Thomson-CSF. Apart from Teldec, which has now been released on the German market, there are now four videodisc systems under development – Philips, RCA, Bosch Fernseh and Thomson-CSF. These latter four all use a laser to scan the disc.

A new videocassette system, which is already being produced and sold in Japan, was shown at Montreux by Sony. The main disadvantage of videocassette systems as opposed to videodisc systems is the high cost of the videotape itself. Sony's new system has been developed to reduce the disparity by getting more on to the tape. A relatively low tape speed – 1·57in/sec – is used, as a result of which a 494ft, ½in tape gives an hour's playing time. This has been made possible by using a new helical scanning mechanism which produces very narrow recorded tracks, the special heads being able to record and play back very short wavelength signals. A combined VCR plus 18in Trinitron colour receiver console with timing switch sells at about £675 in Japan: a one hour cassette costs £6.75 while a half-hour cassette costs £4.50.

HOW MANY SERVICE ENGINEERS?

There are no official figures apparently for the number of radio and TV service engineers in the UK, but after some research S. Gaunt of Wigfalls has come up with an estimate that there are at least 30-40,000. The close correlation between the estimated number of service engineers on various occasions and the circulation of this magazine has never ceased to intrigue us. S. Gaunt suggests that some 600 new recruits a year are required to take care of business expansion and the inevitable wastage. These figures were presented to the industry's "Train for Tomorrow" committee, which expressed reservations about the length (four years) of the present City and Guilds course. Members of the committee felt that the course is out of touch with the present technical situation in the industry and also lacks interest. As a result there is a high fall-out amongst trainees and apprentices. Our own feeling is that anyone really interested should be able to pick up the required technical knowledge in half that time at the most, while expecting a bright youngster to keep his nose to a rather dull grindstone for four years is just asking him to chuck it in. This is a subject we'd welcome readers' views on however.

NEW TV IC

SGS-ATES have announced the availability of an interesting new TV i.c., the TDA1270, which provides a complete field timebase – oscillator, ramp generator and output stage. For large-screen colour TV sets the i.c. can be used to drive a low-cost complementary-symmetry transistor output stage. See Fig. 2.

NEW APPROACH TO TV FILTER DESIGN

Mullard Research Laboratories have announced the results of research into a new approach to the design of tuned circuits for TV receivers, though they emphasise that the devices produced so far are purely experimental. The basic idea is that if the signal gain required can be obtained by using one or two i.c.s it would be very convenient to reduce the tuned circuits to the same dimensions. What is needed is some means of simulating inductance. This can be done by using gyrator circuits which in combination with *pn*-junction capacitors provide integrated tuned circuits. MRL have succeeded in producing resonators with Q factors of up to 30 and trap circuits with a rejection of better than 40dB. Each resonator employs fifteen transistors on a chip area of roughly one square millimetre. The devices produced by MRL represent fully integrated inductance, at 4·43MHz and 6MHz, and have been successfully employed in TV receiver sound and chrominance selectivity circuits. The latest experimental arrangement combines five resonators on a single chip to provide a filter able to separate the luminance, chrominance and intercarrier sound signals. Tuning is achieved by varying the bias applied to the integrated junction capacitors. As a result of the close matching of the components on the chip only a single tuning adjustment is required.

It looks as if we can expect interesting developments in this area over the next few years. Mullard have also been working for some time on acoustic-wave bandpass filters for use in i.f. strips.

CONGRATULATIONS THORN

Congratulations are certainly due to Thorn for the success they have achieved over the last four years with their monochrome portables. Sales have risen steadily, from 38,000 in 1971 to over 200,000 in 1974. The important point however is that 1974 saw Thorn very comfortably exceeding Japanese imports (130,000) in this section of the market.

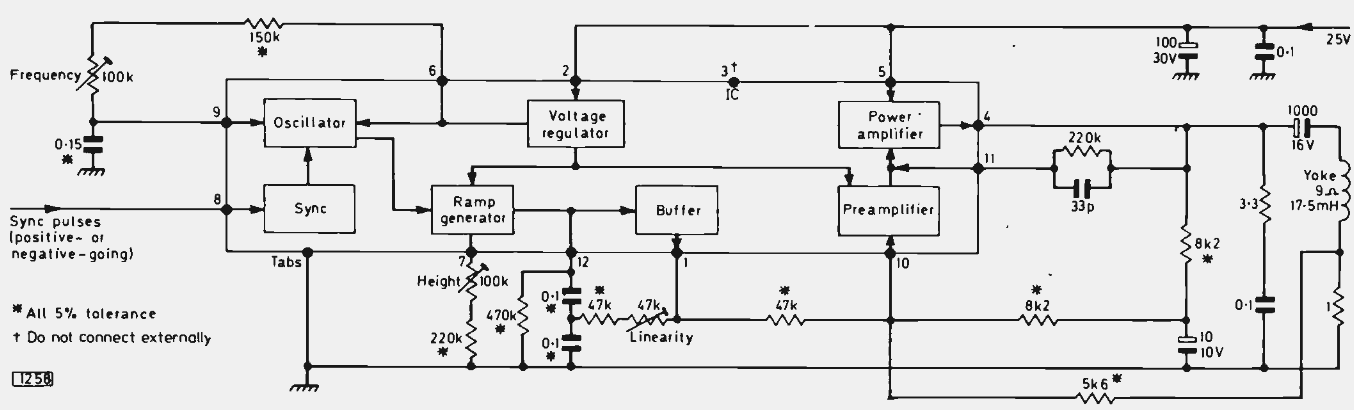


Fig. 2: Block diagram of the TDA1270 field timebase integrated circuit, together with external circuit suggested by SGS-ATES for use with 12-17in (110°, 20mm neck) monochrome TV sets. The maximum peak-to-peak scan current is 0·9A, total TDA1270 power dissipation 2·4W and supply current 110mA with this circuit. The i.c. and its associated components can be mounted on a small printed board approximately 3 x 4in. In this application, the i.c.'s tabs should be connected to a heatsink as well as to the board's copper earth section – which must be connected to the set's chassis. For use in large-screen colour sets the TDA1270 can be employed to drive a separate discrete transistor output stage.

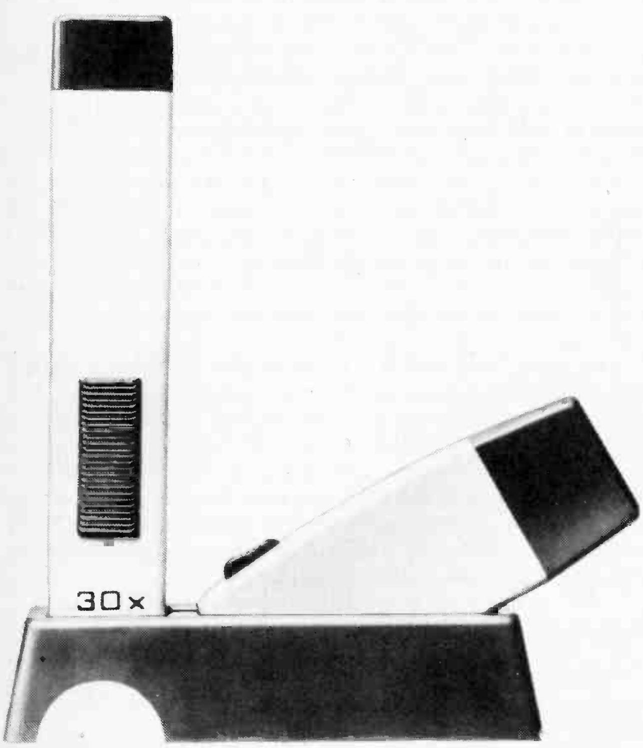
LINE SCAN

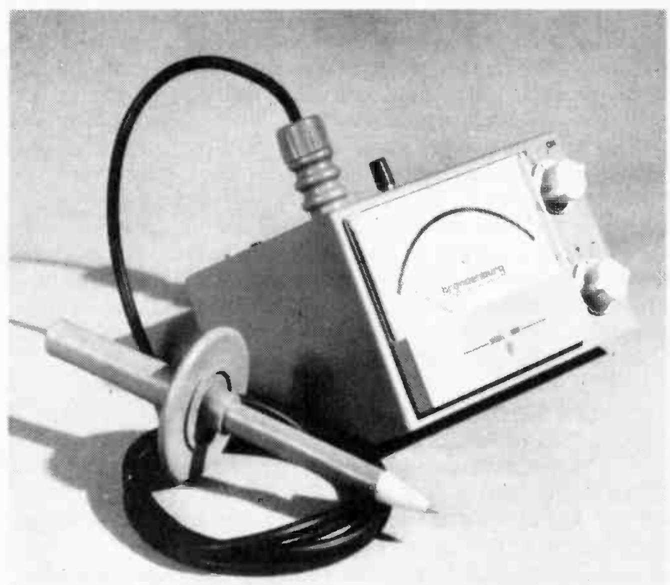
NEW PRODUCTS REVIEW

A new compact microscope recently introduced by Northgate Instruments Limited is designed especially for television colour spot testing by TV field service engineers, as well as by workshop and manufacturers staff.

This microscope has a magnification of 30X, and features high clarity optics and easy slide-action focusing for precise definition. The field of view can be lit by a built-in battery powered illuminator, and the unit clips firmly together to ensure rigidity when used on a vertical surface.

The instrument costs £10·15 including 8% VAT and is available by post from Northgate Instruments Limited, 19 London Road, Gloucester, from whom further details may also be obtained.





BRANDENBURG have recently announced an improved version of their Model 88M high-voltage meter. This is a rugged benchtop instrument designed for measurements of e.h.t. voltages up to 30kV, offering significant advantages in performance and price over multimeters and electrostatic meters for routine tests on c.r.t. displays during servicing.

This instrument uses a battery-powered solid-state amplifier to reduce the loading on the circuit under test to less than 1μA at full scale deflection. Readout is on a moving coil meter with a linear mirror scale. Switch selection of positive and negative polarity and a battery check facility is provided.

A high-voltage probe (pictured here with the meter) is available as an accessory.

Price of the instrument is £75·60 and of the h.v. probe £5·40 (including 8% VAT). Further details are available from: Brandenburg Limited, High-voltage engineering division, 939 London Road, Thornton Heath, Surrey CR4 6JE, telephone 01-689 0441/5.

OVER-VOLTAGE PROTECTION TECHNIQUES

S. GEORGE

SEMICONDUCTOR devices – line output transistors in particular – are much less tolerant of excess voltage conditions than valves are. A feature generally found in solid-state TV chassis therefore is an over-voltage protection circuit. This is particularly important with stabilised power supplies since a fault in the stabilising circuit can result in the h.t. voltage rising to an excessive value. The e.h.t. will also rise due to the higher amplitude flyback pulse. The over-voltage protection arrangements in use are many and varied: the purpose of this article is to survey some of the arrangements commonly employed.

One of the first and still widely used techniques is to short-circuit the h.t. supply in the event of the h.t. voltage rising excessively. This results in the mains fuse or cut-out going open-circuit to protect the set against the excessive h.t. voltage condition. Thyristors and glow-switches are commonly used to short-circuit the h.t. line.

Crowbar Circuits

Two thyristor "crowbar" circuits are shown in Fig. 1. That shown in Fig. 1(a) is used in the Thorn 3000/3500 chassis. The correct h.t. rail voltage, stabilised by the transistor chopper circuit, is 58-65V. The 72V zener diode W617 is thus normally non-conducting and there is no voltage across R626 therefore. Should a fault result in the h.t. line rising above 72V, W617 will conduct and the voltage across R626 will be applied via R615 to the gate of the crowbar thyristor W621. This will then conduct and short-circuit the input to the chopper. In consequence the cut-out operates or the mains fuse (earlier versions) blows. C618 acts as a short-circuit for brief h.t. rises due to c.r.t. flashovers, preventing the crowbar operating under these conditions. The arrangement shown in Fig. 1(b) is used in the Pye group's 731 110° colour chassis. If the h.t. voltage rises excessively the voltage at the junction of R878/RV879 will rise to the breakover voltage of the diac D881. This will consequently conduct and the gate of the crowbar thyristor D884 will rise sufficiently above chassis potential for it to conduct, short-circuiting the h.t. line and blowing the mains fuse.

Glow-switches operate on the same principle but do not require any additional circuitry to operate them. In the Philips 320 monochrome chassis and the Pye 713 colour chassis one of these devices connected in series with a current limiting resistor is incorporated across the stabilised h.t. line. The glow-switch has a striking voltage somewhat above the normal h.t. line voltage. If a fault results in the h.t. line rising to an excessive voltage the neon gas in the glow switch ionises and the heat operates bimetallic strip contacts. Again, the mains fuse blows.

GEC C2110 Series

Rather than using a crowbar to remove the mains supply the set may be made inoperative in other ways. One of the simplest approaches is that used in the GEC C2110 series of colour receivers. In this a small 47V zener diode is connected across the l.t. supplies, which are obtained from the line output stage. The circuit is shown in Fig. 2. There are three l.t. rails, at 40V, 24V and 12V, the latter two being dropped from the 40V rail. The 40V rail reservoir capacitor C601 charges as a result of the BU108 line output transistor and the scan rectifier D601 conducting. If the h.t. line voltage rises excessively both these devices will conduct more and the 40V rail voltage will rise. When 47V is reached the 400mW zener diode D51 goes short-circuit, removing all the l.t. supplies and protecting the devices operating from these rails. Since the line oscillator is operated from the 12V rail there will be no drive to the line output stage and the net result will be no sound or raster. Note that unlike a line output valve which draws excessive current in the absence of drive a line output transistor simply switches off under these conditions and is in a perfectly safe condition therefore. The most common cause of D51 going short-circuit however is a defective line output transformer fifth harmonic tuning capacitor (C52).

Rank Circuits

The over-voltage protection circuit used in the RRI 110° colour chassis (Z179) uses a combination of the previous techniques. As Fig. 3 shows, crowbar thyristor 4THY1 will short-circuit the h.t. rail when it conducts. A circuit breaker in the mains input circuit then opens. The set cut-out control 4RV3 is adjusted so that 4THY1 fires in the event of the e.h.t. voltage rising by 25 per cent. During normal operation the voltage produced by the protection rectifier 4D8 is lower than the zener voltage of 4D6. Since 4D6 is non-conducting therefore there is no voltage at the gate of 4THY1. Under excessive h.t./e.h.t. conditions the voltage produced by 4D8 will rise to the zener voltage (27V) of 4D6, which will then conduct and switch on 4THY1. In addition, diode 4D9 causes the circuit to operate in the event of excessive voltage appearing on the l.t. supply. Transients due to c.r.t. flashovers are limited by 4D7/4R34/4C24 so that the crowbar trip does not operate under these conditions.

In the later 18in. RRI Z718 colour chassis the over-voltage trip, a couple of transistors, short-circuits the base of the line driver transistor, removing the raster and the signals since the l.t. supplies are all obtained from the line output stage (see last month). In the 90° single-standard Rank colour chassis the technique used is to render the line oscillator inoperative when the h.t. line rises by 10 per cent. Since this action kills the e.h.t. the symptom is sound but no picture. The circuitry was described in detail in the July 1974 issue of *Television* (see pages 422-3).

Philips G8 Chassis

A totally different approach, giving an entirely different fault symptom, is used in the Philips G8 chassis. The circuit of the stabilised power supply is shown in Fig. 4. It's a conventional controlled thyristor rectifier circuit: C1376 charges via R1373

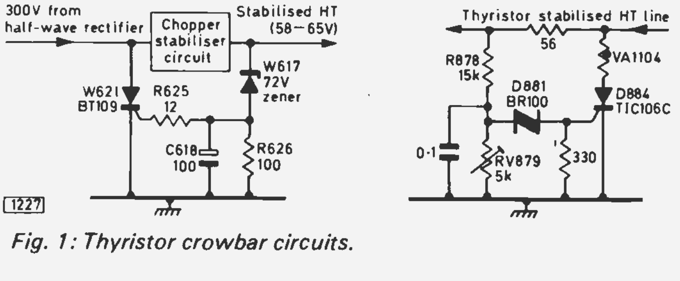


Fig. 1: Thyristor crowbar circuits.

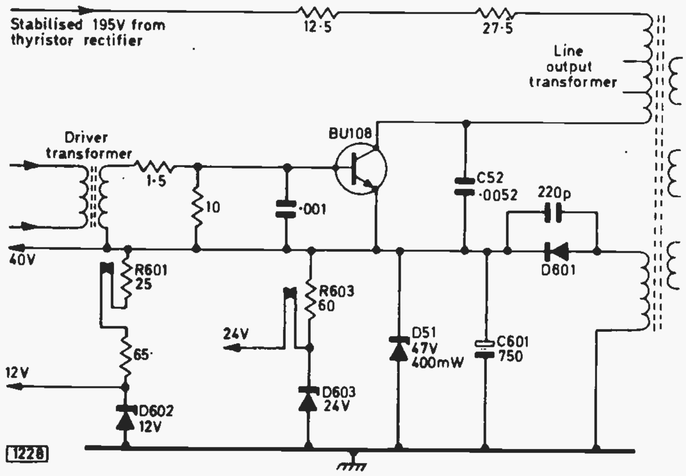


Fig. 2: Protection in the line output stage by means of a smaller zener diode (D51).

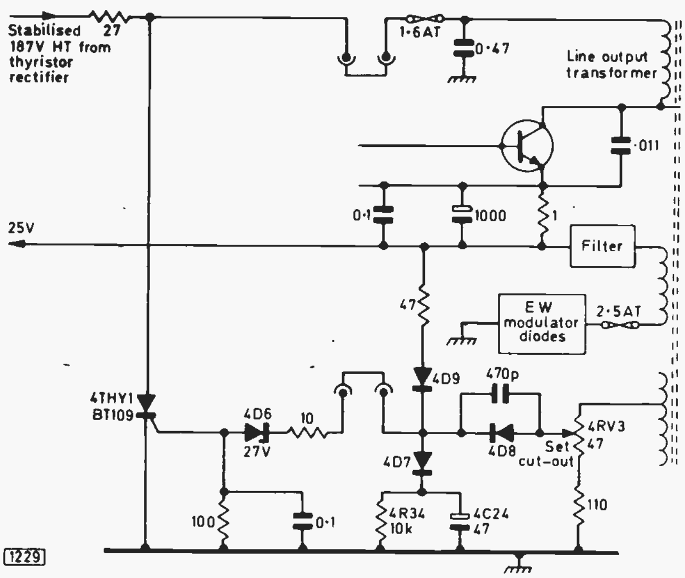


Fig. 3: Crowbar circuit operating in the line output stage.

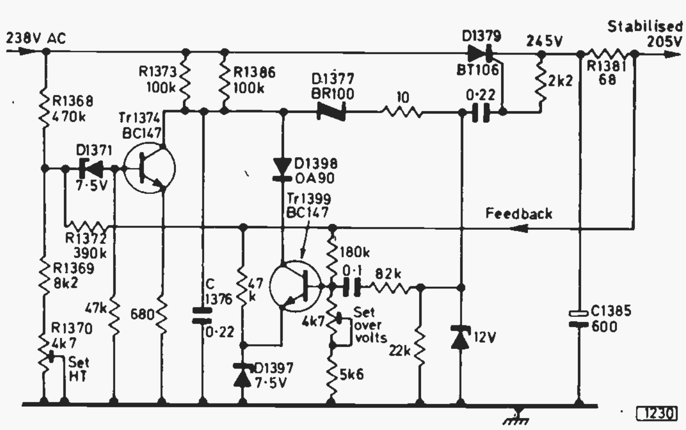


Fig. 4: This over-voltage protection circuit delays the firing of the diac in the thyristor rectifier circuit.

and R1386 until the breakover voltage of diac D1377 is reached, D1377 then conducting and switching on thyristor D1379 until the mains input sinewave drops below the voltage across the reservoir capacitor C1385. The charging of C1376 is controlled by transistor Tr1374 whose conduction is determined by the feedback line via R1372 between the h.t. rail and its base circuit and the amplitude of the a.c. waveform applied to its base via the potential divider network R1368/R1369/R1370.

Over-voltage protection is provided by transistor Tr1399 which is normally cut off. If due to a fault the h.t. line voltage rises excessively Tr1399's base voltage rises and it conducts,

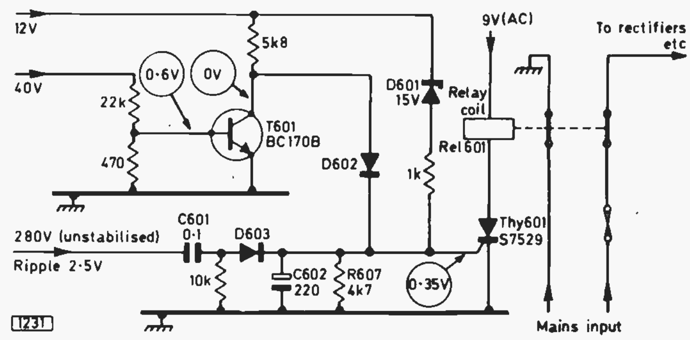


Fig. 5: Comprehensive protection circuit used in the Saba Model CSL2725H.

supplementing the action of Tr1374. When Tr1399 conducts the firing of D1379 is further delayed and the h.t. voltage falls, Tr1399 then cutting off again. If the fault condition persists the process keeps on repeating and the symptom is a very obtrusive picture flutter to call attention to it. Faults which can bring the protection circuit into operation are R1368, D1371 or Tr1374 going open-circuit. If D1379 goes short-circuit the h.t. fuse blows.

Saba 110° Models

Finally, a particularly interesting and comprehensive power supply protection circuit which is used in the Saba 110° colour Model CSL2725H. This uses a thyristor operated relay (see Fig. 5) to switch the set off in the event of excessive current demand from the h.t. rail, failure of the 40V rail which supplies the field timebase, or increase of the 12V l.t. rail to 15V. The chassis employs a thyristor line output stage and an unstabilised h.t. rail.

The base of transistor T601 is fed via a potential divider from the 40V rail. Consequently it is normally fully conductive, its collector voltage is practically zero and D602 is non-conducting. If the 40V rail fails T601 is without forward bias and cuts off, its collector voltage rising to 12V. Consequently D602 conducts, raising the gate voltage of thyristor Thy601 which also conducts, operating relay Rel601 to open the mains on-off switch. Zener diode D601 provides the protection against the 12V rail rising above 15V. Since it is rated at 15V it is normally cut off. Should the 12V rail rise to 15V it will conduct and fire Thy601 so that again the set is automatically switched off.

The excess h.t. current protection circuit is something different again. Diode D603 is fed from the h.t. line via C601: under normal conditions the h.t. ripple results in only a small voltage being developed across the reservoir capacitor C602 and this is insufficient to trigger Thy601. When there is excessive h.t. current demand the h.t. voltage falls and the amplitude of the ripple content increases – since the h.t. reservoir capacitor can no longer retain sufficient charge while the rectifier is non-conductive during the negative excursions of the mains input waveform. The increased ripple results in a rise in the voltage developed across C602 so that Thy601 is triggered on to operate the relay and on-off switch. The triggering level is determined by the values of C602 and R607. Circuits can be designed to sense voltage reduction but it is generally simpler to use a ripple sensor as here. This is excess current not excess voltage protection of course.

Model CSL2725H is fitted with a thin-neck 110° colour c.r.t. Other sets in the Saba 110° range of solid-state models are fitted with thick-neck c.r.t.s. These employ a different field timebase and north-south pincushion distortion correction circuit. The 40V supply for the field output stage is derived from the line output stage and in consequence the 40V section of the power supply circuit is dispensed with and the protection circuit simplified by the omission of T601 and its associated components.

Conclusion

It is as well for those concerned with servicing television sets to be aware of these protection techniques. They could cause considerable confusion to anyone dealing with sets using solid-state chassis with which they are unfamiliar. ■

LARGE-SCREEN TV OSCILLOSCOPE

PROJECT PART 2

D.HALEY C.Eng MIEE

IN last month's article the facilities of the TV oscilloscope were described together with the selection and conversion of a monochrome TV receiver. This month's article deals with the construction of the control unit power supply, front panel layout and drilling, and the Y deflection amplifier.

Power supplies

Before a television receiver can be used for oscilloscope purposes, some means must be found of isolating the chassis from the supply mains. In this project this is accomplished by an isolating transformer fitted in the power supply section of the control unit case.

To power the control unit, two supply rails are derived from a single transformer. These are +55V at 0·3A for the Y amplifier and +15V at 0·3A for the remainder of the circuits. The small +5V supply for the two digital i.c.s is derived from the 15V rail and is included in the 0·3A loading.

The circuit of the power supply is shown in Fig. 2. A 100V 2A bridge rectifier, D1, connected across the 48V tap on the secondary of T2 provides the rectification for both rails. The bridge output is smoothed by C1, R1, C2, to give approximately 55V at 0·3A for the Y-deflection output amplifier. By taking a connection from the 24V tap a supply of about 28V is obtained, using two arms of the bridge in a normal fullwave rectifier circuit. This is smoothed by C3, R2, C4, and regulated to 15V by the simple series regulator circuit Tr1, Tr2. R2 also serves to limit the dissipation of Tr1.

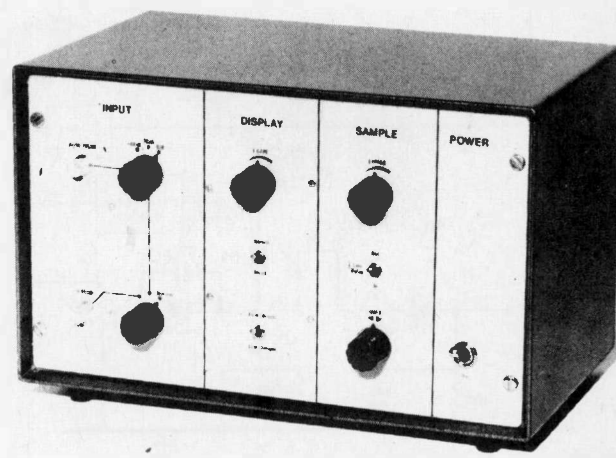
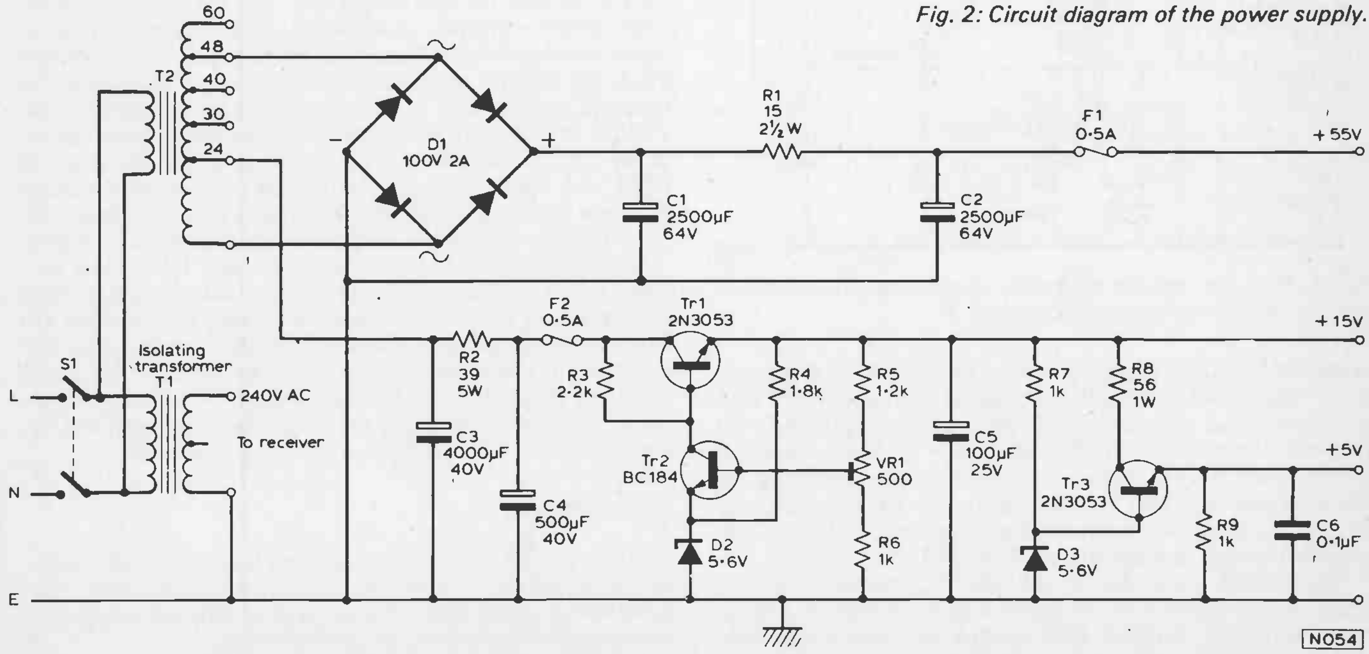
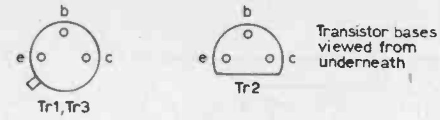


Fig. 2: Circuit diagram of the power supply.





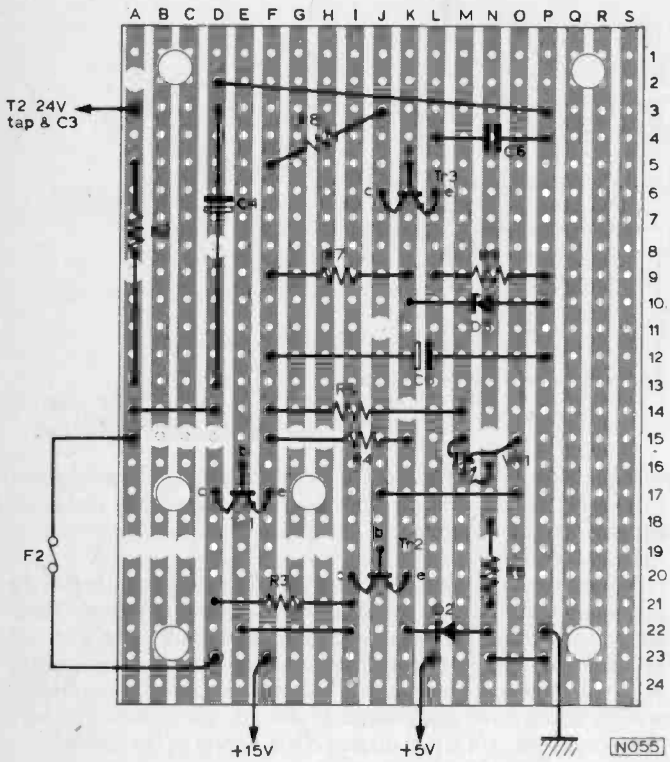


Fig. 3: Layout of the power supply regulator board, viewed from the component side. The copper strips must be broken at the following locations:– A2, 9, 19; B15, 19; C15 19; D8, 15; G15, 19; H15, 19; J11; K14; N15, 19.

The regulating action is as follows. A proportion of the 15V output is applied via the potentiometer network R5, VR1, R6, to the base of transistor Tr2, the emitter of which is held at a constant voltage by a 5·6V zener diode D2. Thus a proportion of any change in the 15V output is amplified by Tr2 to control the series regulating transistor Tr1. Following the regulating action round the loop, if the 15V line increases in voltage, the current in Tr2 increases pulling the base of Tr1 in the negative direction, which tends to reduce the 15V output. The 15V output level is set by adjusting the preset control VR1. The 5V supply is produced from the 15V line through the zener diode-controlled series transistor Tr3. Since the base of this transistor is held at 5·6V by the zener D3, the emitter will remain at about 5V irrespective of any change in load current.

Assembly of P.C.B.

The two mains transformers, bridge rectifier, large electrolytic capacitors and fuses are mounted directly in the box, and the regulating amplifier is built on a 95 x 76 mm (3·75 x 3 in) piece of 3·81 mm (0·15 in) matrix strip board. Cut a piece of board with the printed strips running parallel to the long dimension, and break the track at the points shown in Fig. 3. Enlarge the four holes near the corners to 6BA clearance as shown, for fixing on spacers to the side of the isolating transformer as illustrated in the photograph. Next assemble the components onto the board as shown in the layout Fig. 3. A heat shunt should be used on the transistor and diode leads when soldering.

Connections to and from the board are best made by using veropins or short pieces of thick wire inserted in the appropriate holes and soldered to the copper track. After assembly, fit the two transistor heat sinks to Tr1 and Tr3, a larger clamp-on type is required for Tr1 and a standard clip type for Tr3.

★ Components list

POWER SUPPLY

Capacitors:
C1, C2 2500μF 64V — C5 100μF 25V
C3 4000μF 40V — C6 0·1μF 100V ceramic.
C4 500μF 40V

Resistors: (all ±5%)
R1 15Ω 2·5W W/W — R5 1·2kΩ
R2 39Ω 5W W/W — R6, R7, R9 1kΩ
R3 2·2kΩ — R8 56Ω 1W
R4 1·8kΩ — Unspecified powers ¼W
VR1 500Ω preset, carbon track.

Semiconductors:
D1 100V 2A Silicon bridge
D2, D3 5·6V 400mW Zener diodes
Tr1, Tr3 2N 3053 — Tr2 BC184

Transformers:
T1 Mains isolating 200VA (Douglas MT30AT)
T2 48V 0·5A secondary (Douglas MT121AT) centre-tapped.

Miscellaneous:
S1 DPST mains.* F1, F2 500mA slow-blow with panel-mounting holders.* Heat-sinks for Tr1 (Redpoint 5C) and Tr3 (Redpoint 5F). Stripboard 95 x 76 mm (3·75 x 3 in), 3·81 mm (0·15 in) matrix. Stripboard pins, 6 off. Spacers 6BA x 9·5 mm (0·375 in), 4 off. Instrument case 317 x 190 x 190 mm (12·5 x 7·5 x 7·5 in) approx.

*NOTE. – S1 is mounted on the Front Panel. F1, F2 are mounted on the Rear Panel.

Y AMPLIFIER

Capacitors:
C1 250μF 25V — C3 1000μF 60V
C2 125μF 16V

Resistors: (all ±5%)
R1 1·5kΩ — R8 180Ω
R2 3·3kΩ — R9 – R11 10Ω 3W W/W
R3 3·9kΩ
R4 47Ω — R12 1·5kΩ
R5 4·7kΩ — Unspecified powers ¼W
R6, R7 2·2kΩ

Preset Resistors: (carbon track)
VR1 10kΩ — VR2 680Ω

Transistors:
Tr1, Tr2 BF178 — Tr3, Tr4 2N3055

Miscellaneous:
Stripboard 140 x 50 mm (5·5 x 2 in), 2·54 mm (0·1 in) matrix. Stripboard pins, 10 off. Finned heatsink 100 x 124 x 27 mm (3·9 x 5·5 x 1·1 in) for Tr3/Tr4. TO3 insulating kits for Tr3, Tr4, 2 off. Spacers 4BA x 38 mm (1·5 in).

FRONT PANEL

FUNCTION	DESCRIPTION	UNIT
Y Gain	1kΩ Lin. Potentiometer	Preamp.
Expand	250kΩ Lin. Potentiometer	Sample Pulse Gen.
Shift	1kΩ Lin. Potentiometer	Sample Pulse Gen.
Attenuator	1P 3W Wafer switch	Preamp.
Input Sel.	2P 3W Wafer switch	Preamp.
Normal/Invert	SPDT Min. toggle switch	Preamp.
Field/Line	SPDT Min. toggle switch	Preamp.
½ Line Delay	SPDT Min. toggle switch	Sample P.G.
Power On	DPST Toggle switch	Power Supply
AF/VF Probe	B.N.C. Socket	Preamp.
IF Probe	B.N.C. Socket	I.F. Amp.

NOTE – Front Panel controls also appear in their respective unit circuits and components lists.

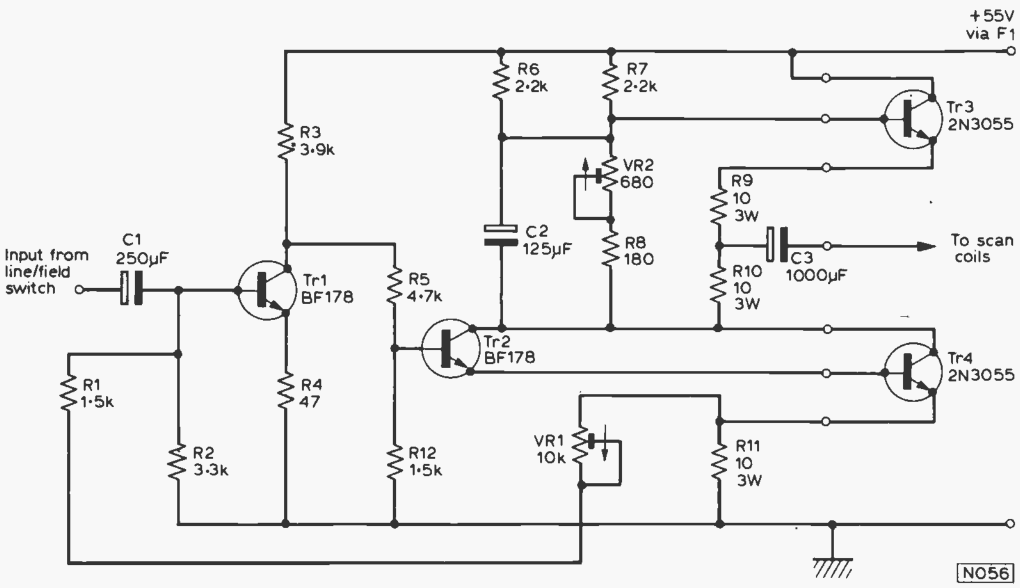


Fig. 4: Circuit of the Y deflection output amplifier.

Testing

The power supply is tested off load with the aid of a voltmeter. Simply check that the isolation transformer is giving 240V a.c. and that each d.c. rail is giving its correct voltage. The 5V rail should be very close to its nominal value. The 15V rail is adjustable and should be set, using VR1, to give precisely 15V. The +55V rail will be 'high' off load and will be of the order of 70V. This is reduced to +55 when loaded fully by the drive circuits.

WARNING – As the 'off load' voltage exceeds the capacitor ratings in the main smoothing circuits, the supply must not be left without a load for any length of time. If fault finding necessitates leaving the supplies switched on, then a load resistor of 180Ω 16W must be connected across the 55V supply. Alternatively 100V working capacitors may be fitted.

The Y Deflection circuits

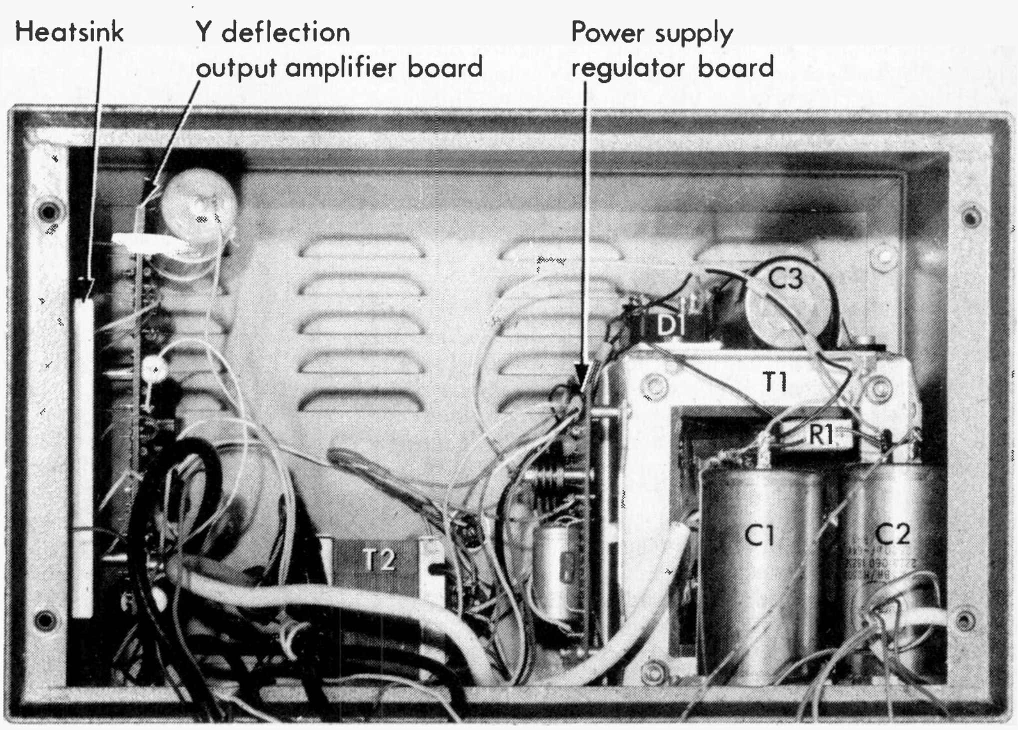
The line coils are used for Y deflection because they have a lower inductance than field coils. Line coils are usually about 6mH. This means that for a given voltage swing across the coils there is a higher rate of change in the current, giving a higher deflection speed. The coils are driven by a push pull circuit working from the 55V supply. The use of field coils reconnected in parallel instead of line coils was considered but discarded because of the complication involved when switching back to normal operation.

The test for this amplifier, described later, involves displaying the sound waveform on the face of the cathode ray tube. These sound waveforms are quite fascinating especially when they are producing multiple waveforms in response to music. Some people may not want to go any further than this because such a display will no doubt have applications in discotheques, clubs and with pop groups wh..e a visual display could appeal to the teenagers.

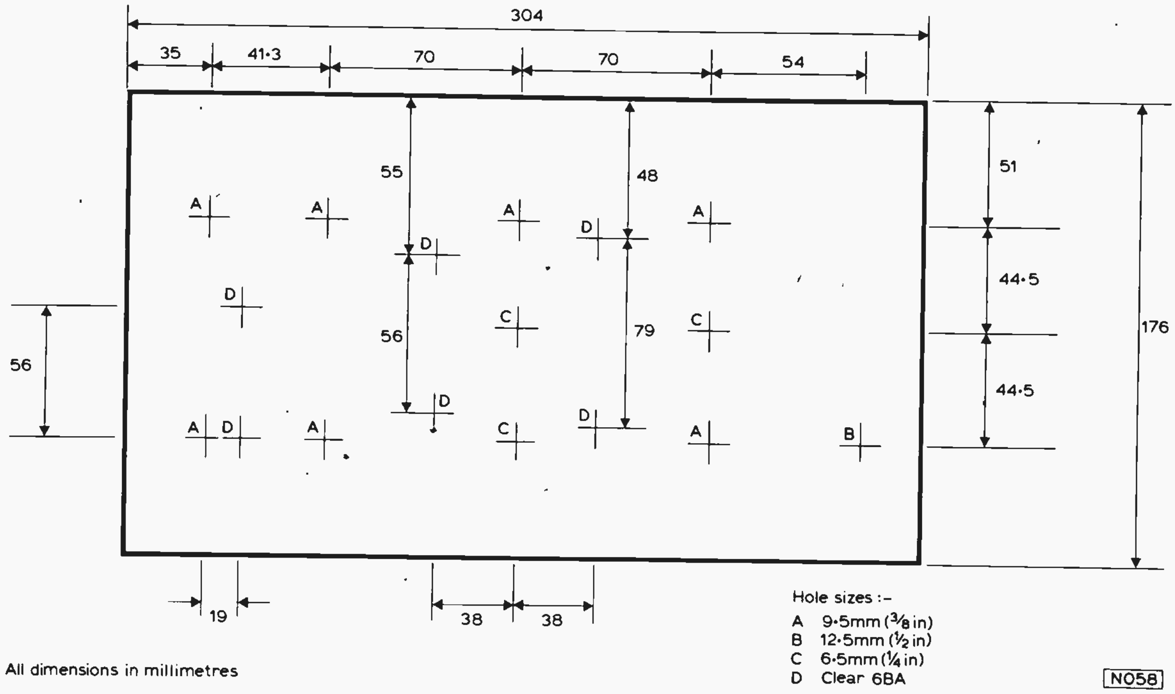
Amplifier

The Y amplifier circuit is shown in Fig. 4. The input signal from the Line/Field switch is applied to amplifier stage Tr1 and emitter follower Tr2, which drives the base of the lower output transistor Tr4. Tr3 and Tr4 form a class A pushpull amplifier capable of delivering ±0·35A peak to peak scan current into the line coils via isolating capacitor C3. Drive for Tr3 is derived from the signal voltage developed across R9 and R10. VR2 adjusts the balance between the two output transistors.

The whole amplifier is d.c. coupled, optimum conditions for maximum signal handling being set by VR1. The no-signal standing current in the output transistors is about 0·25A.



This photograph shows the layout of the power supply (right) and Y deflection output amplifier (left), seen with the front panel removed.



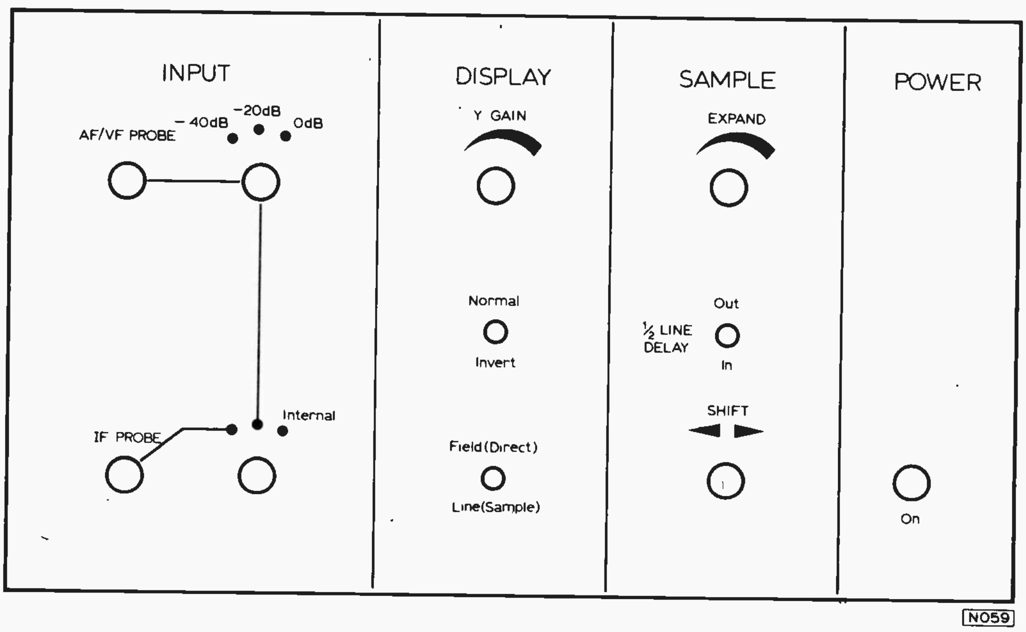


Fig. 5: Front panel. (a) (above) Drilling details. (b) Control markings.

Construction and testing

Most of the Y amplifier is built on a 140 x 50 mm ($5\frac{1}{2}$ x 2 in) piece of 2·54 mm (0·1 in) matrix strip board, with just the exception of the two power transistors, which are mounted on a heatsink bolted to one side of the case. The cases of the power transistors must both be insulated electrically from the heatsink by means of the mica washer and insulating bushes. Check carefully to see that all holes are deburred and the surfaces are clean and free from any matter which might prevent the transistor from bedding down fully to give maximum heat transfer, or even puncture the mica washer and short circuit the collector to chassis. The transistors should be mounted on the underside of the heat sink, with the mica washer between transistor and sink and the insulating bushes on the top. A 6BA solder tag should be mounted on one fixing bolt of each transistor, between the nut and the bush, for connection to the collector. After assembly, a meter check should be made to ensure that the cases of the transistors are insulated from the heatsink.

The rest of the amplifier should be mounted on the piece of strip board using layout and wiring as shown in Fig. 6. The assembled board is mounted on the inside of the box using 38 mm (1·5 in) spacers on the two rear fixing screws of the heat sink, with the connecting tags adjacent to the output transistors.

The bias levels throughout the Y amplifier are set by the two preset potentiometers VR1 and VR2 using a d.c. voltmeter. First switch on and check that the supply to the amplifier is approximately 55V, then adjust VR1 to obtain 2·6V across R11. Next connect the voltmeter between the junction of R9 and R10 and earth, and adjust VR2 to give a reading of half the supply rail voltage. The amplifier is now ready for testing with an a.c. signal.

If a low frequency oscillator is available, connect this to the amplifier input. Alternatively, if no oscillator is available, the receiver can be tuned to a television signal and the sound waveform at the secondary of the loudspeaker transformer used as a test signal. Set the scan changeover switch to the "Oscilloscope" position and switch on. A display of the test signal, sound or sine wave, should be obtained on the c.r.t. face. Adjust the level of the signal until some clipping of the waveform peaks is observed, and if necessary readjust the preset bias control VR1 until the clipping is symmetrical on positive and negative peaks.

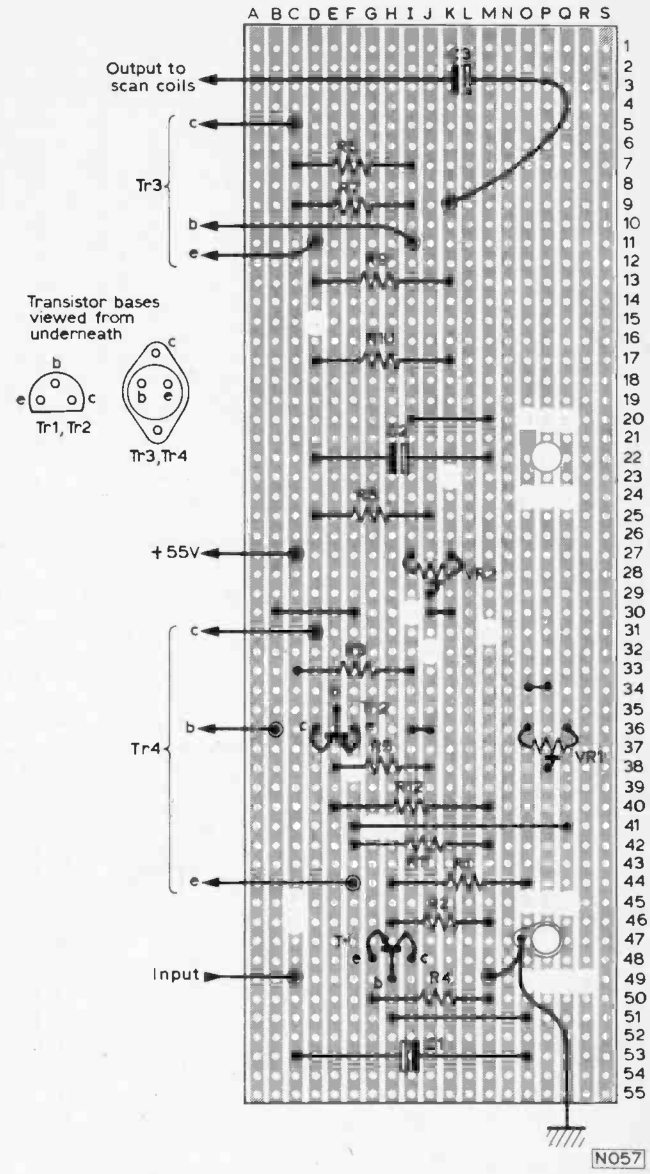


Fig. 6: Layout of the Y deflection amplifier board, viewed from the component side. The copper strips are broken at the following points:– C45, 46; D15; F38; G41; H41; I30; J32; K23; M31; O20, 24, 45, 49; P20, 24, 45, 49; Q20, 24, 45, 49; R49.

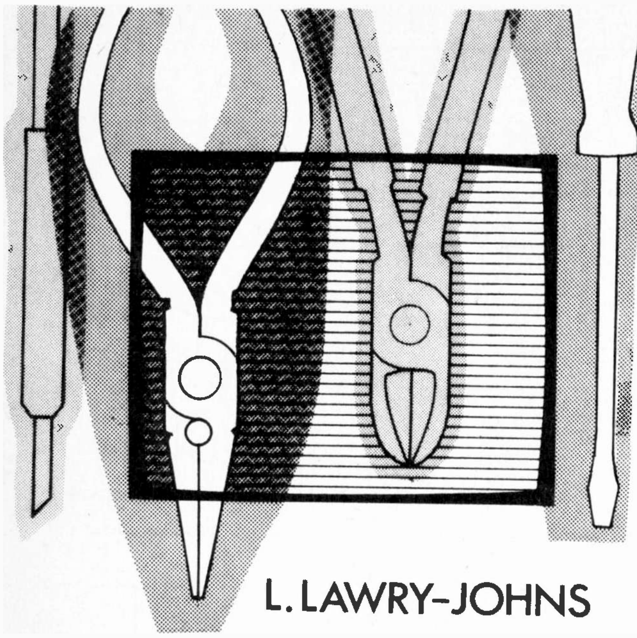
If only a low frequency display, such as the sound waveform across a loudspeaker, is required it only remains to fit a mains switch and input socket as required. If the display is for amusement rather than instruction, for example as a visual display of pop music, it may be preferred to leave the scan coils in their original orientation, giving a vertical display.

Front Panel

A suggested front panel layout and drilling details are given in Fig. 5. The hole sizes given are for the components used on the prototype. The constructor would be well advised to check the hole size requirements of the components he is using before drilling. The control identification is in Letraset transfer lettering, which should be covered with clear varnish for protection.

All the front panel controls and the two probe input sockets can now be mounted on the front panel, with the exception of the input attenuator switch. It is easier to connect up the attenuator components, which are mounted directly on the switch, before the switch is fitted, and this will be dealt with next month. The small holes are for mounting the remaining circuit boards.

In the next part of this series, we shall describe the i.f. preamplifier, the inverting amplifier and the sampling circuits.



SERVICING TELEVISION RECEIVERS

PHILIPS G6 CHASSIS

CONCLUDED

L. LAWRY-JOHNS

Power Supplies

When the main chassis is lowered and one looks down the back of this lot for the first time one's first reaction is to put it back up and join the Foreign Legion. After a time however the mass of electrolytics and wirewound resistors down the bottom can be assigned their separate functions and it will be noticed that the electrolytics are mainly cross connected. Very little actually goes wrong in these regions except for poor earthing of the electrolytics. This causes a horizontal band of light to move slowly down (or is it up?) the screen, with perhaps a slight hum on the sound. A general tighten up of the clamps and earthing tags seems to clear this trouble without the need to replace any of the cans.

The other trouble spot has already been mentioned. This is the 10Ω resistor on the left side supplying the line output stage. Whilst it can go open-circuit on its own account, more often it parts company with its mounting springs due to overheating. This of course directs attention to the right side line output stage.

Should any supply line be absent, a quick check for voltage across each end of each wirewound resistor will reveal which has become open-circuit. It should be appreciated that not all the lines are positive: HT7 is 120V negative.

Audio Circuit

The sound output stage uses a PCL86 valve. This has a habit of suddenly cutting out with a loud crack and just as suddenly coming on again. Tapping the valve may well produce these symptoms so there is no problem here. It is essential however to check the value of the cathode resistor R7293 which should be 180Ω. The valve can pass considerable current which damages the resistor. If this point is ignored there will be further trouble in a short time.

Video Circuits

The colour-difference drive technique used in these receivers means that there is a separate output stage for the luminance signal and three colour-difference output stages. The output from the former is applied to the tube cathodes via the drive controls (these are set to obtain the right white and greys); the latter three outputs are applied to the c.r.t. grids. Thus the mixing process is carried out by the tube itself.

From a picture quality and general brightness/contrast level point of view the luminance output stage is most critical and it is essential for this to give of its best at all times. There is a great deal of difference between the design of the original dual-standard luminance output stage and the later single-standard version. In the original circuit the brightness control varies the potential applied to the screen grid (pin 9) of the valve whereas in later models this potential is fixed and the brightness control operates via the black-level clamp in the control grid circuit. Also, the original circuit uses conventional cathode bias with a 330Ω resistor shunted by a zener whilst later versions have the cathode returned direct to chassis with all the bias applied to the control grid.

When the picture is light and lacking in contrast suspect the PFL200 and, in the original circuit, check the associated

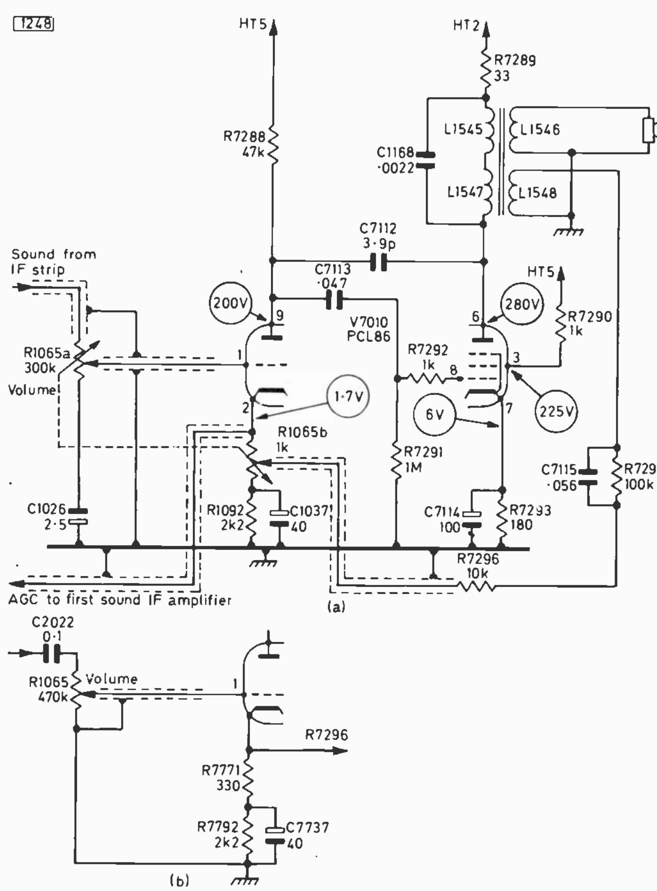


Fig. 7: Audio circuit used in the Philips G6 chassis. (a) Circuit as used in later dual-standard models – in earlier versions a more elaborate feedback circuit with tone control switch was used. (b) Modifications in the single-standard chassis.

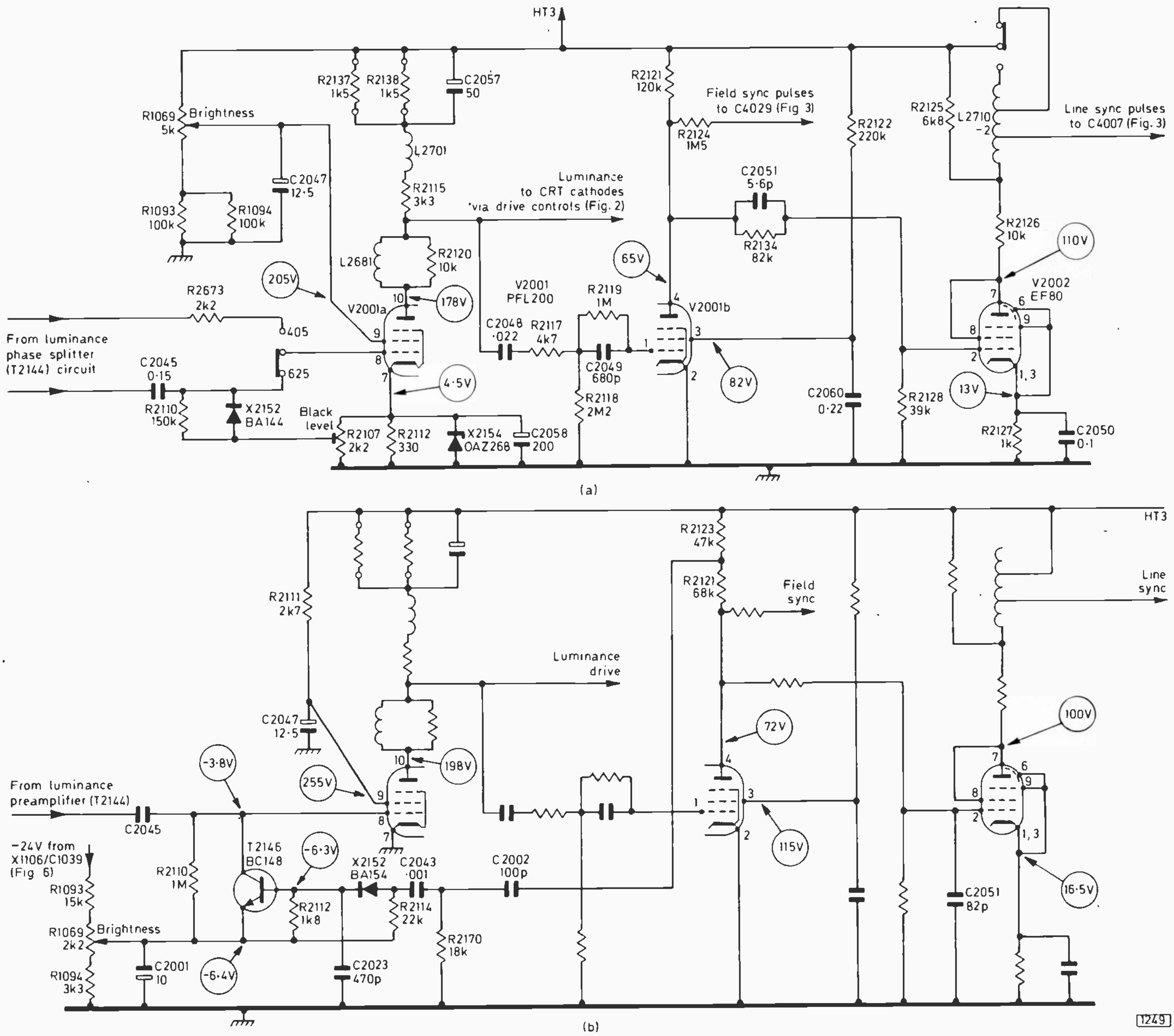


Fig. 8: (a) Luminance output and sync circuits used in the dual-standard chassis. Voltage readings apply to 625-line operation. (b) Modifications to the luminance output and sync circuits in the single-standard chassis.

electrolytics and the cathode components. We mention this fault first because the PFL200 was inclined to run into grid current, thus dropping its anode voltage. When the valve merely loses emission the picture will be very dark with probably only outlines visible. We have not had much trouble with the transistor (later versions) or diode (earlier versions) and so cannot speak from first hand experience of such troubles. Others however seem to have encountered faults due to these components.

Faulty connections to the luminance delay line (L2651) can cause various intermittent disturbances on the picture due to the mismatching introduced in the signal path.

The second half of the PFL200 is used as the sync separator. This section can fail causing total loss of hold in both timebases.

Colour-difference Amplifiers

The three PCF200 valves (V7005-7) function as amplifiers (pentodes) and clamps (triodes), applying the colour information to the tube grids (R–Y, G–Y and B–Y respectively). As the emission of any one valve falls, the picture will assume an overall cast of that colour since the c.r.t. grid voltage will rise due to the smaller voltage drop across the valve's anode load resistor. It pays therefore to ensure that these valves are well up to scratch. On the other hand, should the load resistors of the clamps rise in value (10MΩ resistors are prone to do this) the result will be an absence of this colour. Say R7241 goes high: the voltage at pin 7 of the c.r.t. base will be lower than the correct 62V and the result will be a picture of mainly red plus blue which adds up to magenta.

Incorrect Colours

Most colour problems are very easy to trace merely by taking voltage readings at the c.r.t. base and comparing these to those given in the service information. When this is not to hand, compare the voltages of the three guns: one will normally be found to differ from the other two if the colours are incorrect, thereby giving you the required clue. The cathode voltages (pins 2, 6 and 11) are normally correct, the differences usually being at the first anodes (pins 4, 5 and 13) or the grids (pins 3, 7 and 12). If these voltages read out well or near enough (the differences being accounted for by the grey-scale adjustments) move back to the PCF200 valve bases and check the anode, screen grid and cathode voltages – pins 7 (anode), 8 (screen grid) and 2 (cathode). Whilst the screen grid voltages should be the same (95V) the anode and cathode voltages are not all the same, the G–Y amplifier anode voltage being slightly higher than the other two while its cathode voltage is slightly lower.

The drive for the G–Y amplifier control grid is obtained by mixing measured proportions of the R–Y and B–Y outputs. These are applied via the green amplitude control R7236. The original design had the R–Y and B–Y pentode cathodes coupled by a tint control: in this circuit all three cathodes should read 1V. The addition of a tint control is a dubious advantage and it was omitted in later versions.

Occasionally one encounters intermittent colour faults due to the coupling capacitors in these stages.

The Decoder

The full circuit of the decoder, with an admirable description by Caleb Bradley, appeared in the December 1973 issue, with notes on faults and setting up in the January 1974 issue. This is a complex piece of design work which takes a lot of explanation and space to present: we do not propose to repeat it. Any reader who seriously intends to service these sets should have the service manual for the dual-standard and single-standard versions or the volumes of *Radio and Television Servicing* which contain them. He should also appreciate that the receiver to be worked on may not have an identical layout or circuit to those shown but may be a mixture of the two basic designs.

Fault Location Guide

In the event of suspected trouble in the decoder the Philips G6 *Fault Location Guide* can be consulted. This will unerringly lead to the stage where the fault is, all that then remains to do being to check a limited number of components to ascertain which is causing the trouble. We have used this plan for some years and find it invaluable from every point of view, not the least of which being that it saves the writer thinking too hard, something he doesn't do very often.

Troubles Encountered

Most of the troubles we have encountered consist of valve defects, diode failures, faulty crystals, intermittent preset controls and the occasional changed value resistor. A defective capacitor is very rare (in some makes you go for the capacitors first). Due to the large number of diodes used it is only to be expected that one or more will fail during the lifetime of the set.

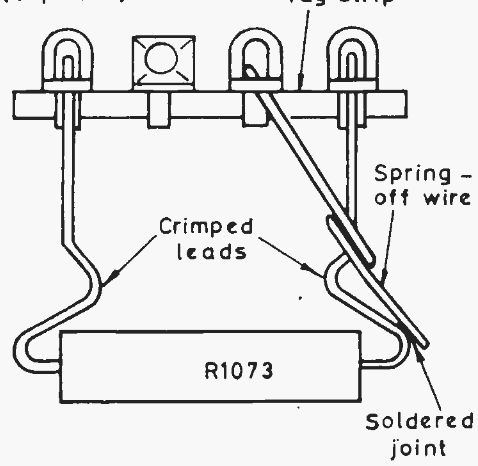


Fig. 9: The spring-resistor assembly R1073/FS1115 which is mounted on a tagstrip near the mains transformer and is included to protect the valves in the line output stage in the event of certain fault conditions. To reconnect, the spring-off wire must be soldered to the outside of the bend in the resistor's leadout wire, using ordinary 60/40 resin-cored solder. If it is necessary to replace either the resistor or the spring-off wire, the new parts must be carefully fitted as shown above. Slip the bent end of the spring-off through the second tag from one end of the strip, then turn it approximately 45° to the strip before soldering it to the outside of the crimped part of the resistor's leadout wire.

A different arrangement is used in earlier models.

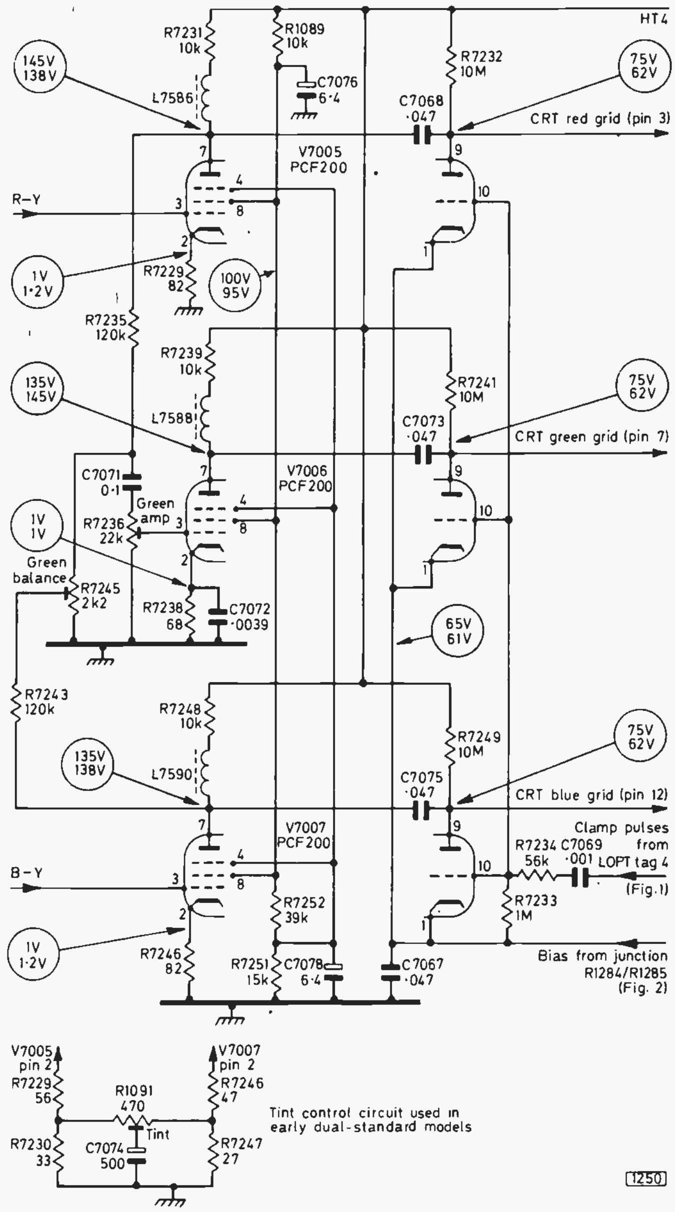


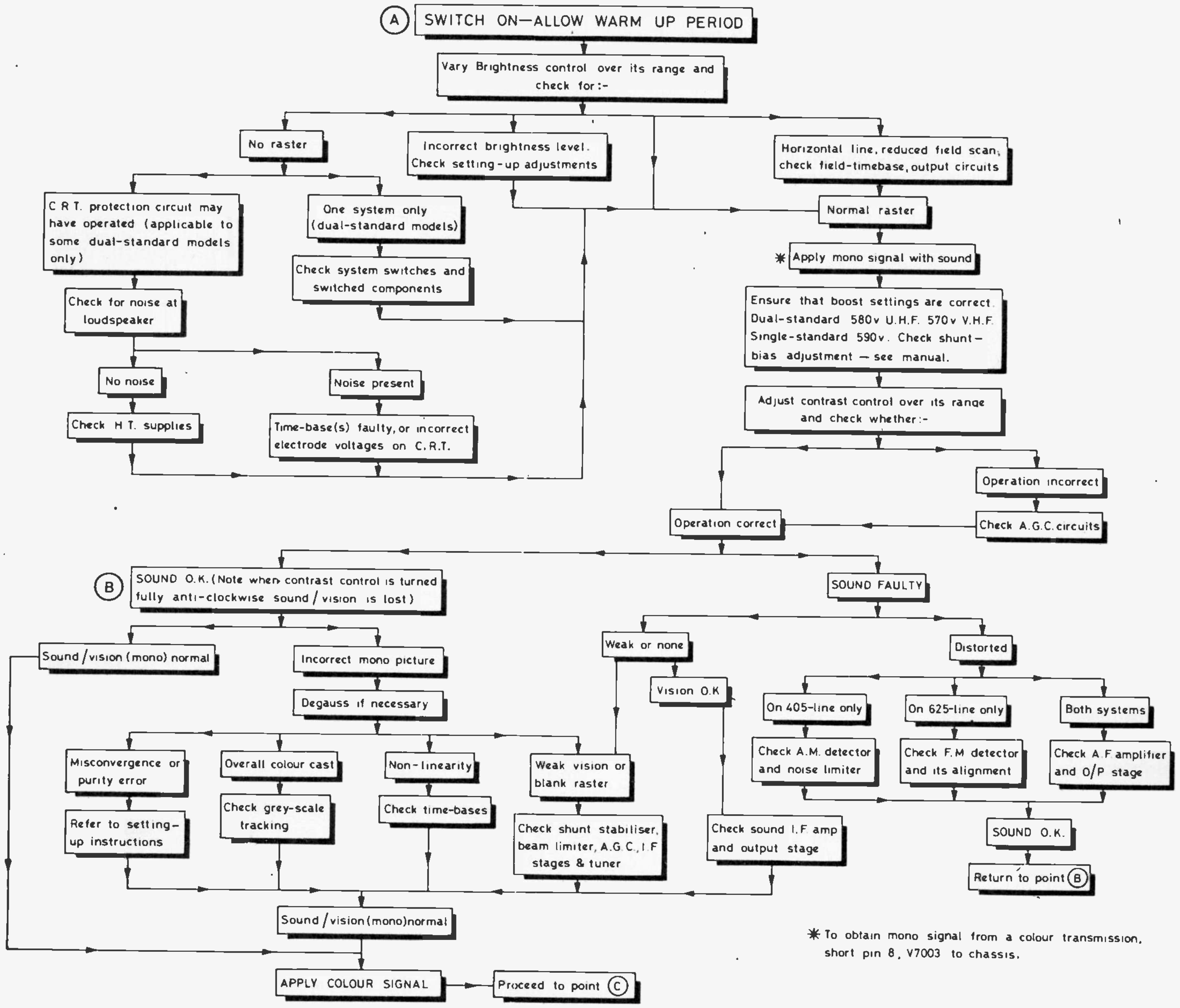
Fig. 10: The colour-difference output stage/clamp circuits. The upper voltages shown apply to the dual-standard chassis (measured on 625 lines), the lower voltages to the single-standard chassis.

Other troubles can be due to poor soldering in the coil lead outs and intermittent connections from the small printed panels in the coil cans to the print on the panel. Both problems necessitate removal of the can assembly and some delicate rewiring or resoldering if the complete unit is not to be replaced. Faults in particular assemblies often show up only when the stage concerned has been disturbed, perhaps for some other reason.

The can which seems to give the most trouble is the burst detector coil assembly (can F) which contains the burst and the a.c.c. (automatic chrominance control) detectors. The colour killer turn-on bias is obtained from the a.c.c. circuit rather than, as is usually the case, the ident stage. Thus lack of output from the burst amplifier V7008 (EF184) will result in no colour while low output from the ident amplifier T7015 (BC107) will not result in no colour but in incorrect PAL bistable switching (i.e. green faces) from time to time. In the latter event T7015's emitter decoupling electrolytic C7093 (16μF) is a suspect.

Although capacitor faults are rare there is one other that occasionally gives trouble. The first chrominance amplifier V7001 (EF183) screen grid decoupler C7025 (0.047μF) can short,

G6 Fault Location Guide



burning out the associated feed resistor R7140 (22kΩ). This robs the valve of screen grid voltage of course and the result is no colour.

Over-riding the Colour Killer

To over-ride the colour killer, connect the junction of R7196/R7198 to chassis. Fortunately faults do not happen very often on this panel, but when they do the work involved can be most tedious.

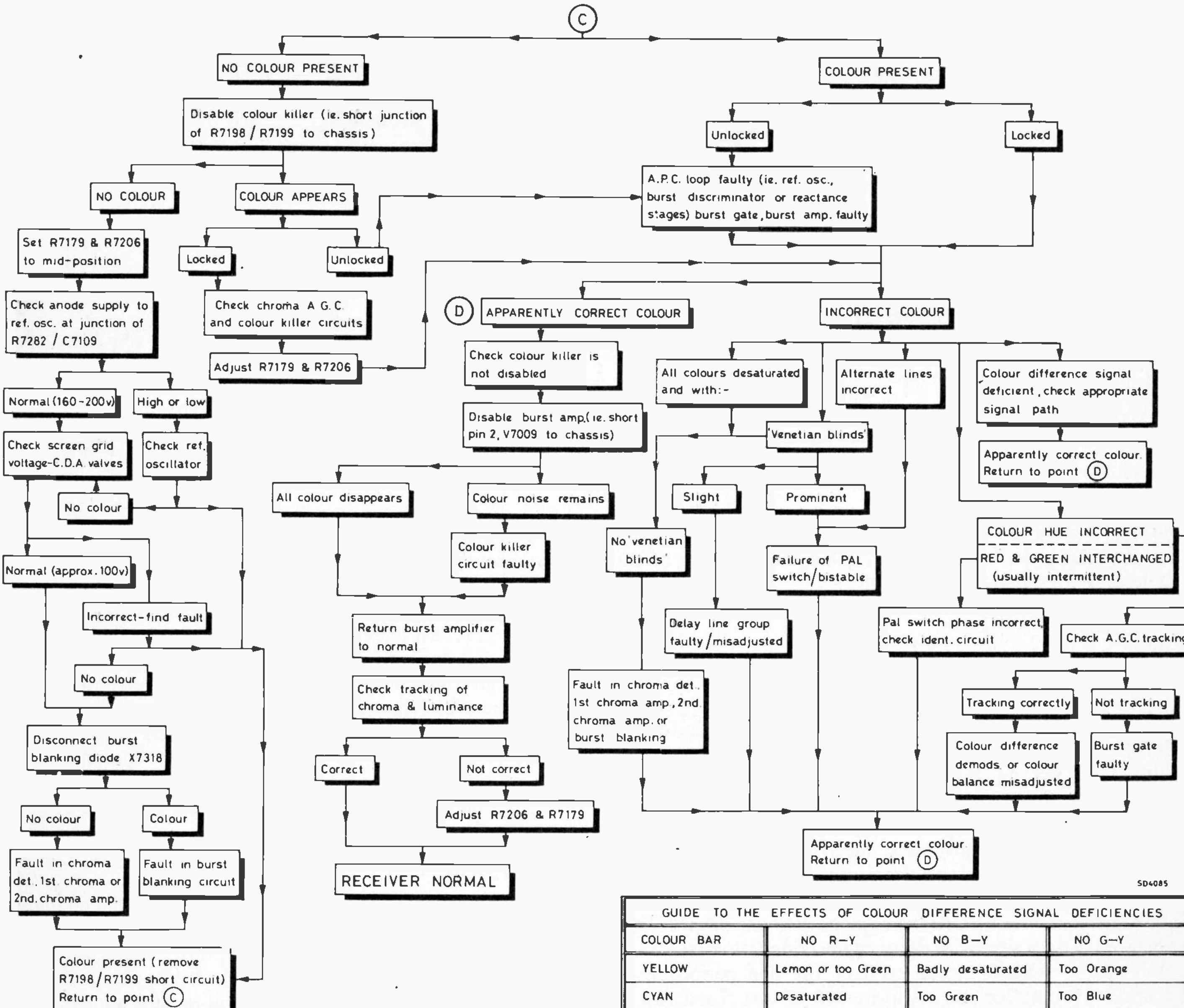
Pitfalls

We were asked recently to service a G6 chassis which we had not sold and had not previously serviced. The owner stated quite firmly that he wanted a quote for a new or reguned tube. We asked him why he thought he needed a new tube. "Because although all the other valves light up, the tube heaters don't" was the answer. Upon opening up we found that this was very nearly so except that the PCC85 (V7003) didn't light up either and also there was no sound. Briefly, the situation was that the mains transformer was out of action, leaving the main series heater line intact and incidentally the high voltage h.t. lines. There was no reading across the primary of the transformer, due to the thermal fuse FS1114 being open-circuit. This little item is inside a plastic housing in the main transformer and was open because of the short across the l.t. supply line caused by a shorted diode. Replacing the diode and repairing the thermal fuse restored normal working. Now this could not have happened (to produce the same symptoms) on the earlier dual-standard versions because a thermal fuse was not fitted in these – the transformer being protected by FS1107 in the mains input only – while V7003 was in the main series heater chain.

Horror Story

This was nothing compared to the horror we had in a short time ago. The set belonged to a friend of our butcher (so we couldn't say no). He had been unable to get it repaired after obtaining it due to a death in the family, or something like that.

After a few checks we found that resistor R1073 was off its spring mount and that this had been caused by a defective PY500. We fitted a nice new PY500 plus a PL509 for good



GUIDE TO THE EFFECTS OF COLOUR DIFFERENCE SIGNAL DEFICIENCIES			
COLOUR BAR	NO R−Y	NO B−Y	NO G−Y
YELLOW	Lemon or too Green	Badly desaturated	Too Orange
CYAN	Desaturated	Too Green	Too Blue
GREEN	Lemon or too Green	Greenish Cyan	Too dark
MAGENTA	Too Blue	Too Red	Desaturated
RED	Too dark	Slightly Magenta	Orange
BLUE	Slightly Magenta	Too dark	Slightly Cyan

measure and hooked up the resistor to its original position. Having restored normal line timebase working we then had to trace a couple of field faults to restore normal height etc, and sort out the system switch. This left us with a red, blue and green monochrome picture! Not to be defeated at this stage, we went through the whole purity and convergence procedure and then set up the grey scale to obtain a reasonable black and white picture. Meanwhile the sound went distorted but this was only a sidetrack as a new PCL86 put that right. No, the point was where was the colour? Ditching the colour killer didn't help so we went down the Philips fault guide, ending up finally on the i.f. panel where we found an 0·02μF capacitor wired smack across the input to chrominance i.f. can E, i.e. from the can side of C2052 to chassis. Removing this capacitor sent the whole i.f. strip into oscillation. A closer examination showed that some pretty frantic work had been carried out in several parts, particularly in the area of can A.

To condense many miserable hours of fruitless endeavour into one sentence we eventually replaced the whole panel and were at last rewarded with a good picture in full colour. The customer was very happy but we have not yet recovered. You may ask what this has to do with pitfalls: not much really perhaps, but we thought you would like to know that we get our share of the rough ones.

Line Output Transformer

Finally, some notes on the line output transformer. As previously mentioned, the set must not be operated with the transformer's screening can removed. All the tappings are externally available, however, at the two ten-way sockets at the side of the transformer can assembly.

It is important that the boost voltage is correct. In the single-standard chassis it should be 590V, in the dual-standard chassis it should be 570V on 405 lines, 600V on 625 lines. Unless the scan coils are faulty, correct boost voltage means that the primary output transformer circuit is operating correctly. Very low boost voltage indicates a heavy load or lack of drive – check the valves first. Roughly correct boost voltage but no raster should direct attention to the c.r.t. base voltages. The boost voltage is set by the line stabilisation control(s) R5040/R5041. This should be done with a monochrome transmission being received, under normal picture conditions. Check the voltage by connecting a high-impedance meter across the boost reservoir capacitor C5013 (line output transformer taps 11 and 12 are available at the lower ten-way socket).

If a fault in the PD500 shunt stabiliser circuit is suspected, check the grid and cathode voltages of this valve – there should be about −15V at the grid, 1·2V at the cathode (set by R5053, see earlier notes on the e.h.t. shunt stabiliser).

CEEFAX/ORACLE

reception techniques

Steve A. MONEY T. Eng. (CEI)

PART 2

BEFORE going on to discuss the actual decoding process it is important that we should examine the structure of the teletext data signals in more detail.

The data signal

Two lines during the field blanking interval of the television signal are used to carry the data signals for the CEEFAX/ORACLE service. Lines 17/18 on one field and lines 330/331 on the interlacing field are used for this purpose. Some of the other lines in the blanking interval are used to carry test and monitoring signals (Fig. 3). On lines 19/332, after the teletext lines, there is a signal composed of a bar and dot pattern and a staircase type waveform whilst on lines 20/333 there is a signal for checking the colour subcarrier. Some BBC transmissions also use lines 16/329 before the data signals to carry engineering test data.

For the teletext signal each of the line periods used carries the data for one complete row of text characters to be displayed. In the 625-line system the period of one line scan is exactly 64μs of which some 12μs is taken up by the synchronising pulses and line blanking. This leaves 52μs for the picture signal itself. In lines carrying data this 52μs period is split up into 45 equal segments each of which contains one word of the data. These word periods are further subdivided into eight equal parts each of which holds one binary bit of data. The pattern made up from the combination of the eight bits in the word will define which of the characters is to be displayed on the screen. Using eight bits, each of which may be in one of two states, gives 256 (2^8) possible combinations.

Five of the word spaces at the start of each line of data are used for synchronisation and row identification. The remaining 40 data words contain the information for the 40 characters to be displayed in the row of text.

To minimise the bandwidth required for the data the signals are transmitted in a widely used format known as NRZ (non return to zero). In this format, when the voltage of the signal during a bit period is high the bit is said to be at the 1 level and when the voltage is low or zero the bit is said to be a 0. When several 1 bits follow one another the voltage merely remains at high level for the appropriate number of bit periods as shown in Fig. 4. Normally the received signal has the bit pulses rounded off as shown in Fig. 4(a) but after shaping the pulses become squared up as shown in Fig. 4(b).

Clock run in

One of the problems with using NRZ type coding is that there is no built-in clock in the signal when several bits with the same state follow one another. In order to decode the data the receiving system must provide its own clock to define the positions of the individual bit periods so that the state of the signal during each bit period can be correctly detected.

For correct operation the decoder's internal clock must be running at exactly 6·9375MHz (444 times the line scan frequency) which is the bit rate of the received data. In addition, the relative phase of the clock and signal should keep the clock pulse roughly in the middle of the bit period.

At the start of the data line the first two words are used to provide a clock 'run in' signal to enable the decoder clock to be properly synchronised to the incoming signal. During these two words the data bits alternate between 1 and 0 as shown in Fig. 5. This clock run in signal is used in much the same way as the colour burst is used to synchronise the reference oscillator in a colour television receiver.

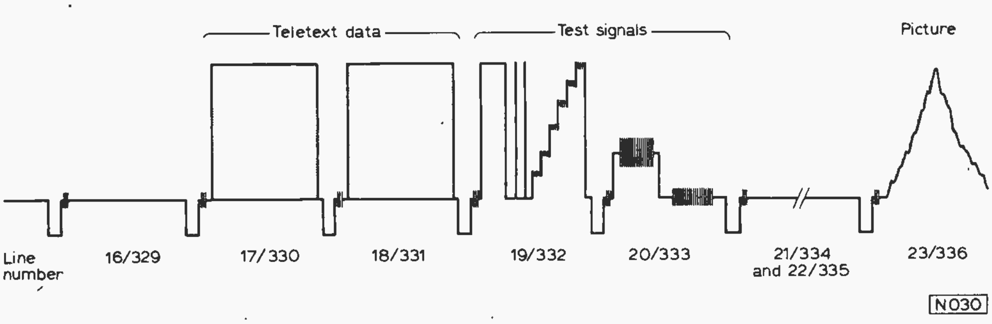


Fig.3: Location of the data signals in the TV line sequence.

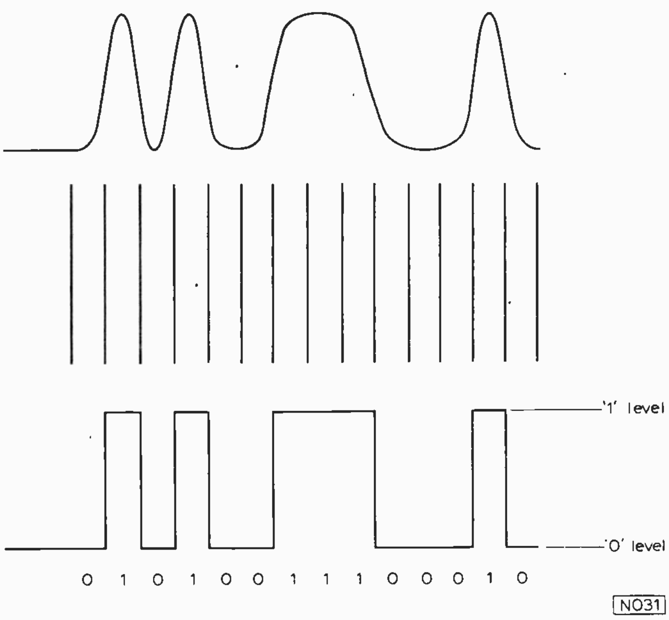


*Fig. 4: Non return to zero (NRZ) data coding.
(a) (top) Signal as received.
(b) (bottom) Signal after pulse shaping.*

Framing code

Once the decoding clock has been locked on to the received data signal the next stage is accurately to locate the start of each data word so that it can be properly deciphered. One possibility might be to make use of the line sync pulse as a timing reference. This is in fact not practicable since the precise timing of the line sync pulse depends upon the characteristics of the receiver and the quality of the received signal.

In order accurately to define the starting time of the data words, a special word known as the Framing Code has been included in the data line immediately after the clock run in words. The decoder now searches through the data as it is received until the particular bit pattern of the framing code word is detected. When it is detected, the framing code enables the decoder to pinpoint one particular bit period in the data stream which is then used as a reference point to which the timing of all of the other words of the data can be related.

Shift register

Since the data bits are arriving at the receiver in a serial stream one of the first requirements in the decoder is to temporarily freeze the data in some way so that it is possible to examine the states of eight successive bits of data simultaneously. To achieve this a shift register is normally used.

We shall be meeting the shift register type circuit a number of times in the decoder system so at this point let us examine the construction of a shift register and see how it works. Basically a shift register consists of a series of flip-flop circuits connected in cascade as shown in Fig. 6. When a clock pulse is applied to each flip-flop its output will be set to the same state as its data input. In the shift register connection, each stage when clocked will take up the state of the previous stage so that the data pattern moves along the register from left to right one stage for each clock pulse applied. This is shown in Fig. 7 where the state of the register after each clock pulse is shown for a number of clock periods.

If the shift register used has eight stages it will contain the pattern of the last eight bits of data that were applied to the input. This pattern remains static in the register during the period between the clock pulses. Since the decoder clock is synchronised to the incoming data the pattern in the data stream will move steadily through the shift register. At any given clock time the last eight bits of data received will be held in the shift register and may be examined simultaneously to see if they match the pattern of the framing code word.

Simple frame detector

To detect the presence of the framing code pattern in the shift register the simplest approach is to make use of a coincidence gate circuit as shown in Fig. 8. For this purpose an eight-input NAND gate, such as the 7430, is used to detect a match with the code pattern.

In a NAND gate the output will go to the 0 state only when all of the inputs are at the 1 level. If any of the inputs is at 0 the output of the gate will be at the 1 level.

The pattern chosen for the framing code is 11100100. Now if we assume that the code has been received and is correctly lined up in the shift register then the states of the individual stages of the register will be as shown in Fig. 8. From the stages that are at the 1 level the outputs are simply fed directly to the inputs of the gate G5. Where the shift register stages are at 0 the output signals are inverted by the gates G1, G2, G3 and G4 to produce 1 level inputs for the gate G5. When the correct pattern of bits exists in the register all of the inputs of the coincidence gate G5 will be at the 1 level and its output will drop to the 0 level.

After the next clock pulse is applied to the register the matching conditions will no longer apply and at least one of the inputs to G5 will go to 0 thus driving its output to the 1 state. The output from G5 is therefore only at 0 for the one clock period when the pattern in the register matches the framing code. This output pulse gives the reference point from which the word timing will be measured.

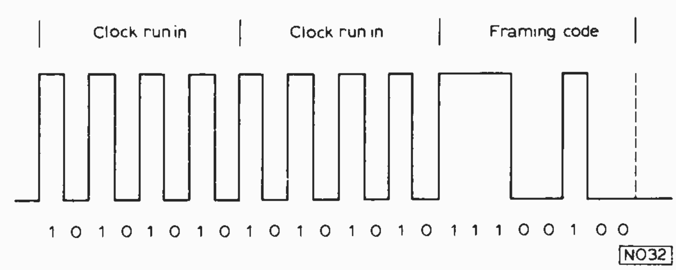


Fig. 5: Clock run in and framing code sequence.

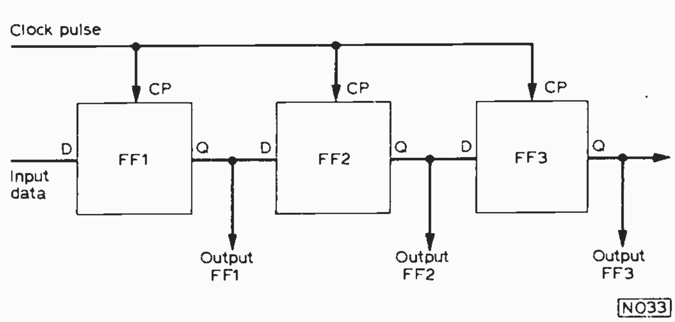
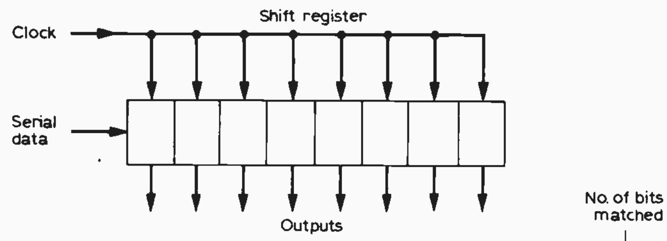


Fig. 6: Organisation of a three-stage shift register.



Step									No. of bits matched
1	0	1	0	1	0	1	0	1	4
2	1	0	1	0	1	0	1	0	4
3	1	1	0	1	0	1	0	1	3
4	1	1	1	0	1	0	1	0	3
5	0	1	1	1	0	1	0	1	5
6	0	0	1	1	1	0	1	0	4
7	1	0	0	1	1	1	0	1	3
8	0	1	0	0	1	1	1	0	4
9	0	0	1	0	0	1	1	1	8
10	X	0	0	1	0	0	1	1	4 + 1X
11	X	X	0	0	1	0	0	1	2 + 2X
12	X	X	X	0	0	1	0	0	3 + 3X
Framing code	0	0	1	0	0	1	1	1	N034

Fig. 7: Data movement through the register. The framing code word is indicated by the shaded section. In this drawing data is moving from left to right.

Single error detection

A simple framing code detector such as the one just described will only operate properly when the received signal is perfect. Under normal conditions the received signal is likely to be affected by interference and noise which would upset this simple detector.

When the pattern for the framing code word was chosen, this problem was catered for by arranging that the code would still allow accurate selection of the reference point even if one of the bits in the pattern is in error. To make use of this feature however a rather more complex detection system is required.

The pattern of bits held in the shift register at successive clock pulses as the framing code pattern passes through it was shown in Fig. 7. On the first step the register contains the final eight bits of the clock run-in signal. At step nine the framing code is correctly lined up in the register and this is the only step where all of the bits held will match the framing code pattern. After step nine the next data word starts to enter the register and the bits are shown as Xs because they will vary from one data line to the next. Because of this variation it must be assumed that sometimes these bits may match with the bits of the pattern being searched for.

During the first eight clock periods a maximum of five of the bit states in the register will match with the pattern of the framing code. For the next few periods after the ninth, even if we assume that some of the bits in the next data word entering the register happen to match, only six of the bits will match the desired pattern. It can now be seen that provided seven or eight bits of the pattern in the register match the framing code this will always occur at step nine and thus define the correct timing reference point.

A typical arrangement for a detector circuit which can cope with a single-bit error in the received pattern is shown in Fig. 9. In this circuit the outputs from the register are dealt with in pairs. The four bits that should be at 1 are grouped into two pairs and similarly the bits that should be at 0 are paired off.

Each pair of bits is now examined to see if the two bits match with the code pattern and if both are correct this will be referred to as a 'true' condition. Each pair of bits is also checked to see if only one of the two bits is correct and this will be called the 'error' condition.

Gate G1 checks that the bits in stages A and B of the register are both at 1. This is an AND gate which gives a 1 output only if both inputs are at 1. Similarly gate G3 detects for correct 1 states in stages C and F. For those stages which should be at 0, such as D and E a NOR gate (G5) is used to detect that both bits are at 0. In the NOR gate the output goes to 1 only if both of the inputs are at 0. A similar gate G7 checks bits G and H. Thus gates G1, G3, G5 and G7 will produce 1 outputs when the corresponding pairs of bits give a 'true' match.

The four EXCLUSIVE OR gates G2, G4, G6 and G8 are used to check for a one bit error in each of the pairs of bits. In this type of gate the output is 1 only when one input is 0 and the other is at 1 so that one of the two bits is therefore in error. If both inputs are at the same state the gate output is at 0. These four gates now give us an 'error' condition for each of the bit pairs.

Gate G9 is fed with the 'true' outputs from gates G1, G3, G5 and G7. This gate gives a 0 output when a correct match of all the framing code bits is detected. Gates G10 to G13 are fed with combinations of three 'true' and one 'error' state for the four pairs of bits to produce the other four acceptable code patterns where only one bit is in error.

Now the output of one of the gates G9 to G13 will go to 0 whenever an acceptable code is detected. These gate outputs are fed to five of the inputs of a 7430 NAND gate G14. The three unused inputs of G14 are set to the 1 level. When any of the inputs of gate G14 is at 0 its output is at 1 and this will occur when an acceptable code is in the register.

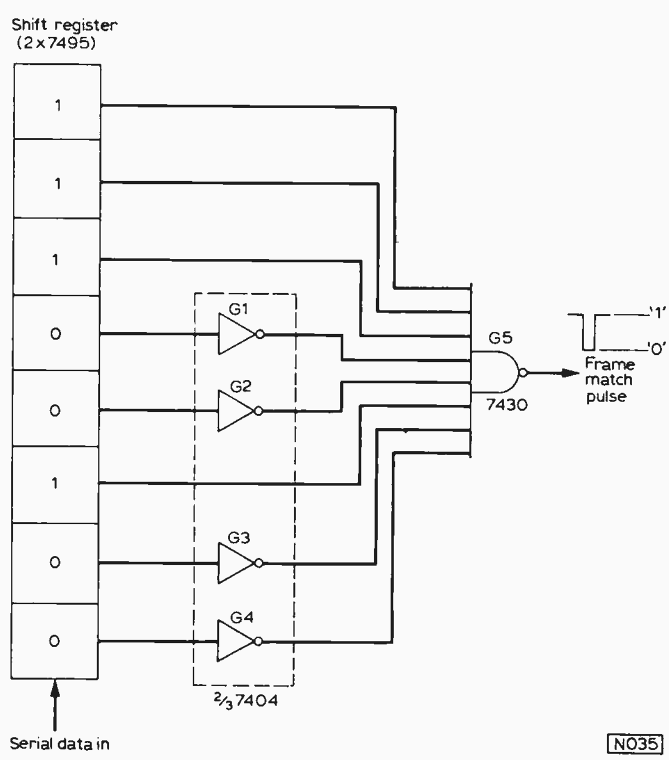


Fig. 8: A simple framing code word detector circuit.

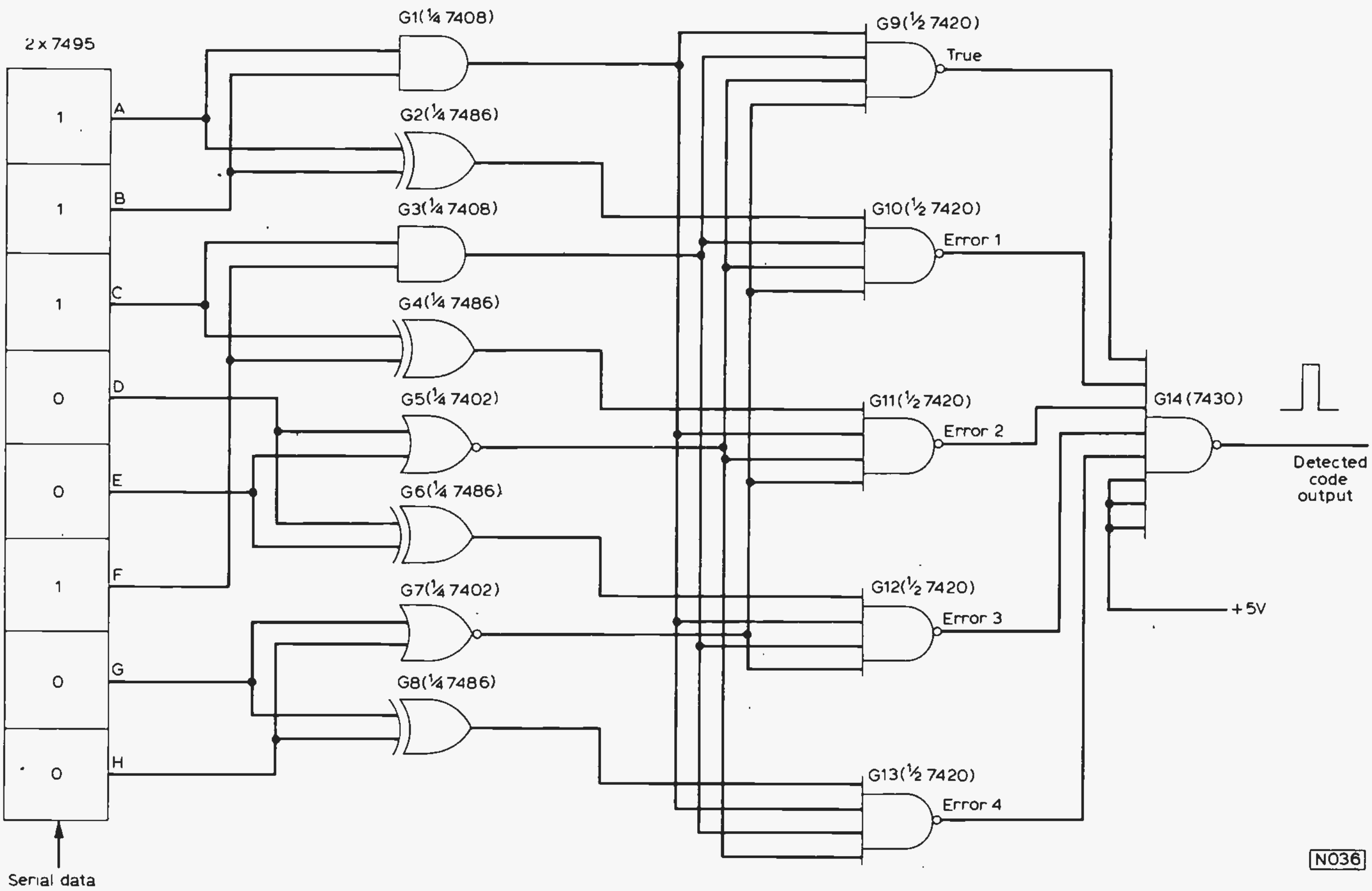


Fig. 9: A circuit capable of correctly detecting the framing code even in the presence of one error in the received signal.

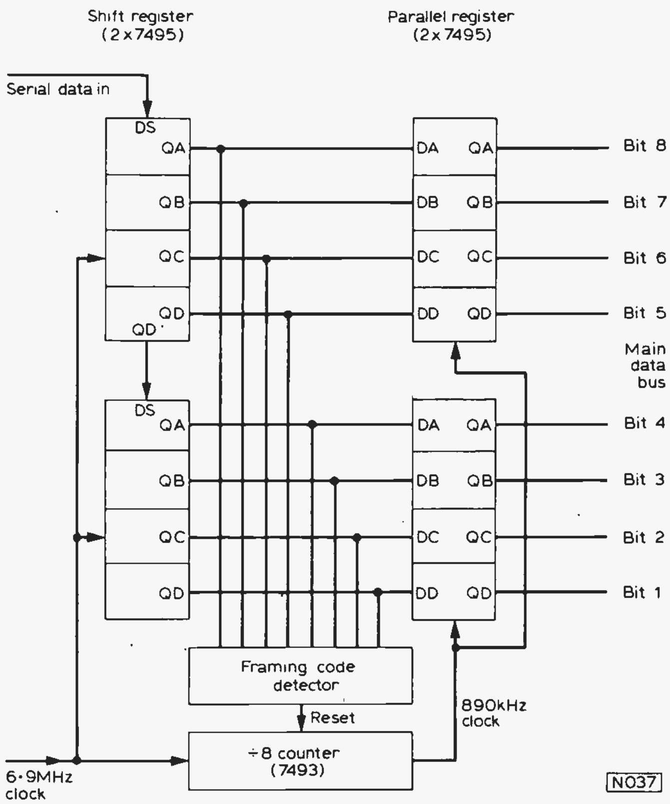


Fig. 10: A basic circuit for serial to parallel conversion of the incoming teletext data.

Other logic arrangements could be used to produce the same end result and it may be possible to reduce the number of integrated circuits used. Although the gates shown are from the 7400 TTL series it would also be possible to implement the detector circuit using DTL or CMOS logic devices.

Serial-parallel conversion

Once the framing code has been detected and the start of the data words located, the next stage is to convert the data from serial form into parallel form where each bit of the word is presented on a separate wire and held stable for a complete word period.

The basic circuit arrangement for the serial to parallel conversion is shown in Fig. 10. Here the outputs from the stages of the shift register are connected directly to the inputs of a second register, the parallel register. When a clock pulse is applied to the second register the data transfers directly so that this register takes up the state of the shift register. If this clock pulse is applied only when the data word is correctly set up in the shift register it will remain in the second register for the next eight shift pulses applied to the shift register. The clock for the second register is simply obtained by dividing the shift register clock by eight. For this a counter can be used and to ensure correct timing the counter is reset to zero when the framing code is detected.

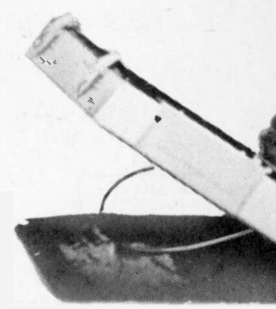
From the parallel register the outputs are taken on eight separate wires which then act as the main data bus feeding data to the rest of the decoder system.

So far, the decoder system has locked its internal clock to the incoming data and detected the framing code for correct word synchronisation. The data has also been changed from the serial form to parallel for later use in the decoding process. Next month we shall be looking at the decoding of the row and page addresses.

VIDEOTAP RECORDIN

Part One

M. P. Riley



DURING the past two years videotape recorders, in their various forms, have begun to make a considerable impact on the domestic and educational television markets. Regrettably, there is as yet no recognised standard of tape format or recording parameters for this type of VTR. Because of this there are many different formats in use, each of which is incompatible with machines produced by other manufacturers. The two inch tape format used in broadcast videotape recording was standardised in the late 1950s, and since then there has been only one major alteration – due to the changeover from monochrome to colour. The range of VTRs available to the public at the moment is quite large, from the complete portable unit manufactured by Sony, shown on our front cover, to the larger reel-to-reel machines manufactured by Bell and Howell.

This is the first of a series of articles on the videotape recording techniques used in machines intended for the educational and domestic markets. In later articles the Philips Video Cassette Recorder (VCR) will be dealt with in detail. This machine was launched on the domestic market about eighteen months ago and, priced at about £550, is well within the range of many colour TV set owners. With its obvious advantages over video disc systems it would seem only a matter of time before it becomes as commonplace as the colour receiver is today.

Magnetic Recording

Before describing any tape recording system it is necessary to study the fundamentals of magnetic recording, and to discuss the differences in the techniques used in audio and video tape recorders. As sound is recorded in the conventional manner in all VTRs it is a convenient starting point on familiar ground.

The range of audio frequencies that are recorded on a good quality tape recorder will cover 25Hz to 25kHz, a span of almost 10 octaves (25Hz doubled in frequency 10 times). The highest frequency that the machine will record is determined by three factors: the tape speed, the magnetic particle size of the tape, and the width of the gap in the record/playback head. This highest frequency is known as the extinction frequency and can be calculated as follows:

$$f_{EXT} = \frac{\text{Tape speed}}{\text{Head gap-width}}$$

If the frequency of extinction is set at 25kHz and the tape speed at 19cm/s (7·5in/s), the head gap will be:

$$\text{Head gap} = \frac{\text{Tape speed}}{\text{Extinction frequency}}$$

$$= \frac{19 \times 10}{25\,000}\text{mm}$$

$$= 0{\cdot}0076\text{mm } (0{\cdot}0003\text{in})$$

This would more commonly be spoken of as 76 microns (or 0·3 'thou').

Having selected the tape speed and the head gap of the audio recording system, a bias frequency has to be fixed to enable the audio signal to be recorded on the linear part of the tape transfer characteristic. This is shown in Fig. 1. The frequency of the h.f. bias is normally three times the highest frequency recorded; for the system just explained this would mean a bias frequency of 75kHz. The sinewave signal is also applied to the erase head so that pre-recorded information can be removed before new information is recorded.

Most of the problems in tape recording, whether audio or video, are encountered in the playback process. The voltage output of the replay head is directly proportional to the rate of change of the flux at the head. This rate of change is of course proportional to the frequency of the signal being replayed, and the resulting induced voltage rises by 6dB per octave. This means that the output at the lowest frequency of 25Hz will theoretically be 60dB below the level at 25kHz, see Fig. 2.

This rise of 6dB per octave is modified in many ways by other losses present in the playback path. The falloff in output level as the frequency of extinction is approached is one of the factors to be taken into consideration. Any gap between the head and the tape surface gives rise to spacing losses, this loss is again effective at the higher frequencies. One other cause of high frequency loss is incorrect azimuth of the record/playback head, a common fault in many audio tape recorders. After all these losses are taken into consideration the overall playback response is as shown in Fig. 3. In audio tape recording this response is equalised during recording and playback to produce a flat frequency response at the output of the machine.

If we now examine video tape recording, many problems will become apparent. First of all, the frequency spectrum of the video signal is from d.c. to 5·5MHz, an infinite number of

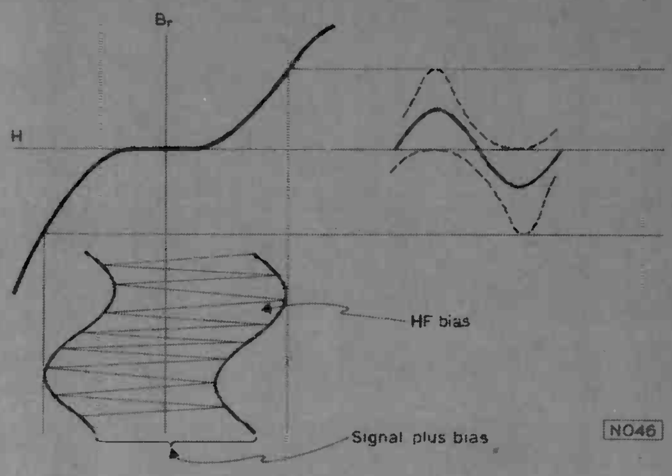


Fig. 1: Tape transfer characteristic, showing the application of h.f. bias.

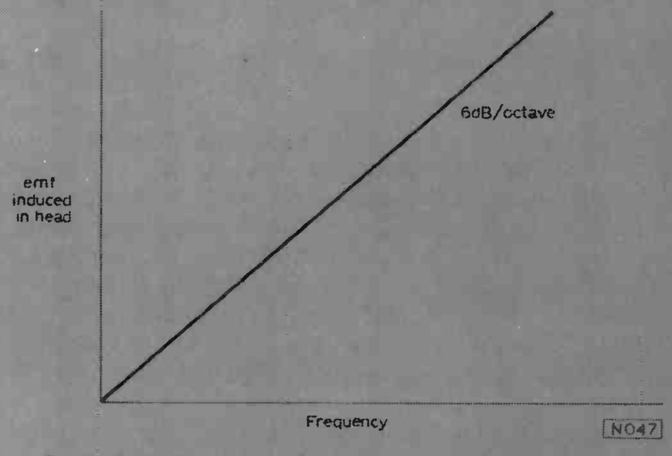


Fig. 2: A theoretical rise in response of 6dB per octave.

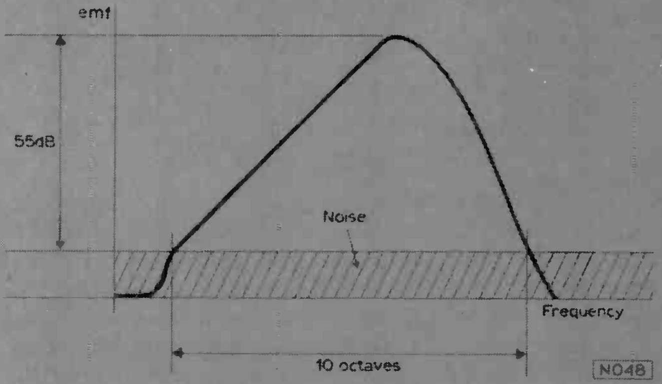


Fig. 3: The overall playback response.

octaves, but if we take the spectrum to be between 25Hz and 5·5MHz it will span a range of 18 octaves. If the frequency of extinction of the video recorder is set at 5·5MHz, and the same head gap as the audio recorder is used, the new tape speed will be:

$$\text{Tape speed} = f_{EXT} \times \text{Head gap}$$
$$= 5{\cdot}5 \times 10^6 \times 7{\cdot}6 \times 10^{-4}\ \text{cm/s}$$
$$= 4180\text{cm/s}\ (1650\text{in/s})$$

It can easily be seen that a machine with a tape travelling at this speed (nearly 100mph) would be impractical, if not dangerous to the operator! A one hour programme would require 100 miles of tape!

If we put this problem aside for a moment and consider other problems such as the h.f. bias frequency, we will find even further complications. Assuming that the bias frequency is again three times f_{EXT}, this would put it up to 16·5MHz, so that the oscillator would have to be well screened to avoid r.f. radiation problems and beat patterns with the video frequencies. The output level from the playback head will still rise at 6dB per octave, which would mean that the field sync information at 25Hz would be more than 100dB below the level of the highest recorded frequency. If this signal could be equalised to produce a flat response, the field information would be at or below the level of the noise of the equaliser. Because of the higher head to tape speeds used in VTRs the problem of spacing loss becomes greater, although this can be partially solved by making the record/playback head push into the tape by about 250 microns (1 'thou').

To summarise the problems that have been outlined, the video tape recorder has to be able to:—

(a) Reduce the number of octaves occupied by the video signal without affecting the horizontal resolution of the picture.

(b) Produce a high head to tape speed and at the same time keep the speed of the tape down to an economic rate.

(c) Produce a tape path that will ensure good head to tape contact without introducing excess friction.

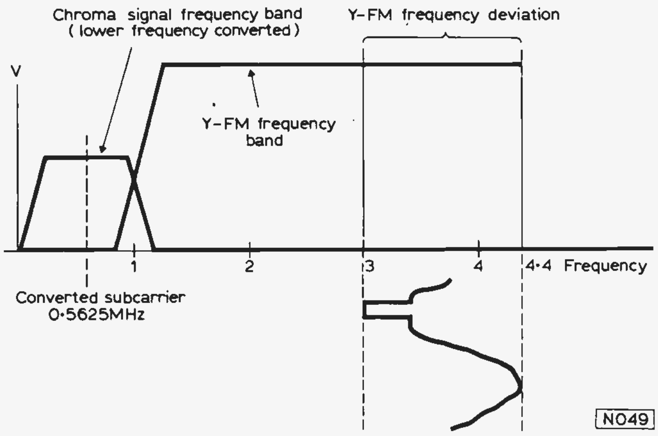


Fig. 4: A typical VTR signal frequency spectrum.

(d) If h.f. bias is used it must be at a frequency that will not beat with the h.f. content of the video signal, but is not so high as to produce r.f. radiation from the machine.

Bandwidth reduction

The effective bandwidth of the video signal can be reduced by raising the frequency to be recorded. If the video frequencies could be transposed to lie between 10MHz and 15·5MHz then less than one octave would be covered, thus making the theoretical change in gain over the band less than 6dB. This is not the complete answer however, because the h.f. bias frequency would still be too high. If frequency modulation of the video signal was used, the bandwidth of the signal would be slightly higher than that described above, but well within the system capabilities of a VTR.

Frequency modulation of the video signal before it is recorded on the tape has other advantages. In the first place an h.f. bias signal is not required because the f.m. carrier will act as its own bias signal. Secondly an f.m. system is less susceptible to amplitude variations, so greater variations in spacing loss can be tolerated. In practice a carrier at approximately 3MHz is used, corresponding to sync tips, and this is deviated up to approximately 4·5MHz at peak white. A typical frequency spectrum is shown in Fig. 4.

Tape speed

The system described above can only work if a high head to tape speed is used, and as we have seen a system with a stationary head is going to result in a very high tape speed. An alternative does exist however, and that is to move both the tape and the record/playback head so that the resultant speed between the two is high. If the head is mounted on the circumference of a drum, around which the tape is wrapped, relatively high speeds can be produced. Let us take as an example the situation of the record/playback head mounted on a drum of diameter 178mm (7in). The circumference of the drum is therefore 559mm (22in). If the drum revolves at field frequency the head to tape speed is 50 × Circumference = 2794cm/s (1100in/s). If the previous head gap of 76 microns (0·3 'thou') is used then the frequency of extinction will be 3·66MHz. Much smaller head gaps are common on videotape recorders, meaning that the diameter of the drum and the tape speed can both be reduced without any great effect on the performance of the machine. The Philips VCR for instance has a drum diameter of 104mm (4·1in) and a head to tape speed of 792·23cm/s (319·037in/s). The speed of the

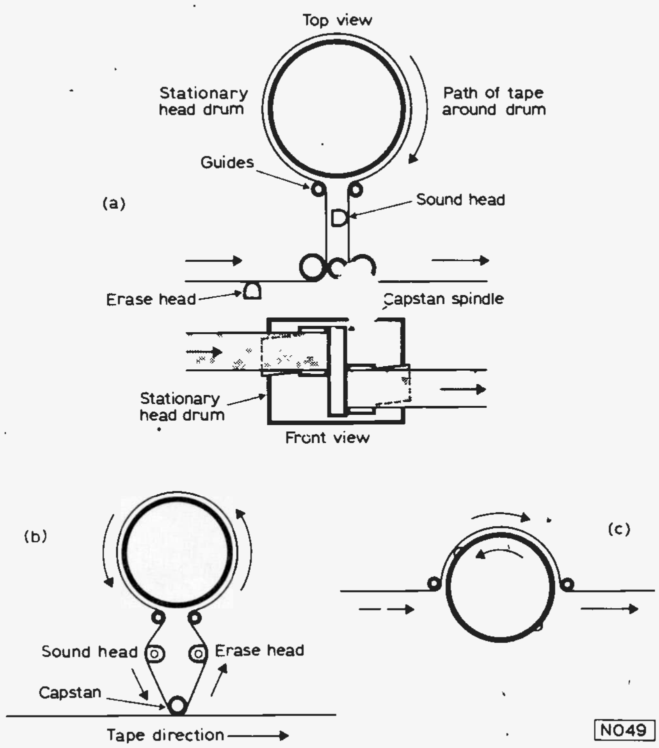


Fig. 5: The three basic tape path arrangements used in videotape recorders:–
(a) Omega (Ω) wrap.
(b) Alpha (α) wrap.
(c) Half wrap.

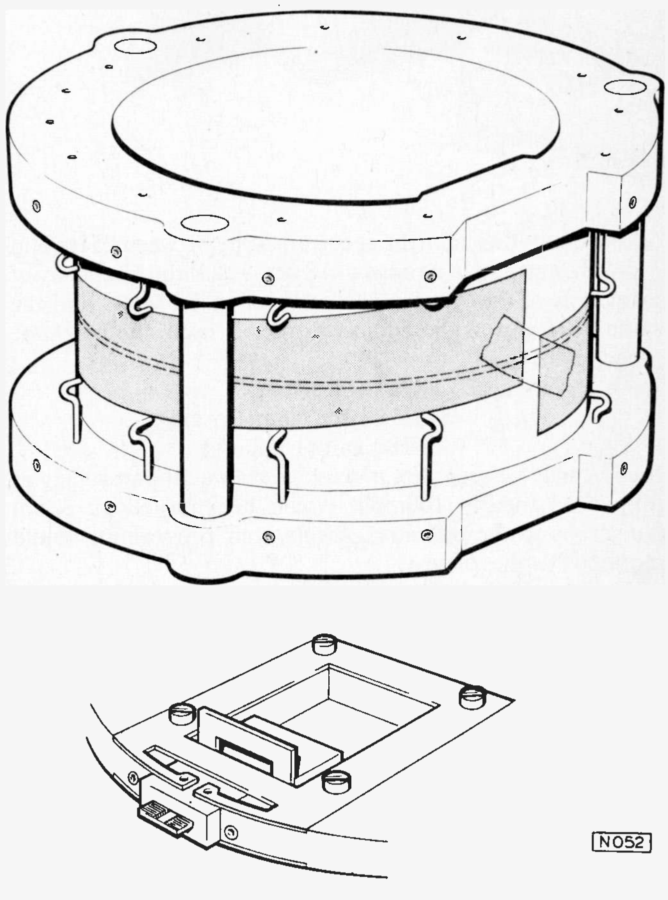


Fig. 6: The tape path around the head drum and detail of the video head mounting.

tape makes little difference in this system and is mainly used to separate the information laid down on the tape. Early machines had the tape and the head travelling in opposite directions, but on modern machines both travel in the same direction so that wear on the tape and the head is reduced.

Tape path

The path taken by the tape around the circumference of the drum housing the video head can be varied considerably, and it is this that produces the main incompatibility between machines of different manufacturers. There are three basic ways in which the tape can be wrapped around the drum – these are the Omega, Alpha and Half Wraps, illustrated in Fig. 5. The path taken by the tape between the feed spool and the drum, and between the drum and the take-up spool can differ enormously, especially in cassette machines where the machine has to remove the tape from the cassette and wrap it around the head drum.

As the tape is wrapped around the drum it takes the form of a helix, hence the term helical scan. The video head is normally mounted in a horizontal plane, and the resultant scan travels obliquely across the tape. This is shown in Fig. 6, where it can be seen that if the head is travelling in an anticlockwise direction and the tape in a clockwise direction, the head will scan the tape obliquely from the bottom to the top.

If the tape is unwrapped from the drum then the basic format will be similar to that shown in Fig. 7. The audio track is normally recorded along the lower edge of the tape with the control track, which will be explained later, along the upper edge. Standard techniques are used to record the audio track, which will therefore not be dealt with in depth beyond this point. The length of the video scan is one TV field, but it will be noticed that the audio and control tracks, plus the space between the two edges of the tape when it is wrapped around the head drum, will cause a gap in the information between one field and the next.

Information gap

Exactly where this gap is placed in the picture seems to be a matter of choice between manufacturers. Some, such as Sony, place it directly after the field sync information. This has the disadvantage that the line oscillator will lose synchronisation during field blanking and will possibly not relock in time before the picture information of the next field is displayed. The advantage of placing the gap after field sync is that it is outside the active picture time, and cannot be seen by the viewer. Other manufacturers, such as Philips, prefer to place it at the bottom of the picture directly before the field sync. The line oscillator of the receiver will still lose synchronisation but it does have the whole of the field flyback blanking period in which to relock. The disadvantage of this method is of course that the drop-out will occur during the picture time and will therefore be seen by the viewer.

The half-wrap format is one widely used at the moment. Sony have used it for many years, and Philips are using it in the VCR. In the system used by Sony two record/playback heads are mounted 180° apart on the circumference of the drum. The tape wraps around the drum a little more than 180° so that as one head is about to leave the tape the other is already starting its scan. This means that the information at the end of one scan and at the beginning of the other is being duplicated. After the audio and control tracks have been recorded a very small overlap of information is produced just after the field sync, thus removing the drop-out altogether. If

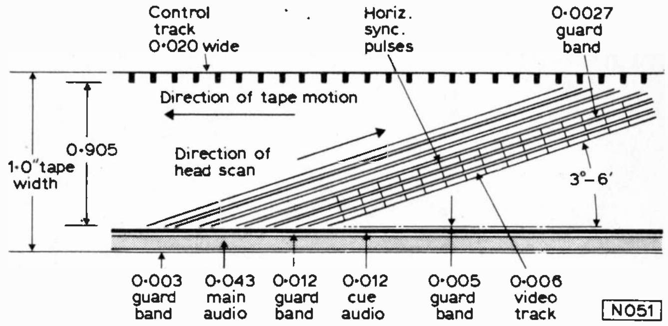


Fig. 7: Tape format for the 1in Ampex videotape recorder. All dimensions are in inches.

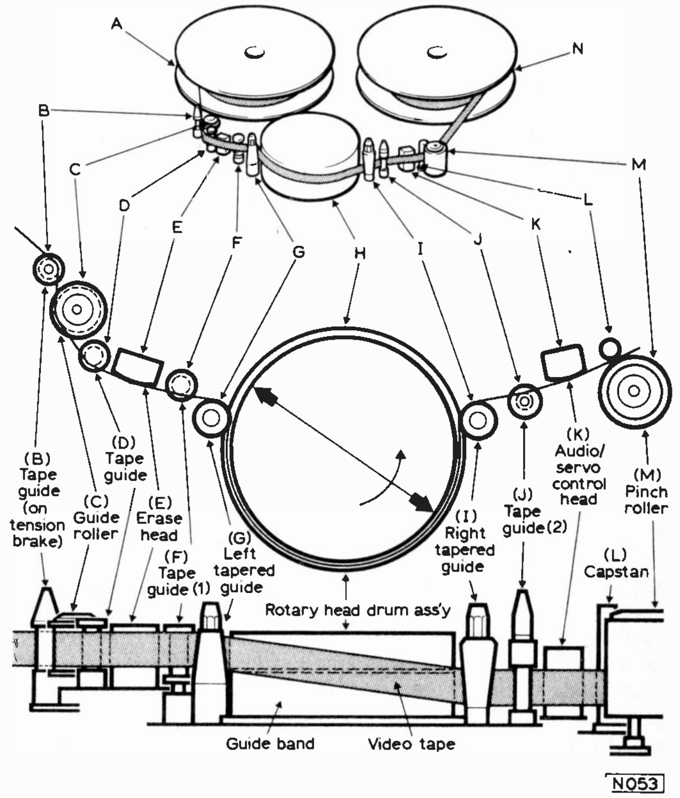


Fig. 8: The tape path of a Sony half wrap recorder.

two video heads are used on the drum, each recording one field, the drum has to revolve at picture frequency (25Hz), rather than at field frequency (50Hz). This reduction of head to tape speed will of course reduce the bandwidth of the recorded signal.

A typical tape path as used by Sony is shown in Fig. 8. If the tape is followed from left to right then the sequence of events during the record mode can be traced. As the tape leaves the feed spool it passes via a tension arm and two tape guides to the master erase head. This head will erase the whole width of the tape if an ordinary recording is being made, or selected parts of the tape if editing is required, for example an audio only edit. After erasure of the tape the video information is recorded across the tape as previously described, and afterwards the audio and control tracks are recorded longitudinally along the edge of the tape. The h.f. bias of the audio signal partially erases the video information that lies in its path. Any remaining information will produce a

continued on page 488

Service Notebook

G.R.WILDING

Gradual Brightness Increase

The Murphy Model V849 (Bush TV125 series) was probably one of the last examples of a hand-wired chassis. We were called in to see one of these very good old dual-standard sets which had lost definition. The main complaint made by the owner however was that the brightness level gradually increased from switch-on, so that after about half an hour there were no black or dark tones in the picture which became unwatchable. Drift in picture brightness level is generally caused by internal leakage in the c.r.t., but checks proved that this was not the cause in this instance – the gradual increase in brightness being due instead to a proportional decrease in the c.r.t.'s cathode voltage.

These sets use a PCF80 as the video amplifier, the triode section being used as a cathode-follower which is d.c. coupled to the c.r.t. cathode. The triode grid is in turn d.c. coupled to the anode of the pentode section. This arrangement gives a much better bandwidth/gain figure than can be obtained using a pentode on its own. The reason for this is that the cathode-follower removes the c.r.t. and sync separator input capacitance from the pentode's anode load circuit, which in this chassis consists of a single 10kΩ resistor.

When the set was switched on from cold the c.r.t. cathode voltage was found to be below normal. This meant that the PCF80 triode cathode and grid and the pentode anode voltages were also below normal, due it was discovered to the 10kΩ anode load resistor having increased in value to about 20kΩ. On fitting a correct value resistor the brightness level returned to normal and stayed so, while the definition improved 100%, giving a really excellent picture from the original c.r.t.

This makes one wonder how many old receivers have changed value anode load resistors, probably giving the impression that the i.f. alignment has gradually drifted from optimum. Usually it's the cathode, screen grid feed, or cathode bias stabilising resistors that change value, the symptoms, due to the incorrect d.c. conditions, being sync pulse crushing on 405 lines and highlight limiting on 625 lines – since the pentode is operating on the curved part of its characteristic. For good tonal reproduction, video output pentode voltages must be close to the correct figures.

No Sound

An elderly dual-standard set fitted with the Pye 67 chassis still gave a good picture but the sound had suddenly disappeared on both systems. The audio circuit wasn't at fault since a good hum was produced from the speaker when the volume control in the grid circuit of the triode section of the PCL82 was contacted. The fault was almost certainly in the two-stage transistor sound i.f. circuit so our first move was to check the voltages here. The chassis is unusual in employing npn transistors powered from a negative (–18V) l.t. rail. Thus the collectors of the transistors are returned to chassis while their emitters are returned to the l.t. rail. The collector voltage of the second sound i.f. transistor was found to be zero (instead of –0·5V) while its emitter was at almost the rail voltage (instead of –14·7V). On contacting the base of the transistor with the test prod, weak sound was restored. This was due to the meter's resistance applying a limited amount of forward bias to the transistor's base – when a transistor is emitter fed from the supply line, forward base bias must be obtained from a resistive feed from chassis. This is normally provided in this circuit by R39 (5·6kΩ), but a dry-joint at the base of the transistor had removed it. Resoldering the printed circuit connection completely restored normal sound.

Incorrect Colours

The fault reported on a set fitted with the Thorn 8000 chassis was incorrect colours, and on examination we found that this was due to complete absence of red picture content. This suggested that the red output transistor was at fault and as anticipated we found that its collector voltage was the same as the h.t. rail voltage, i.e. 180V, thus biasing off the red gun of the c.r.t. The base and emitter voltages were below normal, though there was adequate base-emitter voltage. Everything pointed therefore to an open-circuit collector-base junction and a resistance check showed that this was the case. A new BF258 and adjustment of the red drive preset resulted in a first class picture.

Power Supply Faults – Rank S-S Colour Chassis

There are three fuses on the power supply panel used in the Rank A823 single-standard colour chassis, a 5A fuse in series with the mains input, a 2A fuse in series with the a.c. feed to the l.t. bridge rectifier, and a 600mA h.t. fuse. The cause of the 5A fuse blowing is generally a short in the thyristor h.t. rectifier, while the cause of the 2A fuse blowing is almost always a short in one or more of the l.t. bridge rectifier diodes.

In a Bush Model CTV182 that came in recently with the complaint no results two of the diodes in the BY164 bridge rectifier circuit were found to be shorted. After replacing them and switching on however there was only the slightest suggestion of l.t. across the various 2,500ΩF reservoir/smoothing capacitors in the circuit. Tests showed that the normal a.c. input to the bridge was present, the cause of the trouble being traced to a dry-joint between one of the diode leadout wires and the printed panel. Resoldering this connection restored normal l.t. supplies. The lower the impedance of a circuit, the more pronounced the effect of a dry-joint – and l.t. supply circuits are of comparatively low resistance.

Gradual Picture Deterioration

A set fitted with the ITT VC100 chassis would work normally for about a quarter of an hour from a cold switch on. The picture quality and contrast would then gradually deteriorate, giving the impression of a low-emission c.r.t. The standard of line locking would also deteriorate, and it would usually be necessary to readjust the hold control after each channel change. In view of the delay before the fault symptoms appeared the first suspicion was naturally a faulty valve. Changing all possibles failed to clear the trouble however.

The second i.f. amplifier valve V6 (EF184) seemed much hotter than normal for a valve of this type, and voltage checks showed that both its screen grid and anode voltages were considerably below the correct figure (165V). A short across the cathode bias resistor was first suspected, but instead the trouble was found to be due to a slight positive voltage on its control grid. This could be caused only by a leak in the coupling capacitor C44 (120pF) from the anode circuit of the preceding stage, and on replacing

Service Notebook 2

this the anode and screen grid voltages returned to normal and there was no further picture quality deterioration. To obtain perfect line sync however it was found necessary to replace the two OA91 diodes in the flywheel sync discriminator circuit.

Intermittent Bottom Cramping

An interesting field timebase fault was encountered recently in a set fitted with the Thorn 1400 chassis. At first the picture had rolled a lot when the set was switched on, settling down after a few minutes. Then really bad intermittent bottom cramping, extending almost a third of the way up the screen from the base of the raster, had developed. Occasionally there would be complete field collapse. Though we hardly expected that it would cure the trouble, a new PCL805 field timebase valve was fitted to see whether this produced any improvement – with any fault you must start work on the basis that all relevant valves are o.k. There was no improvement at all. Now bad bottom cramping and/or foldover at the base of the raster generally suggests insufficient bias, the positive-going second half of the field drive waveform, producing the bottom half of the raster, almost or completely overcoming the bias on the valve, possibly even running the control grid positive.

In this chassis however the system of biasing the field output pentode is unusual (see Fig. 1). Instead of using a cathode bias resistor, a negative voltage from a point along the rectified heater supply chain is applied to the grid circuit via R105. The idea is to prevent the set being used should the heater rectifier go short-circuit, since in this event the a.c. applied to the PCL805's pentode control grid will constantly trip it. The pentode's cathode is connected directly to chassis.

On checking at the control grid we found zero voltage. Now the mean value of the negative voltage that should be present is not given in the service manual, since the high value of the feed resistors makes the reading very dependent on the internal resistance of the meter used to check it. Nevertheless a clearly discernible negative potential should be found whatever the meter. On making further checks we found a negative potential at each end of R105, also at each end of R110 and at the junction R108/R110. At the junction R108/R109 however there was zero voltage. There was near normal voltage at the anode of the triode section of the valve, so it seemed that the absence of bias on the pentode was due to R108 being open-circuit. It looked in good shape however, and doesn't pass current, so we became sceptical

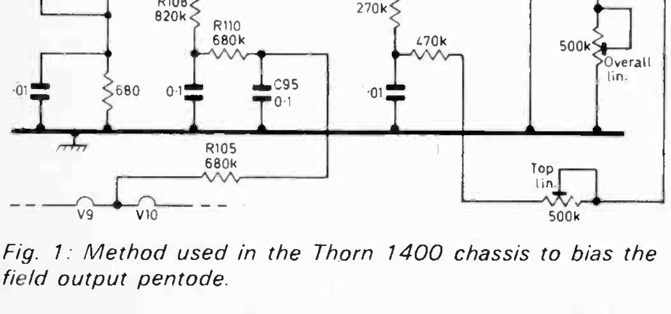


Fig. 1: Method used in the Thorn 1400 chassis to bias the field output pentode.

about this possibility. We then realised that a slight leak in C93 could remove the negative supply to the pentode's control grid circuit while as the pentode's cathode is connected directly to chassis the grid and cathode will act as a diode, preventing the grid becoming positive. So C93 was disconnected, and the pentode control grid then registered a negative voltage. On replacing C93 a perfect, stable raster was obtained.

Although the effect of the leak in C93 was so marked, a resistance test on the capacitor out of circuit showed only a very small leak.

It may seem surprising incidentally to find the heavy 50Hz ripple in the supply from the heater chain filtered by only an 0·1μF capacitor (C95) – normally electrolytic capacitors are required to remove 50Hz ripple. The reason is that zero d.c. is passed. Thus although the reactance of C95 to the a.c. component is high the resistance of R105 is very much higher and nearly all the ripple voltage is developed across this resistor.

Cut-out Blowing

The mains cut-out on a set fitted with the Thorn 3000 chassis repeatedly blew, but a resistance check failed to indicate a definite short in the receiver. On examining the power supply board we found the cause to be leakage from the 1,000μF capacitor C607 which is the reservoir for the 30V supply rectifier. The leakage was providing a conductive path from the two rectifiers W603/4 used in this full-wave rectifier circuit. No further trouble was experienced after thoroughly cleaning the printed board and replacing the capacitor.

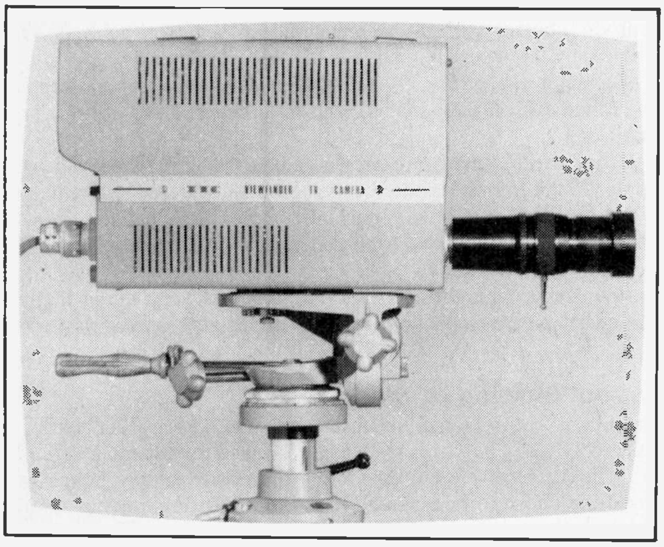
Brightness and Colouring Variations

The complaint with a Pye dual-standard colour receiver (691 chassis) was that the brightness level and picture colouring would intermittently vary together. On examination we found this to be the case and as no particular colour seemed to be involved our first move was to change the PL802 luminance output valve. This gave no improvement so we shorted its cathode pin to chassis in case the flyback blanking transistor in its cathode circuit wasn't being kept fully conducting during picture information. Again there was no improvement, so after checking the electrolytics in this part of the circuit we turned our attention to the circuitry associated with the clamp triodes in the colour-difference output stages. The cathodes of the three clamp triodes are connected together and taken to a potential divider which is decoupled by a 4μF electrolytic. The voltage developed here (107V) turned out to be correct, but to be on the safe side we replaced the electrolytic. There was again no improvement, so we took a look at the grid circuits of the clamp triodes. These are again connected together – via 470Ω grid stopper resistors – and there is little to go wrong. On replacing the 0·047μF clamp pulse coupling capacitor C372 however the trouble was completely cured.

No Results

The fault on a Pye Model CT200 (713 chassis) was simply no results, due to a blown 1·6A mains input fuse. The 630mA h.t. fuse was intact however, so the fault was clearly in the power supply circuit. The BY127 bridge rectifier diodes were checked, also the BT107 regulator thyristor, but the trouble turned out to be a short in the over-voltage protection neon – the h.t. voltage was checked and found to be normal after replacing this device.

CCTV



PART 17 **Peter GRAVES**

THIS series of articles has concentrated on the CCTV camera and monitor – digressing only to discuss equipment directly connected with their operation and setting up (such as the sync pulse generator and the grating and dot generator). On the applications side there are a number of pieces of auxiliary equipment such as camera housings, remote positioning devices and video signal mixing equipment that may be encountered. Although many of these devices are "one-offs" for specific jobs, it is possible to make some generalisations about the more common items.

Pan and tilt head

The pan and tilt head is a remote positioning device enabling the camera to rotate in two axes so that a large area may be viewed. Fig. 1 shows the difference between the terms pan and tilt which are also used in connection with ordinary tripods and camera mounts. Many cameras used with a pan and tilt head are also fitted with a zoom lens – a very useful combination allowing large areas to be scanned or a small area to be viewed in detail. The size and position of the area to be viewed can be quickly and easily determined by an operator who may be literally miles away.

In its simplest form a pan and tilt head (sometimes abbreviated to P & T head) has two electric motors independently driving the two axes, something like the sketch shown in Fig. 2. The motors are geared down and complete rotation on either axis is prevented by limit switches mounted inside the body of the unit and operated by moving cams or pins. These can be set to allow any desired degree of travel up to a full circle, further rotation is undesirable to prevent snarling up the cables – of which more later.

The operating control can be a set of four switches for the four functions (Pan Right, Pan Left, Tilt Up, Tilt Down) but more commonly, and more conveniently, a joystick is used (Fig. 3) operating microswitches as it is pushed from its central position. A pan and tilt head operated by a joystick control will be familiar to viewers of the "Golden Shot" programme, the button shown in Fig. 3 being used to fire the crossbow. The joystick panel markings refer to the direction in which the camera will move when that function is selected. If the joystick is pushed to the right, the camera will move to the right. However, the picture on the monitor will appear to move to the left and this can be confusing until some experience is gained in operating the equipment. Normally, pushing the joystick to a corner will simultaneously operate both functions selected so that the camera will move diagonally.

Braking

A simplified circuit of a pan and tilt head and its control unit is shown in Fig. 4. The motors are fed from the mains and have split fields so that they can be reversed by applying power to the appropriate winding. The limit switch opens the winding in use when the limit of travel in that direction has been reached, preventing further rotation so that the motor can then only be driven in the opposite direction. The arrangement described above is fine as far as it goes, but a camera, maybe in a weatherproof housing with its auxiliary gear, is pretty heavy and once moving is not so easy to stop. The motor tends to overrun after the joystick has been released, which is extremely irritating when trying to line the camera up on a specific object particularly one that is moving irregularly. It is desirable to brake the rotation as soon as the power to the motor is turned off and this can be done electrically or mechanically with brakes that are held off while the power is on to the motor.

To do it electrically (a common method) two microswitches are fitted to each position of the joystick; one acts as described before, turning the power on to one of the field windings of the

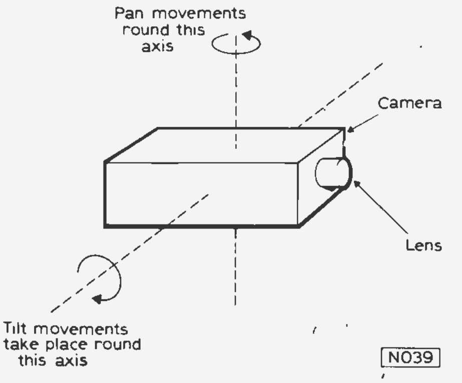


Fig. 1: Pan and tilt directions.

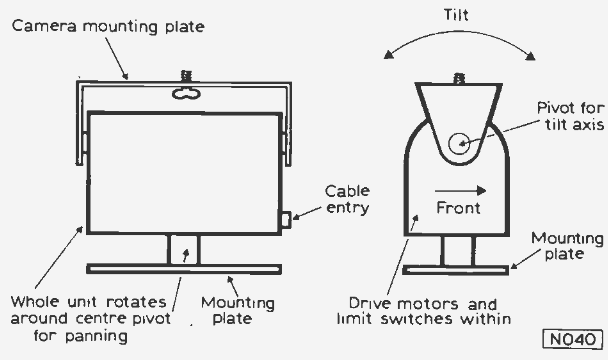


Fig. 2: Features of a pan and tilt head.

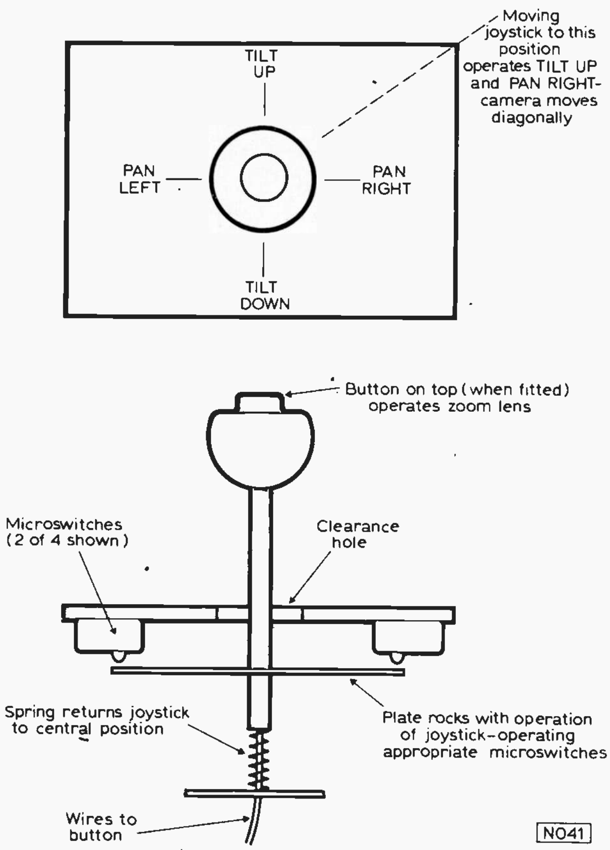


Fig. 3: The joystick control unit.

motor, while the other is set to operate as the first is released and it injects d.c. (typically 20-30V) into the motor field winding. The magnetic fields set up inside the motor rapidly bring it to a halt. It is also normal practice to fit suppression components onto all the current-carrying contacts to prevent arcing. There is no reason why the microswitches in the control unit should carry mains current; it is safer and sometimes more convenient to use them to switch low-voltage relays nearer the pan and tilt head which, in turn, switch the mains. For really long distance work (over several miles) the microswitches control tone generators (accurate audio oscillators) which are then fed to tuned relays switching the mains at the far end, different frequencies being used for different functions. Ordinary GPO telephone lines can be used for this but, of course, the camera video output needs a coaxial or radio link.

Maintenance

Maintenance of pan and tilt heads is minimal, just occasional greasing of the gears (and, where applicable, the motor bearings) and an all-round check on the tightness of all screws, paying particular attention to the limit switch settings as the operating pins sometimes work loose after long operations. The main practical problem is what to do with the cables. Camera cables (from separate-head cameras) cannot be bent into sharp curves, 500mm (20in) minimum radius is typical. They must not get trapped as the head is moved as this could damage the cable or stall the head. The technique is to strap all the cables (camera and auxiliaries) together and form them into a loose coil of two or three turns with a radius greater than that of the pan and tilt head. The pan and tilt head is at the centre of the coil and its movements will only make the turns get larger or smaller with no danger of their getting trapped.

There are many variations on the basic unit described above, versions having just pan or just tilt functions are available and some types use d.c. motors so that a change in direction can be achieved simply by reversing the supply. Other, more sophisticated types have a number of microswitches fitted so that the limit switch operating pin operates them in turn. By pressing one of a set of buttons that selects the microswitches the camera can be instantly turned to a predetermined position. The switches at the end of the travel act as limit switches in the normal way. Suppose in a factory there are several gates, parts of a fence, huts, etc. which must be kept under surveillance. If each of these places is fitted with a burglar alarm then the camera can be automatically turned to the suspect point when one of the alarms is tripped.

Measuring displacement

The amount of rotation on one or both axes (as applicable) is a measure of the position of the pan and tilt head and hence the position of whatever the camera is looking at. This can be of use in some applications. An ordinary potentiometer attached to an axis can be used to provide a readout of the position by measuring the resistance changes but, for more accurate work, optical encoders are used which give a digital readout suitable for coupling directly into computer or data processing equipment.

Inside an optical shaft encoder is a thin, transparent disc split into segments as indicated in Fig. 5. Each segment is printed (photographically) with a pattern of opaque areas forming a unique digital code, so that suitable processing equipment can work out from the code presented to it exactly how far the disc has been rotated from some arbitrary datum point. The code is read off by a series of lamps and corresponding photocells which are illuminated as the transparent portions of the disc pass over them. The accuracy with which the angle turned through can be measured depends on the number of segments on the disc – in the simple version of Fig. 5 we could only say that the disc was in one of six positions.

Practical application

To clarify the application let's look at a practical example (Fig. 6). When an ingot of steel (strictly called a billet of steel) is rolled out into, say a girder or railway line it is impossible to know exactly what its final length will be. We know that it will be, perhaps, about 10 metres but this is not good enough to avoid waste when it comes to be cut up into smaller pieces. The girder (as an example) after rolling passes along a set of steel rollers until it comes up against a stop. The camera, mounted in the roof on a tilt-only head, is scanned along the length of the girder until a graticule line – marked permanently on the tube target during the manufacturing process – coincides with the end of the girder. A zoom lens gives a close up view allowing for more accurate setting.

Since the camera is fitted at a known height above the stop, the amount of rotation is a measure of the girder's length and an optical encoder fitted to the rotating axis can measure this off. If the height above the stop is h metres and the angle turned through by the head is θ then the length of the girder l is: $h \tan \theta$ metres. A processing circuit following the encoder performs this calculation

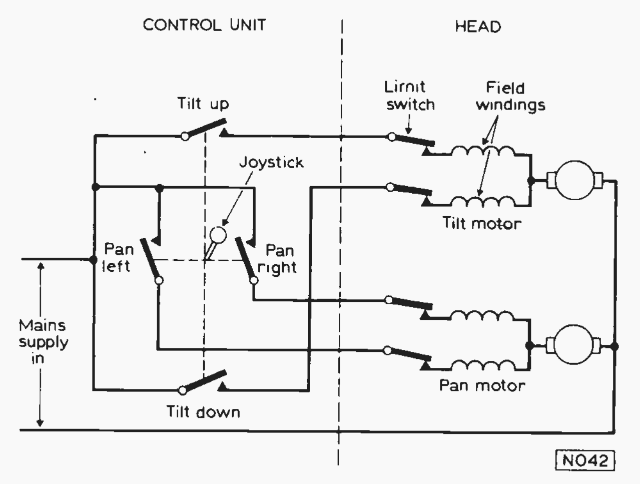


Fig. 4: Simplified circuit of a pan and tilt head and its control unit.

continuously as the camera is moved and gives a direct readout of the girder's length on a digital display. This can be fed directly to a computer in which is stored the length requirements for all the firm's customers. When the length of all the girders is known, the computer can be programmed to work out the most economical way of cutting them up to produce the minimum amount of waste.

Safety precautions

One hazard of using pan and tilt heads out of doors is the danger of leaving the camera in such a position that the tube could be damaged by unwanted light (such as that from street lights) falling on it or forgetting that the sun, which may be out of the way when the camera was parked, can move so that it shines on the vidicon, causing irreparable damage. In areas where this danger could exist (particularly if unskilled personnel use the equipment) it is advisable to fit a sun shutter, a small flap which can be moved in front of the vidicon by an actuator. These are made fail safe so that turning the power off causes the shutter to drop into the protective position. More sophisticated versions incorporate a photocell fitted at the front of the camera to close the shutter if the camera points at the sun during operation.

An alternative and cheaper method, which is useful if the area viewed looks similar in all directions (leading to confusion over where the camera is pointing) is to fit a target board at some convenient point where there is no danger of unwanted light damaging the vidicon. After use, the camera is parked looking at the board and slightly defocused to prevent the image of the board being imprinted permanently on the vidicon target.

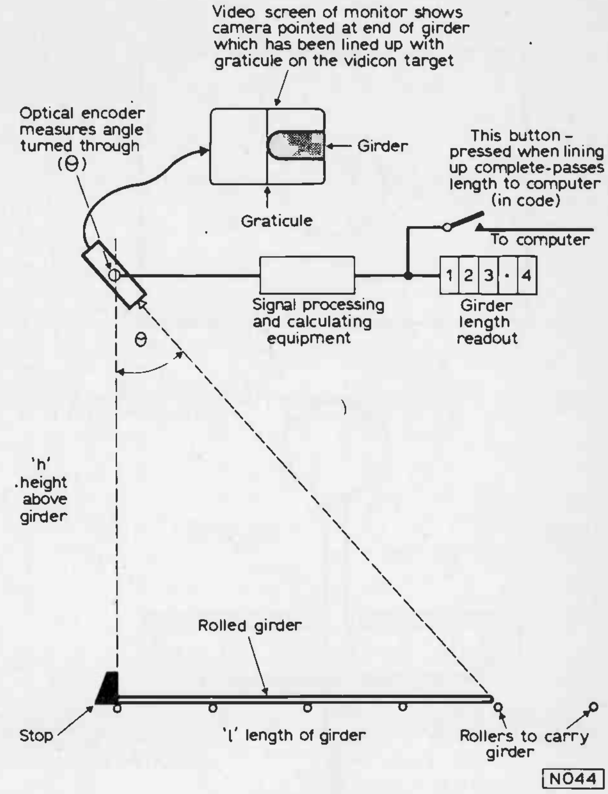


Fig. 6: Measuring the length of a girder.

Using cameras out of doors

Weather-proof housings, mentioned above, are essential for any camera used out of doors to keep the camera dry, warm in winter, cool in summer and to give it a clear window to look out of under all conditions. It must also be capable of taking the camera and remote control cables, which are generally admitted from underneath the housing through watertight glands to prevent leaks. At the front is a flat windscreen fitted with a remotely-controlled windscreen wiper driven by a motor inside the housing – just like a car but on a smaller scale. Windscreen washers can also be fitted for particularly dirty situations but normally the rain is enough to keep the window clear. A pair of thermostatically controlled tubular heaters (about 250W total in a typical unit) are fitted inside the housing to combat condensation and icing. To keep the heat down in summer a fibreglass sunshield is fitted over the top.

The top cover is secured by clips, and lifts off leaving a base on which the camera is mounted and (typically) a terminal strip used to distribute the mains supply and the remote control wiring for the windscreen wiper, heaters, camera remote focus and zoom

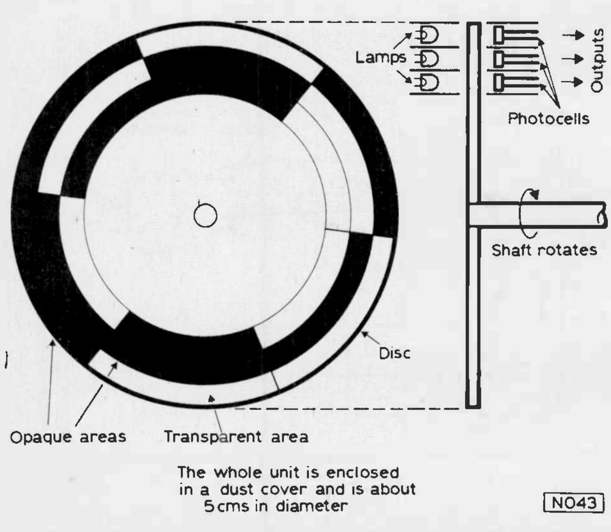


Fig. 5: Principle of the optical shaft encoder.

lens. Since many of these terminals carry full mains voltage care must be taken when removing the cover if the mains cannot be turned off. The cover itself is fairly large and no light weight with cables to things like the wiper motor and heaters attached to it, so a rather delicate balancing act is sometimes called for. Many remote cameras live up to their name and the only way of reaching them is by a platform lift truck such as is used to service street lamps or by acrobatics at the top of tall buildings. To remove the housing cover on one installation the author worked on involved straddling the parapet railing with a 14-storey sheer drop down one side – CCTV work can have a hazardous side to it!

Modern weatherproof housings are very reliable and, in the author's experience, the main trouble arises from connections to the terminal strip working loose or being torn off while removing the lid, or being trapped when it is replaced. If there is any likelihood of damage being caused by dropping the lid as it is removed, a safety chain between it and the base is advisable. When working on the exposed camera under these conditions tools can be tied to some safe point by thin string or wire, a sheet steel tray is sometimes fitted below the camera to catch any dropped items.

Furnace supervision

Cameras used for furnace supervision (for instance, in a power station or cement kiln) require more specialised forms of housings. These cameras are used to view the fuel burners of the furnace, allowing an experienced operator to gain much valuable information regarding conditions within the furnace from the size and appearance of the flames. The camera housing is tubular (and is sometimes referred to as a bomb housing from its appearance) and bolts directly onto the furnace wall looking through an aperture cut for the purpose.

Water cooling of the parts in contact with the furnace minimises heat transfer to the camera, and compressed air is fed up a large-diameter, asbestos-covered tube with the camera cable running up its centre. The air passes round the camera and out of

continued on page 485

LONG-DISTANCE TELEVISION

ROGER BUNNEY

THE long awaited Sporadic E season has arrived! From the second week of May very strong openings have been occurring daily, providing excellent reception from most European countries. At this stage it is difficult to say how the season will turn out, but experience so far can be summarised as follows. Signals have been mainly of medium to long distance, relatively few short distance, i.e. up to 700 miles, signals having been seen. The direction of reception has varied, with no specific path favoured. There have as yet been none of the always hoped for exotic signals, but this is certainly something to be looked out for in the coming weeks – by the time this column is read I'm certain something will have been received. For my part I'm hoping to receive Jordan channel E3: this signal has evaded me for many years and although near misses last year included Lebanon ch. E4 and a mysterious (and as yet unidentified) announcer wearing a fez, still no Amman!

The Month's Log

As I was away on holiday during the first part of May log keeping was taken over by our Derby friends Keith Hamer and Garry Smith. Their combined log up to the 11th is as follows:

1/5/75 RTP (Portugal) ch. E2; RTVE (Spain) E4 – both SpE.
2/5/75 Switzerland E3 – MS (meteor shower).
3/5/75 ORF (Austria) E2a; TVP (Poland) R1; Switerland E3 – all MS.
4/5/75 CST (Czechoslovakia) R1; MT (Hungary) R1; Switzerland E2 – all MS.
5/5/75 Switzerland E3; CST R1; ORF E2a – all MS.
6/5/75 RTVE E3; CST R1 – both MS.
7/5/75 RTVE E3; RAI (Italy) IA; TVP R1 – all SpE; CST R1 – MS.
8/5/75 TVP R1; CST R1; ORF E2a – all MS.
9/5/75 TVP R1; ORF E2a – both MS.
10/5/75 TVP R1; ORF E2a; RAI IB – all MS.
11/5/75 CST R1; MT R1 – both MS.

Continuing for the rest of the period with my own log:

12/5/75 JRT (Yugoslavia) E4; RAI IA; ORF E2a; RTVE E2; SR (Sweden) E2; DFF (East Germany) E3; CST R1; TVP R1, 2; TSS (USSR) R1, 2 – all SpE, in fact a very good opening which lasted most of the day!
13/5/75 YLE (Finland) E2; TSS R1; SR E2; NRK (Norway) E2 – all SpE.
14/5/75 RAI IA; unidentified programmes on R1, 2 – all SpE; SR E4 – MS.
15/5/75 MT R1, 2; JRT E3, 4 – all SpE; TVP R1 – MS.
16/5/75 RAI IA; CST R1; DFF E4 – all MS.
17/5/75 TSS R1; SR E2, 4 – all SpE; DFF E4; CST R1; RTVE E2; MT R1 – all MS.
18/5/75 RTVE E2, 3, 4; RTP E3, NRK E2, 3; SR E4 – all SpE.
19/5/75 RAI IA; TVP R1, 2; plus unidentified programmes – all SpE.
20/5/75 Unidentified programmes on R1, 2.
21/5/75 TVP R1, 2; RTP E3; DFF E4; unidentified programmes – all SpE.

Excellent Tropospheric conditions were present during the 19th-21st: many French u.h.f. stations were received here.

22/5/75 TVP R1, 2 – SpE. The ch. R2 signal was from the low-power (1kW e.r.p.) second chain transmitter at either Krakow or Wroclaw.
23/5/75 DFF E4 – MS; MT R1; RTVE E2 – both SpE.
24/5/75 RTVE E2, 3, 4; NRK E2, 3; YLE E2; WG (West Germany) E3; SR E2, 3; TSS R2; TVP R2; CST R1 – all SpE.
26/5/75 DFF E4 plus unidentified PM5544 test card on ch. E4 at 0740 – both MS.

Matters Arising

As can be seen then the season really opened up from the second week and apart from several days without signals there have been long duration conditions for much of the time. There seems to be a tendency for the higher frequency signals (E4 and Band II) to be less in evidence though other enthusiasts have seen signals up to ch. R4, including TVR (Rumania), TSS and TVP. The new Spanish test card has been observed on a number of occasions. Both Garry Smith and Ian Beckett have seen a mystery signal from ORF (Austria) on ch. E3. There are five transmitters operating on this channel in Austria but the highest has a power of only 100W – so either a new transmitter has opened or our friends have received one of these low-power relay stations!

Garry Smith gives warning about confusing captions: he received a caption from JRT on ch. E3 with "SKENDIJA" and underneath "RTP". Care is obviously necessary over this logging. On the 19th I noticed the old circular West German test card on ch. E25 at 2250. This faded to a very low level and was followed by a clock and the news at 2300. I suspect this was BRT (Belgium) ch. E25 and not West Germany: has anyone else seen Belgian TV using alternative test cards?

News Items

East Europe: It appears that CST-1 (Czechoslovakia) has been including colour test transmissions during normal programme periods since May 1st. Up till then all colour tests were on CST-2. It is planned that TVP (Poland) transmissions will be 100% colour by 1978. A new 200kW transmitter is operating on ch. R26 at Tokaj (Hungary).

Eire: Paul Duggan reports that the second chain will be operated by RTE. The channels have been allocated and equipment is being purchased. Except for u.h.f. coverage in the Dublin area all transmitters will operate at v.h.f. Initial tests will start in February 1976 with January 1st 1977 as the opening date.

Nigeria: Rivers State TV Service commenced test transmissions on ch. E10 on January 1st. The Beneu Plateau State TV station was commissioned in February, covering three-quarters of the state. Colour TV is to be introduced in the mid-west later this year and the government has announced that a national colour

LONG-DISTANCE TELEVISION

TV service covering the whole country is to be built during the period covered by the Third National Development Plan.

Iran: Iranian Radio and Television has signed an agreement with a French company to manufacture transmission equipment in Iran under licence. There is to be rapid expansion of broadcasting in Iran, including two TV networks. The country is vast, so a great number of transmitters and relays will be required.

China: A second TV channel is now in operation at Canton on ch. R8.

Libya: New transmitters and links are to be installed deep in the Sahara to extend the coverage which is at present mainly limited to the coastal area.

Present Sunspot Cycle

A report from Pat Dyer via the WTFDA indicates that on the basis of recent Swiss and American sunspot counts the sunspot minimum during the present cycle will *not* occur during August this year as previously expected but during 1976 or 1977. There is further gloom since it is now being predicted that the next cycle (21) will have a maximum count less than the present declining one. This is sorry news for possible world-wide DX-TV via F2.

New Test Card Booklet

We mentioned briefly last month the new test card book *Guide to World-Wide Television Test Cards* by Keith Hamer and Garry Smith, and have now had an opportunity to examine it carefully. This excellent work has been compiled from their vast collection of test card photographs to give a really comprehensive guide which is an essential for all DXers. There are 264 photographs in all and a further 11 pages of text which includes world transmission standards and other notes. The 56-page booklet is available – with either green or magenta cover – from HS Publications at either 7 Epping Close, Mackworth Estate, Derby DE3 4HR, or 17 Collingham Gardens, Derby DE3 4FS. The price is £1·30 including postage to any part of the world. It is understood that only a limited first edition has been produced, so it may be wise to avoid delay in ordering.

Whilst on the subject of booklets please note that my *Long Distance Television* book is no longer available from Weston Publishing. All copies of the last edition have been sold. A new edition is being produced by Bernards and as soon as a publication date and other details are available these will be passed on.

TV in Eastern Europe – 2

Though the USSR extends far beyond Europe, it is logical to include it in this summary (continued from last month). The USSR has a vast complex of networks and several programme chains. Multi-lingual radio and TV is necessary because of the large number of nationalities within the USSR. TV broadcasting started from Moscow in 1946 and the ch. R1 outlet is still in operation though with power increased to 15kW. Ten years later the Moscow ch. R3 station came into operation while colour transmissions began in 1963 on ch. R8. Monochrome transmissions from Leningrad on ch. R1 started only a month after the first Moscow transmissions. Leningrad-2 subsequently opened on ch. R3. The Molinya satellite system was introduced in 1959-60. It provides network feeds for distant stations in the USSR and for OIRT networks in Eastern Europe. There are 34 main provincial TV centres, and over 120 programme centres plus some 161 which take the Moscow programmes on network. Most small local centres operate two channels. The NIIR colour system used is a modified version of the French SECAM system. The executive control centre is on Sjabolovka Street, Moscow, though the Moscow technical centre and studios are now at the Ostankino TV centre.

Reception of TSS (Televidenie Sovietskogo Soiuza) is relatively easy given favourable conditions, but problems arise since apart from the regional identifications transmitted at programme commencement identifying specific transmitters is difficult. A common test card is used. At times the electronic patterns carry network identifications (e.g. EESTI) but the 0249 card does not generally carry an identification.

Yugoslavia

Television began in Yugoslavia in May 1956 at Zagreb (Croatia). Transmissions from the capital, Belgrade (Serbia), started two years later. Yugoslavian TV is extremely regional, with entirely separate organisations for Belgrade, Zagreb, Ljubljana (Slovenia), Sarajevo (Bosnia and Herzegovina), Skopje (Macedonia) and Titograd (Montenegro). The central Jugoslovenska Radio Televizja (JRT) and the Radio Television Belgrade (RTB) offices are at separate addresses in Belgrade. RTB operates ten main transmitters and a number of relay stations. Radio-TV Zagreb operates seven main transmitters.

The Slovenian networks are controlled by Radio-Television Ljubljana: the Krvavec transmitter (ch. E5) was one of the first in Yugoslavia. There are nine main stations and over eighty repeaters. The first Radio-TV Skopje experimental v.h.f. transmissions were in May 1961 while the Montenegro TV service was set up in May 1963 with transmitting centres at Bjelasica and Lovcen.

The various Band I Yugoslavian transmitters are well received in the UK when SpE conditions favour that direction. Recent reports indicate that a new ch. E2 outlet is in operation.

Grateful acknowledgement is due to Stuart Cox of the Whitton Press Ltd. for giving us permission to extract the information in these notes from the *International Broadcast Engineer*.

Book Recommendation

An interesting and enlightening account of television networks both in Europe and world-wide is given in *The Universal Eye – World Television in the Seventies* by Timothy Green (Bodley Head, published 1972). I recommend this to anyone interested in the subject.

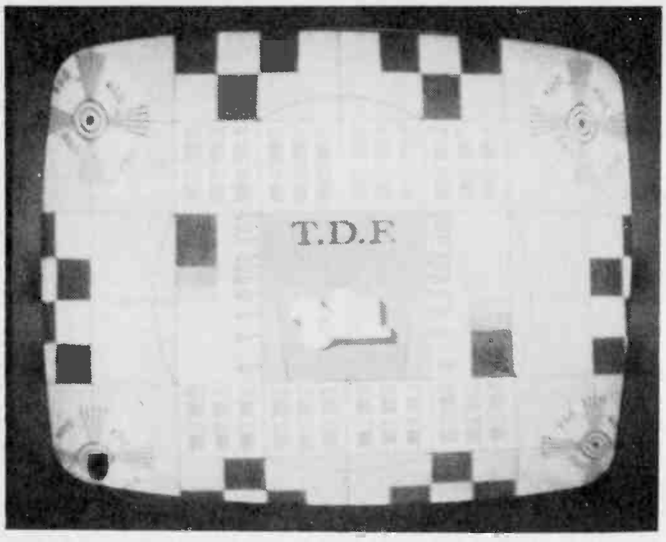
New EBU Listings

West Germany: Göttingen ch. E21 e.r.p. reduced from 220kW to 160kW; Schnaitsee ch. E26 e.r.p. reduced from 500kW to 180kW; Langenburg ch. E28 e.r.p. reduced from 230kW to 200kW; Rhön ch. E29 e.r.p. reduced from 490kW to 350kW; Höhbeck ch. E29 e.r.p. increased from 110kW to 160kW; Schnee-Eifel ch. E30 e.r.p. reduced from 250kW to 195kW; Baden-Baden ch. E31 e.r.p. reduced from 330kW to 220kW; Eggebirge ch. E31 e.r.p. reduced from 250kW to 175kW; Saarbrücken ch. E32 e.r.p. increased from 330kW to 470kW; Deggendorf ch. E40 e.r.p. reduced from 400kW to 270kW; Baden-Baden ch. E41 e.r.p. reduced from 300kW to 150kW; Bad Marienberg ch. E44 e.r.p. increased from 138kW to 200kW; Hesselberg ch. E47 reduced from 260kW to 200kW; Eggebirge ch. E48 e.r.p. increased from 110kW to 190kW; Schnaitsee ch. E54 e.r.p. reduced from 252kW to 140kW.

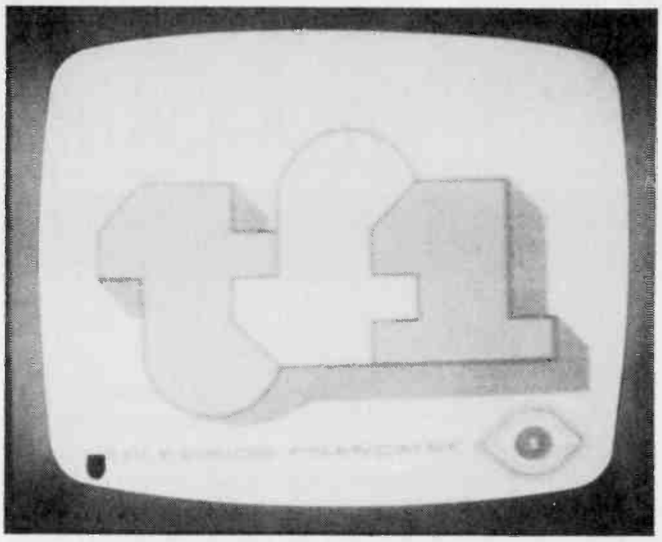
Wideband Preamplifier IC

The OM185 hybrid integrated circuit used in the wide-band aerial preamplifier featured in the June issue of *Television* can be obtained from Ian C. Beckett, Gorran, Chackmore, Buckingham MK18 5JF. The cost is £10·95 which includes post and packing and VAT at 25%. Delivery is about fourteen days, depending on the stock situation at the manufacturers (Mullard).

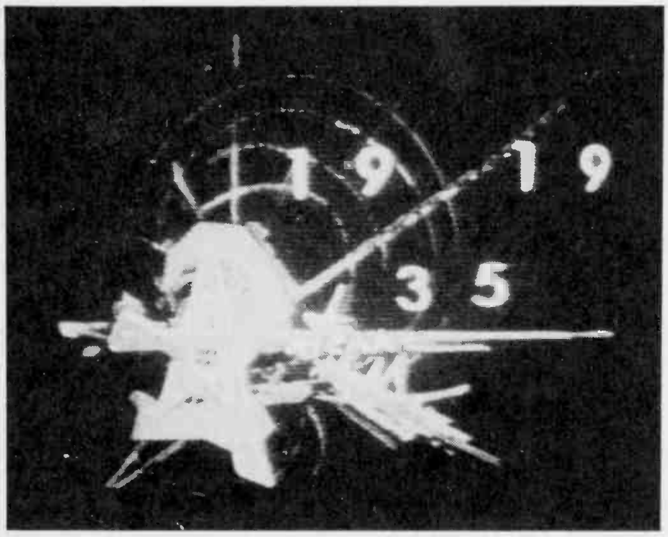
NEW FRENCH TEST CARD AND SLIDES



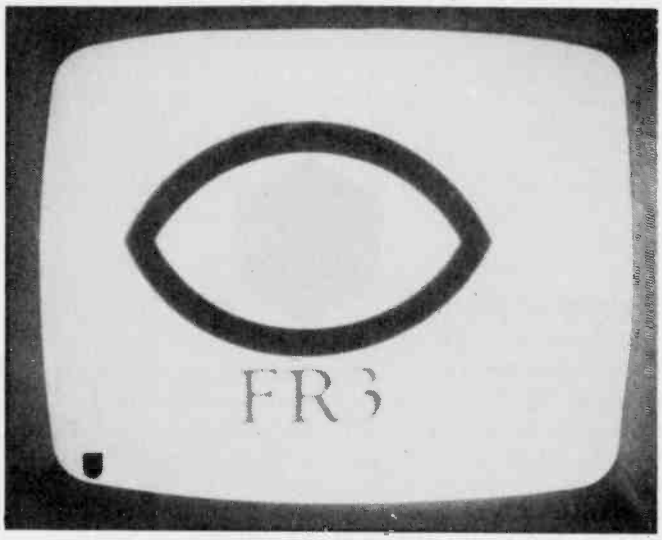
(1) Télévision Française TF1 (French first chain) test card.



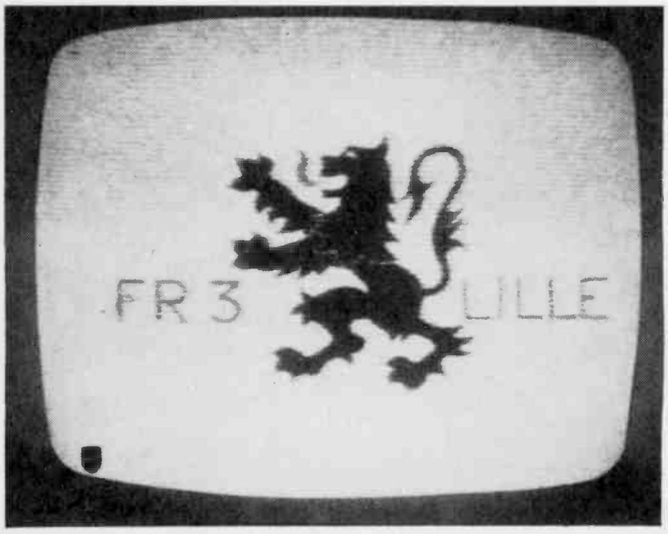
(2) Télévision Française identification slide.



(3) Antenne 2 (French second chain) identification slide.



(4) France Régions FR3 (French third chain) identification slide.



(5) A regional identification slide – FR3 Lille.

(6) Télédiffusion de France slide. TDF is the new overall organising body.

All photographs courtesy Ryn Muntjewerff.

THE THORN 9000 CHASSIS

Syclops and all that

Barry F. PAMPLIN

THE new Thorn 9000 colour chassis, built around the PIL c.r.t., introduces to the UK domestic electronics market circuitry which is both novel and ingenious – in particular the Syclops line output/regulated power supply arrangement. The purpose of this article is to explain the operation of this circuit and to discuss some servicing aspects: we shall also take a look at the rather unusual field output stage.

Syclops, derived from SYnchronous Convertor and Line Output Stage, has the somewhat abstract connection with its mythological namesake that whereas the latter saw all with one eye the former does all (or nearly so) with one transistor. By using a single transistor as both a power supply chopper and the line output device, economies have been achieved: the cash saved has been used to provide a really effective automatic overload trip circuit.

Evolution of Syclops

The way in which Syclops was evolved is illustrated in Fig. 1. Consider first the basic shunt chopper arrangement shown in Fig. 1(a). The mains input is rectified by D1, C1 and applied to a transformer (T1) whose primary winding is returned to chassis via the chopper transistor Tr1. A squarewave input applied to the base of this transistor switches it between cut off and saturation, the resulting build up and decay of flux in the transformer inducing a voltage in the secondary winding. The value of this voltage varies according to the mark-space ratio of the transistor's base drive waveform: it feeds a second rectifier D2 which provides d.c. for the various circuits in the receiver. The circuit shown in Fig. 1(b) is a conventional transistor line output stage with shunt efficiency diode: for this circuit to function the base of the transistor must be fed with a squarewave drive synchronised to the line frequency.

The combination of these two circuits to give the Syclops arrangement is shown in Fig. 1(c): the circuit requires a transistor base drive waveform consisting of line frequency pulses with a variable mark-space ratio, while the primary of the line output transformer T2 must be fed from an h.t. rail derived from the secondary winding of the chopper power supply transformer T1. This, in bare essentials, is the Syclops circuit.

Putting Syclops into Practice

Converting this essentially simple concept into a practical circuit is of course a long-term design job. How it has been put into practice in the Thorn 9000 chassis will now be explained.

The complete line timebase/power supply circuit is shown in simplified form in Fig. 2. To start at the beginning, let's first consider what happens at switch on. The 230V a.c. mains supply is applied to W701, which conducts on alternate half cycles charging C702 to 325V d.c. This voltage is applied via T701 and W702 to the collector of the Syclops transistor VT701, which is cut off since it is without base bias. The 325V supply is also applied to the collector and base of the driver transistor VT412, via R422 and R419 respectively. In consequence this transistor turns on and its emitter current, flowing via the regulator circuit, generates a nominal 12V supply for the line oscillator and the Syclops control circuit.

Two things then start to happen: the line oscillator starts up and provides approximately squarewave pulses to VT602 base, and the charging (ramp) capacitor C604 commences to charge towards 12V at a rate determined by R_B and the transistor in parallel with it (VT601). When the voltage across C604 reaches 4·9V it operates a switch circuit which biases VT605 into conduction (the switch consists of a couple of transistors, VT603 and VT604, connected in a regenerative circuit — see Fig. 3). Consequently VT605's emitter voltage falls towards chassis potential, removing the forward bias to VT412 via R419. The driver transistor cuts off, and the resulting pulse at its collector is coupled by T401 to the base of the Syclops transistor VT701. This now conducts and after a few cycles the h.t. supplies appear.

One of these supplies is the 90V rail used to feed the line

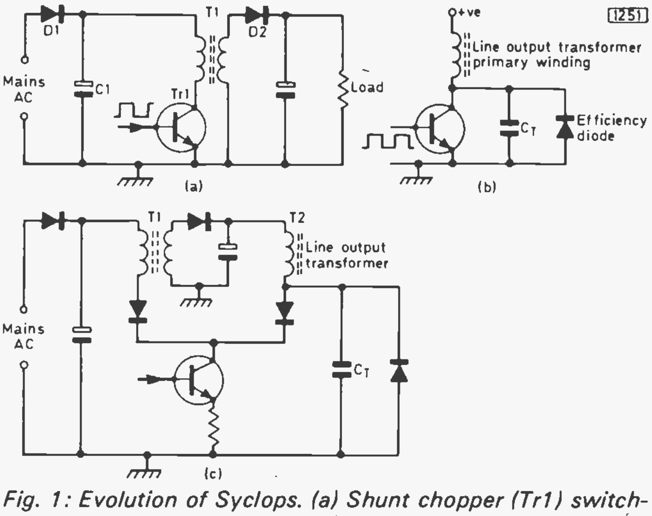


Fig. 1: Evolution of Syclops. (a) Shunt chopper (Tr1) switch-mode power supply circuit. (b) Basic transistor line output circuit. (c) How (a) and (b) combine to give Syclops—synchronous converter and line output stage.

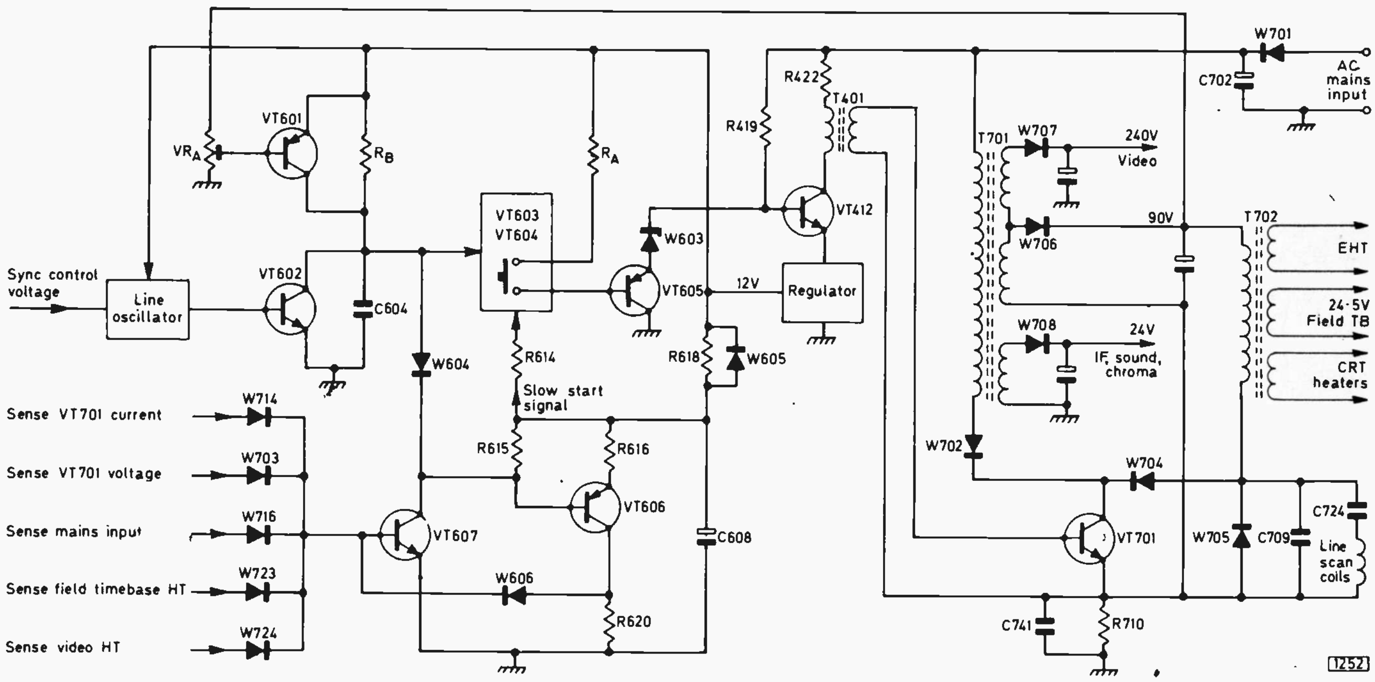


Fig. 2: Simplified Syclops circuit. In practice W716 and W723 are zener diodes—see Fig. 3.

output side of the Syclops circuit. This voltage is also fed back to a potential divider (VRA) which sets the base bias applied to VT601 which is connected in parallel with the ramp timing resistor RB. Thus if the 90V rail voltage varies so will the conduction of VT601 and the charging time of C604. This in turn alters the mark-space ratio of the squarewave pulse train produced by VT603 and VT604, used to switch the Syclops transistor VT701 on and off.

The rising voltage across C604 operates the switching circuit VT603/VT604 – turning the switch on. VT602 is used to discharge C604 periodically. This action occurs at line frequency, under the control of the line oscillator, and when C604 is discharged VT603 and VT604 switch off. C604 then recharges and the cycle of events repeats. The important point is that VT603/VT604 are switched off at a fixed time during each cycle, the point at which they switch on again depending on C604's charging rate. This gives the variable mark-space ratio drive waveform.

Line Output Section

Once the line output stage comes into operation VT701 carries both the line scan current and the power supply current – a total of about 5A peak. When VT701 cuts off the flyback occurs followed by the efficiency diode (W705) action which as usual provides the first part of the forward scan. Continuity of scan current conduction is ensured by using a diode with a long reverse recovery time as the efficiency diode – i.e. it actually remains conducting for about 3μS after VT701 has been switched on again.

This covers everything in Fig. 2 except VT606 and VT607. These are the slow-start and trip transistors which perform vital actions in ensuring that the chassis gives reliable performance.

Slow-start System

The start up of the Syclops circuit involves a complex chain of events and it is important to ensure that initially the width of the switch-on pulses applied to VT701 is narrow, so that the h.t. supplies start low, gradually increasing as the mark-space ratio of the drive waveform increases. C608 is used to achieve this state of affairs, by modifying the operation of the switch VT603/VT604 for about 500mS after the set has been switched on.

Trip Circuit

The trip circuit, using VT607 and VT606, is a self-resetting arrangement. VT607 monitors the important circuit parameters indicated in Fig. 2, shutting down the Syclops circuit in the event of abnormal conditions. The presence of an excessive voltage at any of the trip transistor input diodes results in VT607 conducting, short-circuiting and discharging the ramp capacitor C604. VT607 and VT606 are cross-coupled, and in consequence lock-on, keeping the ramp capacitor discharged and also discharging the slow-start capacitor C608. Once C608 has discharged the only feed to the circuit is via R618, which cannot supply sufficient current to hold the transistors on. Consequently they turn off, removing the short-circuit across the ramp capacitor so that Syclops restarts. Since C608 has been discharged the slow-start mechanism will operate. To ensure that C608 discharges rapidly when the set has been switched off, it is connected via W605 to the 12V supply.

Pulse Sequence

This description, together with the pulse time sequence shown in Fig. 4, should enable the operation of the complete circuit (Fig. 3) to be understood.

Servicing

The very novelty of the Syclops circuit makes the service engineer wary, while the comprehensive nature of the tripping circuit tends to mask the root of a fault condition. Two obvious fault conditions are set dead and set tripping. We will consider these two in turn.

Set Dead

If the set is dead the first check should be the mains fuse F1. Failure of this will usually indicate trouble with W701, C702, T701 or VT701. First establish whether voltage is present on C702, working backwards or forwards from

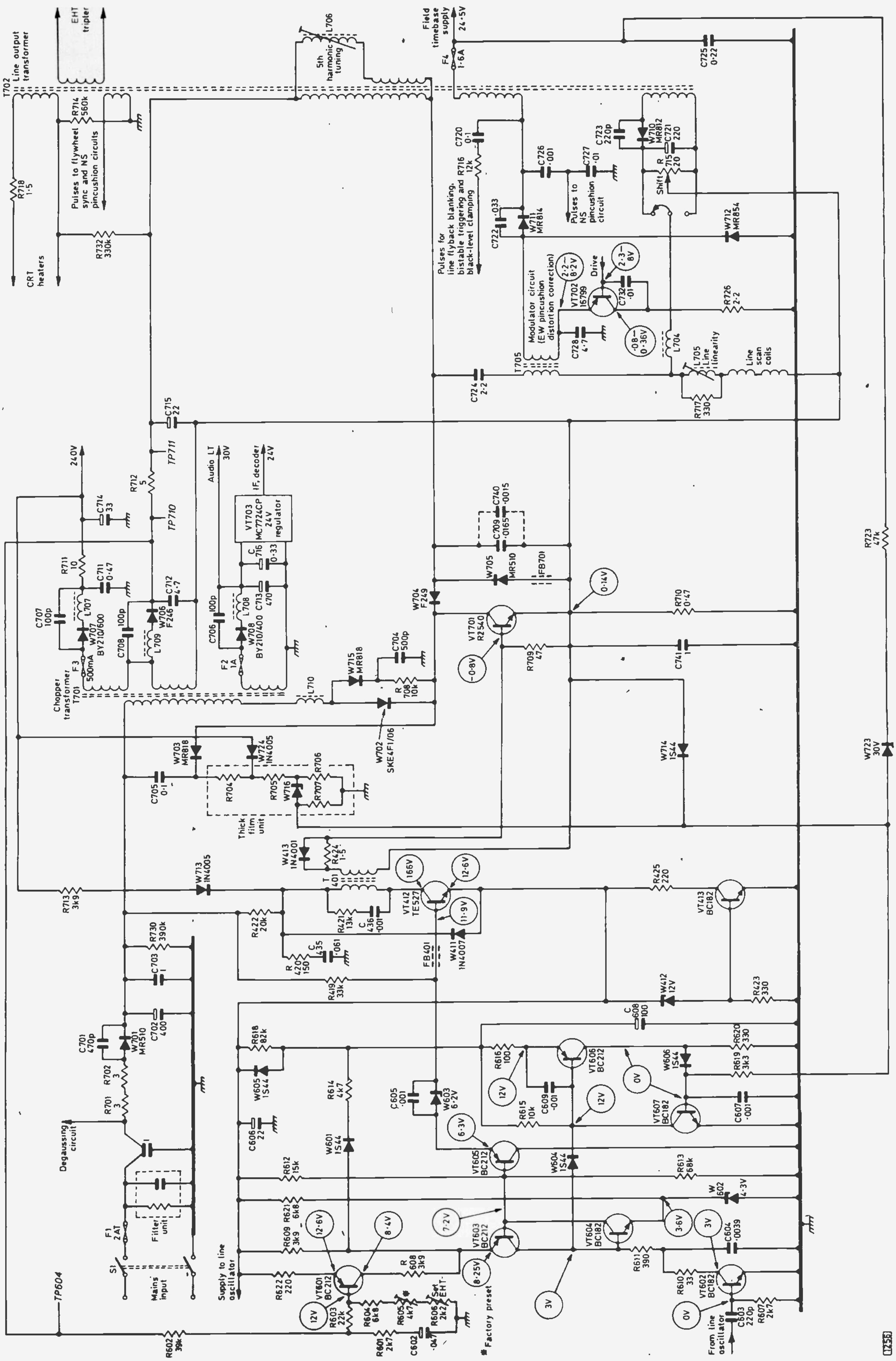


Fig. 3: The complete Syclops circuit as used in the Thorn 9000 chassis.

there. The presence of voltage at VT701 collector with "dead set" symptoms indicates lack of base drive. Check for 12V at VT412 emitter. If this is present the trouble will lie in the circuit encompassing the line oscillator, VT601/ VT602/VT603/VT604/VT605/VT606/VT607. A check around the transistor voltages should provide the answer. Note particularly that a leak between the collector and emitter of either VT602 or VT607 will stop the circuit operating.

Set Tripping

If the circuit is in the continuous tripping state, the best approach is to remove the various fuses in the circuit to see whether the fault can be isolated. If this does not reveal the source of the trouble the assumption must be that there is a fault in the line output stage, the tripler or the 90V feedback loop.

A feature of the field output circuit used in this chassis is that a fault which reduces the current drawn by the stage will result in a dramatic increase in the field timebase supply voltage. The first step therefore is to see if the tripping stops when F4 is removed. This cuts off both the feed to the field timebase and the sensing feed to the trip circuit. If the tripping stops, connect a 120Ω 5W resistor between the field timebase supply line and chassis and then trace the cause of the fault.

If removing F4 does not stop the tripping remove F2. This isolates the sound output stage, i.f. and chrominance circuits and the 24V regulator. If tripping then stops check with the fuse replaced but the sound panel disconnected. If tripping persists suspect the 24V regulator VT703 (i.c. type MC7724CP) or W708.

If the 24V circuits seem to be in order remove the 240V video supply feed fuse F3. Note that in this condition the 90V rail will rise and the drive to VT701 will be at "minimum": the set should not be operated in this condition for long. If this stops the tripping check W707, C714 and for leaks around the RGB output stages.

If these fuse isolation checks do not reveal the source of the trouble the next step is to look around the line output stage. Check for a start the resistance between TP711 (junction R712/C715) and chassis. Normally the resistance should be 10-20Ω one way and more than 10kΩ the other. A guide to whether the stage is passing more current than it should is the voltage developed across R712. More than 5V here indicates trouble with the e.h.t. tripler, the line output transformer or the horizontal shift circuit.

If all these tests show that the other stages are o.k. the final culprit is the 90V stabilisation loop. This can develop faults which drive the 90V line up and keep it there. Check first that there is continuity between TP710 (junction W706/C712) and TP604 (90V input to the line generator/Syclops control circuit). If this is o.k. short the base and emitter of the 90V comparator transistor VT601. This will keep the 90V rail low and stop the tripping until the fault, probably around VT601, is tracked down.

Warning

Finally, on no account should the set be operated with any of the trips disconnected.

Field Timebase

The field timebase circuit is similar in basic operation to that of the Rank Z718 chassis, which is also built around an in-line gun c.r.t., described last month. The common starting point in these designs is the use of toroidally wound field scan coils. The newness of this type of circuit justifies a close look at the Thorn version. We will start with the oscillator (see Fig. 7).

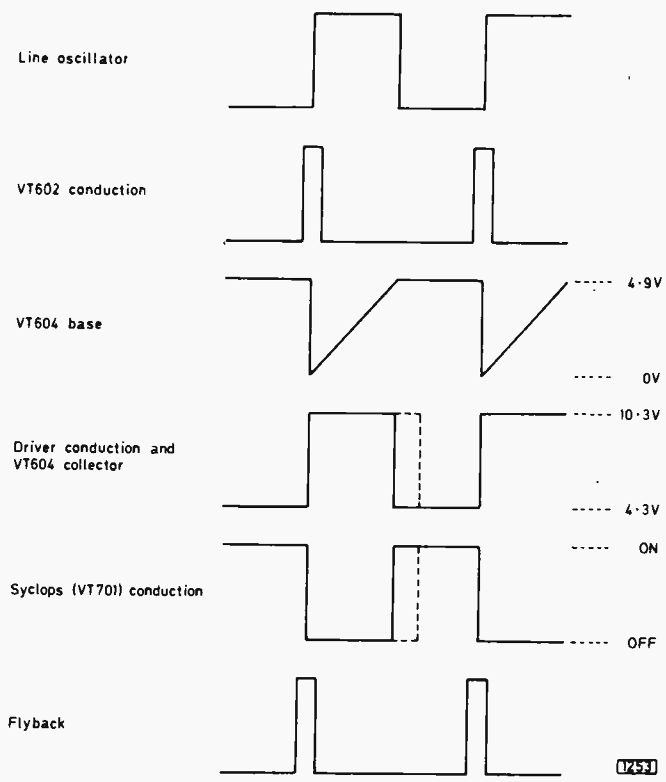


Fig. 4: Time sequence of Syclops pulses.

Oscillator

Positive-going field sync pulses from the SN76226 i.c. on the signal panel are integrated by FR1 1-2 (field film resistor module one, section between pins 1 and 2) and C401 and fed via W401 and C402 to VT402 base.

The field oscillator consists of the complementary pnp/npn pair VT401/VT402. During the field scan period neither transistor conducts, the positive charge on C404 reverse biasing W402 so that there is no current through

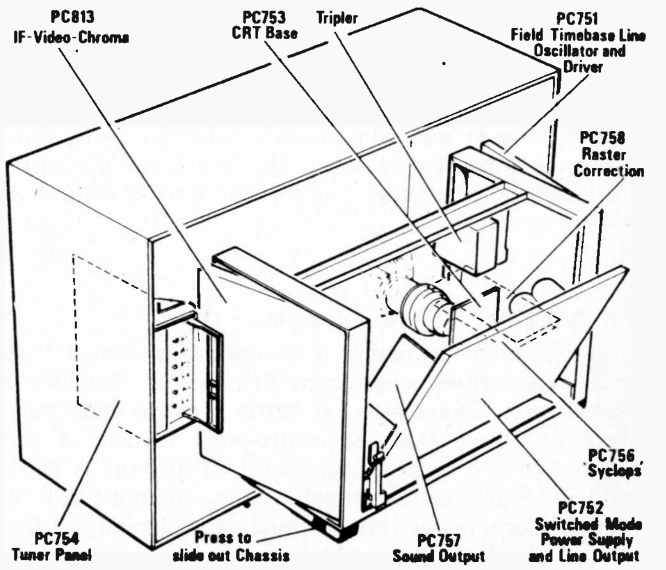


Fig. 5: Arrangement of the printed panels in the Thorn 9000 chassis. The bottom panel is shown tilted for access to the copper side.

FR2 2-4, VT401's base and emitter voltages being in consequence the same. With no current being passed by VT401 there is no voltage across FR1 7-5 so that VT402 is also without base bias. During the scan period the charge on C404 slowly leaks away via FR1 6-5 and as the end of the scan approaches W402 and VT401 gradually turn on. As the collector current through VT401 increases, the base potential of VT402 rises and regenerative action results in both transistors saturating, thus initiating the flyback. During the flyback C404 begins to recharge, gradually reducing VT401's base current: its collector voltage falls, bringing VT402 out of its saturated condition. The increase in VT402's collector voltage is a.c. coupled by C404 to W402 cathode, reverse biasing W402. The action is regenerative, both transistors turning off. The timing capacitor C404 then starts discharging again and the next field scan commences.

Field Charging Capacitor

This circuit action may seem complex but the end product is simply that VT402 is switched at field frequency between saturation and cut-off. When it saturates, W403 also turns on discharging C405. It is this capacitor which produces the field scan waveform: when VT402 cuts off again C405 charges via FR3 1-2. Because of the time-constant values of the circuit the voltage build up is exponential, i.e. as the waveform amplitude increases it deviates more and more from a linear ramp. This factor is made use of to provide scan correction during the second half of the field.

FET Buffer Stage

The waveform generated across C405 feeds the source-follower field effect transistor VT403 which acts as a buffer stage with a high input impedance and low output impedance. The output from VT403 is tapped from one of its source resistors R426 which controls the height of the raster.

Scan Correction

Since the first part of the scan waveform present at VT403 source is still linear it requires scan correction before being fed to the output amplifier. This is achieved by feeding back to VT404 base via the differentiating network C414, R415 the signal developed by the scan current across R411. This signal is in opposite phase to the signal at VT403 source and consequently subtracts from it to produce the correction required. The field linearity control R413 is connected in series with R415 to provide control of the scan correction.

Field Amplifier: DC Conditions

The field amplifier design is somewhat unusual. It can best be explained by considering first the d.c. conditions. As the output voltage swing is nearly equal to the supply voltage it follows that the centre-point voltage at the collectors of the output transistors VT406 and VT407 should be roughly half the supply voltage and must be held stable – failure in this respect could cause limiting of the output signal, resulting in a non-linear scan.

The scan-corrected waveform at VT403 source is fed to the driver transistor VT404. The output from the collector of this transistor is d.c. coupled to the output stage. D.C. stabilisation over this loop must be provided therefore. For this purpose feedback is applied from the centre point of the output stage to VT404 base via R402, W405 and FR3 7-3. C410 together with R402 provide integration to ensure that a.c. feedback does not occur.

Quite apart from the need to stabilise the centre-point voltage, stabilisation of the quiescent current flowing in the output pair is vital. This is where VT408 comes in. Its base is fed from the network W407, W408, R409 across the supply, while its emitter is fed from R405 through which the quiescent current of the output transistors flows. Consequently VT408 compares the voltage across R405 with the fixed bias applied to its base.

The base of the lower transistor (VT407) of the output pair is tied to the collector of VT408. Thus if the quiescent current falls the voltage across R405 drops, VT408's emitter is driven positively so that it turns on harder, the increased voltage across R408 turns VT407 on more and the voltage across R405 returns to normal – equal to the bias on VT408. W406 ensures that the voltage across R405 cannot exceed about 2V. R406 and C411 provide damping in this feedback arrangement to prevent instability.

Field Amplifier: AC Operation

So much then for the d.c. aspects of the circuit. We will now consider the part they play in the circuit's a.c. operation. For the purposes of our discussion we will assume that the Darlington pair VT405, VT406 forms a single transistor, VT4056, to the base of which the field drive sawtooth waveform is applied.

Consider the waveforms shown in Fig. 6. A sawtooth drive is applied to VT4056 and from point A to point B VT4056 acts as a straightforward amplifier, providing drive to the scan coils. Current flows from chassis via R411, C413, the scan coils, VT4056 and R405 to the positive supply rail. During this part of the scanning cycle the voltage across R405 is such that both VT408 and VT407 are cut off. When the current through VT4056 reaches the stabilised quiescent current level however – point B – the d.c. feedback circuit comes into operation. Thus VT407 starts conducting. This reduces further the voltage applied to the scan coils, and the decaying flux around them draws current from chassis via VT407. As a result between B and C VT407's collector current rises from zero to the stabilised quiescent current. At point C the current flowing in the coils falls to zero. The coils are then connected across points of equal potential – the junction of VT4056

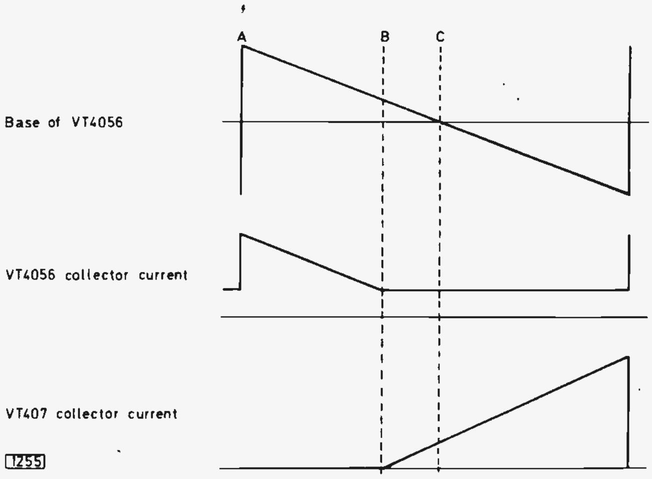


Fig. 6: Field output stage waveforms.

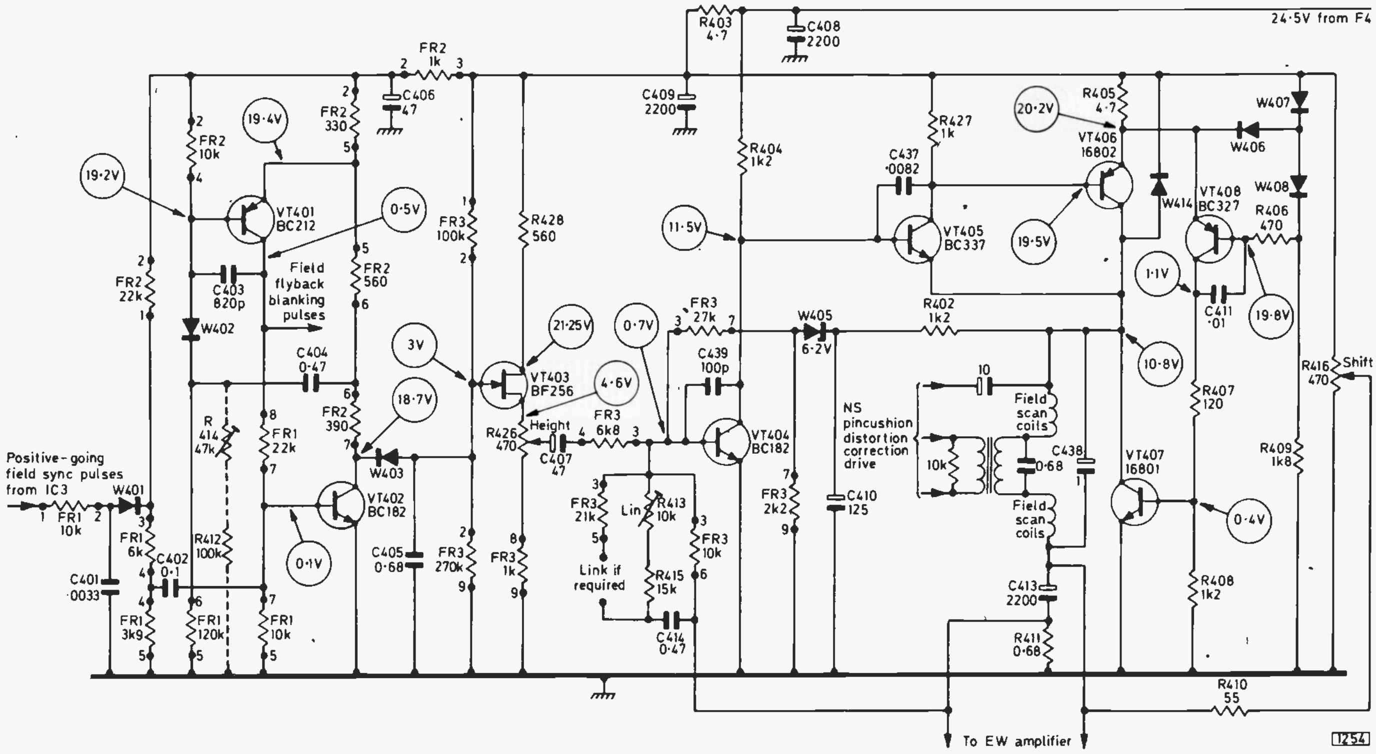


Fig. 7: Complete field timebase circuit used in the Thorn 9000 chassis.

and VT407 collectors and the slider of the vertical shift control R416. The quiescent current in the circuit flows via VT407, VT4056 and R405 to the positive supply line. The drive applied to the base of VT4056 continues to fall, reducing the voltage across R405 so that VT407 is turned progressively harder on. The increased current flowing through VT407 passes via the scan coils to C413, producing the bottom half of the field. At the end of the scan VT4056 is driven fully on, turning VT408 and VT407 off. This produces the flyback. The sudden change in the scan current results in a positive back e.m.f. appearing at W414 anode. When this voltage rises to the supply line voltage W414 conducts, clamping the scan coil voltage at this level until the current in the coils falls to zero.

Servicing

Thorn's transistor field timebase circuits have proved to be fairly trouble free in the past. It is to be hoped that the arrangement used in the 9000 chassis will continue this tradition. The most common failure of course is likely to be the 16081/16082 output pair, with the various electrolytics in the circuit coming close behind. The extensive use of multiple thick film resistor assemblies should give increased reliability, though if failures occur repair costs will be increased. ■

CCTV Part 17

continued from page 476

the tiny aperture in the front of the housing that the camera looks through. The current of air out of the aperture (and into the furnace) keeps it cool and prevents ash particles accumulating and blocking it. The lens is made of heat-resisting quartz rather than ordinary optical glass and filters are fitted to cut down the heat radiation. Pressure switches are fitted to both the air and water supplies, if either pressure drops too low an alarm sounds – coolant failure can lead to the melting of the front of the housing, the front of the camera and the vidicon! If the atmosphere near the furnace is normally very cold, glycol (as used in car antifreeze) may be substituted for water as a coolant.

Another type of furnace viewer is the probe or periscope, which is inserted into the furnace as required by pneumatic rams. The camera remains outside the furnace but moves in and out with the probe. A quartz lens is fitted to the end of the probe and a mirror (Fig. 7) directs the light from the image down the probe to the camera. Air is blown up the probe and bled out around the quartz lens to keep it cool. Cracked or dirty lenses are a common problem in practice, but this method has the advantage that the probe can be moved in and out and rotated to view the whole of the furnace interior.

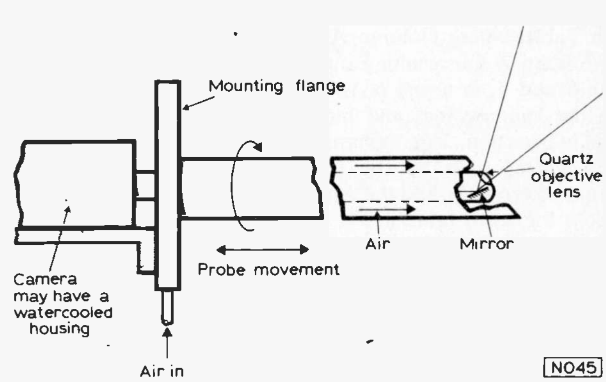


Fig. 7: A furnace viewing probe.

Cameras that must look at hot objects (such as red-hot steel ingots), although the camera itself is far enough away not to need special protection, need a filter to prevent the infra-red radiation focused by the lens onto the target layer from damaging it. A dichroic (pronounced die-crow-ic) filter is fitted in front of the lens, allowing visible radiation to pass through but filtering out the damaging heat radiation. For tubular cameras the filter is mounted in a lens hood that clips over the front of the camera, at the same time keeping dust and dirt off the lens.

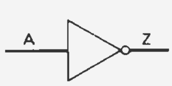
Introduction to ELECTRONIC LOGIC

LOGIC GATES

Geoffrey C. ARNOLD

TO those of us reared on analogue techniques, whether in television or some other area of electronics, the first encounter with digital circuitry is like stepping into another world. There is a new vocabulary to be learned, with AND, NAND, OR and NOR, and a new mathematics (called Boolean Algebra after its originator, the nineteenth century Cambridge mathematician George Boole) where . means AND, + means OR and *1* + *1* = *1*! The only consolation is that there are only two digits, *0* and *1*.

The first thing to understand is what the various circuit symbols mean and what each "block" does. Unfortunately there are several different sets of symbols in use. Some rely on their distinctive shape to convey their function, others use signs or figures inside variously shaped outlines. The latter type, using a box outline, is gaining favour because the symbols are easier for automatic drawing equipment to reproduce. In *Television,* for the present anyway, we use one of the distinctive-shape systems – probably the most widely used of all – as laid down in American Specification MIL-STD 806 B.

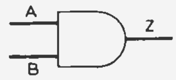


A	Z
0	1
1	0

Fig. 1: The NOT *gate or inverter.*

The simplest logic gate, with just one input and one output, is the Inverter or NOT gate. Fig. 1 shows the circuit symbol: the little circle at the output indicates that inversion has occurred inside that particular gate. Fig. 1 also introduces us to the Truth Table, where Column A lists all the possible input states and Column Z the resulting output states. The precise meanings of the *0* and *1*, in terms of voltage levels and polarities, depend upon the logic system and family in use, and must be defined on each occasion. For example, in TTL (Transistor-Transistor Logic) gates, such as the widely used 74' series, the *0* is nominally zero volts and the *1* nominally +5V.

From the truth table it will be seen that the output is always the opposite of the input, hence the name Inverter. This also defines the logic term NOT – the output is always "Not" the input. The inverter is also said to Negate or Complement the input, both in the sense of producing the opposite. The mathematical symbol for inversion is a bar placed above the term being inverted. Thus the algebraic expression for this gate is $Z = \bar{A}$.

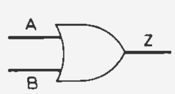


A	B	Z
0	0	0
0	1	0
1	0	0
1	1	1

Fig. 2: The AND *gate*

Passing on to gates with two or more inputs, called combinational gates, we deal first with the AND gate. For the two-input gate shown in Fig. 2 the truth table has four lines, since there are four (2^2) possible combinations of two binary (two-state) inputs (i.e. *00*, *01*, *10* and *11*). A three-input gate has a truth table with eight (2^3) lines, a four-input gate sixteen (2^4) lines, and so on.

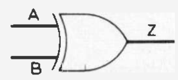
The truth table shows that the output *Z* is *1* only when both *A* AND *B* are *1*. Otherwise it is *0*. The AND gate is also sometimes called a Coincidence circuit or gate, because the output signal (*1*) is present only when the input signals (*1*'s) are coincident. The mathematical symbol for AND is a dot (.) or sometimes a cross (x), and the algebraic expression is $Z = A.B$ for the two-input gate. In some other sets of logic circuit symbols, a dot or a figure equal to the number of inputs is placed inside the symbol to indicate the AND function.



A	B	Z
0	0	0
0	1	1
1	0	1
1	1	1

Fig. 3: The OR *gate.*

The next type of gate, depicted in Fig. 3, is the OR gate. Here, as the truth table tells us, the output is *1* if one OR other OR both of the inputs are at *1*. The mathematical symbol for the OR operation is +, so that here $Z = A + B$. In the alternative systems of circuit symbols, you would find a + or a *1* inside the outline, the latter indicating that you require only one *1* to get an output.

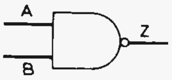


A	B	Z
0	0	0
0	1	1
1	0	1
1	1	0

Fig. 4: The EXCLUSIVE OR *gate.*

This definition of OR is not quite the same as one would expect to apply in everyday life. If, for instance, your seaside landlady offered you the choice of kippers OR bacon and egg for breakfast, you would assume (probably rightly) that you could have one or the other but ***not*** both. In logic, this situation is known as the EXCLUSIVE OR relationship, often shortened to EX OR. The circuit symbol and truth table are shown in Fig. 4. The expression for EX OR takes us a little further into the realms of Boolean algebra, for it is $Z = \bar{A}.B + A.\bar{B}$, which translated into words means that *Z* equals [(NOT *A*) AND *B*] OR [*A* AND (NOT *B*)], the brackets serving to emphasise the grouping of terms. Note that where $\bar{A}$ (translated as NOT *A*) appears in the expression it means that *A* has the value *0* in the truth table.

Nowadays, logic circuits are constructed mostly from developments of the AND and OR gates called NAND and NOR. The NAND gate, probably the most commonly used of all the gates, is shown in Fig. 5 where inspection of the truth table reveals that the output is the complement of that of the AND gate. In other words it is a NOT-AND, hence NAND gate. The algebraic expression for the NAND gate is $Z = \overline{A.B}$.

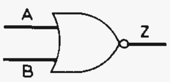


A	B	Z
0	0	1
0	1	1
1	0	1
1	1	0

Fig. 5: The NAND *gate.*

The NOR gate, depicted in Fig. 6, is a NOT-OR gate; an OR gate with its output inverted. The algebraic expression, as you might expect, is $Z=\overline{A+B}$.

With both NAND and NOR gates it is important to realise that the inversion takes place after the AND or OR operation, not before. Taking the NAND case, if the inputs were instead inverted and then applied to an AND gate, you would get quite a different animal – in fact it effectively becomes a NOR gate! You can prove this for yourself by changing all the *0*'s to *1*'s and all the *1*'s to *0*'s in columns A and B of the Fig. 2 truth table, whereupon it becomes identical with that of Fig. 6 except that the lines appear in a different order, which is immaterial.



A	B	Z
0	0	1
0	1	0
1	0	0
1	1	0

Fig. 6: The NOR *gate.*

This completes the list of basic logic gates, but you will probably be wondering just why NAND and NOR gates are so popular when we are more likely to want to perform AND and OR operations. The answer lies in their versatility: given a suitable number of NAND and NOR gates you can interconnect them to perform NOT, AND, OR and EX OR operations. For this reason they are sometimes known as "Universal Gates". If on the other hand you use AND and OR gates you can perform AND and OR but nothing else. Integrated circuit logic packages usually incorporate a number of separate but similar gates, generally as many as the number of pins allow. It is therefore more economical if we have to use only two types of gate instead of five.

To make an inverter we simply parallel the inputs of a NAND or a NOR gate. The second and third lines of the truth tables then disappear and what is left is identical with the inverter truth table in Fig. 1. Another arrangement frequently used is to connect the signal to be inverted to one input of a NAND gate and to apply a permanent *1* potential to the remaining inputs. This is generally done by returning them, via a surge-limiting resistor, to the supply rail (+5V in the case of TTL). A NOR gate with unused inputs returned to a permanent *0* is also sometimes encountered. In each case, the truth table is reduced to two lines only.

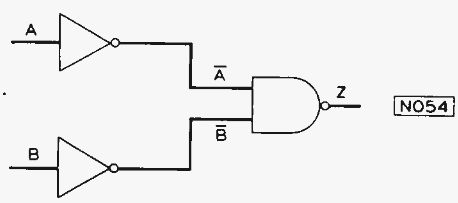


Fig. 7: Using a NAND *gate to perform the* OR *function.*

You will sometimes see a NAND gate described as performing the OR function. This is a little baffling at first sight. The explanation is that the input signals are being inverted before being applied to the NAND gate. This principle is illustrated in Fig. 7, and once again you can prove the action for yourself by swapping the *0*'s and *1*'s in columns A and B of the truth table in Fig. 5. It will then become equivalent to that of Fig. 3, the OR gate.

No doubt you are thinking that this is an odd sort of economy, using three gates where one OR would do. The advantage can be seen however if we pass on to a slightly more complex circuit. Suppose we want to detect (*A* AND *B*) OR (*C* AND *D*), in algebraic form $A.B + C.D$: i.e. we want a *1* output with these particular inputs present. We could use two ANDs and an OR, a total of three gates. Alternatively we could form it from NANDs and inverters as in Fig. 8(a) using no less than seven gates! But wait a moment, those two pairs of inverters are simply changing $\overline{A.B}$ to $A.B$ and back again, and similarly for $\overline{C.D}$. So we can do away with them, leaving us with the circuit of Fig. 8(b) which uses three gates, all of the same type – very convenient.

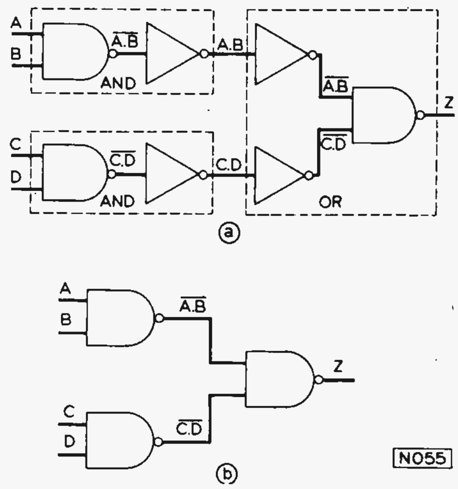


Fig. 8: Performing a logic function with "universal" gates:
(a) Before simplification.
(b) After removing redundant inverters.

The more mathematically inclined may have realised that the output (Z) of Fig. 8 besides being $A.B + C.D$ is also $\overline{\overline{A.B}.\overline{C.D}}$ and that therefore these two expressions are equal. You're quite right, but this takes us further into the intricacies of Boolean algebra than I have room for in this article.

Occasionally you will come across two inverters in series in a circuit where they can't just be done away with. They are usually there to delay the signal slightly – generally to allow some subsequent part of the circuit sufficient time to reset. The propagation delay through a standard 74' series TTL gate is about 10ns.

Sometimes a pair of inverters is used as a buffer, allowing one gate to drive a larger-than-usual number of other gates. Each type of gate has a maximum safe output load which if exceeded may cause erratic operation of the following circuitry. This safe load is usually quoted as the number of "standard" gates that can be driven – the number is known as the "fan-out".

Thus to drive 16 gates from a gate with a fan-out of 10, the 16 could be arranged into two groups of 8. One group together with a buffer would be driven directly by the original gate, and the other group driven by the buffer. Note that some gate inputs, or more often flip-flop inputs, present a heavier load than the standard.

AND, OR, NAND and NOR gates can have more than two inputs each. Two, three, four and eight-input gates are commonly available in i.c. packages. The circuit symbols are expanded as shown in Fig. 9. EXCLUSIVE OR gates are normally available with two inputs only. It is theoretically possible to have one with more than two inputs, but it would be necessary to define the combinational laws to be followed.

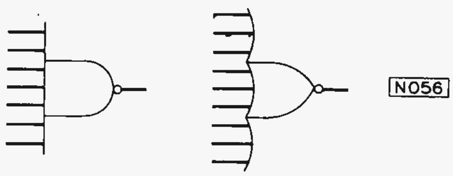


Fig. 9: NAND *and* NOR *circuit symbols for multiple inputs.*

Readers who followed the TV Games series will have encountered electronic logic already. Those who are following the Ceefax/Oracle series will become embroiled in it from this issue onwards. The gates also lend themselves to the design of equipment such as crosshatch generators (see *Television*, September 1972) and grey-scale generators, such as that in our March 1975 issue. ■

VIDEOTAPE RECORDING

continued from page 471

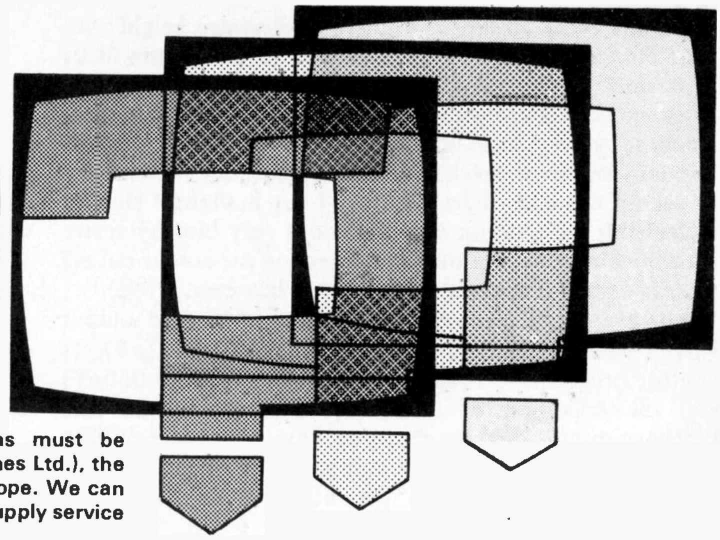
50Hz buzz on the sound playback signal, and for this reason the audio l.f. response of the VTR extends only down to 80Hz.

Up to this point, only the VTR has been discussed and nothing has been said about the tape itself. Not only can the width of the tape differ from one type of machine to another but the physical structure of the tape can also change, especially with the introduction of the new "high energy" tapes. There are at present three widths of tape used with helical scan machines, these are 25·4mm (1in), 19mm (0·75in) and 12·5mm (0·5in). The largest of these was used a great deal with earlier VTRs, but as the design of the machine and the construction of the tape improved, the tape width has been reduced. The Philips VCR and many reel-to-reel machines use 12·5mm tape, but with the advent of the new Sony and JVC Nivico cassete machines 19mm tape is being used. It should be noted that these are the only compatible cassette machines on the British market at the time of writing.

High-energy tape has been on the market for some years, and although it does have many advantages over the conventional oxide tapes, it has produced many problems in the VTR field. The most difficult was that of its abrasive qualities. With the high head to tape speeds encountered in videotape recording, especially the broadcast machines where they exceed 3800cm/s (1500in/s), new head materials had to be found so that a reasonable head life could be achieved. With most of these problems now solved, high-energy tape is used extensively with colour VTRs.

In Part 2, next month, we start to look at the circuitry used in videotape recorders.

Your PROBLEMS solved



Requests for advice in dealing with servicing problems must be accompanied by an 11p postal order (made out to IPC Magazines Ltd.), the query coupon from page 491 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.

DECCA CS2230

The fault on this colour receiver is occasional field jitter on high luminance scenes. The field timebase valves have been replaced without improving matters.

The fact that the jitter occurs only on high brightness scenes eliminates problems in the field generator stage. The sync separator is letting video through. The circuit is unusual, consisting of two stages: TR202 (BC159) on the decoder board whose output is d.c. coupled to the pentode section of V2 (PCF80) on the timebase board. Check the input coupling capacitor to TR202 base (C207, 1μF), TR202 itself and the associated components. On the timebase panel (bottom) R426 (2·2MΩ) in the field sync pulse integrating circuit and D400 (1N914) in the field sync feed circuit are suspect. (Decca 30 series chassis.)

CRT DEFECTS

I'd be grateful if you would summarise the common c.r.t. defects and the tests that can be made to identify the type of fault in a defective tube.

The aim of the Query Service is to deal with specific servicing problems rather than to give general guidance which could involve very lengthy replies. However, this matter can be dealt with fairly briefly. The most common defects are low emission, a partially shorted heater, interelectrode shorts, and open-circuit electrodes.

Low emission: This is normally due to age and is the result of the emitting surface of the cathode becoming hard. The symptoms vary according to how poor the tube is. The picture tends to be an overall dullish grey, with the peak white parts having a shiny look. Several remedies can be tried, such as high-voltage pulsing, but c.r.t. replacement is the only long term answer.

Partially shorted heater: The heater element takes the form of an elongated M. A particle dislodged from the cathode may fall into the heater, shorting out part of it – resulting in a "V" instead of an "M". Only half the heater element or less is then active, the voltage across it being correspondingly low. The tube appears to have suddenly lost emission. A sharp tap on the tube neck can sometimes restore results.

Interelectrode shorts: The problem is normally a grid-to-cathode or cathode-to-heater short. A grid-to-cathode short results in maximum screen brilliance with no control possible. Again this can sometimes be temporarily cleared by tapping the neck of the tube. There are degrees of leakage, causing some variation in the effect observed. A cathode-to-heater short results in no picture and a bright raster since the cathode's signal and voltage are shorted to the heater potential.

Open-circuit electrodes: The result is normally a very dull and uncontrollable raster.

GEC 2041

The problem with this colour set is that all vertical lines on the picture are buckled or wavy.

Ensure that the c.r.t. aquadag earthing contact is good, then check the h.t. smoothing capacitors and the sync separator transistor TR109 (BC117). It is possible that a different value flywheel sync filter resistor (R505) may help: try replacing it temporarily with a 500kΩ preset, adjusting this for best results. It is possible that a new line output transformer may be required.

BUSH TV125U

Over the years this set has worked well. There is now a fault on 625 lines however. About ten minutes after first switching on there is a "plop" then the picture goes very grey. If the set is switched off and allowed to cool down, then switched on again, the same thing happens. The sound and vision on 625 remain good, also the sound on 625.

Faults of this type are often due to a defective valve, possibly in the tuner unit, i.f. strip or video stage. Voltage checks throughout before and after the fault appears should enable the faulty stage to be located. Check the power supplies as well. Look for discoloured resistors, clean the system switch and treat it with Servisol.

PHILIPS 524

After fitting a new e.h.t. tripler the set developed intermittent picture judder. The condition has improved but still gives slight trouble. Occasionally the picture comes on brighter when the judder is present. Am I right in suspecting the tripler?

The new tripler could indeed be to blame. The symptom can also be caused by the thyristor rectifier (BT106) or the diac (BR100) in the power supply section however. These should be checked by substitution. (Philips G8 chassis.)

PHILIPS G25K500

When the set is switched on there is excessive height with poor colour etc. After about ten minutes the picture flicks to normal height, width and focus, but the convergence takes another couple of minutes to become right. The field timebase valves have all been renewed. The set works normally once the height has become normal. When I try to set up the c.r.t. drive controls I get a slightly blotchy raster with the red gun only on and a very blotchy raster with the blue gun only on. On depressing the colour cut-off there is a good black-and-white picture however.

For the height problem check the PL508 field output valve's cathode decoupling electrolytic C4043 (32μF), its control grid input coupling capacitor C4039 (0·056μF) and the condition of the preset controls in the field timebase circuit. We assume you have checked carefully for dry-joints – the symptom can sometimes be traced to a dry-jointed connection to the height stabilising v.d.r. R4090. The second problem should be resolved by carrying out the purity adjustment procedure given in the manual. Perfect purity is often unattainable on early 25in. models however. (Philips G6 chassis.)

DEFIANT 901

After working for a short time the set developed what appeared to be a sound fault. Finally the printed circuit fused near pin 6 of the PL504 line output valve however. I repaired this and replaced the PL504 but the original fault reappeared. The sound returns to normal on removing the PY800 top cap.

It is often necessary on these sets (similar to the Bush TV141 series) to cut away the panel in the vicinity of the line drive input to the PL504 in order to clear shorts through parts of the panel that have become conductive. If this is not the case, try to trace the source of the discharge which could be around the line output area or perhaps in the PY800.

HMV 2703

The picture was badly out of focus, giving every indication of convergence trouble. Before any adjustments could be made however the picture vanished, leaving a clear screen. On feeding a crosshatch pattern generator output to one end of the luminance delay line a faint pattern appeared on the screen. On operating the colour gun switches clear red, green and blue rasters can be obtained, and the sound is o.k. on all channels. The screen is filled with a jumble of colours when the colour control is advanced. The voltages at the c.r.t. cathodes are slightly high (190V instead of 160V). When the set is first switched on the picture can just be glimpsed disappearing into the corners to leave a bright, blank screen.

The presence of chrominance and absence of sync mean that the fault lies in the luminance delay line driver stage VT105 (BC157) or its immediate vicinity. Check the voltages around VT105, which itself could well be faulty. Check also the continuity of the luminance delay line – the feed to the sync separator is taken from the output side of the luminance delay line – and for dry-joints in this area. A remote possibility is that the luminance detector diode W102 (OA90 in can L113/4/5) is faulty. An oscilloscope is invaluable when tackling this type of fault. (Thorn 3000 chassis.)

DECCA CTV25

There is lack of width on this receiver – a gap just over an inch wide at each side with the controls set to maximum. The size of the picture alters according to how light or dark the scene. The PL509 line output valve has been replaced without improving the situation.

Check the 10MΩ resistor R401 in the width/set e.h.t. circuit. If this and the PY500 are o.k. the line output transformer could be faulty. A less likely possibility is shorting turns on the PL509's anode feed choke L408.

EKCO T464

There is neither sound nor raster. A few minutes after switching on the PY800 glows red hot: if its top cap is lifted off the valve cools down but the PL36 line output valve's screen grid feed resistor starts to smoke. All line timebase valves, the boost capacitor C97, C94 (12pF) and R119 (100kΩ) which provide the feedback from the line output transformer to the line oscillator triode, and the resistors in the PL36's screen grid circuit have been replaced. There is a small choke marked L37 alongside the line output transformer: it is loose and untidy and seems to be burnt.

It seems as if C96 (0·1μF) which decouples the anode of the PY800 is leaky. Try replacing it. The small choke mentioned can be shorted out for testing purposes – it is fitted to reduce interference on adjacent sets. The correct value of R119 is 270kΩ and it is worth using a 1W component. (Pye 11U series.)

BUSH CTV25

The anode of the PL509 line output valve was red hot, due to an internal short in the PD500 shunt-stabiliser triode. Replacing this valve cleared the trouble. It was then discovered however that there was no colour, the picture appearing in black and white only. The preset contrast control and preset colour control have both been advanced, but without success.

We assume that the tuning is correct. See what happens when you over-ride the colour killer by connecting a 15kΩ resistor from the delay line driver transistor's base circuit to the l.t. rail – between points P2 and P3. This may have no effect however since a common cause of no colour in this circuit is a short-circuit in 5C6 (1,000pF) – the short earths the base of the delay line driver transistor (5VT2).

The colour-killer arrangement in this decoder is rather unusual. A synchronous detector (5D5, 5D6) is fed with the ident signal and the ouput from one of the PAL bistable switch transistors. Its output is fed to the colour-killer amplifier transistor 5VT8. The idea is that there is no colour if the bistable switching is in the wrong phase. One result unfortunately is that a fault in quite a lot of components could result in no colour. First check the voltages around the colour-killer amplifier transistor 5VT8 – these should be 13V at the emitter, 11V at the base and 7·8V at the collector for a colour picture. Then if necessary check the bistable transistors 5VT5 and 5VT8, the colour-killer detector diodes, the ident phasing diode 5D8, the ident amplifier transistors 6VT4 and 6VT5 and that there is output from the burst channel. The whole decoder has to be aligned rather carefully to get an adequate colour turn-on bias from the colour-killer arrangement. We feel however that of these various possibilities the most likely is that one of the bistable transistors is faulty. You should find 1V at the emitters (which are coupled together), 1·2V at the bases and 5·6V at the collectors.

PHILIPS 19TG170A

The fault on this set is cogging, i.e. pulling on the verticals when the contrast is up full. I assume that the trouble is in the video output stage but am not sure which components should be suspected. The PFL200 itself has been checked.

Some degree of pulling must be expected if the contrast control is fully advanced as the video stage will be overloaded. If the trouble is experienced at normal contrast level we suggest you check the a.g.c. clamp diode X206 (BA115) and the d.c. restorer diode X205 (BA115). Both are in the vicinity of the PFL200. (Philips Style 70 series chassis.)

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TELEVISION AUG. 1975

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.

A colour receiver exhibited two main fault symptoms. One was an intermittent total disappearance of picture information on monochrome transmissions, only the luminance information disappearing on colour transmissions. The second was intermittent horizontal displacement of the brightness (luminance) parts of the picture with respect to the colouring parts.

During workshop soak tests it seemed that the two symptoms were somehow related; sometimes the displacement symptom occurred just before the total disappearance of the luminance information, while on other occasions the displacement symptom would occur just prior to the display jumping back to normality.

The symptoms were not temperature dependent – they were as likely to occur just after the set had been switched on as after some hours of operation. Further, they could not be produced by subjecting the chassis to mild vibration, by tapping around the circuit boards, etc.

The sound was not affected in any way and there were no clicks or crackles from the loudspeaker when the fault symptoms were present. The chassis was a hybrid one and it was first ensured that all valves and board connectors were making good connections. Fault tracing was made difficult because of the intermittent symptoms, while to make matters worse when the symptoms did appear they seemed to clear immediately an instrument test probe was applied to virtually any part of the circuit.

After the junior service technician had spent an hour or so endeavouring to track down the source of the fault, the chief engineer was consulted. He merely viewed the symptoms and, without making any measurements or tests whatsoever, removed one printed circuit board, carefully examined a certain part of the circuit and replaced one component. After this the receiver worked perfectly with no sign at all of the original intermittent faults.

What was the most likely circuit section to have been examined by the chief engineer, and which component do you think he replaced? See next month's Television *for the solution and for a further item in the Test Case series.*

SOLUTION TO TEST CASE 151
(Page 435 last month)

The cool PL504 line output valve in the Sobell set should have indicated fairly conclusively to the technician that either the emission was right down – it is unlikely for this to be intermittent however – or that for some other reason the valve was failing to pass anode or screen grid current. The anode current will be cut off by lack of screen grid or anode voltage, the screen grid in the latter case then usually taking an abnormally high current – often visible by a glowing screen grid in the valve – with the result that the screen grid voltage is low due to the increased voltage drop across the feed resistor. It will be recalled however that the screen voltage was high.

The technician was surprised to find a relatively high voltage at the cathode because this should have been at chassis potential! Clearly the cathode had become disconnected from chassis return, which is tantamount to the valve being "switched off" (hence its low temperature). Further investigation revealed a disconnection on the board between the cathode and chassis.

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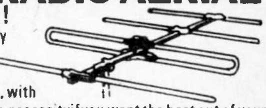

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AC142K	25
AC151	20
AC154	18
AC155	18
AC156	20
AC176	22
AC187	19
AC187K	24
AC188	17
AC188K	26
AD142	45
AD149	40
AD161	38
AD162	38
AF114	24
AF115	21
AF116	22
AF117	19
AF118	50
AF139	35
AF178	45
AF180	45
AF181	45
AF239	40
AF240	60
BC107	11
BC108	10
BC109	14
BC109C	14
BC113	13
BC116A	19
BC117	14
BC125B	15
BC132	25
BC135	15
BC137	19
BC138	26
BC142	23
BC143	25
BC147	11
BC147A	11
BC148	10
BC149	10
BC153	15
BC154	15
BC157	14
BC158	10
BC159	11
BC173	18
BC178B	20
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V2311C
V2414D
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V2423

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CS2211
CS2213
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CS2611
CS2630
CS2631

BUSH

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CT73
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CT153
CT154
CT200
CT201
CT202
CT203
CT205
CT212
CT216
CT218
4212/H

MURPHY

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CV1916S
CV2210
CV2212
CV2213
CV2214
CV2510 Mk. 1 & 2
CV2510 Mk. 3
CV2511 Mk. 1 & 2
CV2511 Mk. 3
CV2516S
CV2610
CV2611
CV2614

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CT103
CT104
CT105
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