TELEVISION

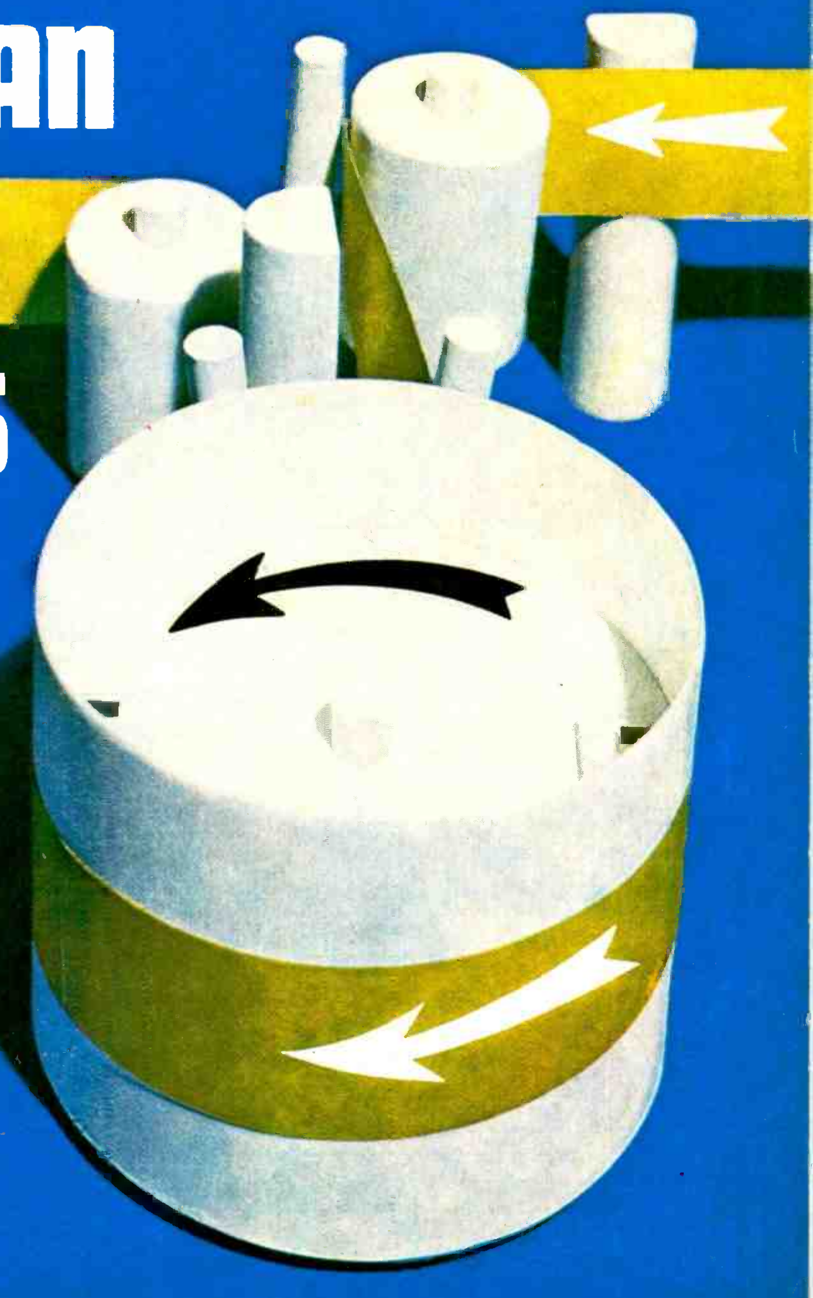
17½p (3'6)

SERVICING · CONSTRUCTION · COLOUR · DEVELOPMENTS

MARCH 1971

25

HELICAL-SCAN VIDEOTAPE RECORDERS



ALSO:

IN-SITU VALVE MONITOR

INTRODUCTION TO DIGITAL ICs

SERVICING THE DECCA DR100 SERIES

STEPHENS

ELECTRONICS, P.O. BOX 26, AYLESBURY, BUCKS.

SEND S.A.E. FOR LISTS
GUARANTEE
Satisfaction or money refunded.

GUARANTEED VALVES BY THE LEADING MANUFACTURERS BY RETURN SERVICE

1 YEARS GUARANTEE ON OWN BRAND, 3 MONTHS' ON OTHERS

AZ31	50p
AZ50	60p
CBL1	80p
CBL31	85p
CY31	35p
DAF91	41p
DAF96	41p
DF91	45p
DF96	45p
DK91	57½p
DK96	57½p
DL92	37½p
DL94	37½p
DL96	46p
DM70	32½p
DY86/7	40p
DY802	42½p
E55L	£2·75
E88CC	40p
E130L	£4·50
E180F	95p
EABC80	52½p
EAF42	50p
EBC33	55p
EBC41	47½p
EBC81	32½p
EBC90	47½p
EBF80	40p
EBF83	40p
EBF89	40p
EB91	26p
EC53	50p
EC86	60p
EC88	60p
EC90	30p
EC92	32½p
EC93	47½p
ECC81	40p
ECC82/3	42½p
ECC84/5	42½p
ECC88	55p
E88CC	62½p

ECF80/2	47½p
ECF86	55p
ECH35	67½p
ECH42	66p
ECH81	51p
ECH83	40p
ECH84	47½p
ECL80	40p
ECL82	49p
ECL83	57½p
ECL86	49p
ECLL800	£1·50
EF39	52½p
EF80	40p
EF83	50p
EF85	41p
EF86	66p
EF89	40p
EF91	42½p
EF92	50p
EF93	47½p
EF94	77½p
EF95	62½p
EF183	56p
EF184	35p
E280F	£2·10
EF800	£1·00
EF804	£1·00
EF811	75p
EL34	52½p
EL36	47½p
EL41	55p
EL42	57½p
EL81	50p
EL83	41p
EL85	42½p
EL86	42½p
EL90	32½p
EL91	25p
EL95	35p
EL360	£1·15

EL803	85p
EL821	55p
ELL80	75p
EM34	80p
EM71	62½p
EM80	40p
EM81	42½p
EM84	37½p
EM87	55p
EN91	32½p
EY51	40p
EY80	45p
EY81	40p
EY83	55p
EY86	40p
EY87	42½p
EY88	42½p
EZ35	27½p
EZ40	45p
EZ41	45p
EZ80	27½p
EZ81	27½p
EZ90	25p
GS10C	£5·00
GY501	80p
GZ30	37½p
GZ31	30p
GZ32	47½p
GZ33	80p
GZ34	55p
HK90	32½p
HL92	35p
HL94	40p
KT66	£1·37½
KT88	£1·66
N78	£1·05
PABC80	40p
PC86/8	51p
PC95	36p
PC97	41p
PCC84	46p

PCC85	42½p
PCC88	70p
PCC89	61p
PCC189	61p
PCF80	51p
PCF82	52½p
PCF84	47½p
PCF86	61p
PCF200/1	81p
PCF801	61p
PCF802	61p
PCF805	65p
PCF806	61p
PCF808	67½p
PCH200	70p
PCL82	51p
PCL83	61p
PCL84	51p
PCL85	52½p
PCL86	51p
PD500	£1·52½
PFL200	74p
PL36	64p
PL38	90p
PL81	51p
PL81A	62½p
PL82	36p
PL83	51p
PL84	41p
PL500	82½p
PL504	85p
PL505	£1·45
PL508	£1·00
PL509	£1 54
PL802	86p
PL805	86p
PY33	62½p
PY80	32½p
PY81	41p
PY800	41p
PY801	41p
PY82	35p

PY83	50p
PY88	41p
PY500	£1·00
PZ30	80p
QQUO2-6	£2·10
QQUO3-10	£1·25
QVO3-12	65p
R19	65p
R20	75p
SU2150A	75p
TT21	£2·40
TT22	£2·50
U18/20	67½p
U20	67½p
U25	75p
U26	75p
U31	45p
U37	£1·50
U50	30p
U52	30p
U76	25p
U78	25p
U191	75p
U201	35p
U281	40p
U282	40p
U301	57½p
U403	50p
U404	37½p
U801	£1·00
UABC80	52½p
UBF89	40p
UBC41	49p
UCC85	46p
UCH42	69p
UCH81	54p
UCL82	51p
UCL83	61p
UF41/2	55p
UF80/5	37½p
UF89	41p

UL41	57½p
UL84	55p
UM80/4	45p
UY41	40p
UY85	34p
U25	75p
U26	75p
U191	72½p
U193	41p
U301	85p
W729	55p
Z759	£1·22½
OA2	32½p
OA3	45p
OB2	32½p
OB3	50p
OC3	35p
OD3	32½p
3Q4	40p
3S4	35p
3V4	40p
5R4GY	55p
5U4G	30p
5U4GB	37½p
5V4G	40p
5Y3GT	30p
5Z3	45p
5Z4GT	40p
6/30L2	75p
6AB4	32½p
6AF4A	47½p
6AG7	37½p
6AH6	50p
6AJ8	29p
6AK5	30p
6AK6	57½p
6AL3	42½p
6AL5	16p
6AM5	25p
6AM6	22½p
6AQ5	32½p
6AQ6	50p

6AR5	32½p
6AR6	32½p
6AS5	35p
6AS7G	80p
6AT6	45p
6AU6	29p
6AU6	30p
6BA6	47½p
6BE6	60p
6BH6	42½p
6BJ6	42½p
6BK7A	50p
6BL8	35p
6BN5	42½p
6BN6	40p
6BQ5	25p
6BR7	75p
6BR8	95p
6BW6	82½p
6BW7	69p
6BX6	25p
6BZ6	32½p
6C4	30p
6C5GT	35p
6CD6G	£1·40
6CA4	27½p
6CA7	52½p
6CBC	27½p
6CD6GA	£1·15
6CG7	45p
6CH6	55p
6CL6	50p
6CW4	62½p
6CY5	40p
6CY7	60p
6D3	40p
6DC6	67½p
6DK6	42½p
6DQ6B	60p
6DS4	75p
6EA8	55p
6EH7	32½p

6EJ7	35p
6EW6	60p
6F1	70p
6F8	40p
6F6G	25p
6F11	32½p
6F12	22½p
6F13	35p
6F14	60p
6F15	55p
6F18	40p
6F22	32½p
6F23	77½p
6F24	67½p
6F25	75p
6F26	35p
6F28	70p
6F29	32½p
6F30	35p
6J4	47½p
6J5GT	30p
6J7	42½p
6K6GT	50p
6K7	32½p
6K8G	30p
6K23	50p
6K25	75p
646GT	45p
6L7	32½p
6L18	30p
6LD20	32½p
6N7GT	35p
6P1	60p
6P25	£1·05
6P28	62½p
6Q7	37½p
6R7G	35p
6S2	40p
6S4A	55p
6SA7	37½p
6SG7	32½p
6SJ7	37½p

6SK7	32½p
6SL7GT	32½p
6SN7GT	30p
6SQ7	40p
6SR7	37½p
6T8	32½p
6U4GT	62½p
6U8	35p
6V6GT	32½p
6X4	25p
6X5GT	27½p
6X8	55p
6Y6G	80p
7Y4	60p
9BW6	42½p
10C2	50p
10D1	40p
10D2	40p
10F1	90p
10F9	50p
10F18	40p
10L1	40p
10LD11	55p
10P13	55p
10P14	£1·00
12AB5	50p
12AC6	37½p
12AD6	37½p
12A15	40p
12AQ5	40p
12AT6	25p
12AU6	75p
12AY6	30p
12AV7	45p
12AX7	30p
12AY7	67½p
12B4A	50p
12BA6	32½p
12BA7	32½p

12BE6	32½p
12BH7	32½p
12BY7	50p
12K5	50p
12K7GT	35p
12Q7G	25p
12SC7	25p
12SG7	35p
12SH7	25p
12SJ7	25p
12SK7	40p
12SL7GT	40p
12SN7GT	40p
12SQ7	40p
12SR7	32½p
14S7	80p
20D1	45p
20L1	£1·00
20P1	50p
20P3	60p
20P4	£1·00
20P5	£1·00
25C5	45p
25L6GT	37½p
25Z4G	30p
25Z6GT	50p
30A5	40p
30AE3	40p
30C15	75p
30C17	80p
30C18	75p
30F5	85p
30FL1	75p
30FL2	92½p
30FL13	50p
30FL14	77½p
30L1	45p
30L15	85p
30L17	85p
30P12	80p
30P18	35p
30P19	75p

30PL1	77½p
30PL13	90p
30PL14	85p
35A3	50p
35A5	55p
35B5	65p
35C5	35p
35D5	65p
35L6GT	47½p
35W4	25p
35Z3	55p
35Z4G	25p
35Z5GT	37½p
50A5	65p
50B5	35p
50C5	35p
50L6GT	40p
83A1	90p
85A2	37½p
90AU	£2·40
90C1	60p
90CU	£1·25
807	47½p
811A	£1·50
612A	£3·25
813	£3·75
866A	70p
5642	60p
6080	£1·37½
6146	£1·50
6146B	£2·37½
6267	32½p
6360	£1·25
6939	£2·10
7199	75p
7360	£1·80
7586	£1·25
9002	32½p
9003	50p

SEMICONDUCTORS

BRAND NEW · MANUFACTURERS MARKINGS · NO REMARKED DEVICES

2N388A	62½p
2N404	22½p
2N696	20p
2N697	20p
2N698	25p
2N699	62½p
2N706	12½p
2N706A	12½p
2N708	15p
2N709	62½p
2N718	25p
2N718A	30p
2N726	30p
2N727	30p
2N914	17½p
2N916	17½p
2N918	30p
2N929	22½p
2N930	27½p
2N987	52½p
2N1131	27½p
2N1132	32½p
2N1302	17½p
2N1303	17½p
2N1304	22½p
2N1305	22½p
2N1306	25p
2N1307	25p
2N1308	30p
2N1309	30p
2N1507	27½p
2N1613	25p
2N1631	42½p
2N1632	42½p
2N1637	42½p
2N1638	37½p
2N1639	37½p
2N1701	£1·62½
2N1711	25p
2N1889	32½p
2N1893	42½p
2N2147	72½p
2N2198	62½p
2N2160	57½p
2N2193	47½p
2N2193A	50p

2N2194A	22½p
2N2217	27½p
2N2218	32½p
2N2219	32½p
2N2220	25p
2N2221	25p
2N2222	30p
2N2287	£1·07½
2N2297	30p
2N2368	17½p
2N2369	17½p
2N2369A	20p
2N2410	42½p
2N2483	27½p
2N2484	32½p
2N2539	22½p
2N2540	22½p
2N2613	35p
2N2614	30p
2N2646	57½p
2N2696	32½p
2N2711	30p
2N2712	30p
2N2713	27½p
2N2714	30p
2N2865	62½p
2N2904	35p
2N2904A	40p
2N2905	40p
2N2905A	45p
2N2906	30p
2N2906A	32½p
2N2907	40p
2N29023	17½p
2N2924	17½p
2N2925	17½p
2N2926	
Green	14p
Yellow	12½p
Orange	12½p
2N3011	30p
2N3014	32½p
2N3053	27½p
2N3054	55p

2N3055	75p
2N3133	30p
2N3134	30p
2N3135	25p
2N3136	25p
2N3340	97½p
2N3349	£1·30
2N3390	37½p
2N3391	30p
2N3391A	30p
2N3392	20p
2N3393	20p
2N3394	20p
2N3402	22½p
2N3403	22½p
2N3404	37½p
2N3405	45p
2N3414	27½p
2N3415	27½p
2N3416	37½p
2N3417	37½p
2N3439	£1·80
2N3440	97½p
2N3570	87½p
2N3572	87½p
2N3605	27½p
2N3606	27½p
2N3607	22½p
2N3662	37½p
2N3663	37½p
2N3702	17½p
2N3703	22½p
2N3704	22½p
2N3705	20p
2N3706	22½p
2N3707	20p
2N3708	17½p
2N3709	17½p
2N3710	20p
2N3711	20p
2N3713	£1·50
2N3714	£1·75
2N3819	35p
2N3823	£1·12½
2N3826	30p

2N3854	27½p
2N3854A	27½p
2N3855	27½p
2N3855A	30p
2N3856	30p
2N3856A	35p
2N3858	25p
2N3858A	30p
2N3859	27½p
2N3859A	32½p
2N3860	30p
2N3866	£1·50
2N3877	40p
2N3877A	40p
2N3900	37½p
2N3900A	40p
2N3901	97½p
2N3903	35p
2N3904	35p
2N3905	37½p
2N3906	37½p
2N4058	27½p
2N4059	25p
2N4060	25p
2N4061	22½p
2N4062	22½p
2N4244	47½p
2N4245	42½p
2N4254	42½p
2N4255	42½p
2N4284	17½p
2N4285	17½p
2N4286	17½p
2N4287	17½p
2N4288	17½p
2N4289	17½p
2N4290	17½p
2N4291	17½p
2N4292	12½p
2N5027	52½p
2N5028	57½p
2N5029	47½p
2N5030	42½p
2N5172	15p
2N5174	52½p
2N5175	52½p

2N5176	45p
2N5232A	30p
2N5245	62½p
2N5246	62½p
2N5249	67½p
2N5249A	67½p
2N5265	£3·25
2N5266	£2·75
2N5267	£2·62½
2N5305	37½p
2N5306	40p
2N5307	37½p
2N5308	37½p
2N5309	62½p
2N5310	42½p
2N5354	27½p
2N5355	27½p
2N5356	32½p
2N5365	47½p
2N5366	32½p
2N5367	57½p
2N5457	37½p
2S005	75p
2S020	£1·87½
2S102	32½p
2S103	32½p
2S104	32½p
2S501	27½p
2S502	27½p
2S503	27½p
3N83	£1·87½
3N128	92½p
3N140	97½p
3N141	97½p
3N142	97½p
3N143	87½p
3N152	£1·12½p
R.C.A.:	
40050	67½p
40250	50p
40251	97½p
40309	40p
40310	57½p
40311	47½p
40312	62½p
40314	47½p

40315	47½p
40316	62½p
40317	47½p
40319	67½p
40320	47½p
40323	42½p
40324	57½p
40326	97½p
40329	35p
40344	35p
40347	42½p
40348	82½p
40360	55p
40361	62½p
40362	67½p
40370	37½p
40406	72½p
40408	62½p
40467	82½p
40467A	72½p
40468A	72½p
AC107	30p
AC117	60p
AC126	20p
AC127	25p
AC128	20p
AC154	22½p
AC176	25p
AC187	62½p
AC188	87½p
ACY17	27½p
ACY18	25p
ACY19	25p
ACY20	25p
ACY21	25p
ACY22	20p
ACY28	20p
ACY40	20p
ACY41	25p
ACY44	40p
AD140	40p
AD149	57½p
AD150	62½p
AD161	37½p
AD162	37½p

AF106	42½p
AF114	25p
AF115	30p
AF116	25p
AF117	25p
AF118	60p
AF119	20p
AF124	22½p
AF125	20p
AF126	20p
AF127	17½p
AF139	37½p
AF178	45p
AF179	45p
AF180	52½p
AF181	42½p
AF186	66½p
AF239	42½p
AF279	47½p
AF280	62½p
AFZ11	32½p
ASY26	25p
ASY27	37½p
ASY28	27½p
ASY29	27½p
ASY36	25p
ASY50	25p
ASY51	32½p
ASY53	25p
ASY54	25p
ASY62	25p
ASY63	17½p
ASY72	25p
ASY83	25p
ASY86	32½p
ASZ20	37½p
ASZ21	42½p
AUY10	£1·50
BC107	15p
BC108	15p
BC109	15p
BC113	27½p
BC114	37½p
BC115	32½p
BC116	62½p
BC116A	37½p

BC117	39p
BC118	32½p
BC121	20p
BC122	20p
BC125	55p
BC126	55p
BC134	57½p
BC140	37½p
BC147	17½p
BC148	15p
BC149	17½p
BC152	17½p
BC157	20p
BC158	17½p
BC159	20p
BC160	62½p
BC167	15p
BC168B	14p
BC168C	15p
BC169B	14p
BC169C	15p
BC170	17½p
BC171	17½p
BC172	17½p
BC175	27½p
BC182	22½p
BC183	22½p
BC184	22½p
BC182L	20p
BC183L	17½p
BC184L	20p
BC187	28½p
BC212L	22½p
BC213L	26½p
BCY10	27½p
BCY12	27½p
BCY30	27½p
BCY31	27½p
BCY32	37½p
BCY33	20p
BCY34	22½p
BCY38	22½p
BCY39	42½p
BCY40	37½p
BCY42	15p
BCY43	15p

BCY54	32½p
BCY58	22½p
BCY59	22½p
BCY60	97½p
BCY70	20p
BCY71	42½p
BCY72	17½p
BYZ10	27½p
BCZ11	37½p
BD116	£1·12½
BD121	65p
BD123	82½p
BD124	62½p
BD131	97½p
BD132	97½p
BDY10	£1·37½
BDY11	£1·87½
BDY17	£1·87½
BDY18	£2·47½
BDY19	£3·12½
BDY20	£1·52½
BDY38	97½p
BDY60	£1·80
BDY61	£1·80
BDY62	£1·37½
BF115	25p
BF117	47½p
BF163	35p
BF167	25p
BF173	32½p
BF177	32½p
BF178	35p
BF179	72½p
BF180	35p
BF181	32½p
BF184	25p
BF185	42½p
BF194	22½p
BF195	27½p
BF196	42½p
BF197	31½p
BF198	42½p
BF200	36½p
BF224	30p
BF225	30p
BF237	32½p

BF238	32½p
BF257	47½p
BF22A	47½p
BFX12	22½p
BFX13	22½p
BFX29	35p
BFX43	37½p
BFX44	37½p
BFX68	67½p
BFX84	30p
BFX85	35p
BFX86	30p
BFX87	30p
BFX88	25p
BFX89	22½p
BFY10	32½p
BFY11	42½p
BFY17	22½p
BFY18	32½p
BFY19	32½p
BFY20	82½p
BFY21	42½p
BFY24	45p
BFY25	25p
BFY26	20p
BFY29	50p
BFY30	50p
BFY41	50p
BFY43	62½p
BFY50	22½p
BFY51	22½p
BFY52	22½p
BFY53	22½p
BFY56A	57½p
BFY75	30p
BFY76	42½p
BFY77	57½p
BFY90	67½p
BFW58	27½p
BFW59	25p
BFW60	25p
BPX25	£1·85
BPX29	£1·80
BPY10	£1·45
BSX19	17½p

BSX20	17½p
BSX21	37½p
BSX26	45p
BSX27	47½p
BSX28	32½p
BSX60	82½p
BSX61	62½p
BSX76	22½p
BSX77	27½p
BSX78	27½p
BSY10	27½p
BSY11	27½p
BSY24	15p
BSY25	15p
BSY26	17½p
BSY27	17½p
BSY28	17½p
BSY29	17½p
BSY32	25p
BSY36	25p
BSY37	25p
BSY38	22½p
BSY39	22½p
BSY40	32½p
BSY51	32½p
BSY52	32½p
BSY53	37½p
BSY54	40p
BSY56	90p
BSY78	47½p
BSY79	45p
BSY82	52½p
BSY90	57½p
BSY95A	12½p
BSW41	42½p
BSW70	27½p
D16P1	37½p
D16P2	40p
D16P3	37½p
D16P4	40p
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ADD 3p PER ITEM FOR POST AND PACKING FOR ORDERS UNDER 24 PIECES.

TERMS, CASH WITH ORDER ONLY. POST & PACKING PAYABLE ON ORDERS UP TO £6·00, AFTER THAT FREE EXCEPT C.R.T.'s.

LAWSON BRAND NEW TELEVISION TUBES

SPECIFICATION: *The Lawson range of new television tubes are designed to give superb performance, coupled with maximum reliability and very long life. All tubes are the products of Britain's major C.R.T. manufacturers, and each tube is an exact replacement. Tubes are produced to the original specifications but incorporate the very latest design improvements such as: High Brightness Maximum Contrast Silver Activated Screens, Micro-Fine Aluminising, Precision Aligned Gun Jigging, together with Ultra Hard R.F. High Vacuum Techniques.*

DIRECT REPLACEMENTS FOR MULLARD-MAZDA BRIMAR GEC, ETC.

A21-11W (P)	AW47-91 (M)	C19/AK (M)	CME1902 (M)	173K (M)
A28-14W	MW43-64 (M)	C21/1A (M)	CME1903 (M)	212K (M)
A31-18W (P)	MW43-69 (M)	C21/7A (M)	CME1905	7205A (M)
A47-11W (P)	MW43-80 (M)	C21/AA (M)	CME1906	7405A (M)
A47-13W (T)	MW52/20 (M)	C21/AF (M)	CME1908	7406A (M)
A47-14W (M)	MW53/80 (M)	C21/KM (M)	CME2101	7502A (M)
A47-17W (P)	AW47-97 (M)	C21/SM (M)	CME2104 (M)	7503A (M)
A47-18W (P)	AW53-80 (M)	C23/7A (M)	CME2301 (M)	7504A (M)
A47-26W (P)	AW53-88 (M)	C23/10 (M)	CME2302 (M)	7601A (M)
A59-11W (P)	AW53-89 (M)	C23/AK (M)	CME2303 (M)	7701A (M)
A59-12W (P)	AW59-90 (M)	CME1101 (P)	CME2305 (P)	CRM121 (M)
A59-13W (T)	AW59-91 (M)	CME1201 (P)	CME2306 (T)	MW31-74 (M)
A59-14W (T)	C17/1A (M)	CME1402 (M)	CME2308 (M)	A50-120W/R (P)
A59-15W (M)	C17/5A (M)	CME1601 (P)	CRM172 (M)	
A59-14W (T)	C17/7A (M)	CME1602 (P)	CRM173 (M)	
AW36-80 (M)	C17/AA (M)	CME1702 (M)	CRM212 (M)	
AW43-80 (A)	C17/AF (M)	CME1703 (M)	CRM211 (M)	
AW43-88 (M)	C17/FM (M)	CME1705 (M)	23SP4 (M)	
AW43-89 (M)	C17/5M (M)	CME1706 (M)	171K (M)	
AW47190 (M)	C19/10AP (T)	CME1901 (M)	172K (M)	

LAWSON TUBES
18 CHURCHDOWN ROAD,
MALVERN, WORCS.
Malvern 2100

2 YEARS' GUARANTEE FULL TUBE FITTING INSTRUCTIONS

Tubes are despatched passenger train, road or goods taking far too long for customer satisfaction.

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LAWSON "RED LABEL" *CRTS are particularly useful where cost is a vital factor, such as in older sets or rental use. Lawson "Red Label" CRTS are completely rebuilt from selected glass, are direct replacements and guaranteed for two years.*

	Brand New Tubes	Red Label Rebuilt	Carr. Ins.
12–14" mono (M)	£4·50	£4·25	12" - 19" 62p
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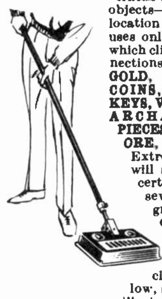
19" „ „	£6·95	£5·25	
21" „ „	£8·50	£6·87	20" - 23" 75p
23" „ „	£9·75	£7·25	
19" Panorama (P)	£8·62		
23" Panorama (P)	£11·95		
19" Twin Panel (T)	£10·25		
23" Twin Panel (T)	£13·87		
20" Panorama (P)	£16·12		

FIND BURIED TREASURE!
TREASURE LOCATOR



Metal locator detects and tracks down buried metal objects—it signals exact location (no phones used—uses only transistor radio which clips inside—no connections needed). **FINDS GOLD, SILVER, LOST COINS, JEWELLERY, KEYS, WAR SOUVENIRS, ARCHAEOLOGICAL PIECES, METALLIC ORE, NUGGETS, ETC.** Extremely sensitive, will signal presence of certain objects buried several feet below ground. Can be built with ease in one short evening with the wonderfully clear, easy to follow, step-by-step, fully illustrated instructions. Fully transistorised—no valves. Uses standard PP3 battery. No soldering necessary. Size of detector head 13¾" × 10" × 2¼". *Great demand expected at this remarkably low price*—All parts including detector head case, nuts, screws, wire, simple instructions, etc. Send now £2·37 + 33p p.&p. (47/6 + 6/6). (Telescopic handle as illustrated £1·75 (35/-). Parts available separately. Made up looks worth £15.

ONLY £2·37 (47/6)

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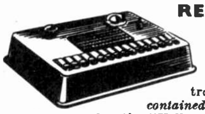
Listen in to AIRLINES, PRIVATE PLANES, JET PLANES. Eavesdrop on exciting crosstalk between pilots, ground approach, ground control, airport tower. Hear for yourself the disciplined voices hiding tenseness on talk downs. Be with them when they have to take nerve-ripping decisions in emergencies—tune into the international distress frequency. Covers aircraft frequency band including **HEATHROW, GATWICK, LUTON, RINGWAY, PRESTWICK, ETC.** This fantastic fully-transistorised instrument can be built by anyone nine to ninety in under two hours. (Our design team built four—every one worked first time). No soldering necessary. Fully illustrated simply worded instructions take you step-by-step. Uses standard PP3 battery. Size only 4¾" × 3" × 1¾". All you do is extend rod aerial, place close to any ordinary medium wave radio (even tiny pocket radios). **NO CONNECTIONS WHATEVER NEEDED.** Use indoors or outdoors. **SEND NOW ONLY** £2·37 (47/6) + 23p (4/6d) p.&p. for all parts including case, nuts, screws, wire, etc., etc. (parts available separately).

ONLY £2·37 (47/6)

REAL WORKING ELECTRONIC ORGAN



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Don't confuse with ordinary electric organs that simply blow air over mouth-organ type reeds, etc. Eight months were spent in creating and testing this superb, revolutionary electronic organ. Fully transistorised, no valves. *Proper self-contained loudspeaker.* Fifteen separate keys span two full octaves—play the "Yellow Rose of Texas," "Silent Night," "Auld Lang Syne" and ots of similar tunes on this real working electronic organ. Size 13¾" × 10" × 2¼". Uses standard battery. Have the thrill and excitement of building it together with the pleasure of playing a real electronic organ. Play it anywhere. No soldering necessary. Easy as A.B.C. to make following the fully illustrated step-by-step instructions. **BIG DEMAND ANTICIPATED FOR THIS UNIQUE INSTRUMENT** at our low price. **ONLY** £2·75 + 23p p.&p. (55/- + 4/6d.) for all parts, including case, loudspeaker, transistors, condensers, resistors, knobs, transformers, volume control, wire, nuts, screws, instructions, etc. (parts available separately). Have all the pleasure of making it yourself, finish with an exciting gift for someone.

Examine at home for seven days. Your money back if not delighted.

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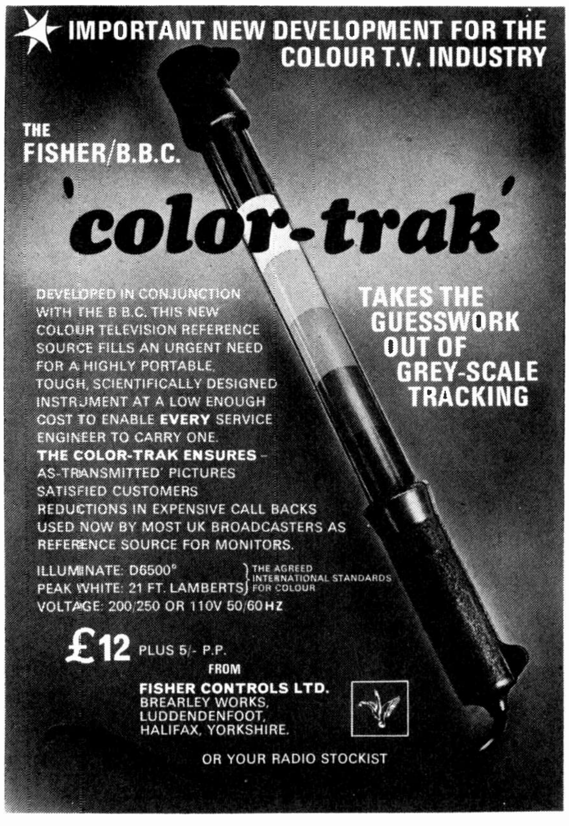
(Near Bayswater Tube) Callers welcome, 9-6, including Saturdays.



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·0022	600v.	£0·04
·0033	600/1500v.	£0·04
·0047	600/1500v.	£0·04
·01	400v.	£0·04
·022	600v.	£0·05
·033	600v.	£0·05
·047	600v.	£0·05
·1	600v.	£0·05
·22	600v.	£0·10
·47	600v.	£0·14
·01	1000v.	£0·06
·022	1000v.	£0·06
·047	1000v.	£0·09
·1	1000v.	£0·09
·22	1000v.	£0·14
·47	1000v.	£0·19
·001	1500v.	£0·08

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10 watt rating, suitable for mains dropper sections.

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10	Ohms	£0·09
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25	,,	£0·09
33	,,	£0·09
50	,,	£0·09
87	,,	£0·09
100	,,	£0·09
150	,,	£0·09
220	,,	£0·09
330	,,	£0·09
1K	,,	£0·09
2·2K	,,	£0·09
3·3K	,,	£0·09
4·7K	,,	£0·09

PULSE CERAMICS (5's) 12KV

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120pf	47pf	£0·06
180pf	68pf	£0·06
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50mfd	25v.	£0·08
100mfd	25v.	£0·10
250mfd	25v.	£0·15
500mfd	25v.	£0·19
1000mfd	12v.	£0·30
1000mfd	30v.	£0·30
2000mfd	25v.	£0·35
2500mfd	30v.	£0·45
3000mfd	30v.	£0·47
5000mfd	30v.	£0·55
25mfd	50v.	£0·08
50mfd	50v.	£0·10
100mfd	50v.	£0·13
250mfd	50v.	£0·18
500mfd	50v.	£0·24
2000mfd	50v.	£0·47
2500mfd	50v.	£0·55

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4mfd	£0·11
8mfd	£0·13
16mfd	£0·16
32mfd	£0·23
50mfd	£0·25
8/8mfd	£0·19
8/16mfd	£0·25
16/16mfd	£0·26
16/32mfd	£0·27
32/32mfd	£0·27
50/50mfd	£0·42
50/50/50mfd	£0·52

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100/400mfd	£0·83
200/200mfd	£0·85
200/200/100mfd	£0·95
200/400/32mfd	£0·95
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100/400/32mfd	£0·95
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100K	,,	£0·07
250K	,,	£0·07
500K	,,	£0·07
1 meg	,,	£0·07
2 meg	,,	£0·07
500K	Horizontal	£0·07
680V	,,	£0·07
1 meg	,,	£0·07

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2mfd	18v.	£0·09
4mfd	18v.	£0·09
5mfd	18v.	£0·09
8mfd	18v.	£0·09
10mfd	18v.	£0·09
16mfd	18v.	£0·09
25mfd	18v.	£0·09
32mfd	18v.	£0·09
50mfd	18v.	£0·09
100mfd	18v.	£0·09
200mfd	18v.	£0·09

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5 amp.	£0·14
15 amp	£0·29

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Westinghouse S10AR2	£0·33
BY127 Mullard	£0·26
BY327	£0·25

CONTACT COOLED FULL WAVE

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100ma	£0·70
150ma	£0·86

CO-AXIAL PLUGS

Bakelite top	£0·04
Egen metal	£0·08
Single point (car radio)	£0·10

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100K	£0·08
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Chrome standard	£0·20
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3-pin	£0·10
5-pin	£0·11
Sockets	£0·06

CARBON FILM RESISTORS

½ watt, 1 watt and 2 watt.

The following values are packed in cartons of *six of each value.*

10	ohm	1·2K	150K
12	,,	1·5K	180K
15	,,	1·8K	220K
18	,,	2·2K	270K
22	,,	2·7K	330K
27	,,	3·3K	390K
33	,,	3·9K	430K
39	,,	4·3K	470K
43	,,	4·7K	560K
47	,,	5·6K	680K
56	,,	6·8K	820K
68	,,	8·2K	1M
82	,,	10K	1·2M
100	,,	12K	1·5M
120	,,	15K	1·8M
150	,,	18K	2·2M
180	,,	22K	2·7M
220	,,	27K	3·3M
270	,,	33K	3·9M
330	,,	39K	4·3M
390	,,	43K	4·7M
430	,,	47K	5·6M
470	,,	56K	6·8M
560	,,	68K	8·2M
680	,,	82K	10M
820	,,	100K	12M
1K	,,	120K	15M

All the above values are available in both ½ watt, 1 watt and 2 watt versions.
***Special for Philips TV's:**
8·2M 2-watt, 23p per pack.
Price ½ watt ·10, 1 watt ·13, 2 watt ·23

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3 leg	£0·31
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5 leg	£0·31

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Standard spindle with flat.

Double pole switch	£0·25
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GP91/SC.	Stereo-compatible replacement	£1·10
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GENERAL PURPOSE REPLACEMENT FOR TC8's etc.		
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TC8	£0·23
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REBUILT	BRAND NEW	A FEW SAMPLE TYPES. REMEMBER WE STOCK EVERY TUBE
17" @ £5·95	£6·50	CME1702, AW43-80, CRM173, MW43-80, MW43-69*, CRM172*, AW43-88, AW43-89, CME1705, CME1703, C17AF, C17SM, etc.
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ECC81	PC88	PL83
ECC82	PC97	PL84
ECC83	PC900	PL302
ECC804	PCC84	PL504
ECH81	PCC88	PL508
ECH84	PCC89	PL509
ECL80	PCC189	PY33
ECL82	PCC806	PY81
ECL83	PCF80	PY800
ECL84	PCF86	PY801
ECL86	PCF87	PY82
EF80	PCF801	PY83
EF85	PCF802	PY500
EF86	PCF805	UABC80
EF89	PCF806	UCH81
EF183	PCF808	UCL82
EF184	PCL82	UCL83
EH90	PCL83	UL41
EL34	PCL84	UL84
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42% ORDERS UP TO £50
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0Z4	0·23
1A3	0·23
1A5	0·25
1A7GT	0·37
1D5	0·38
1D6	0·48
1FD1	0·35
1G6	0·30
1H5GT	0·35
1L4	0·13
1LD5	0·30
ILN5	0·40
1N5GT	0·39
1R5	0·28
1S4	0·24
1S5	0·22
1U4	0·29
1U5	0·48
2D21	0·35
3A4	0·20
3A5	1·00
3B7	0·25
3D6	0·19
3Q4	0·38
3Q5GT	0·35
3S4	0·29
3V4	0·32
5R4GY	0·53
5V4G	0·38
5Y3GT	0·28
5Z3	0·45
5Z4G	0·35
6/30L2	0·58
6A8G	0·33
6AC7	0·15
6AG5	0·25
6AK5	0·25
6AK6	0·30
6AM6	0·17
6AQ5	0·28
6AR6	1·00
6AT6	0·20
6AU6	0·25
6AV6	0·30
6B8G	0·13
6BA6	0·23
6BE6	0·24
6BH6	0·43
6BJ6	0·43
6BQ5	0·24
6BQ7A	0·38
6BR7	0·79
6BR8	0·63
6BS7	1·25
6BW6	0·72
6BW7	0·65
6BZ6	0·33
6C6	0·19
6C9	0·73
6CD6G	1·15
6CH6	0·38
6CL6	0·43
6CW4	0·63
6D6	0·15
6F1	0·63
6F6	0·63
6F6G	0·25
6F12	0·17
6F13	0·33
6F15	0·65
6F18	0·45
6F23	0·72
6F24	0·68
6F25	0·65
6F28	0·70
6F32	0·15
6H6GT	0·15
6J5G	0·19
6J6	0·18
6J7G	0·24
6J7GT	0·38
6K7G	0·10
6K7GT	0·23
6K8G	0·20
6L1	0·98
6L6GT	0·39
6L7GT	0·63
6L18	0·45
6L19	1·38
6LD20	0·48
6N7GT	0·40
6P28	1·25
6Q7	0·43
6Q7G	0·30
6R7	0·55
6R7G	0·35
6SA7GT	0·35
6SA7M	0·35
6SC7GT	0·33
6SG7GT	0·33
6SH7	0·53
6SJ7	0·35
6SK7GT	0·23
6SN7GT	0·38
6U4GT	0·60
6U7G	0·53
6V6G	0·18
6V6GT	0·33
6X4	0·22
6X5GT	0·25
6Y6G	0·55
6Y7G	0·63
7B6	0·58
7B7	0·35
7C6	0·30
7F8	0·88
7H7	0·88
7R7	0·65
7V7	0·25
9BW6	0·50
9D7	0·78
10C1	1·25
10C2	0·50
10D1	0·50
10D2	0·75
10F1	0·75
10F9	0·45
10F18	0·35
10LD11	0·53
10P13	0·65
10P14	1·10
10P18	0·33
12A6	0·63
12AC6	0·40
12AD6	0·40
12AE6	0·48
12AT6	0·23
12AT7	0·19
12AU6	0·24
12AU7	0·23
12AV6	0·28
12AX7	0·23
12AY7	0·68
12BA6	0·30
12BE6	0·30
12BH7	0·40
12E1	0·85
12K5	0·50
12K7GT	0·34
12Q7GT	0·28
12SA7GT	0·40
12SC7	0·35
12SG7	0·23
12SH7	0·15
12SJ7	0·23
12SK7	0·24
12SQ7GT	0·50
14H7	0·48
14S7	1·15
19AQ5	0·24
19H1	2·00
20D1	0·65
20D4	1·05
20F2	0·70
20L1	0·98
20P1	0·88
20P3	0·90
20P4	0·93
20P5	1·00
25A6G	0·29
25L6G	0·29
25Y5	0·38
25Y5G	0·43
25Z4G	0·30
25Z5	0·40
25Z6G	0·43
30C1	0·30
30C15	0·65
30C17	0·80
30C18	0·64
30F5	0·80
30FL1	0·64
30FL2	0·75
30FL12	0·80
30FL14	0·73
30L1	0·32
30L15	0·64
30L17	0·78
30P4MR	0·98
30P12	0·69
30P19/30P4	0·60
30PL1	0·69
30PL12	0·37
30PL13	0·78
30PL14	0·75
30PL15	0·98
35A3	0·50
35A5	0·75
35D5	0·70
35L6GT	0·44
35W4	0·23
35Z3	0·50
35Z4GT	0·24
35Z5GT	0·30
50B5	0·35
50C5	0·32
50CD6G	2·17
50L6GT	0·45
72	0·33
85A2	0·43
85A3	0·40
90AG	3·38
90AV	3·38
90CG	1·70
90CV	1·68
90C1	0·80
150B2	0·58
150C2	0·30
301	1·00
302	0·83
303	0·75
305	0·83
306	0·65
807	0·59
1821	0·53
5763	0·50
6060	0·30
7193	0·53
7475	0·70
A1834	1·00
A2134	0·98
A3042	0·75
AC044	1·18
AC2/PEN	0·98
AC2/PEN/DD	0·98
AC6PEN	0·38
AC/PEN(7)	0·98
AC/TH1	0·50
AC/TP	0·98
AL60	0·78
ARP3	0·35
ATP4	0·12
AZ1	0·40
AZ31	0·48
AZ41	0·53
B36	0·33
B319	0·32
CL33	0·98
CV6	0·53
CY1C	0·53
CY31	0·38
D63	0·25
D77	0·12
DAC32	0·35
DAF91	0·22
DAF96	0·35
DCC90	1·00
DD4	0·53
DF33	0·39
DF91	0·14
DF96	0·35
DF97	0·63
DH63	0·30
DH76	0·28
DH77	0·20
DH81	0·58
DH107	0·90
DK32	0·37
DK40	0·55
DK91	0·28
DK92	0·43
DK96	0·37
DL33	0·35
DL92	0·29
DL94	0·32
DL96	0·37
DM70	0·30
DM71	0·38
DW4/350	0·38
DW/500	0·38
DY86/7	0·29
DY802	0·48
E80F	1·20
E83F	1·20
E88CC	0·60
E180F	0·95
E182CC	1·13
E1148	0·53
EA50	0·18
EA76	0·88
EABC80	0·33
EAC91	0·38
EAF42	0·50
EB34	0·20
EB41	0·50
EB91	0·12
EBC41	0·48
EBC81	0·33
EBC90	0·20
EBC91	0·30
EBF80	0·34
EBF83	0·40
EBF89	0·32
EBL21	0·60
EC54	0·50
EC70	0·24
EC86	0·63
EC88	0·60
EC92	0·35
ECC32	1·58
ECC33	1·58
ECC40	0·60
ECC81	0·19
ECC82	0·23
ECC83	0·23
ECC84	0·30
ECC85	0·28
ECC86	0·40
ECC88	0·35
ECC189	0·48
ECC804	0·58
ECC807	1·35
ECF80	0·33
ECF82	0·33
ECF86	0·65
ECF804	2·10
ECH21	0·63
ECH35	0·29
ECH42	0·64
ECH81	0·29
ECH83	0·40
ECH84	0·38
ECL80	0·35
ECL82	0·33
ECL83	0·52
ECL84	0·60
ECL85	0·55
ECL86	0·40
EF22	0·63
EF36	0·33
EF37A	0·35
EF39	0·40
EF40	0·50
EF41	0·50
EF42	0·33
EF54	0·98
EF73	0·33
EF80	0·23
EF83	0·48
EF85	0·29
EF86	0·32
EF89	0·25
EF91	0·17
EF92	0·13
EF97	0·55
EF98	0·65
EF183	0·30
EF184	0·30
EFP60	0·50
EH90	0·38
EL32	0·18
EL34	0·53
EL37	0·87
EL41	0·55
EL42	0·53
EL81	0·50
EL83	0·38
EL84	0·24
EL85	0·40
EL86	0·40
EL91	0·23
EL95	0·35
EM34	0·90
EM80	0·38
EM81	0·42
EM84	0·34
EM87	0·38
EY51	0·37
EY81	0·35
EY83	0·55
EY84	0·50
EY86/7	0·33
EY88	0·43
EY91	0·53
EZ35	0·25
EZ40	0·40
EZ41	0·43
EZ80	0·23
EZ81	0·24
EZ90	0·22
FW4/500	0·75
FW4/800	0·75
GZ30	0·35
GZ32	0·45
GZ33	0·70
GZ34	0·53
GZ37	0·75
HABC80	0·45
HL23DD	0·40
HL41DD	0·98
HL42DD	0·50
HN309	0·40
HVR2	0·53
HVR2A	0·53
IW3	0·38
IW4/350	0·38
IW4/500	0·38
KT2	0·25
KT8	1·75
KT41	0·98
KT44	1·00
KT63	0·25
KT66	0·83
KT74	0·63
KT76	0·63
KT88	1·70
KTW61	0·63
KTW62	0·63
KTW63	0·50
M8162	0·63
ME1400	0·74
MHL4	0·75
MHLD6	0·75
N78	2·05
N108	1·40
N308	0·98
N339	1·25
P61	0·50
PABC80	0·35
PC86	0·52
PC88	0·52
PC95	0·53
PC97	0·40
PC900	0·38
PCC84	0·32
PCC85	0·33
PCC88	0·49
PCC89	0·48
PCC189	0·49
PCF80	0·30
PCF82	0·33
PCF84	0·40
PCF86	0·50
PCF200	0·67
PCF801	0·35
PCF802	0·45
PCF805	0·64
PCF806	0·64
PCF808	0·73
PCH200	0·62
PCL82	0·37
PCL83	0·50
PCL84	0·38
PCL805/85	0·45
PCL86	0·43
PCL88	0·75
PEN45	0·35
PEN45DD	0·75
PEN46	0·20
PEN453DD	0·98
PENA4	0·98
PENDD 4020	0·88
PFL200	0·59
PL33	0·38
PL36	0·48
PL81	0·48
PL81A	0·63
PL82	0·33
PL83	0·33
PL84	0·33
PL302	0·60
PL500	0·68
PL504	0·68
PL505	1·44
PL508	1·40
PL509	1·44
PL802	0·75
PM84	0·39
PX4	1·18
PX25	1·18
PY32/3	0·50
PY80	0·33
PY81	0·27
PY82	0·27
PY83	0·29
PY88	0·34
PY301	0·63
PY500	1·08
PY800	0·38
PY801	0·34
PZ30	0·48
QQV03/10	1·20
QS75/20	0·63
QS150/15	0·63
QV04/7	0·63
R10	0·75
R11	0·98
R16	1·75
R17	0·88
R18	0·50
R19	0·33
R20	0·59
R52	0·38
RK34	0·38
SP42	0·75
SP61	0·33
TH4B	0·50
TH233	0·98
TP2620	0·98
UABC80	0·33
UAF42	0·52
UBC41	0·45
UBC81	0·40
UBF80	0·29
UBF89	0·34
UBL21	0·55
UC92	0·35
UCC84	0·40
UCC85	0·37
UCF80	0·42
UCH21	0·60
UCH42	0·63
UCH81	0·33
UCL82	0·35
UCL83	0·50
UF41	0·50
UF42	0·60
UF80	0·35
UF85	0·34
UF86	0·63
UF89	0·34
UL41	0·59
UL46	0·88
UL84	0·33
UM80	0·33
UR1C	0·53
UU5	0·38
UU9	0·40
UU12	0·24
UY1N	0·50
UY21	0·55
UY41	0·38
UY85	0·29
U10	0·45
U12/14	0·38
U16	0·75
U17	0·35
U18/20	0·75
U19	1·73
U22	0·39
U25	0·65
U26	0·59
U31	0·30
U33	1·48
U35	1·50
U37	1·75
U45	0·78
U47	0·65
U49	0·59
U50	0·28
U76	0·24
U78	0·22
U107	0·92
U191	0·63
U251	0·73
U281	0·40
U282	0·40
U301	0·53
U403	0·33
U404	0·38
U801	0·95
U4020	0·38
VP13C	0·35
VP23	0·40
VP41	0·38
VR75	1·25
VR105	0·33
VR150	0·33
VT61A	0·35
VU111	0·44
VU129	0·60
VU120A	0·60
VU133	0·35
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W729	0·60
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600	0·07	0·16	0·10	0·23
800	0·10	0·17	0·13	0·25
1000	0·11	0·25	0·15	0·30
1200	—	0·33	—	0·33
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50	0·14	0·21	0·47	
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TELEVISION

SERVICING·CONSTRUCTION·COLOUR·DEVELOPMENTS

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MARCH 1971

TAPE OR FILM?

One problem in writing comment columns is the occasional feeling that "it has been said before". Certainly the subject of videotape has been mentioned in this column before but we make no apologies for bringing the matter up again, principally because this specialised aspect of television is making such rapid progress.

Videotape recording has come a long way since those days of the BBC's VERA, a precocious lady in her time but now distinctly Victorian. Those who have been watching television over the last 10-15 years have seen tremendous strides in recording. Early video recordings were of poor definition and far inferior to films and it was many years before they achieved anything like parity with film transmitted via flying-spot scanners. The gap narrowed, however, and controversy began.

Although from the viewing side of things videotape recordings were equal to or better than film there were problems from the engineering or programme end; films were much easier to handle and provided greater versatility and flexibility. And of course the advent of colour presented new problems for videotape recording.

Developments over the last few years have again swayed the balance however. Apart from good transmission quality, modern quadruplex tape machines can handle all the colour systems and their "lock-up time" has been reduced from seconds to milliseconds while the helical-scan system has been so improved as to be on the point of giving broadcast standard results at very reduced cost. The state-of-the-art is now such that programme video recording is much cheaper than film —for comparison it has been stated that *The Avengers* would cost £20,000 for an hour in a television studio against £60,000 in a film studio.

Apart from other developments the signs are that video recorders are going the way of their humbler audio counterparts—into cassettes. Which leads to renewed speculation on the prospects for commercially viable domestic v.t.r. equipment. Although costs *have* come down over the last decade the type of machine which could be sold to the ordinary viewer still seems a long way off. Perhaps we will have to wait for the exploitation of newer techniques before the possession of a home videotape recorder becomes a status symbol —then part of the furniture!

W. N. STEVENS, *Editor*

THIS MONTH

THE NEXT ISSUE DATED APRIL WILL BE PUBLISHED MARCH 29

TELETOPICS

VARICAP TUNERS FROM MULLARD

Mullard are now producing two variable-capacitance-diode tuner units, the ELC1042 covering Bands I and III and the ELC1043 covering Bands IV and V. Channel selection with this type of tuner is effected by altering the preset d.c. bias potential applied to the tuning diodes. The two tuners are electrically and mechanically interchangeable and are housed in metal boxes with overall dimensions of 96 × 58 × 28mm. A hole at one end enables i.f. adjustment to be carried out and all connections are brought out through lead-through capacitors. A 12V supply is required to power the transistors and potentials of 0·3 to 28V to tune the diodes. Both tuners employ three transistors. In the v.h.f. tuner these operate as r.f. amplifier, mixer and oscillator while in the u.h.f. tuner there are two r.f. amplifier stages and a self-oscillating mixer. Coupling between the first and second r.f. amplifier stages in the u.h.f. tuner is by means of a half-wave tuned line while the second r.f. amplifier and mixer are coupled by bandpass half-wave tuned lines. Typical noise figures for the v.h.f. tuner are 7·5dB for Band I and 7dB for Band III, with power gains of 20dB for Band I and 22dB for Band III. A typical noise figure of 8dB is quoted for the u.h.f. tuner with a power gain of 20dB.

CAMERA TUBE ADVANCES

A new camera tube, the silicon storage vidicon, has been developed at RCA's David Sarnoff Research Centre by Dr Edward Luedicke and Robert Silver for taking and storing for later playback stills of continuous programme material. The tube can store and relay up to 200 frames a minute. To store a picture the silicon target is first scanned by a high-velocity beam to erase the previous picture information. The picture is then placed on the target optically in the conventional manner and the target scanned for several frames with a somewhat lower-velocity beam to build up an electron charge pattern which effectively stores the picture. To read out the picture the target is scanned by a still lower-velocity beam while a small light bulb outside the tube illuminates the target. Once the picture is stored on the target it can be displayed on a TV screen for several minutes before the read beam erases it, and the picture can be stored for over a month before being read out. The tube can be used to convert scanning rates, storing at one rate and reading out at another.

A new high-sensitivity silicon-target tube, the Epicon, has been developed by Dr Morry Blumenfeld, Dr William Engeler and Ernest A. Taft of the US General Electric research centre. Silicon-target tubes are based on the production of a large number of junction diodes which form a silicon diode target array. These are generally formed by the planar diffusion technique, but problems arise with this type of target from the accumulation of electrons on the target. In the new tube the silicon diode structure is formed by epitaxial growth, giving a simpler structure that is not damaged by being pointed directly towards a bright light source. Production of the new tube has started at GE's Syracuse, NY plant. The tube's sensitivity enables it to be used with normal room lighting and one of its first applications is expected to be in "photophones".

The English Electric Valve Co. Ltd. is developing a vidicon-type camera tube with silicon target to be known as the Sidicon. The silicon target consists of an array of some 300,000 silicon diodes of which about 187,750 are utilised in the picture area. Advantages of the new tube are its capacity to withstand extreme light and scanning beam overloads and the fact that it can be stored at high temperatures and under any lighting conditions. These features and the mechanical ruggedness of the 0·9in. target mean that the tube would be ideal for video-telephone applications and industrial CCTV systems. A problem that English Electric in common with other tube makers have encountered is in obtaining a target with a 100 per cent blemish-free diode yield. Development samples are expected to be available later this year.

SET NEWS

Teleton have reduced the recommended retail prices of two of their models. The 12in. Model TA12 will retail now at £69·25 (previously £75) while the 12in. Model TX12, which has a detachable daylight viewing screen, is reduced from £79 to £72·50. Both these monochrome receivers can be operated from the mains or a 12V car battery. The company (Teleton Electro (UK) Company Ltd., Teleton House, Robjohns Road, Widford, Chelmsford, Essex) claims to have handled two-thirds of the battery-mains portables imported from Japan during 1970.

TRANSMITTERS IN OPERATION

BBC-2 is now being transmitted from **Redruth**, West Cornwall, on channel 44 with horizontal polarisation (aerial group B). The ITA has started transmissions from **Sandy Heath,** Bedfordshire, on channel 24 with horizontal polarisation (aerial group A). This is the third in the series of main u.h.f. transmitters allocated to Anglia Television and has an e.r.p. of 1,000kW. The ITA reports that some viewers living close to Sandy Heath have been receiving the ITA's transmissions from London on channel 23 and are experiencing adjacent-channel interference from Sandy

Heath: the ITA points out that Sandy Heath is the station planned to serve the area and should be received without interference. There have also been reports of cross-modulation between the ITA and BBC-2 transmissions from Sandy Heath: the cause is excess signal overloading the initial stages of the receiver.

The new Emley Moor u.h.f. aerials are now in operation, increasing the coverage from Emley Moor from about 2½ to some 4¼ million people.

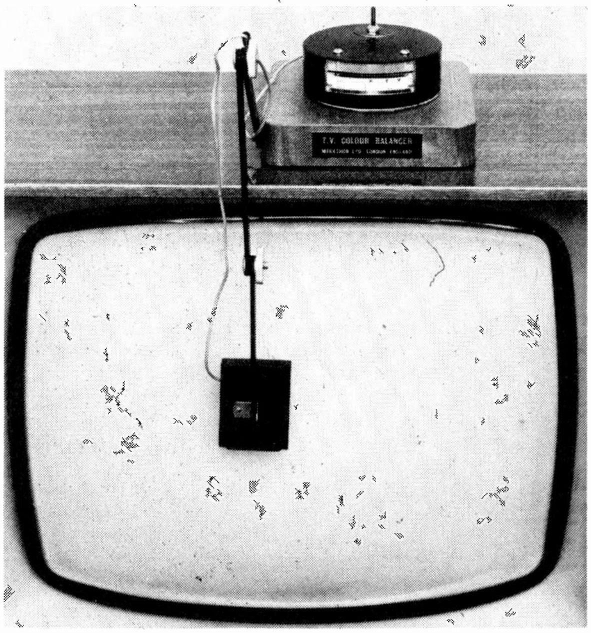
NEW ICs FOR TV

Details have now been released of the complete new range of Mullard i.c.s. for TV receivers—the TBA550Q, which replaces the TAA700 with which it is identical in electrical specification, was briefly mentioned last month. The other new i.c.s are the TBA500Q luminance section, TBA510Q chrominance section, TBA520Q synchronous detector-PAL switch section, TBA530Q RGB matrix and TBA540Q reference oscillator-a.p.c. loop section. All six new i.c.s are encapsulated in quad-in-line packs with zig-zag pins giving a spacing of 3·7mm. between adjacent pins. The existing TAA570 intercarrier sound channel and TAA550 voltage reference source (for use with varicap tuner units) i.c.s are retained.

The TBA500Q luminance i.c. comprises a gated luminance black-level clamp, delay line matching stage and d.c. contrast control which maintains constant black-level over its range of operation: a beam-current limiting facility is provided which reduces the picture contrast and then brightness, and line and field blanking pulses can be applied. The TBA510Q chrominance i.c. comprises an automatic chroma-controlled amplifier, burst gating and blanking circuits, colour killer, burst output and PAL delay line driver stages: it contains a d.c. chrominance control which when linked to the d.c. contrast control in the TBA500Q provides luminance and chrominance control tracking and also functions during beam-current limiting. The TBA520Q demodulator i.c. comprises active synchronous detectors for the R – Y and B – Y signals, a flip-flop circuit to control the PAL switching and PAL switch network, and also the G – Y matrix. It is suitable for d.c.-coupled drive to the picture tube when used with the TBA530Q matrix and RGB output stages. The TBA530Q RGB matrix provides red, green and blue output signals to drive external RGB transistor amplifiers: thermal matching of the three channels, high gain and overall d.c. feedback stabilise the black levels without the need for additional clamps. The TBA540Q i.c. combines the functions of an automatic phase- and amplitude-controlled 4·43MHz reference oscillator with a synchronous detector which provides the a.c.c., ident and colour-killer outputs in addition to the signal to control the oscillator.

NEW PRODUCTS

The ITT-Metrix electronic millivoltmeter type VX213A is now available in the UK from ITT Electronic Services, Harlow. With an input impedance of 10MΩ the meter will measure direct voltages and currents and a.c. voltages up to 1MHz directly (up to 30MHz with a probe and up to 1,000MHz with a measuring tee), resistances up to 100MΩ, temperatures from – 200 to + 600C and lighting intensities up to 200ft./cd.



The Megatron photoelectric colour balancer

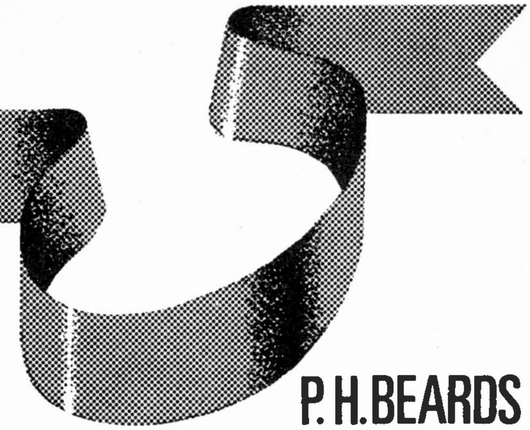
A photoelectric colour TV set white tone and colour balancer (see photo), has been introduced by Megatron Ltd., 115a Fonthill Road, London N4, at £15 plus 22½p postage. The instrument enables setting up to illuminant D (white) and colour balancing to be carried out by reading a meter scale instead of having to judge colours and brightness by eye. The meter is housed in a wooden base which is placed on top of the receiver and can be rotated to face the front or back of the set, while the photocell in a pad at the end of an extension arm is pressed against the screen of the set. After setting the meter for zero, i.e. no extraneous light, the set is switched on and adjustments made in accordance with preset markings on the meter scale.

A further set-top aerial has been added to the J-Beam range (J-Beam Aerials Ltd., Rothersthorpe Crescent, Northampton). This, the Starbeam Super Six, has six elements and has been designed to allow adjustment through 360° in order to obtain optimum performance and for convenience in use with vertical or horizontal polarisation. Recommended price £1·09.

Solderstat Ltd. (PO Box 10, Bush Fair, Harlow, Essex) have introduced a new kit for soldering and desoldering based on the HMS series soldering iron. The kit includes a soldering iron stand, wire stripper/ screwdriver, core of cored solder, solder tags, p.v.c. insulation tape, wiper pad, spare bit and desolder braid dispenser. Recommended price £3·25.

Antiference Ltd. (Aylesbury, Bucks) have added to their range of products three new aerial accessories, the MA101 u.h.f. masthead amplifier, PU101 power unit to go with this amplifier and BSA201 set-back amplifier with integral power unit. Both amplifiers use a single low-noise germanium transistor and each amplifier is individually tuned for high gain and even response over its particular channel group. The gain of the group A version is 17dB, group B version 15dB and the group CD version 13dB. The recommended retail price of the MA101 is £5·24, the PU101 £4·62 and the BSA201 £7.

HELICAL-SCAN VIDEOTAPE RECORDERS



P. H. BEARDS

In replaying magnetic tape there are two aspects of the process which make it more difficult to reproduce video signals than audio signals. The first concerns the *extinction frequency* associated with the length of the replay head gap. Each cycle of a recorded signal effectively produces in the tape two bar magnets lying end to end as shown in Fig. 1. When replaying the gap in the head bridges the tape and the flux

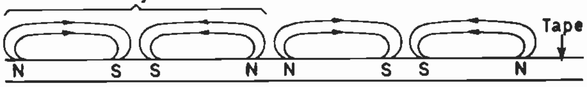


Fig. 1: Recorded cycles of signal form bar magnets on the tape.

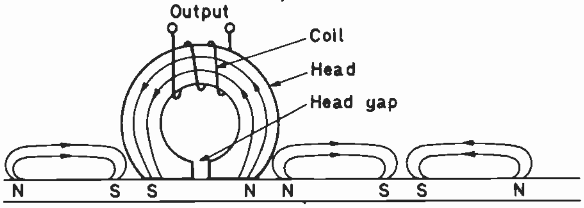


Fig. 2: The flux from the tape across the head gap passes through the head.

passes around the head material and not through the gap (see Fig. 2). The fact that the tape moves relative to the head means that the flux in the head changes and a voltage proportional to the rate of change of flux is produced across the head coil.

Extinction Frequency

For a particular tape speed the length of the recorded bar magnets will decrease as the frequency of the recorded signal increases and a point will be reached where the length of two bar magnets—i.e. one recorded cycle—is equal to the width of the head gap. This situation is depicted in Fig. 3. No flux can be induced in the head and whatever the position of the tape the flux around the head will be zero. Consequently there will be no output. The frequency at which this phenomenon occurs is called the *extinction frequency*, *f* ext.

To give some idea of the scale of the problem consider an audio replay head with a gap length of $0{\cdot}25 \times 10^{-3}$in. (i.e. one quarter of a "thou") used on a recorder with a tape speed of 7½in./sec. To find *f* ext we work out how many cycles corresponding to a wavelength of $0{\cdot}25 \times 10^{-3}$in. can be accommodated in one second's worth of tape, i.e. 7½in. It will

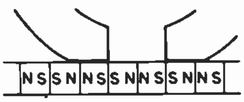


Fig. 3: Length of the bar magnets on the tape at the extinction frequency.

be $7{\cdot}5/(0{\cdot}25 \times 10^{-3}) = 30{,}000$, i.e. *f* ext = 30kHz. Such a low frequency is clearly inadequate for video signals of several megahertz—e.g. broadcast-standard 625-line video signals requiring an upper frequency limit of 5·5MHz.

Video Replay Signal Dynamic Range

The second difficulty of video recording is concerned with the number of octaves occupied by a video signal. We may first of all note that basically the frequency response of the recording process is fairly flat; that is to say, for a given value of record head current the flux remaining on the tape does not vary greatly with the frequency of the signal being recorded. On replay however the situation is quite different. We can neglect for a moment the extinction phenomenon by considering frequencies low enough for the effect not to have come into action. Fig. 4

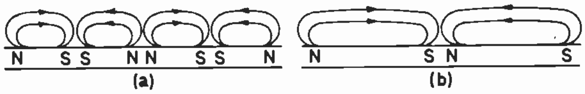


Fig. 4: (a) Flux from tape recorded at frequency f, (b) flux from tape recorded with same amplitude signal but at frequency f/2.

shows that as the frequency of the recorded signal is halved then although the value of the flux in the replay head will be the same in both cases *the rate of change of flux* will be halved. In frequency response terms this means that for every halving in frequency (i.e. every octave drop) the voltage output will be halved—i.e. reduced by 6dB.

The particular difficulty this effect causes in videotape recording is that a video signal occupies more octaves than an audio signal. A good-quality audio signal for example would occupy say 50Hz to 15kHz, which is between 9 and 10 octaves. Strictly, since a video signal has a d.c. component, it occupies an infinite number of octaves, but if frequencies down to about 25Hz only are retained the d.c. component can be recovered by clamping. Even so the band from 25Hz to 5·5MHz occupies about 18 octaves. To

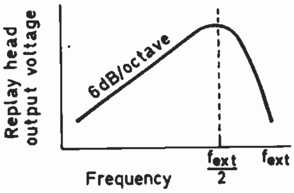


Fig. 5: Replay head frequency response characteristic. Maximum output occurs at about f ext/2: only the band below this frequency is normally used.

see the difficulties this produces consider Fig. 5 which shows the overall response of the replay head including the extinction effect. The maximum output occurs at about 0·5f ext and only the band below this frequency is normally used. The extra 8 octaves means that as frequency is reduced the output is halved a further eight times—i.e. reduced by 48dB. It would be extremely difficult to amplify a signal with such a tremendous dynamic range and the consequence would be for the lower frequencies to be lost in noise.

Basic VTR Techniques

Taking the solutions to these two problems in turn we can see from our example that f ext is (a) inversely proportional to the gap width and (b) proportional to the head-to-tape speed. Reductions *have* been made in the gap widths of video heads compared to audio heads, but the improvements have only a marginal effect on the scale of the problem. The basic approach is to increase the *head-to-tape speed.* In audio recording it is usual to refer just to the tape speed because the heads are fixed. Early experiments in v.t.r. increased the tape speed but the degree of mechanical stability achieved in these efforts was unsatisfactory. The real breakthrough in v.t.r. came when the head-to-tape speed was increased by moving the heads relative to the tape as well as the tape itself, achieving head-to-tape speeds of the order of 1,000in./sec. We shall consider the mechanical details of such processes shortly.

The *octave* problem is solved by translating the frequency to be recorded to a higher frequency band. To see the principle involved consider for example a 0-5MHz video signal amplitude modulating a 10MHz carrier. The result will be a signal of 5-15MHz, i.e. a lower sideband of 10 down to 5MHz and an upper sideband of 10-15MHz. Such a signal occupies less than two octaves. The process involves having to replay even higher frequencies than those encountered with an unmodulated video signal but the head-to-tape speed can be made high enough to make this possible.

The example suggested involves amplitude modulation but in fact frequency modulation is used. In audio tape recording we go to some trouble to ensure that the contact between head and tape is good, either by stretching the tape across the heads or by the use of pressure pads. Where the contact is not good it will produce amplitude variations in the record and replay processes which will be reproduced as noise. With head-to-tape speeds of 1,000in./sec it becomes even more difficult to maintain good head-tape contact so that amplitude variations are inevitable. By using frequency modulation the process becomes insensitive to amplitude variations. Although the use of f.m. requires more octaves than the equivalent a.m. signal, the number of octaves used is still insignificant.

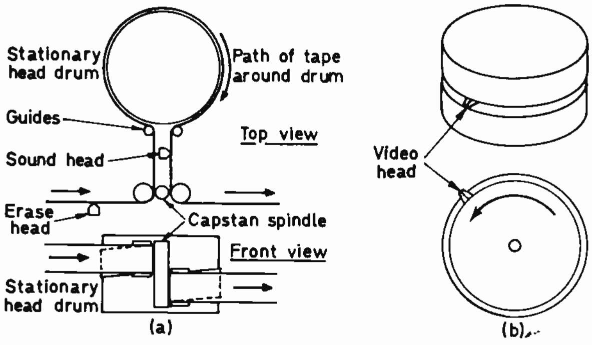


Fig. 6: (a) The Omega wrap format. (b) Video head drum assembly.

The principles outlined so far are quite general to any kind of videotape recording but we shall go on to deal with helical-scan machines in particular rather than the transverse-scan (quadrature-head) machines used as standard in broadcasting since for economic reasons it is the helical-scan recorder that is used for domestic and semiprofessional purposes.

Helical-scan Formats

In common with audio machines v.t.r.s have a capstan which pulls the tape in a longitudinal direction, usually at 7½in./sec. Between leaving the feed spool and arriving at the take-up spool however the tape is wrapped around a drum inside which the video head (or sometimes heads) rotates. It is common practice to use the same head(s) for record and replay purposes.

A number of different arrangements (or *formats*) are available for wrapping the tape around the drum to bring it into contact with the head. One in common use is shown in Fig. 6(a) and is called the Omega (Ω) wrap. The 1in. tape passes over an erase head, a roller and then a guide on to the stationary head drum which is about 6in. in diameter. It begins its wrap around the drum at the top and comes off at the bottom, thereby passing around the drum in a helix of almost one loop. There is a slit all the way around the drum which effectively divides it into two sections as shown in Fig. 6(b). The video head protrudes through this slit to touch the tape. The head is driven around the slit by a motor at the centre of the drum, the motor speed being 50 rev./sec so that one field of picture information is recorded per revolution. The peripheral speed of the head is $\pi \times 50 \times 6 = 940$in./sec. With this geometry the head records one slanting track on the tape in completing one revolution as shown in Fig. 7(a). When the head reaches the bottom of the tape it passes over the gap between the two guides (Fig. 6a) and begins a new track at the top of the tape. However the fact that the tape is moving longitudinally at 7½in./sec means that the tracks are separated.

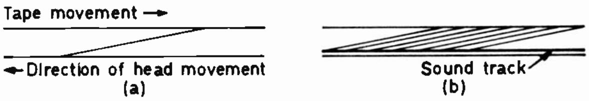


Fig. 7: (a) One video track recorded on the tape. (b) Pattern of video and sound tracks.

Having left the head drum the tape passes over a stationary sound record-replay head which lays a narrow sound track near the bottom edge of the tape giving the video and sound track pattern shown in Fig. 7(b). It can be seen that the tape passes through the capstan spindle and rollers twice.

As with all single-head v.t.r.s there is a short interval between tracks when the head is not in contact with the tape and there is in effect a drop-out of picture information. It is normally arranged that this "band of missing information" occurs during the last few lines of each field (or sometimes in the field blank-

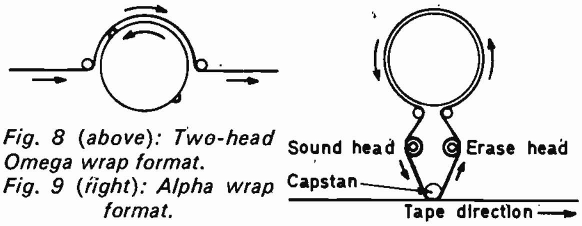


Fig. 8 (above): Two-head Omega wrap format.
Fig. 9 (right): Alpha wrap format.

ing time) so that its effect is not obvious on the reproduced picture.

A different Omega wrap format is shown in Fig. 8 where the wrap is only a semicircle. Two heads are used to scan the ½in. tape. In this arrangement only one head is used on record, with a head speed of 25rev./sec, so that alternate fields only are recorded. On replay both heads are used so that each recorded field is scanned twice, once by each head. With this system a drop-out is avoided but the vertical resolution of the picture is reduced because of the repeated information on adjacent lines of the picture.

An alternative to the Omega wrap is the Alpha (α) wrap, an example of which is shown in Fig. 9. Again the tape passes over the capstan spindle twice as before, once at the top and once at the bottom. In between it passes the erase head, the video head drum and the sound head. The path around the video head drum is similar to that of the Omega wrap so the pattern of sound and video tracks is similar.

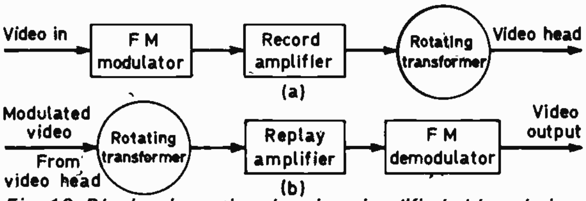


Fig. 10: Block schematics showing simplified video chains, (a) on record, (b) on replay.

The normal method of getting signals into and out of the rotating head is to use a rotating transformer. Fig. 10 shows block diagrams of the record and replay processes.

Need for Synchronisation

Moving the head to raise the head-to-tape speed and therefore the extinction frequency creates a difficulty. We have seen that each rotation of the video head lays down one slanting track with one video field, the end of the track corresponding to the end of the field. We must ensure that on record the time at which the head changes from one track to the next is at the end of a field and that on replay the head scans the recorded track accurately. For this to occur a servo control system is necessary.

Servo Systems

To begin with a signal is generated consisting of one pulse for every revolution of the head. This is known as the head-drum signal and can be produced in a number of ways, two of which are illustrated in Fig. 11. Fig. 11(a) shows a circular plate driven from the same shaft as the head drum. Above the plate is a lamp and below it a photoelectric cell. A hole in the plate near the edge allows the lamp to illuminate the cell to produce the head-drum signal once per revolution of the plate. Another method is shown in Fig. 11(b) where again there is a circular plate attached to the head motor shaft. A small magnet is in this case attached to the edge of the plate and passes through a coil once per revolution of the plate inducing the head-drum signal in the coil.

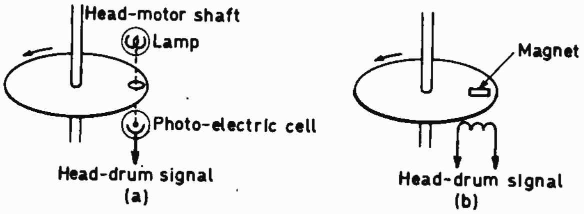


Fig. 11: Methods of generating a head-drum signal.

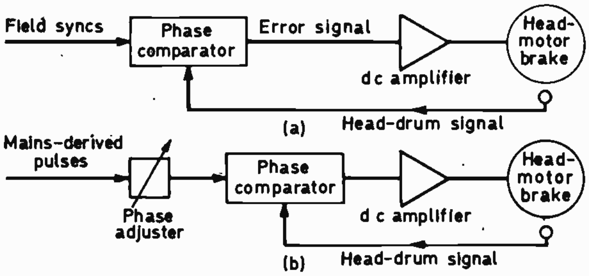


Fig. 12: Head servo system, (a) on record, (b) on replay.

The first object of this signal is to relate the head drum rotation in frequency and phase to the incoming field sync pulses during the recording process. For this reason both the head-drum signal and field sync pulses are fed into a phase comparator as shown in Fig. 12(a). If the two inputs are not equal in frequency and phase the comparator produces an output signal. This error signal is amplified and used to increase or decrease the current fed to an eddy-current brake fitted to the head motor. The corrections will continue until the frequency and phase of the head-drum signal and field sync pulses are equal. The phase is correct when the video track changeover from one track to the next is at the bottom of a field. On replay all that is required to make the head drum rotation correct is to compare the head-drum signal with some reference signal such as a 50Hz mains-derived pulse. The servo operation is then similar to that during recording and is shown in Fig. 12(b).

The other function of the servo system is to make the video head run accurately over the recorded tracks. This can be done by controlling the capstan motor speed so that the recorded tracks are moving longitudinally at such a carefully controlled speed

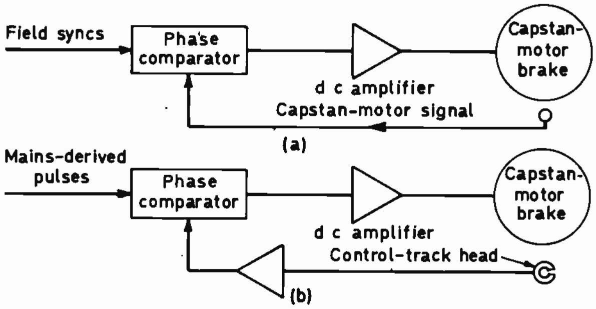


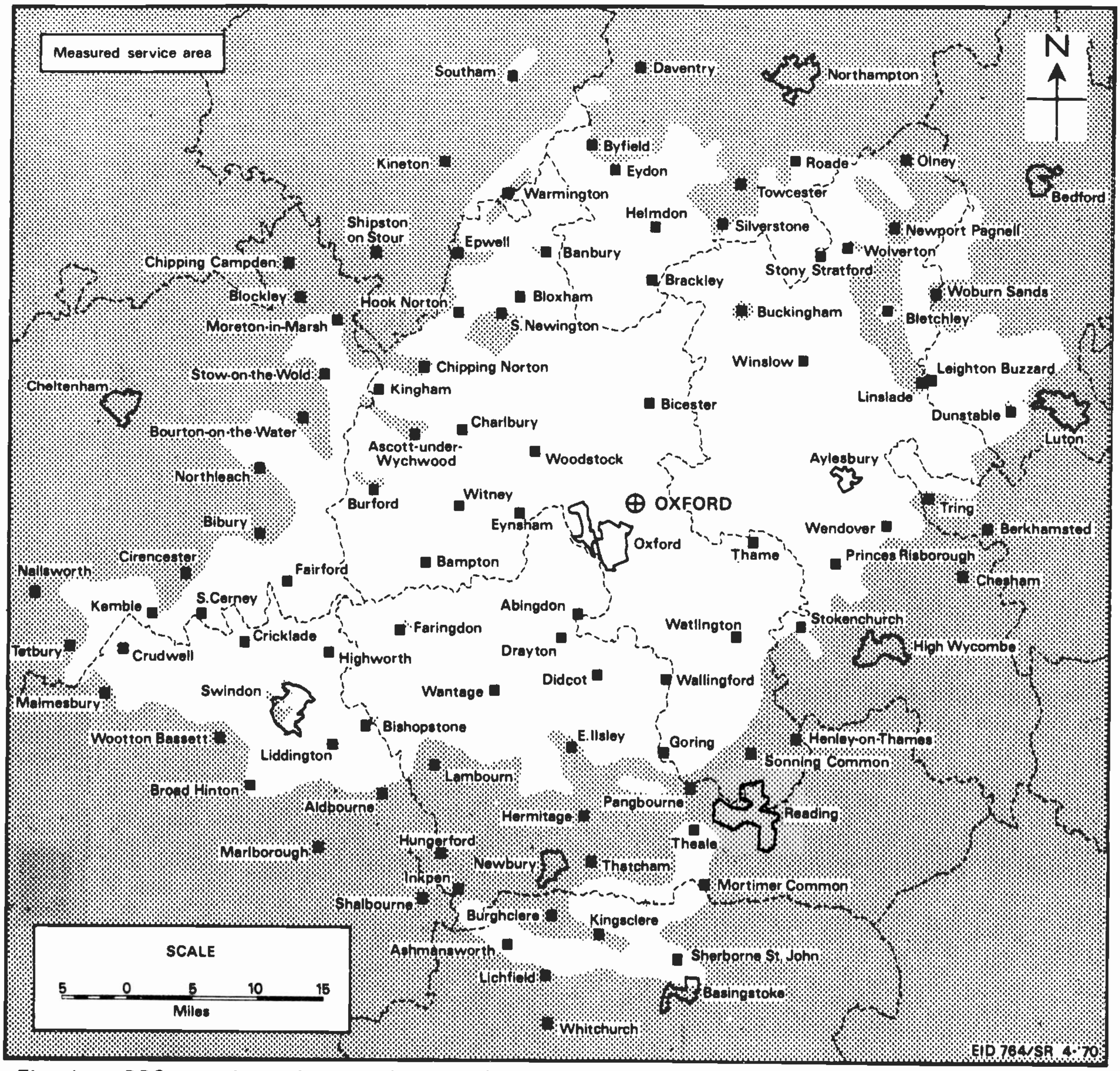
Fig. 13: Capstan servo system, (a) on record, (b) on replay.

that the video head, as it rotates, remains in the centre of a track. For this purpose machines have another stationary head similar to the audio head. During the recording process this head records the head-drum signal on the opposite edge of the tape to the sound track. This additional track is called the *control track* and consists simply of pulses recorded at a frequency of 50Hz.

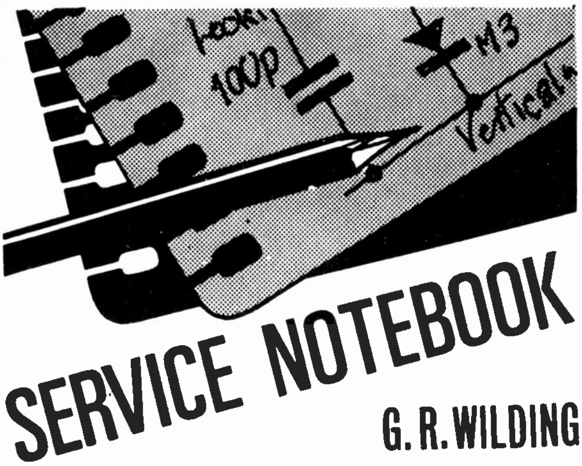
Capstan Servo System

Figure 13(a) shows the capstan servo system in the record mode. A signal is derived from the capstan motor shaft rotation in a manner similar to that used to derive the head-drum signal. This capstan signal is fed into a phase comparator along with the field sync pulses as the second input. The output from the phase comparator is used to adjust the capstan motor speed until the two signals are synchronous.

To understand the capstan servo system action on replay we must remember that the control track consists of one pulse per revolution of the video head and that the distance between the pulses on the tape depends on the capstan motor speed during the recording process. On playback the control-track head is used to replay the control track. This signal is compared with the incoming reference—now the 50Hz mains-derived pulse—to control the capstan motor as shown in Fig. 13(b) until the control-track pulses are in phase with the reference. Since the same reference signal controls the head rotation, the relationship between head rotation and capstan motor rotation are the same for both the record and replay processes. All that is necessary therefore is to adjust the phase of the reference until the head runs along the centre of the track, a condition which is indicated by maximum output from the replay amplifier or by minimum disturbance on the picture. ■



The above BBC map shows the approximate service area of the ***Oxford*** *u.h.f. transmitter. ITV ch. 53, BBC-1 ch. 57, BBC-2 ch. 63. Horizontal polarisation, receiving aerial group C, max. vision e.r.p. 500kW.*



Weak Sync

THE complaint was intermittent field tripping on ITA only unless the field hold control was carefully set but on inspection we also found weak line hold on this channel. BBC-1 reception seemed faultless and BBC-2 was unobtainable in the area. As the timebase locking was normal on BBC there seemed little point in changing the PFL200 video amplifier/sync separator valve or in making voltage checks in these stages and it appeared that slight drift had occurred in the tuner or i.f. circuits as the ITA test card resolution was much inferior to that on BBC and the overall bandwidth must be in excess of 2.5MHz to preserve correct sync pulse shape.

Although slug drift is rare it must be admitted that on more than one occasion we have found weak and distorted u.h.f. sound to be caused by slight misalignment of the 6MHz sound i.f. transformer. This strengthened our present suspicions. After checking that all the valves were good and of the correct type—for a variable-mu EF183 in place of a straight EF184 or vice-versa will always introduce some misalignment—and before embarking on a lengthy retrim we decided to note the effect of readjusting the coil slugs in the first i.f. stage on test card since these are often most critical in their setting for good Band I/Band III balance. We then found that turning the slug in L221 (grid circuit) less than half a turn completely restored the Band III test card resolution and marginally improved that of the BBC while the field and line timebase locking became equally good on both transmissions.

While mentioning the effect of reduced bandwidth on sync pulse shape it is worth noting an interesting point about sync separator inputs. These are invariably fed via a series resistor and capacitor—the latter being an a.c. coupler while the resistor "holds off" the sync separator input capacitance to prevent it shunting the video load and thus impairing definition. If however this resistor is of excessive value it will cause test card cogging. The reason—not always appreciated—is that the series resistor in conjunction with the sync separator's input capacitance forms a low-pass filter which attenuates the higher video frequencies: if the resistor value is increased the filtering effect is accentuated. The arrangement is similar to the grid stoppers used in the grid circuits of a.f. output pentodes to filter extraneous h.f. currents across the valve's input capacitance: if the grid stopper value is excessive some attenuation of the higher audio frequencies can be expected.

Now while a TV receiver's video bandwidth may extend to the full requirement the signal bandwidth at the sync separator grid may be much smaller and if further reduced this will prevent high-amplitude picture content at the end of a line falling to the front-porch level before the arrival of the sync pulse. Pulse timing will thus be affected by the nature of the picture content at the end of a line and this on a test card will be either black or white, causing the central circle to appear more like a cogwheel.

Thorn "Cub" Portable

SEVERE raster cramping towards the base and weak field lock which got progressively worse as the set warmed up were the faults on this model. The original fault—remedied by an outside engineer—was complete field collapse due to an open-circuit h.t. feed and decoupling resistor between the h.t. reservoir capacitor and the tetrode section of the 30PL14 field valve.

On inspection it appeared that the base cramping was due to insufficient negative bias on the 30PL14, for both the original valve and a test replacement ran excessively hot. The bias feed to this tetrode is rather unusual in that it is derived from a point along the negative rectified heater circuit instead of by the usual cathode resistor. The feed is smoothed by a simple *RC* filter (R85 and C61) and applied directly to the tetrode control grid.

We obtained a meter reading of about 11V at this point although no figure is given in the service manual doubtless due to the effect of different meter internal resistances on the high-value resistors employed in this part of the circuit. As the 30PL14 tetrode usually operates with about 14·5V bias, the reading we obtained seemed fair after allowance for meter application.

Nevertheless, although there was no short in the heater circuit rectifier—or the bias would have been non-existent—the fact remained that the valve was passing excessive current and it seemed that only inadequate bias could be the cause. We studied the circuit (Fig. 1) and found that the bias could be reduced in one of three ways, by a slight positive leak through C62 from the tetrode anode or through C57 from the triode anode, by a leak in C58, C59 or C61, or by one of the high-value feed resistors going high-resistance. With any pentode or tetrode of course the anode current is largely determined by the screen voltage, but as the screen in this model was directly linked to HT3 there seemed no possibility of it rising above normal.

We then remembered the replacement resistor and on testing found that the screen voltage was about 205V and the anode voltage about 190V, whereas they should have been 180V and 165V respectively. As will now be obvious the replacement h.t. feed resistor was of too low value—it was in fact a 600Ω component instead of the 2·3kΩ resistor originally fitted. We later found that the outside engineer had been unable to make out the

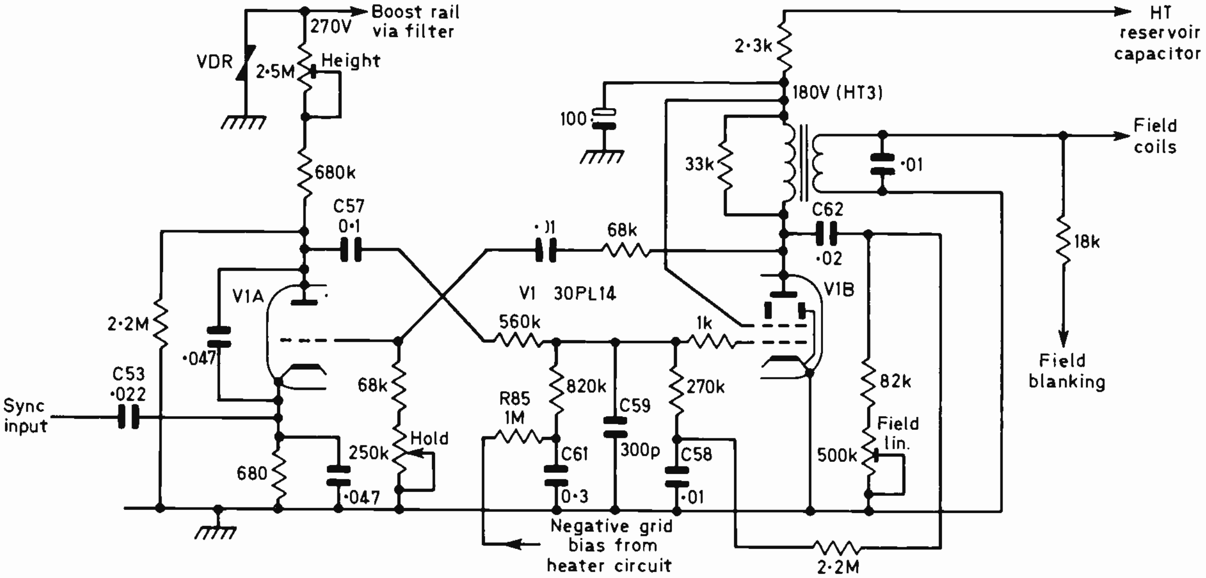


Fig. 1: Thorn 12in. "Cub" portable field timebase circuit: there was severe cramping with weak field hold.

value of the original component and as resistors used to feed individual h.t. rails are usually only a few hundred ohms in value he had fitted one of 600Ω.

A replacement of correct value restored normal anode and screen voltages, cured the base cramping and the weak field hold. Two reasons account for the gross overheating of the tetrode. First the fact that the screen feed comes direct from HT3 so that any increase in this is applied in full to the valve, while secondly the grid bias is fixed. Had the valve been biased by the usual cathode resistor the increased anode and screen currents would have produced a proportionately greater cathode voltage to increase the effective bias.

The great advantage of the bias arrangement used however is that if the heater rectifier goes short-circuit, thus over-running all the valves and the c.r.t., the severely cramped picture with virtually non-existent field hold makes it essential to obtain service attention. Which all demonstrates how vital it is to replace defective components with *exact* replacements and to measure *all* relevant voltages.

Line Drift

THE owner of a 19in. KB receiver complained that the picture started to break into lines when it got really warm after an hour's use. Inspection showed that the fault was due to the line hold control only just locking the picture when fully rotated. Replacing the PCF80 line generator shifted the line lock to a midway position with plenty of tolerance each way and no further trouble was experienced. We quite often get cases of weak line or field hold similarly due to valve or component change shifting the lock position to one extreme and preventing proper setting of the control.

Many receivers incorporate an interior preset line hold control additional to the external user control, but we never readjust this without first replacing the line generator valve or valves. If as is usually the case the control shift is due to changing valve characteristics, adjusting the preset will probably be only a temporary expedient, for within a short while the valve ageing process will necessitate further adjustment even if it doesn't cause reduced width or impair sync.

With certain exceptions the line frequency in most modern receivers is determined by the line generator only, the line output pentode merely amplifying the output from the oscillator. The main exceptions to this arrangement are those Pye-Ekco-Ferranti-Pam-Invicta receivers in many cabinet styles but always identifiable by the high-level contrast control knob protruding from the top rear of the cabinet back and with the entire printed circuit chassis hinged at the bottom. In these models the PL36-PL302 type line output valve also forms half of the generator with the triode section of a PCL84. Short- or long-term line drift can therefore in these models be due to changes in the line output valve or its immediate circuitry—the grid resistors, v.d.r. width stabiliser, or even the boost rectifier.

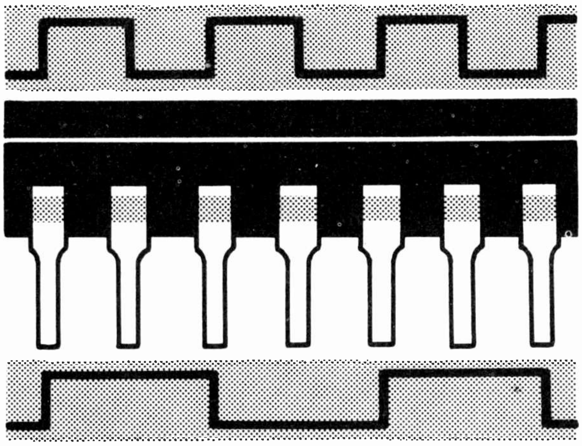
In flywheel sync line circuits the operational frequency is still set by the generator valve but the control potential developed by the a.f.c. diodes is naturally influenced by the shape and amplitude of the reference pulse feed taken from the line output transformer. Obviously therefore drift anywhere in the line output stage can alter the line generator frequency and stability via the discriminator.

Similarly, drift in d.c. amplifiers employed to boost the control potential from the discriminator circuit can also change the generator frequency. On several occasions we have known erratic line hold—sometimes with violent screen flashes—to be due to the bad valveholder seating of such a d.c. amplifier.

Where the line hold position spasmodically changes first check the preset adjustment if fitted. These often have open rotary or strip sliders and if good firm contact is not made will cause constant trouble. In most cases cleaning the track and applying a smear of contact lubricant will stabilise their setting.

TO BE CONTINUED

INTRODUCTION TO Digital ICs



MARTIN L. MICHAELIS M.A.

In a recent article (August, 1970) on integrated circuits we discussed in detail the operational amplifier as a typical representative of linear integrated circuits and subsequently illustrated its practical use with constructional features on an i.c. millivoltmeter and an oscilloscope preamplifier. We will continue our practical survey of integrated circuits by introducing in the present article the digital families.

This will again be followed with constructional features, the first another special signal amplifier with arbitrary input waveform pulsing and frequency counting facilities and the second a test generator for colour television convergence adjustments with properly interlaced line and field pulse waveforms. Digital logic will be used for relating the line and field frequencies and for assembling the required complex sync pulse train of the field blanking interval, in close approximation to the standard television broadcast waveform. The time is now ripe for widespread use of digital integrated circuits by the amateur constructor since prices have fallen drastically in recent times.

The transition in practical circuitry from conventional discrete transistor arrangements to monolithic integrated blocks is as much a revolution as the earlier transition from valve circuits to transistor ones. The new devices have, however, been flung on to the market in a profuse variety of types, families and performance while the information available is largely incomprehensible to the newcomer. It is the aim of the present article to present a clear picture of these devices, getting down to essential practical fundamentals right from the start.

Amplifiers and Switches

Electronic logic is the performance of current or voltage amplification or switching in a sequence determined by the circuit arrangement used: we always have one or more input currents or voltages and one or more output currents or voltages, and these are related by the *logical function* of the particular device or array of interconnected devices through which the signal(s) pass. The most important distinction is between logic functions based on *amplifying* the input signals to produce the output signals and logic functions employing the input signals merely to *switch* output signal sources on and off. The former process requires linear circuits which are refinements of conventional signal amplifiers while the latter requires on-off switching which in modern integrated circuits is carried out by transistor elements used as gated switches and known simply as *gates*.

The ideal switch is a threshold device, i.e. its output should show no variation at all with small changes of input either side of a threshold. If, however, the change at the input crosses the threshold then the output should switch right *on* or right *off* abruptly. Thus a certain threshold effort is required—as the force applied to the toggle of a mechanical switch to make it snap on or off. A certain threshold current is required to make an electromechanical relay attract its armature and close the contacts: correspondingly in digital logic circuits the output is present or absent depending on whether the input is resting above or below the switching threshold.

Basic Specifications

The basic performance specification of a digital logic system is the *truth table* (a simple truth table is shown in Fig. 5). In addition there are restrictions concerning the maximum or minimum rate of input transition through the switching threshold for accurate operation. The truth table relates the states of all outputs (on or off) to the states of all inputs (present or absent).

Some digital i.c. inputs provide *static* control functions while others are for *dynamic* ones. Digital logic circuits with only static control inputs have a simple static truth table in which the states of the outputs are set by the states of the inputs actually present *regardless of the previous history of changes of these input states.* The truth table thus lists all possible permutations and combinations of input states (each input may be above or below the switching threshold, irrespective of the others) together with the corresponding set of states of the outputs for each combination of inputs.

If a dynamic control input is present—properly called a *clock* or *toggle* input—a given set of states of the static control inputs is no longer alone sufficient to determine the set of states of the outputs. Thus the truth table has to be more complicated. If *N* different sets of output states are possible for a particular set of states of the static control inputs, the truth table must list each one of these sets of output states in turn in the Q^{-1} column* and in the Q column the corresponding one produced by the next threshold transition at the dynamic control input without change of the static control input states. Some data lists head the corresponding columns of the truth table Q and Q^{+1} respectively instead. The index merely refers to the order of time sequence steps, not to a logic input or output level. Such a single time sequence step is the interval between successive threshold transitions applied to a dynamic control input,

** It is the convention with digital circuits to designate the output as Q.*

so it is clear why these inputs are commonly called clock inputs in computer terminology. They are usually driven from a pulse generator or with some other signal whose actual or average pulse repetition frequency is an important feature of the operation to be performed. Thus the drive pulses mark out basic time intervals and thus essentially represent a system clock.

Static Controls

The clock inputs serve for counting and scaling pulses whereas the static control inputs provide such functions as starting, stopping, resetting and presetting the counting process. If, for example, a certain set of states of the static control inputs provides ten possible sets of states of the outputs, and these output states are taken up in cyclic succession once every ten input pulses fed to the clock input, then we have a decimal counter stage. The internal circuitry of such digital integrated circuits is usually arranged so that a second set of states of the static control inputs causes the outputs to fall into the set of states representing zero of the decimal sequence, regardless of the previous set of states. This is the counter reset condition. It appears in the truth table as an entry "arbitrary" for the initial state and "all outputs zero" for the new state of the outputs when the static control inputs are changed to this reset condition.

Yet another different set of input states of the device may serve to inhibit the dynamic control input. The last previous set of output states is then held as long as this inhibit set of input states is maintained. Pulses which arrive in the meantime at the clock input have no effect. This is shown in the truth table by entry of Q^{-1} in the Q column or Q in the Q^{+1} column, to show that no change takes place.

Detailed Performance

For practical circuit design using digital integrated circuits the truth table largely fulfils the function of the theoretical circuit diagram of conventional circuits since it embodies all performance information required to make the circuit function nominally as desired. It is therefore unnecessary to go into details of, or even know, the exact theoretical circuit which a manufacturer has integrated into his package. In fact not all data sheets give the theoretical circuit. It is helpful if they do however, because certain tricky questions that occasionally arise in the course of design work on circuits using integrated packages interconnected with conventional stages can then be quickly answered by reference to the actual circuits of the packages. But such circuit diagrams are often complex and highly confusing to the beginner, particularly since the actual arrays of resistors, capacitors, diodes and transistors may differ radically in the respective families of digital circuits yet the truth tables remain nearly or completely identical.

Toggle Frequency

The differences between the families lie in performance details such as the maximum clock input frequency which can be handled, i.e. speed capability of the computer system, power dissipation, relative noise immunity, manufacturing price and so on. None of these are of primary importance in the practical exploitation of digital i.c.s in television receiver and test equipment because the maximum required clock frequency (toggle frequency) is a small multiple of the television line frequency and is very low in relation to the inherent toggle rate capability of all common families. These can handle typical clock frequencies of 30MHz and more, with switching times of typically 20 nanoseconds—often much shorter. Indeed very high speed is often an embarrassment in simple low-speed circuits because these then tend to respond to all manner of spurious h.f. and even v.h.f. r.f. interference if a poor layout is adopted. We shall, however, be considering all the important practical design rules in the course of our constructional features.

Neither is power dissipation a prime consideration for television equipment because the power consumption of all common digital i.c.s is very much smaller than that of valve stages and usually considerably smaller than the equivalent conventional transistorised circuits, whilst television equipment is mostly mains operated so that plenty of power is readily available. Thus the digital i.c. families used have been chosen according to price and availability to the amateur constructor. In this sense the DTL and TTL families are at present the most attractive ones with RTL a close runner-up.

Logic Family Names

These family names indicate the main components used on the monolithic chips. DTL is diode-transistor logic (with resistors and capacitors as subsidiary items), TTL transistor-transistor logic (with diodes and resistors as subsidiary items) and RTL resistor-transistor logic (containing no or very few diodes as subsidiaries). DTL and TTL are closely related; multiple-emitter transistors in the latter replace the input diodes of the former.

Before we have a closer look at the basic characteristics of i.c. packages belonging to the DTL and TTL families, we must discuss the principles governing the interfacing rules given in standard data sheets.

Interfacing

This is the term used for the methods of mutually interconnecting two or more i.c. packages with each other or with conventionally wired stages. Within the same family of digital i.c.s, for example TTL, interfacing is an extremely simple task. All the i.c. packages are designed so that the outputs of any one can be connected straight through to the inputs of any other using a short wire or conductor on a printed circuit board: discrete coupling resistors or capacitors external to the packages are not required.

Apart from their static and dynamic control inputs and outputs, the packages possess only a ground pin and a power supply input pin. For the most common ranges of available digital i.c.s the power supply is a stabilised +5V line with respect to chassis and the ground pins of the packages are taken to chassis. The +5V line is strapped straight through to all package power supply pins without any external decoupling resistors. A high-quality miniature capacitor (value 0·01 to 0·1μF, uncritical) is bridged across the power supply and ground pin of each package. These capacitors must be non-inductive and suitable for bypassing radio frequencies up to at least 50MHz. Modern ceramic or plastic film types are ideal.

The performance of a composite circuit containing any number of packages wired up in this manner is expressed directly by the truth tables and for each connection made from an output Q1 of a package 1 to an input P1 of another package 2 the states appearing for Q1 in the truth table belonging to 1 are the states for P1 in the truth table belonging to 2.

Only one output should be connected to any input otherwise there will be contradictions if two or more outputs which may take different states simultaneously are connected to the same input of another package. The consequence would be short-circuits between the paralleled outputs or at least an indeterminate truth table for the driven package. Exceptions to this rule involve parallel connection of outputs of identical sections of multiple packages to boost the output current rating. The paralleled outputs must always take mutually indentical states, either *all* above or *all* below the switching threshold. To ensure this, it is usually necessary to connect all corresponding inputs of the paralleled sections in parallel too. The data sheets give precise instructions and in particular point out instances where the separate but identical sections of a multiple package must be used separately and may not be paralleled because of conflicting internal circuit features.

Fan-out

It is, on the other hand, essential in order to provide for versatility within a computing system to be able to drive two or more inputs of one or more other packages from the same output of a package. This is referred to as *fan-out* in data sheets. There are practical limitations to the fan-out set by current overloading resulting if too many inputs are connected to the same output. Instability is produced in severe cases, ambiguities of the truth tables in moderate cases, and enhanced susceptibility to r.f. and noise interference in mild cases of such overloading.

Loading Factors

The data sheet for a given package lists a *loading factor* for each input and output. These loading factors are typically 8 for an output, 1 for a static control input (steering input) and 1 or 2 for a dynamic control input (clock or toggle input). The sum of the loading factors of all the inputs connected to the some output must be equal to or any value less than the loading factor of that output. As long as this rule is satisfied the output and the set of inputs may be strapped together directly and the composite circuit will perform as implied by the linkages of the truth tables.

Power Gates and Line Drivers

If the desired set of truth table linkages would require connecting so many inputs to an output that the loading factor of that output is exceeded an amplifier must be interposed. Such amplifiers, usually called *power gates*, are available as packages in each family and possess one or more inputs with small loading factors and outputs with large loading factors, typically 25. Two or more power gates are often found in one package, to make full use of available chip space. They may be used for independent fan-outs from quite different outputs or to obtain still greater fan-out from a single output by driving their inputs from the same output. In principle power gates can be cascaded, so that there is no limit to the possible fan-out in complex systems. Power gates are not amplifiers in the linear sense but rather in the switching sense of relays which simply switch a much larger current on or off when the input state crosses the switching threshold.

Another type of switching amplifier included in the packages offered in each logic family is the *line driver*. This is basically similar to a power gate but must be loaded at the output with a definite value resistor to match the characteristic impedance of a length of coaxial cable or a length of several inches of connecting wire positioned in a definite geometric orientation with respect to the chassis plane. The data sheet will specify the characteristic impedance value and whether or not the resistor is integrated or has to be wired externally as the line termination. The line driver is required whenever it is not possible to place all fanned-out inputs in close proximity to the output driving them, normally whenever any connecting wire or conductor on the printed circuit board is longer than some three to six inches. The transmission line—which such connections represent for the nanosecond switching transients—must be matched with its characteristic impedance as soon as the length gives a propagation delay exceeding the switching time. Otherwise pulse reflections back and forth along the unmatched line may cause multiple toggling with consequent erratic breakdown of the truth tables.

In circuits using relatively small numbers of integrated packages and operating at frequencies much lower than the maximum possible toggle rate—such as the television test equipment designs we will be presenting—it is usually a simple matter to avoid the need for power gates and line drivers. Large fan-outs are not necessary in simple circuits and line drivers, chiefly required for the clock (toggle) inputs, are obviated by arranging the circuit layout with all inputs directly adjacent to the outputs driving them. This means that the static control (steering) inputs are inevitably far removed from the outputs driving them.

In particular the logic requirements often call for quite large fan-outs from one output to a number of steering inputs of several different packages, e.g. to reset or inhibit the several decimal stages of a counter chain. Whilst, however, it is necessary to run the clock inputs fast, the steering inputs used to stop, start or reset the counter may be made much slower without impairing the performance of the equipment. Thus the steering input switching times can be greatly prolonged from the nanosecond range to at least the microsecond range by connecting a fixed capacitor between the steering input and ground pin at each package. When the input voltage is changed this load capacitor takes time to charge and the switching threshold is crossed slowly, giving a single response delayed at least by the propagation time of the latest reflected disturbing pulse which would otherwise have caused a multiple response.

Monostables

It is in most cases unimportant—as far as the truth table is concerned—how fast or slowly the input state crosses the switching threshold. This is certainly so for all packages with a time-independent truth table in which the outputs are always defined by the states of the steering inputs and the number of pulses which have arrived at the clock input and are *independent* of the *time* that has elapsed since the last change at the steering or clock inputs. An important type of package which also involves an elapsed time factor in its truth table, known as the *monostable*, requires however a minimum rate at which the input must cross the switching threshold if the outputs are to respond according to the truth table. Otherwise they will not respond at all or will respond erratically. Monostables possess a truth table with a set of resting states of the outputs which is reverted to automatically after a certain characteristic time (which can be varied at will with externally wired capacitors) has elapsed since a change of the set of input states temporarily produced a change of the set of output states in accordance with the truth table.

For designing television test equipment monostables provide pulse shaping and stretching functions, time-gating facilities and a neat means of solving one of the most difficult of interfacing problems, the introduction of manually actuated switches in the high-speed clock-input lines of digital integrated circuits. All mechanical switches are prone to multiple makes and breaks over a total time lying in the microsecond or millisecond range before the contacts are closed or opened permanently. Thus under certain conditions actuation of a manual switch in a clock-pulse line will produce a rapid burst of spurious responses in addition to the wanted responses to true clock pulses which come through when the switch is properly closed. In steering input lines this trouble can often be overcome by the same means as used for pulse reflection interference in unmatched lines —by loading the inputs capacitively to slow down the switching time beyond the longest likely switch contact rebound period. But this approach is impossible for even moderate-speed clock-pulse lines because switch rebounds may last many milliseconds and capacitive response delays would then limit the counting frequency to a few hundred Hz if they are to be effective in reliably killing switch rebound responses.

Digital Logic Levels

Only two input or output states exist in digital logic, namely the *high state* in which the voltage is above the switching threshold and the *low state* in which it is below the switching threshold. For positive logic, the high state represents a logical one, depicted in truth tables by the symbols 1 or L, and the low state a logical zero represented by the symbol 0. The association is the converse for negative logic. The distinction between positive and negative logic does not concern the actual electronic devices but only the input and output voltage states. Any logical function in positive logic can be translated to an equivalent function in negative logic and vice versa without changing the circuitry or altering its performance in any way. We will confine ourselves to positive logic for all further descriptions.

For the DTL and TTL packages in our constructional features the power supply level is 5V stabilised (tolerance about a quarter of a volt either way), the nominal switching threshold is about 1·2V, the low state (logical zero) is the range below 0·6V and the high state (logical one) the range above 1·6V. The nominal low state is 0·2V and the nominal high is 3·5V.

When interfacing with conventionally wired stages, the low state range may be extended up to 1·0V without erratic performance. The range from 1·0V to 1·5V is unstable and should be crossed as rapidly as possible when the state of an input is being changed. Under no circumstances should an input be left resting at any voltage in this range because the output states are then erratic and largely determined in a random fluctuating manner by incidental background noise in the circuit. The noise immunity margin is better the further the actually adopted low and high states are from the range 1V to 1·5V, because the required amplitude of a noise pulse or transient to actually produce a spurious response must be sufficient to lift or drop the state into the forbidden range. The noise immunity is about 1V when using the recommended high and low states of 3·5V and 0·2V. This is why the inputs, outputs and power supply rails of digital integrated circuits can be strapped directly.

Polarity

All power supply and state voltages are *positive* to chassis in the positive logic system. Negative voltages with respect to chassis are not used and are strictly forbidden. Especially if obtained from a low-impedance source, negative voltages with respect to chassis may cause immediate destruction of the package when applied to an input, either as transient or d.c. potential. The input potential at any input of a package should never exceed the power supply rail voltage of about +5V to chassis. The author has found this condition less critical. Voltages up to +20V have been accidentally applied to inputs of TTL packages without any resulting damage, but this is not to be taken as a recommendation or guarantee.

In a composite circuit using several packages the actual voltages for the high and low states need not be the same at all points, nor at all times at the same point. Widely different actual resting voltages may be found for a logical one or for a logical zero at different points, or at one and the same point depending an the overall loading imposed by the simultaneous states of all other points. The only condition for proper performance of the entire circuit in accordance with the truth tables of all the packages is that all points which are supposed to be in the logical zero (low) state are resting well below the transition range and all points which are supposed to be in the logical one state (high) are resting well above the transition range.

Switching Threshold Transitions

In positive logic the clock inputs respond in accordance with the clock step truth table whenever the input voltage drops from the high to the low level. There is no response to a transition of the input voltage from the low to the high logic level at a clock input. It is most important to memorise this *basic dynamic drive rule*, since it is one of the most fundamental concepts of digital logic in this system.

For a steering (static) input there may be a response to a logic level transition in either direction according to the particular truth table. In some devices the truth table consists of a set of unique relationships

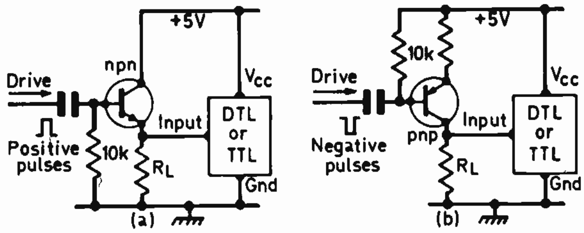


Fig. 1: Input interfacing with a conventionally wired drive stage, giving Q-pulse drive. (a) For positive drive pulses, (b) for negative drive pulses.
The i.c. input rests at the low level and is raised to the high level for the duration of the drive pulse. Clock response is on the lagging edge (i.e. at the end) of the drive pulse. R_L must be less than 1kΩ, preferably about 500Ω.

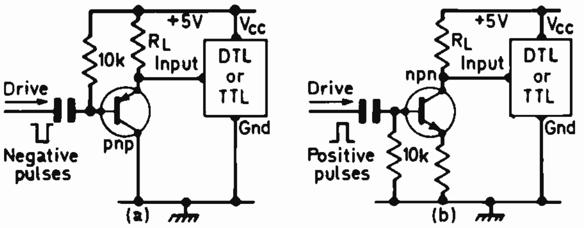


Fig. 2: Input interfacing with a conventionally wired drive stage, giving $\bar{Q}$-pulse drive. (a) For negative drive pulses, (b) for positive drive pulses.
The i.c. input rests at the high level and drops to the low level for the duration of the drive pulse. Clock response is on the leading edge of the drive pulse. There is no basic restriction on the maximum permissible value of R_L.

between possible combinations of input states at the steering inputs and the corresponding sets of output states, but if the states of one or more steering inputs are changed the new corresponding output states defined by the truth table do not appear until a transition from the high to the low logic state takes place at a corresponding clock input. Such devices are called *clocked*, and the truth table may bear the remark "if (steering) inputs changed, new output state appears next time clock goes low".

In a general way the clock may be considered as being the master oscillator of the computer system, analogous to the carrier frequency generator of a radio or television transmitter or the escapement or pendulum of a mechanical clock. It is essentially a pulse generator whose purpose is to produce an ideally rectangular waveform switching abruptly back and forth between the high and the low logic level.

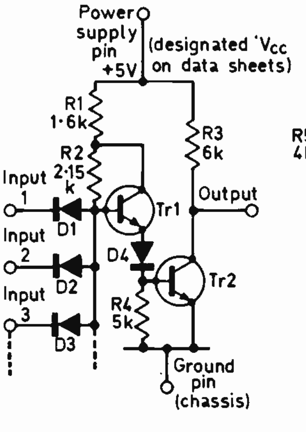
If conventionally wired circuits are used for the actual pulse generator or if the pulse source is some other device such as a photocell or radiation pulse detector, negative voltages and/or large positive voltages may be involved in the power supplies and primary pulse waveforms. However the pulse samples derived therefrom for the inputs of the digital integrated circuits must be confined entirely to positive polarity with respect to chassis and a maximum level of +5V to chassis.

Pulse Drive

This gives us two basic possibilities, known as the Q-pulse and the $\bar{Q}$-pulse. If we are using $\bar{Q}$-pulse drive the voltage normally rests for any length of time at the high level, being dropped temporarily to the low level for the pulse duration. Thus the clock goes low on the leading edge of the pulse, producing an immediate response. For Q-pulse drive, the voltage rests in the low state and is lifted to the high state for the pulse duration. The clock here goes low on the lagging edge of the pulse. Under no circumstances is it permissible to use a pulse any part of which goes negative with respect to chassis. A positive pulse on a resting level in the high state never produces any response on either edge, because it never drops the logical level out of the high state.

With the normal DTL and TTL packages the effective input level is the high level when open-circuit, and the low level is produced at the input by any one of three ways: (a) Direct connection to an output in the low level, observing the loading factor restrictions. (b) Shorting the input directly to chassis (this is permissible for any length of time, e.g. via a conventionally wired switch transistor, manually operated switch contact, electromechanical relay or push-button). (c) As for (b) but not as a direct short circuit to chassis, instead connecting a finite resistance between the input and chassis. There is a maximum permissible value, usually about 500Ω to 1kΩ, for this resistor if it is to produce an unambiguous low state as long as it is connected. If its value is slightly too large the erratic transition range is taken up whilst if the value is much too large the input remains in the ambiguous high state. If in doubt, measure the actual voltage appearing across the resistor, using a voltmeter whose internal resistance is at least twice as great.

Method (a) is the normal method of interfacing several i.c. packages. Method (b) is often used for interfacing with mechanical manual controls on the front panel. Method (c) is the basis of interfacing with conventionally wired drive stages. The resistor is here at the same time the output load resistor of the conventional drive stage. If connected to chassis (Fig. 1) it commonly forms the emitter load of an npn transistor or the collector load of a pnp transistor, whilst if it is connected to the +5V power supply rail (Fig. 2) it forms the emitter load of a pnp transistor or the collector load of an npn transistor. Pulses of appropriate polarity are applied to the base of the



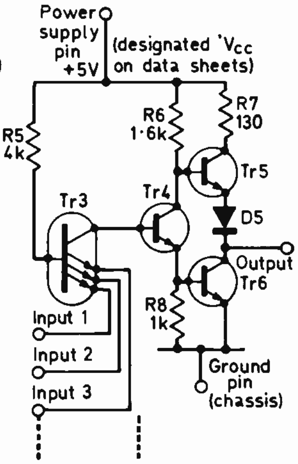


Fig. 3 (left): Circuit of the basic DTL gate.
Fig. 4 (right): Circuit of the basic TTL gate.

transistor. The former case gives Q-pulse drive and the latter case gives $\bar{Q}$-pulse drive.

Q-pulse Drive with Monostables

We have already mentioned that contact rebounds are a possible source of spurious pulse signals when mechanical switches are used to connect or disconnect logic level voltages. To avoid this trouble the intended make or break operation of the switch and any rebounds must not give rise to clock transitions from high to low. This condition is satisfied only if the switched input is resting in the low state regardless of whether the switch is open or closed, so that the switch must connect or disconnect (alternatively, short out or clear) a Q-pulse drive line. The only digital i.c.s producing a proper Q-pulse drive are the monostables mentioned earlier. A monostable Q output always rests in the low state and briefly goes up to the high state following the moments at which the clock input goes low. All ordinary outputs of digital i.c.s, on the other hand, may rest any length of time in either the high or the low state. If a mechanical switch is interposed in any direct connection between such an output and an input a burst of spurious responses is produced at the input whenever the switch is opened or closed whilst the output is in the high state, because the switch contact rebounds represent a corresponding number of successive disconnections of the high output, i.e. high to low clock transitions, before the connection is finally established or broken.

As long as the connection is established only the actual high to low transitions of the output produce a response at the clock input it is driving. The wanted logic function is thus unaffected if a monostable is interposed, except that the response is delayed by the characteristic pulse duration of the monostable. This can be made short, for example some 10 to 15 microseconds, which is briefer than the shortest interval between any two successive switch contact rebounds. Multiple responses are then impossible even if a proper high to low transition of the drive output takes place whilst the switch is being actuated.

Basic DTL Gate

Just as the operational amplifier is the basic element of all analogue logic systems so the switching gate is the basic element of all digital logic systems.

Figure 3 shows the theoretical circuit of the basic DTL gate behind any normal input of a DTL integrated circuit package. It at the same time shows the circuitry immediately behind any normal output. Simple packages with only basic gates contain nothing else except the depicted circuitry between each associated input and output. More complex packages contain several internally interconnected basic gates and auxiliaries, arranged so that the set of externally accessible inputs and outputs obeys the given truth table.

It is now immediately evident why an open-circuit input is in the high state. R1 and R2 connect the input internally to the positive power supply pin, so that Tr1, Tr2 and D4 rest in the same conducting state as when a high level input voltage is actually connected to any one of the input pins, cutting off the corresponding input diode. In this high input state the potential at the anodes of the input diodes is the sum of the silicon threshold voltages of Tr1, Tr2 and D4, which is about 1·8V. An input diode can conduct only when its cathode potential becomes less than the silicon threshold of about 0·6V lower than its anode potential, i.e. less than about 1·2V. This is the already described switching threshold. When the voltage applied to an input terminal is lower than the switching threshold the difference appears as a voltage drop across R1 and R2 so that the anode potential of the input diodes is now less than the sum threshold voltage of Tr1, D4 and Tr2 and these three devices are consequently cut off.

Fig. 5: Truth table for the basic DTL (Fig. 3) or TTL (Fig. 4) gate. The output level is low (0) only if all inputs are high (1) and high if all inputs are not high at least one being low. This is called the "not and" or NAND function.

Input 1	Input 2	Input 3	Output
1	0	0	1
0	1	0	1
0	0	1	1
1	1	0	1
1	0	1	1
0	1	1	1
1	1	1	0
0	0	0	1

The high input state thus causes Tr2 to be cut on hard, connecting the output to chassis and giving the low output state. The low input state cuts Tr2 off, giving the high output state via R3 connected to the power supply pin.

Fan-in

The circuit can have any desired number of independent inputs with respective series diodes. Three inputs with corresponding diodes D1 to D3 are shown. Evidently the low input state for Tr1 is produced when the low state voltage is applied to at least one input pin. The table shown in Figure 5 is the truth table for this three-input gate, showing that the function is an inverting AND in positive logic. The input is in the high state only if *all* inputs are in the high state (AND function) and the output state is always the converse of the input state (inverting function).

We can now understand the loading factors and the previously described grounding conditions to produce a low input state. If any input is shorted to chassis the voltage drop across R1 and R2 must be such that the anodes of the input diodes rest 0·6V above chassis potential (silicon threshold voltage) which is well below the threshold at Tr1 base. Thus the input is definitely in the low state. In this condition the input diode is passing a current to chassis whose value is given according to Ohm's Law by R1 and R2 connected across the power supply voltage less 0·6V. This is slightly more than 1mA for the given component values. A worst case value of 1·6mA is assumed in the data sheets because values of resistors in integrated circuits are subject to large tolerances.

Current Sinking

In a composite circuit using many interconnected packages as indicated in Figure 6 Tr2 of any output must be able to sink as many times 1·6mA to chassis as the number of basic inputs of other packages to which it is fanned out. Thus the output loading factor is largely determined by the maximum permissible collector current of Tr2, which is nominally 13·5mA to give the typical output loading factor of 8 whilst

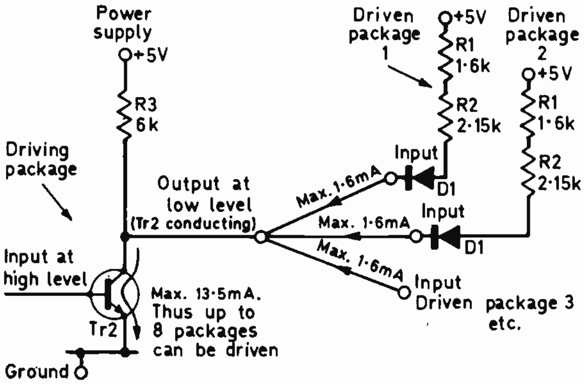


Fig. 6: Showing how the sink currents determine the output loading factor for the basic DTL (Fig. 3) gate in the low-level state.

also sinking the current through R3.

Capacitive Loading

This is the situation for the low output state which of course determines the output loading factor. In the high state of the output there is theoretically no current flowing in the fan-out connections to the driven inputs of other packages because all the input diodes are cut off in the high state. However, capacitive loading is here important because when Tr2 cuts off the total stray capacitances of all connected inputs must first charge through R3 before the high state actually takes over at the output. In high-speed computers it is therefore necessary to make R3 as small as possible in order to speed up the low-to-high transition. To satisfy this demand alternative packages are available with R3 about 2kΩ instead of about 6kΩ. These packages are distinctly faster but the smaller value of R3 sends an additional current equal to one load unit through Tr2 in the low state of the output so that the externally available loading factor is reduced to 7 instead of 8.

Drive Load Resistors

To produce the low input state with a finite drive load resistor instead of a direct short-circuit connected between the corresponding input pin and chassis we must consider the voltage drop across this resistor which is the bottom end of a voltage divider with R1, R2 and the input diode, connected across the power supply voltage. From the typical component values in Figure 3 it is evident that the drive load resistor to chassis must not exceed about 1kΩ otherwise the voltage drop across it comes dangerously close to the switching threshold. If it is desired to fan-out to several inputs from a single drive load resistor connected to chassis and therefore intended for Q-pulse drive, the maximum permissible value of the drive load resistor becomes smaller by the same factor as the number of connected inputs, because the top end of the voltage divider is now several times R1 and R2 in parallel.

This calls for rather high-power conventional drive stages when these must fan-out to many inputs. At least the resting current of such stages can be avoided by adopting $\bar{Q}$-pulse drive from a collector load of the conventionally wired drive stage (Figure 2), but this gives rebound trouble if a manual switch is placed at this point in a circuit as is often the case.

To cope with both problems, use a monostable. This has a normal unit input loading factor and can be driven from a 500Ω or a maximum 1kΩ conventional-stage Q-pulse drive, providing in turn the normal i.c. output loading factor of 8 for fan-out to 8 basic inputs, any or all of which may have input switches. In this sense the monostable functions as a form of power gate to boost the fan-out capability when interfacing with a conventionally wired drive stage.

Basic TTL Gate

Figure 4 shows the basic TTL gate, whose performance is essentially identical to that of the DTL gate. A multiple-emitter transistor Tr3 is here used in place of the diode array D1 . . . D3 of the DTL gate. It is nominally equivalent to the diode array but much faster in response. The physical difference is seen to be very small from the point of view of i.c. manufacture, the diodes being replaced by the multiple-emitter transistor Tr3. The resulting increased input response speed justifies the output modification amounting to the bootstrapping circuit R7, Tr5, D5 in place of the simple R3 of DTL so that the output response is fast enough to be able to exploit the input speeds.

This is of little significance for slow-speed (sub-Mhz) applications in television test equipment designs so that we may take the DTL and TTL gates as being fully compatible and interchangeable for these purposes. Provided that due attention is given to the loading factors, DTL outputs may be strapped indiscriminately to drive TTL inputs and vice versa. This form of compatibility is of course valid only as long as we keep to families with the same power supply voltage rating and nominal logic levels, and this can be quickly checked by reference to the manufacturers' data sheets. DTL for example is also available in a version known as HTL (high threshold logic) in which zener diodes replace the internal threshold diodes and a much larger power supply voltage, typically +15V, is used. HTL is used in particularly noisy regions of high complexity equipment where the normal noise rejection margin of some 1·0V typical for DTL and TTL is inadequate. Logic systems with significantly different operating conditions, such as HTL and DTL, cannot be interfaced with direct galvanic interconnections. Either conventional interface converter stages or special i.c. packages devised for such logic level transitions must be interposed at the interface points.

Practical Circuits

We have now covered all the really basic facts which are necessary for practical utilisation of digital i.c.s. All other points are ones of detail which are best explored in the course of practical projects with which we will be following up. The first project, a frequency meter/counter, will make copious use of the basic factors explained in this introductory article and will include interfacing between digital i.c.s and the operational amplifiers of analogue logic. The circuit design features many conventionally wired stages as well as analogue (linear) and digital logic i.c.s, with interfacing and manual switching in virtually all possible combinations, the digital logic

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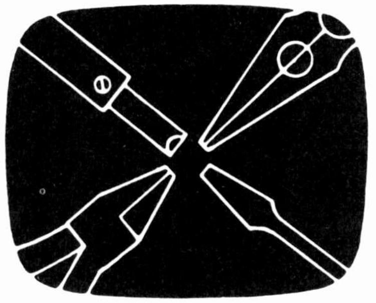


SERVICING television receivers

L. LAWRY-JOHNS

DECCA DR100 SERIES

It is peculiar how service engineers develop an affection for some models by a particular manufacturer and a positive dislike for others. The writer for example always held the original Decca DM1, DM4 series in the highest esteem and even now still services some of them. This regard was somewhat blunted by the DM45 series although many of these still give good service (aided by the judicious use of wire cutters and a good supply of reliable capacitors). The DR100 series however is not regarded by the writer with any affection whatever. This is the writer's opinion only and is passed on to the reader without charge (we are nothing if not generous).

Now to get down to facts and not opinions. The series consists of several 19in. and 23in. models, the DR95, DR100, DR101, DR202, DR303, DR404, DR505 and DR606 (the latter once known as the magic bullet in certain clinical circles—shut up Les, they don't know what you're talking about!).

The method of system switching on these dual-standard models is by a lever pivoted between two solenoids (which are the smoothing chokes CH4 and CH5). The idea is that when one choke is energised the lever is pulled one way and selects one set of contacts, and when the other is switched in the lever is attracted to the other solenoid. This works quite well all the time there is no friction to hinder free and full travel of the lever, but all too often such friction is present and the switching is not positive. This problem is to be solved by the individual and may vary from a thorough cleaning and freeing to removing the white-spot limiter and fitting a manually-operated lever. The rule is that whenever there are intermittent faults—some of which can be unusual—always check the system switch for correct operation before looking elsewhere.

Another feature is the use of several plugs and sockets on the left side of the chassis. There are three phono plugs plus one 7-pin and one 9-pin plug. The function of each pin is shown on the circuit, i.e. pins 1 and 6 of the 7-pin plug are marked 7–6 for the live mains to pin 6 and 7–1 for the neutral mains to pin 1. The phono plugs are coloured red, blue and green. If you don't get the convergence right you'll have a hell of a hum (he's at it again, he even dreams in colour!). Quite seriously though an ill-fitting phono plug (usually blue) can cause an irritating and intermittent hum, the customer's comment being, "we have to hit the cabinet to stop the buzz".

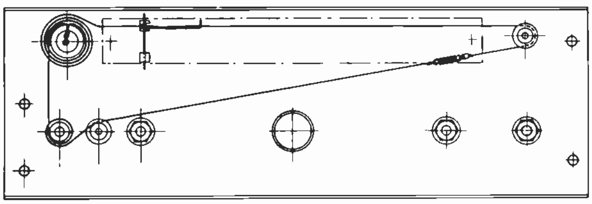


Fig. 1: U.H.F. drive chord mechanism.

If you wonder where the vision and sound signals went when you reassembled, check the blue and green plugs. They can get mixed up, especially if you're colour blind. The blue is the audio input to the PCL82 from the volume control, the green is the i.f. output of the tuner.

Tuner Unit Contacts

The cause of intermittent results on v.h.f. can most often be traced to poor turret contacts on the v.h.f. tuner and can just as often be cleared by simple cleaning of the turret studs or adjustment of the carriage to improve the surface contact. This is generally understood. What is not so generally realised however is that poor u.h.f. reception can often be traced to SW12 on the top of the v.h.f. tuner. This switch is operated by a bar rocked by a cam action on the plate carried on the rear shaft of the turret spindle. Clean these contacts and check the travel of the bar when intermittent or generally poor results are experienced on u.h.f. (remember how you were fooled on those Thorn chassis where it was the bowden cable not clamped tight on the v.h.f. tuner that caused the poor u.h.f. reception? Don't worry, you weren't the only one!).

Both tuners are valved as marked on the circuit and can suffer from the usual crop of shorted lead-through capacitors, wrong value resistors, dry joints, etc., quite apart from faulty valves leading to loss of signals or a grainy picture.

Main Chassis

The main chassis is a rather large unit carrying the tube assembly. It is secured by two screws at the rear and slides out fairly easily. The common troubles which affect this main unit are not those which affect the average run of sets, not in the writer's experience that is.

Line Output Stage

The main troubles seem to affect the line output section. Here the paxolin panel which carries the tags for the top caps of the PL36 and PY800 shorts across to the too near metalwork causing quite a cook-up of leads and tags. This looks worse than it is in most cases and wiring back from the top caps with well insulated wire through rubber grommets to

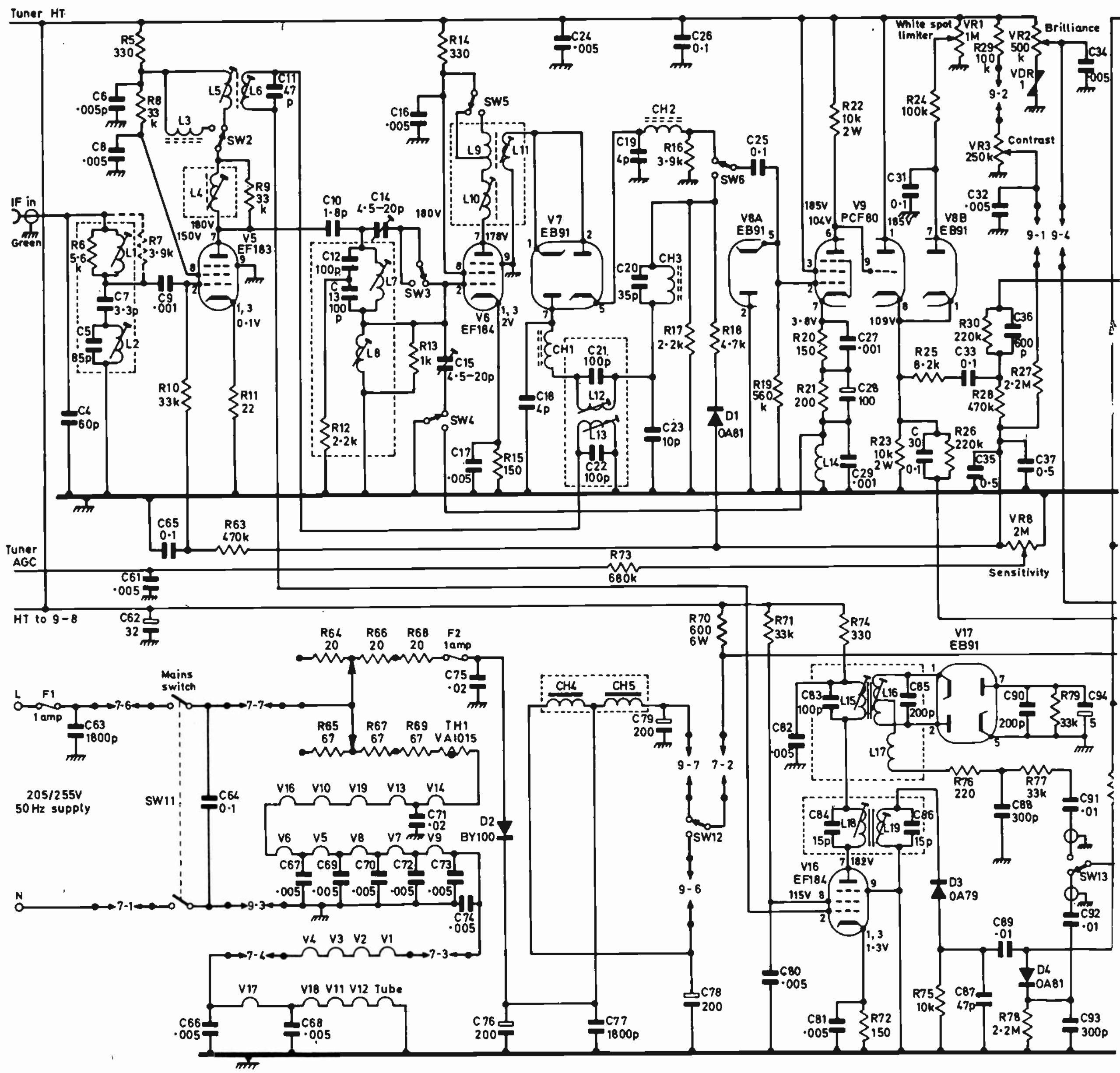


Fig. 2: Circuit diagram of the main chassis, Decca DR100 series. System switching shown in 405-line position. Voltage readings contrast and r.f. gain contro

the line output transformer usually clears up the trouble and leads to more reliable operation.

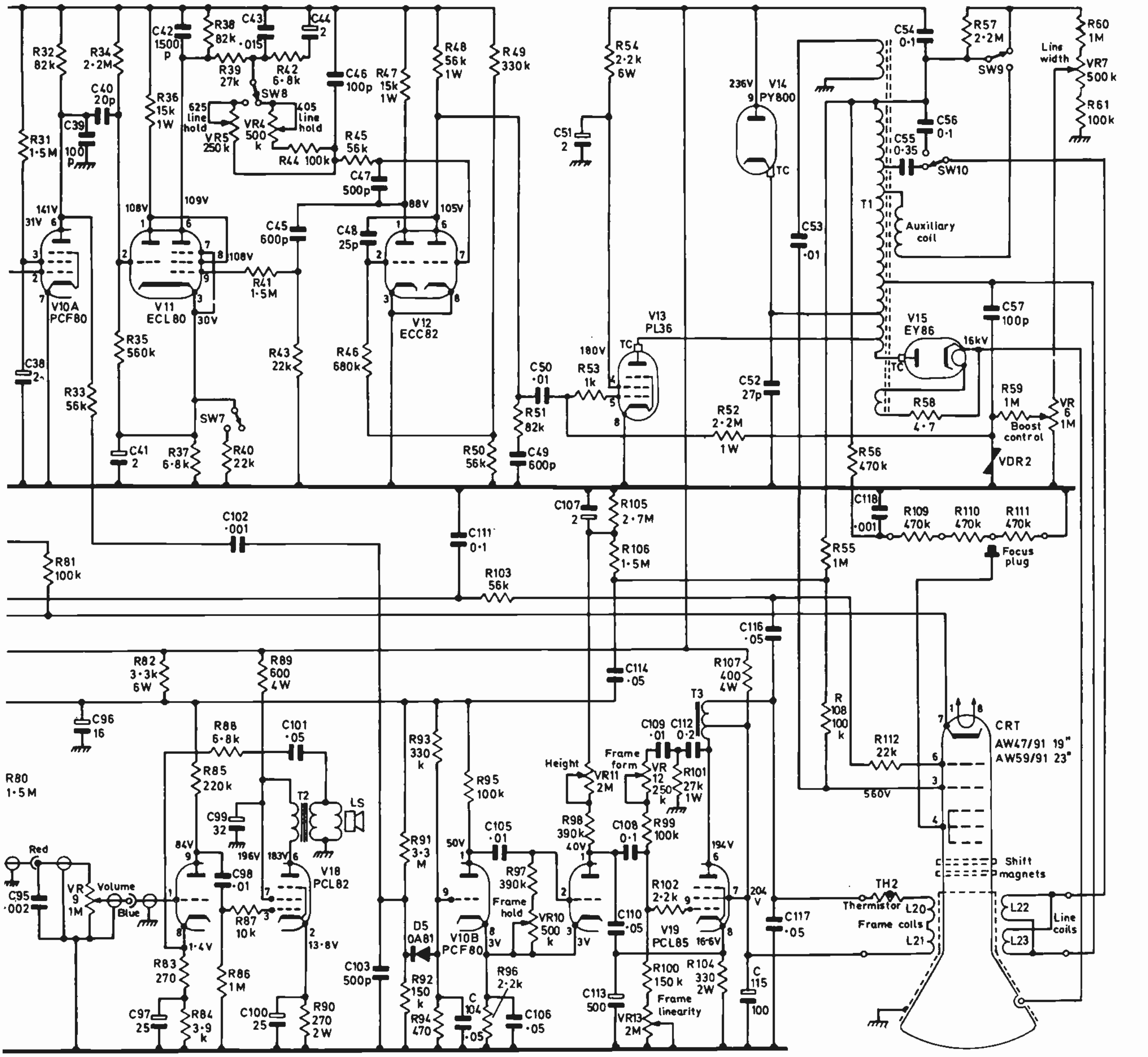
A break down of insulation on the EY86 heater winding is also quite common and the quick answer here is to remove the faulty turns and use one turn only of more heavily insulated cable. Then replace the EY86 with a DY86 (DY87 or DY802). The line output transformer can fail due to shorted turns on the other windings. This of course means a new transformer with no alternative.

No Picture or Raster

Here is the drill for locating faults in the line output stage when the trouble is no picture, no raster. Switch to 405 and listen for the line output whistle. Remove the cover from the screening box and note whether the EY86 heater is glowing or not. If there is a whistle and the EY86 is glowing, the fault is unlikely to be one of no e.h.t. and the fault should be looked for elsewhere (check the tube base voltages).

If the whistle is present but the EY86 does not light up check the heater of this valve (if the glass of the valve gives off a blue discharge to a screwdriver blade the heater is almost certainly open-circuit). If the whistle is harsh, try operation with the top cap of the EY86 removed. If now the whistle is normal and the free top cap very active, the EY86 is most certainly shorted internally.

If the whistle is very low note the effect of removing the top cap of the PY800. If this restores a near normal whistle the boost reservoir capacitor C54 is shorted. If there is no difference check the PL36, PY800 and the screen feed resistor R54 (in that order).



are for 405-line operation and were measured with 230V a.c. mains input using an AVO Model 8 (20,000Ω/volt) and with the ›ls set for normal operation.

If there is no line whistle and the above valves are red hot, change the ECC82 line oscillator as there is almost certainly no line drive from this valve. Check associated components if necessary.

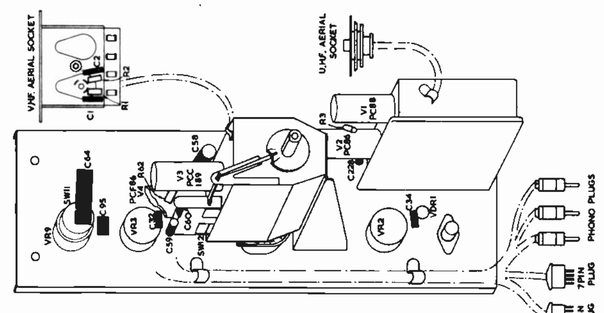


Fig. 3: Control unit layout.

Insufficient Width

Insufficient width is a very common complaint and can arise from a variety of faults. Check the PL36 and PY800 as routine. If there is a slight amount of overheating, change the ECC82 also. Then check the width and boost control circuit. If the fault is on 625 only check R57. If the fault is common to both systems check R52, R59, R60 and both controls (VR6 and VR7). If C57 shorts the v.d.r. will be damaged.

Line Hold Troubles

If the control is hard over one way check the

ECC82 and then the ECL80. Then check C44, etc. If the control is not over one end and the picture is hovering check the ECL80, C41, etc. If the picture is curved or continuously rippled, again check the ECL80. This assumes that the bottom of the picture is *not* rising and falling (if it is check the electrolytics in the h.t. supply).

Field Timebase

Here we have our old enemy the PCL85 which however is not such a frequent offender in this chassis as in some others. Having said that we hasten to add that it should always be checked when there are troubles affecting the height and hold.

The most frequent complaint is insufficient height, leaving an equal gap top and bottom. First check the PCL85 (PCL805) and then check under the chassis where the trouble is most often R106 or R55 which rise in value. C114 can short to the h.t. line which gives not only a drastic loss of height but also a severe loss of brightness as the voltage to the first anode (pin 3) of the tube is also dropped.

Fault-finding Drill

Here is the drill for field timebase troubles. No field scan is denoted by a single white line across the screen. In this event check the PCL85. If this is not at fault check the voltages at the valve base. First pin 6. If the expected 190V is absent check at pin 7. If the voltage is also absent here, check R107. If this is damaged check C115 for shorts. If however there is some 200V at pin 7 but nothing at pin 6 the field output transformer T3 is open-circuit. Assuming that the voltages are present both at pin 6 and pin 7 check at pin 8. Here you should have a little under 17V. If this should be much higher check the value of the bias resistor R104 which should be 330Ω. If it is burnt out change the PCL85 as well as the resistor. If all is well here however it is probable that the trouble is in the oscillator stage. Check the voltage at pin 1 of the PCL85 where some 40V is to be expected. If absent check at the height control. If also absent here check C107 (2μF) which may be shorted to chassis. Remember that there is another valve concerned with the field oscillator, V10. The pentode of this valve is the sync separator and the triode forms with the PCL85 triode the field multivibrator. Therefore a fault in V10 PCF80 can collapse the field scan and lead to very low voltage at pin 1 of the PCL85 (as there is no oscillation).

Field Linearity Troubles

So far we have discussed loss of height (equal top and bottom) and total loss of field scan. Linearity troubles are also quite common however, usually being confined to bottom compression. Check the PCL85 then C113. If this capacitor becomes open-circuit the loss of scan—particularly at the bottom—is severe. An open-circuit C115 can cause a similar though not as severe effect and this component should not be overlooked. Check also C109, C110 and R100. Leakage through C108 will cause bottom fold up and overheating of the PCL85 (excess voltage across R104).

CONTINUED NEXT MONTH

INTRODUCTION TO DIGITAL I.C.s

—continued from page 214

packages used being a mixture of DTL and TTL selected for current availability rather than out of necessity. The second constructional feature will use the logic systems to assemble the complex pulse sequences of an interlaced television waveform with video pulsing to obtain various patterns useful for colour convergence adjustments. Here we will be clocking at rates of up to a few MHz, so that speed considerations will begin to play a role.

Nomenclature

We are not going to give the detailed internal circuits of the digital i.c.s introduced in the constructional features. The i.c.s will be shown as rectangular boxes in the circuit diagrams, with the connecting pins around the periphery and numbered inside the box area according to the standard base diagram. The logic function designations of the pins will be marked on the outside of the box area. The designation for the power supply pin is *V*cc and for the ground (chassis) pin, which is also the power supply return connection, GND. The universal designation for an ouput is Q. Several outputs should be numbered Q1, Q2, Q3 etc. and we will keep to this. In some data sheets the outputs are designated with successive capital letters A, B, C etc. This can lead to confusion because CP is the normal designation for a clock input and C is often used for a "clear" input which has the function of returning all outputs to zero (low state) regardless of the previous states when a high or low state is applied to such a clear input (which one is specified by the truth table in the data sheet). S is the designation for a "set" input, which brings the outputs to the high state. The clear input is sometimes called the reset input, with corresponding designation R. Further commonly found inputs with a characteristic truth table relating them to the outputs are designated J and K. If outputs are present in pairs which are strictly complementary, i.e. one output of each pair is always in the opposite state to the other, they are designated Q and $\bar{Q}$, and numbered Q1 $\bar{Q}1$, Q2 $\bar{Q}2$, Q3 $\bar{Q}3$, etc. if several such complementary pairs are present among the connecting pins of a package. Where a definite truth table relationship to a *particular* input exists, the Q output of a complementary pair is the one which goes high when the logic level drops from high to low at that input.

The truth table for each new type of package will be given and discussed as and where introduced for the first time in our constructional features. This is in lieu of the actual internal circuit which is often very complicated and may in a typical decade counter contain up to fifty transistors and a hundred other components. Purchased in the form of separate components for a conventionally wired circuit such a decade counter would cost at least several pounds and the equipment design would be large and cumbersome. The integrated package now costs about one pound and only a few pins need to be wired up. Thus new projects are now feasible for an outlay in time and money well within reach of the enthusiast. The intention of this article has been to help the newcomer quickly feel as much at home with these integrated circuit devices as with familiar transistors.

COLOUR RECEIVER CIRCUITS

DETECTOR ARRANGEMENTS

GORDON J. KING

So far we have not seen the use of field effect transistors in British sets but since these devices provide a more linear function over a greater dynamic range than bipolar transistors I feel sure that as time goes on they will be adopted. I know that Mullard and others have developed v.h.f. and u.h.f. f.e.t.s which is bringing them into the realm of the u.h.f. front-end. Optimum linearity is becoming of greater importance in avoiding crossmodulation and intermodulation as more and more u.h.f. channels are brought into service. In the i.f. channels these effects are being minimised by concentrating most of the filtering in the early stages of lowish signal level and in the tuner by providing plenty of tuned selectivity ahead of the mixer or frequency changer; but even so under some conditions crossmodulation and intermodulation can trouble the picture and sound, the current solution being to adjust the r.f. gain preset (if fitted) accurately or to introduce suitable signal attenuation between the aerial downlead and aerial socket. At u.h.f. however such attenuation is not quite as easy to apply as at v.h.f. since the signal tends to get across the small capacitances of the resistive attenuating network. This can introduce mismatching effects and impair the voltage standing wave ratio, sometimes resulting in uneven attenuation of the three channels of a local group. An f.e.t. in the mixer stage and/or r.f. amplifier would make aerial attenuation less necessary.

Detectors

At the end of the vision i.f. amplifier chain it is necessary in a colour set to provide three detector functions (1) Y or luminance signal demodulation and (2) and (3) detection of the chroma and intercarrier signals on their subcarriers at 4·43MHz and 6MHz respectively.

The colouring information—in the form of the chroma signal—is at the transmitter integrated with the luminance information on a subchannel within the video channel bandwidth. When this composite luminance-plus-chroma signal arrives at the vision detector the normal Y video signal is obtained (with the sync pulses, etc.) along with the subchannel information. One detector can thus perform the dual functions of extracting the Y video and the subchannel information also at video frequency. Indeed quite a few sets rely on a single detector for these actions but as we shall see in a minute some designers favour the use of two detectors, one for the Y information and the other for the colouring subcarrier information.

Moreover the sound signal at suitably reduced level (we are of course talking about the 625-line standard now) also passes through the vision i.f. channel. The sound i.f. carrier beats with the Y (vision) signal carrier in the non-linear detector and gives rise to a difference frequency which is the 6MHz intercarrier signal, 6MHz merely being the frequency difference between the sound and vision carrier signals.

Things now tend to get a bit complicated. The composite signal is carrying the colouring information on the subcarrier frequency of 4·43MHz. This means that the chroma subcarrier is 4·43MHz from the vision carrier and this puts the chroma subcarrier 1·57MHz from the sound carrier (which is 6MHz from the vision carrier). The non-linear vision detector thus gives rise to another beat signal at 1·57MHz and this is an unwanted spurious signal. The scheme of things is shown in Fig. 1.

Sound-chroma Beat

There is no particular trouble in removing the 6MHz intercarrier sound signal from the composite video output, for the tuned filter which selects this frequency for feeding to the sound i.f. channel commonly doubles in some way as a 6MHz rejector in the video feed. The 1·57MHz beat between the colour subchannel components and the sound carrier however presents more of a problem since it falls within the video spectrum (the 6MHz intercarrier beat is just outside). This incidentally is often called the sound-chroma beat signal. Unless this signal is adequately attenuated from the video channels it can cause interference patterns during colour transmissions. Interference of this nature is shown in Fig. 2 (this is a colour photograph direct from a colour set, but has had to be shown in monochrome here).

Sound-chroma beat elimination has necessitated careful thought amongst colour set design teams. One way of overcoming the problem lies in the use of a synchronous vision detector instead of the conventional single-diode envelope detector. To get such a detector working however it is necessary to regenerate the vision carrier, and this can be both com-

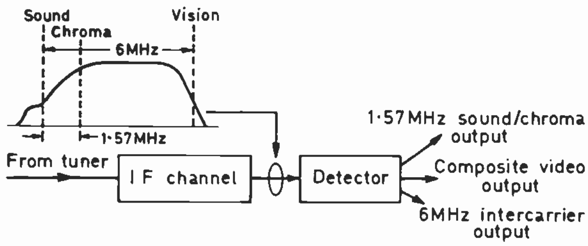


Fig. 1: Basic i.f. channel and vision detector where a single detector is used to handle both the composite video signal (luminance plus chroma) and the intercarrier sound signal. The detector ouput thus consists of video, the 6MHz intercarrier signal and a spurious signal at 1·57MHz due to the sound-chroma beat. The signal positions on the response leading to these conditions are shown on the characteristic curve above.

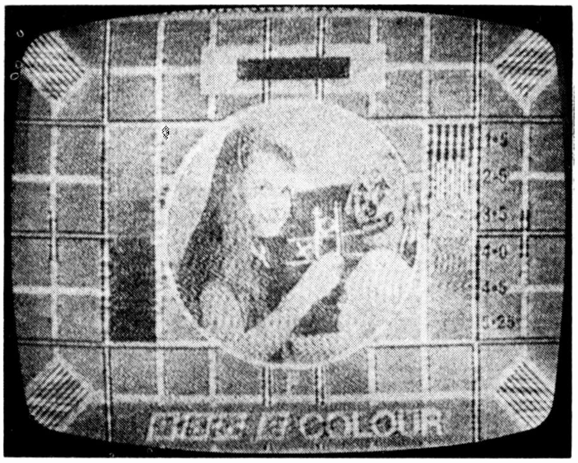


Fig. 2: Typical sound-chroma beat symptom: this was taken in colour with a maladjusted set.

plicated and costly in domestic receivers. A simple approach is thus favoured and the trend now is to use separate envelope detectors for the sound and vision signals as shown in Fig. 3. Here the intercarrier detector delivers intercarrier signal only while the vision detector provides the composite luminance-plus-chroma video signal only. With this arrangement the sound-chroma beat signal is eliminated by incorporating a sound i.f. rejector at the input to the vision detector. This of course means that there is no significant sound i.f. signal to beat with the subchannel signal in this detector.

Modifications to this theme are also in use. For example we sometimes find something like that illustrated in Fig. 4. Here the sound-chroma beat is removed from the Y channel by the use of a separate luminance detector preceded by a sound i.f. rejector. The other detector is then concerned with both intercarrier signal and chroma signal detection, the chroma signal being directed to the chroma bandpass amplifier and the intercarrier signal filtered out and then passed to the intercarrier sound channel.

Another slightly different arrangement is based on the principle shown in Fig. 4 but with the inclusion of a chroma i.f. stage feeding the chroma detector which also delivers the intercarrier signal, as shown in Fig. 5. Here the i.f. signal is split so that the intercarrier signal and the colouring information can be processed independently of the luminance signal. The chroma detector in such arrangements is basically similar to the ordinary luminance detector, but the scheme makes it possible to engineer the chroma detector to cater for the relatively high modulation percentage of the colouring information which can sometimes rise towards 133 per cent. Such levels cannot easily be handled by the conventional envelope detector without distortion. This is also facilitated in Fig. 5 type of circuit by the tuning of the chroma i.f. stage, for this can be aligned so that the response characteristic raises the level of the signal at around 39·5MHz (see last month's instalment) as a means of reducing quadrature distortion on the chroma signal.

Quadrature Distortion

Let us return to the question of quadrature distortion of the chroma signal for a minute. This is found in all receivers which use a simple envelope-type detector on a vestigial sideband signal and as just intimated the distortion tends to increase with rising chroma modulation depth. It will be recalled that it is monochrome receiver practice to combat detector distortion resulting from vestigial sideband working by aligning the vision i.f. channel so that the vision carrier falls at the −6dB point on the response curve. This ensures that the double modulation power present in the sidebands up to about 1·25MHz (625-line standard) is effectively "equalised" by the time it reaches the detector. For those not quite clear on vestigial modulation Fig. 6 illustrates the idea. It will be seen that for modulation frequencies up to about 1·25MHz on each side of the vision carrier the modulation consists of double sideband transmission while for video modulation above 1·25MHz the transmission is effectively single-sideband.

Residual distortion due to this is not particularly troublesome on monochrome because most of the video signal energy lies within the frequencies corresponding to double-sideband working. On colour however a significant amount of video energy is present around the 4·43MHz subcarrier frequency. As a result there are by-product effects of which there are two main ones. First the subchannel components suffer a specific kind of distortion as shown in Fig. 7; and secondly where the transmitted picture contains fairly large uniform areas of colour these areas tend to suffer a decrease in luminance value with negative vision modulation (there would be an increase in luminance with positive modulation). This is because the asymmetry of the distortion component (Fig. 7) results in an increase in the mean d.c. level from the detector. The effect is somewhat modified in practice because of some departure from the constant luminance principle, but unfortunately this fails to compensate for the errors relating to

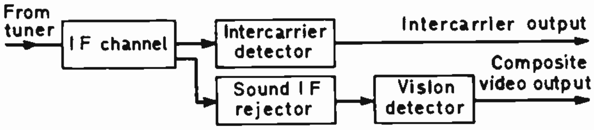


Fig. 3: Separate detectors for the video signal and intercarrier sound signal allow a sound i.f. rejector to be included at the input to the vision detector, to remove the sound-chroma beat.

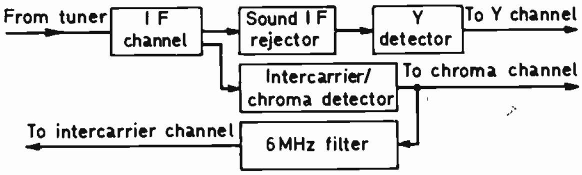


Fig. 4: An alternative system in common use is for the chroma detector to handle the intercarrier signal.

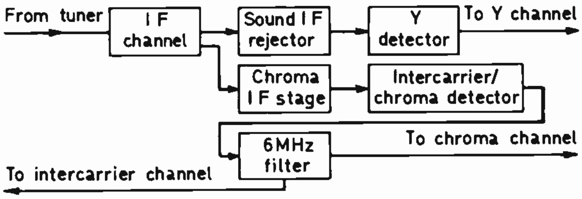
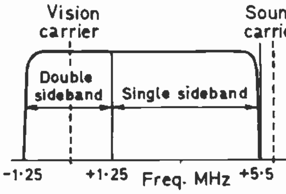


Fig. 5: Sometimes the chroma signal is fed via a chroma i.f. stage the response of which can be arranged for vision i.f. enhancement thereby reducing quadrature distortion.



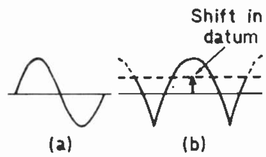
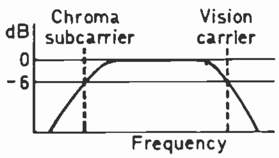


Fig. 6 (left): Vestigial sideband transmission characteristic.

Fig. 7 (right): Chroma-subchannel signal (a) is distorted as at (b) due to quadrature distortion. This gives a shift in datum as shown and the resulting d.c. affects the luminance in heavily coloured areas.



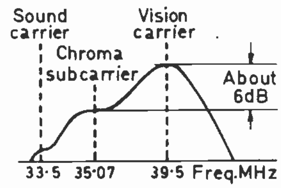


Fig. 8 (left): Single-detector receivers have their response arranged so that the chroma and vision carriers are both 6dB down as a means of reducing quadrature distortion.

Fig.9 (right): When a separate chroma detector is used the response leading to this can be adjusted as shown to provide vision i.f. signal enhancement, thereby reducing quadrature distortion. The response can also be tailored so as to reduce the effects of mistuning.

envelope detection with negative vision modulation (though a degree of compensation occurs with systems using positive vision modulation). The transmitting authorities help with the problem by the use of quadrature equalising, but the receiver designers must also do their bit. The problem could be resolved at the receiver by the use of synchronous demodulation, but this would be costly for domestic use.

When a single vision detector is employed the response characteristic is often arranged so that the chroma subcarrier occurs at the same height (i.e. –6dB from maximum) as the vision carrier (Fig. 8). This equalises the modulation depth of the chroma signal at the vision detector and thus reduces quadrature distortion. It is also common practice to keep the rate of the slope on the chroma carrier side of the characteristic as small as practicable to avoid impairment of the transient response (i.e. to avoid "rings", etc.) and to make the tuning less critical than it would be with a large slope rate, remembering of course that the carriers slide along the response characteristic as the u.h.f. tuning is adjusted.

When however a separate detector is used for the chroma signal as in Figs. 4 and 5 (whether or not this detector handles the intercarrier function as well) the response characteristic of the signal fed into it can be arranged to provide vision carrier enhancement as shown in Fig. 9. When the chroma detector also handles the intercarrier signal, the sound i.f. must of course fall at some lower level down the response as also shown in Fig. 9. This scheme can be optimised to yield the least quadrature distortion and the response characteristic can be tailored so that in the event of mild mistuning the chroma-vision signal ratio remains reasonably constant.

Next month I shall be examining some of the detector circuits used in contemporary receivers.

TO BE CONTINUED

Telecommunications by GUIDED WAVES

JOHN CHAPMAN

NEW types of visual telecommunications, for example in three dimensions, in colour and with standards of definition greatly superior to the current broadcasting standards, could according to W. J. Bray, research director of the British Post Office, be with us by the end of the century. Mr. Bray was addressing a recent I.E.E. conference on trunk telecommunications by guided waves and his predictions were based on the assumption that waveguides would be introduced for the main trunk routes in Britain's telecommunications network, with carriers in the s.h.f. region. The need to use s.h.f. is because of the very wide bandwidth it is expected will be required to carry all present and foreseeable telephone, telex, TV, computer terminal, broadcast sound, etc. traffic. At s.h.f., point-to-point —as opposed to satellite—"through air" transmission systems are not a feasible proposition over any distance, and the only alternative is to use waveguides to carry the signal.

Waveguides

Waveguides consist of metal ducting of rectangular or circular cross-section through which electromagnetic waves can be propagated and are used for feeding microwave signals from one place to another—there is a point beyond which coaxial cable can no longer be used since the resistance of the inner conductor and the shunt capacitance between the inner and outer conductors form a low-pass filter which shorts out the signal. The UK is amongst the leaders in the exploitation of guided waves for trunk telecommunications and is about to lay an experimental waveguide link with a capacity of 400,000 telephone circuits or their equivalent—say 250 TV channels—in either direction. Most of the experimental work on the use of guides in the UK has been done by the Post Office which is, in co-operation with industry and the universities, currently studying two types of guided-wave transmission systems. One is based on using 50mm. diameter circular TE_{01}-mode waveguide with an internal helically-wound dielectric strip and the other on an optical-frequency system with fibre-optic "lightguides". Table 1 lists the electrical and mechanical characteristics of the two systems and their traffic-carrying capacities.

Guides for SHF

The dimensions of ordinary rectangular waveguides are of the same order as the wavelength of the signals being propagated along them. At s.h.f. this would mean waveguide dimensions of the order of parts of a millimeter, impossible to manufacture accurately—and accuracy is very important as we shall see. The answer to this problem, originally suggested by the Bell Telephone Laboratories, is the use of new modes of propagation along a guide. Of particular importance is the TE_{01}-mode in a circular guide, since this has the unique feature that attenuation decreases with increase in frequency. TE stands for transverse electric, meaning that the electric field of the electromagnetic wave being propagated along the guide is circumferential to the guide, the wave being pulled helically down the length of the guide. Now the quality of propagation along a guide is determined by the inner surface of the guide, any irregularities however small altering the mode of propagation along the guide. In practice in a circular guide this means that the mode changes from TE_{01} to TM_{11}, which unfortunately has a very much higher attenuation characteristic.

Helical-dielectric Guides

Thus guides have to be rather special if the signal is to be successfully propagated from one end to the other. One suggestion has been for "continuous-mode filtering" in which torroidal pieces of dielectric (insulator) are mounted along the inner surface of the guide to maintain the transmission mode constant. What this actually does it to continually change the wave from the TE_{01} to the TM_{11} mode and back again, which gets the wave along the guide but introduces attenuation. To overcome this the helical-dielectric guide is being studied. In this the dielectric is wound as a helix along the inner surface of the guide, acting rather like a bobsleigh run to the TE_{01} signal fed into the guide. Considerable engineering development has been done on TE_{01}-mode systems and major field trials are now planned. It is proposed to lay an experimental waveguide linking the Post Office's research station at Martlesham Heath to the country's microwave radio-relay network: the nearest point is at Mendlesham, Suffolk, nearly twenty miles from the reseach station.

Fibre-optic Guides

Work has only just begun on the use of fibre optics for long distance telecommunications with carriers at light frequencies and virtually limitless bandwidth, but engineers are confident that optical systems have a future in spite of the many problems to be solved. Fibre optics have the advantages that they are more flexible than waveguides and do not require special

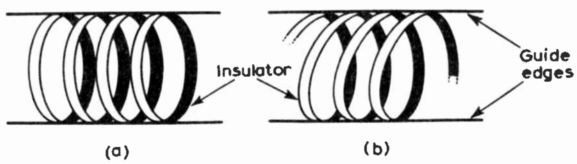


Fig. 1: (a) Circular guide with torroids of dielectric on inner surface, (b) helical-dielectric guide.

Table 1: Electrical and mechanical characteristics and traffic capacities of typical 50mm. TE_{01}-mode and optical-fibre guides.

Characteristic	*TE_{01}-mode Guide*	*Optical-fibre Guide*
Diameter	70mm. external 50mm. internal	10mm. for 100-fibre cable
Rigidity	Rigid	Flexible
Curvature	Not greater than 100m. radius	Not greater than 1m. radius
Frequency range	30-120GHz	300,000GHz approx.
Losses per km.	2.5-3.5dB	10-20dB (objective)
Repeater spacing	10-20km.	1-2km.
Bit rate per second	5×10^8 (2×10^9*) per carrier	10×10^7 (5×10^8*) per fibre
Telephony circuits	400,000	160,000
Viewphones	5,000	2,000
Television (bothway)	250 (fully equipped single guide)	100 per 100-fibre cable

* Proposed figures for the second phase of development.

laying techniques involving the use of long straight lengths, the need to use very gradual bends and the limited number of specially-designed corners that may be used in a system. The main problems are associated with the terminal and repeater equipment. Current solid-state technology makes it a relatively simple project to construct terminal and repeater equipment for TE_{01}-mode systems where the upper frequency limit is about 100GHz. This is not however the case with optical systems. Those under test operate in the near infra-red part of the spectrum (300,000GHz) and the room-temperature lasers used in these experiments are still basically laboratory instruments.

One future for optical systems may be in providing broadband local distribution services between exchange and subscriber: their unique properties of offering many space-divided broadband channels which can be separated at the receiving end with simple equipment, their flexibility and compactness coupled with low cost make them very attractive for local distribution. They may well open up such services as the viewphone and make it possible to have "broadcast" television, videotapes and other facilities supplied directly to the home or office.

Developments

Looking towards the future Mr. Bray suggested it would be natural to assume that solid-state technology would make it possible to operate in the frequency range 80 to 275GHz. This would permit the use of 20mm. diameter helical-dielectric waveguides which could carry a million telephone circuits —about 2·5 times as many as now possible with a 50mm. guide operating in the frequency range 32 to 110GHz. Another possibility Mr. Bray spoke of was the vast region between the upper limit of some 300GHz for helical-dielectric guides and the near infra-red end of the spectrum (300,000GHz) used for optical-fibre systems. A study of this region, he said, might reveal new guided-wave modes with bandwidth capabilities exceeding those of the systems now being developed—which however are considered to be more than adequate to meet our needs to the end of the century.

A researcher from the Bell Telephone Laboratories spoke on their work in developing a circular waveguide system using a 51mm. diameter guide with a capacity of 233,000 two-way voice circuits or their equivalent. Work began on this project in 1969 and is at a fairly early stage of development.

As long ago as the beginning of 1960 France decided to build an experimental link using waveguides of a helix structure and it seems certain that France will be the first country in the world to have a waveguide network for its telecommunications services. Already it is being suggested that France will have some 3,000 to 4,000km. of guided-wave links by 1980. The first big link of 200km. is scheduled to be completed during 1973-74.

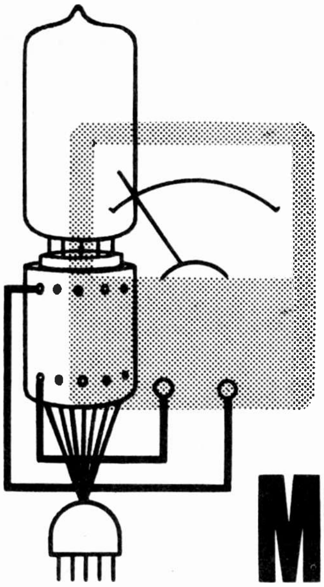
Other reports at the conference came from Japan, Germany and the USSR, and it seems certain that guided-wave telecommunication systems will be adopted by most nations before the turn of the century. All the signs indicate that waveguide technology will result in the introduction of major networks featuring these devices and that these networks will be complementary to the expanding satellite communications systems. ■

TROUBLE GETTING "TELEVISION"?

We receive all too many letters from readers complaining of their difficulties in getting TELEVISION. The problem has been aggravated by the recent printing dispute which led to the loss of the December issue and the late appearance of subsequent issues, and industrial action which made some issues late in mid-1970. If you have difficulty we strongly recommend placing a regular order with your newsagent. If difficulty is still experienced please write direct to the Editor (for address see the next column) giving any relevant details.

RADIO AND TELEVISION SERVICING VOLUMES

The TELEVISION editorial library is missing certain volumes from our set of *Radio and Television Servicing* books. These are the volumes covering 1956-57 and 1960-61 receivers. If you have an unwanted copy of either of these books please let us know (write to The Editor, Television, Fleetway House, Farringdon Street, London EC4) indicating the condition of the books and the price required. These books help us sort readers' problems and your help in restoring our set would be much appreciated. ■



K.J. YOUNG

IN-SITU VALVE MONITOR

DURING the servicing of valved equipment it is usual to single out a particular stage as probably faulty and a quick test is to try a new valve if one is available. This however is risky unless the bias conditions are first checked and it is in fact desirable to check all the voltages before inserting a new valve. A factor which may make this awkward or time-consuming is the inaccessibility of the underside of the chassis or printed board. In one extreme instance—an obsolete television receiver—it was necessary to remove the c.r.t. in order to gain access to many of the valve-bases! Even with a good modern layout however it is useful to be able to make quick tests after removal of the back only, and before removal of the set or instrument chassis from the cabinet.

A convenient device for this purpose consists of a B9A plug and a B9A valveholder mounted at opposite ends of a Lantex cylinder (see Fig. 1). The cylinder must be of sufficient diameter to permit the mounting of nine non-reversible chassis-mounting two-pin sockets with their bases outside its periphery. The cylinder is drilled so that the socket lugs pass through it towards the interior. The same scheme can of course be applied to other types of valve base. With the international octal base (Fig. 2) it is more convenient to mount the socket bases on the inside of the cylinder and drill holes through which the plug pins can be inserted.

The valve plug could be mounted directly on the lower end of the Lantex cylinder but as chassis are frequently crowded it is much better to use a length of colour-coded flexible connections. These should be as short as possible in the interests of stability, etc., but if a length of about 5cm. is tolerable this enables the cylinder to be kept clear of other valves, i.f. cans, transformers, etc.

Voltage and Current Checks

During normal use the sockets, which are connected to the valveholder and valve plug respectively, are bridged by nine shorting plugs with holes accessible to a voltmeter probe (Fig. 3). Opposite each plug the pin number should be clearly marked on the cylinder. Thus if the valve is removed from the set or instru-

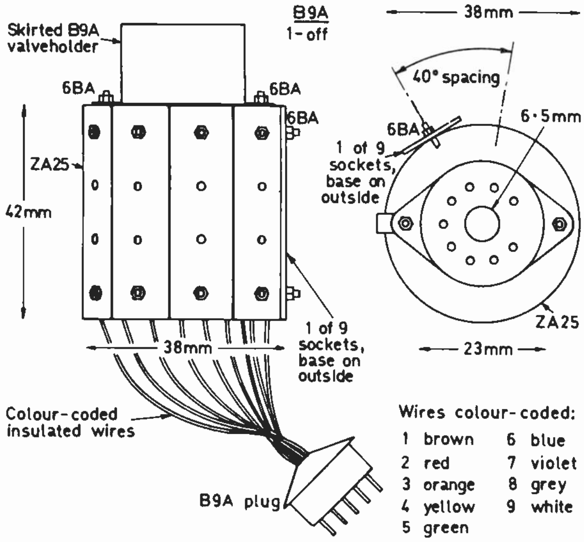


Fig. 1: In-situ valve monitor for use with valves with a B9A base. Nine PK29E sockets are mounted on the outside of the 1½in. diameter ZA25 Lantex tubing. Note that all type numbers quoted are from the Home Radio of Mitcham catalogue.

ment and inserted into the valveholder of the tester while the valve plug is inserted into the vacant valve holder of the equipment voltage readings on any electrode can be quickly obtained.

To take readings of electrode current it is convenient to use a milliammeter fitted with a socket similar to those used in the tester. A set of up to nine colour-coded leads should be provided terminated in half-plugs sawn for the purpose. With the particular plugs referred to in the drawings one obtains a lead with a plug pin of larger diameter at one end than at the other.

Replacement Valve Tests

A further use for the interconnecting leads arises when one wishes to try a replacement valve which has equivalent characteristics but a different base, e.g. a B9A replacement for an international octal valve. In this event two testers can be used together, one to provide the socket for the valve to be tried and the other the plug for the vacant socket on the equipment.

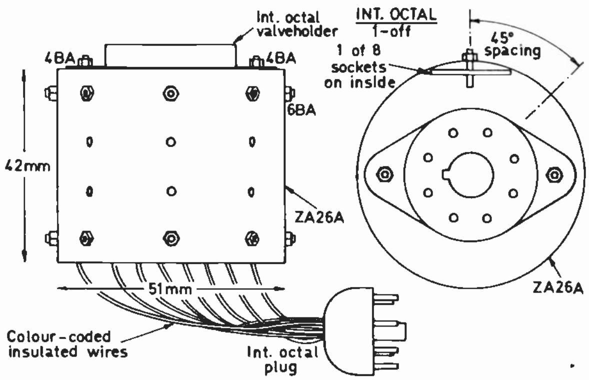


Fig. 2: In-situ valve monitor for use with valves with an international octal base. Eight PK29E sockets are mounted on the inside of the 2in. diameter ZA26A Lantex tubing.

TV Applications

The tester is particularly useful for wave-shaping stages in television receivers, when an oscilloscope can conveniently be used in conjunction with a voltmeter. It is not suitable for use with boost diodes, e.h.t. rectifiers or turret or u.h.f. tuner valves. It can be used for line output valves provided the top-cap connector has first been removed and taped and the anode top cap of the valve temporarily connected to the plug aperture on the tester corresponding to the screen grid. This is to prevent the generation of high flyback voltages and at the same time to safeguard the screen grid against excessive dissipation which may harm the valve if it is operated for long without an anode connection. With i.f. valves some detuning is inevitably caused, depending on the length of the colour-coded leads used in the tester, but instability is rare; the tester would not of course be used while alignment is in progress but only for preliminary voltage and/or current checks.

Use

The results of tests made with the device relate to both the valve itself and the associated circuits. It is then necessary to seek causes for wrong readings which may be attributable to the valve or to the circuit or to damage to the valve caused by a failure of one or more passive components. For large workshops a valve tester with complete data or punched cards is clearly desirable and one person can be deputed to look after this and test valves on behalf of a number of technicians or laboratory staff. In very small undertakings a good valve tester may be considered too expensive, or the tester may be inadequate to cope with newer types of valve base such as the B10A. A design for the constructor was featured in PRACTICAL TELEVISION September-November 1968.

Static and Dynamic Conditions

Incidentally a criticism which can be levelled at many otherwise good valve testers is that they deal with static rather than dynamic conditions, and while adequately testing cathode emission they may not provide a complete diagnosis particularly of valves used at higher frequencies, notably u.h.f. Nevertheless a self-contained conventional valve tester is an undeniable asset particularly in view of the repeatability of the conditions which it provides and the ready availability of a wide range of correct heater voltages. In this regard proper conditions are not always readily obtainable in equipments using the a.c./d.c. technique.

Plotting Valve Characteristics

The value of the in-situ tester already described is enhanced when a self-contained valve tester is not available since it can be used in conjunction with a reasonably priced oscilloscope such as the Heathkit OS2 to plot *Ia*/*Vg* characteristics and hence test valves under dynamic conditions. For this purpose use is made of the h.t. power supplies and heater supplies in the equipment under test. The a.c. signal can be obtained from a separate 6·3V transformer or, better, from a self-contained battery-driven transistor audio generator giving a comparable voltage.

The circuit given by M. G. Scroggie in his *Radio and Electronic Laboratory Handbook* (Iliffe, 1962) can be adapted for this purpose to the in-situ tester (see Fig. 4) if the extension-type (single-ended) leads are used with the sockets on the tester corresponding to anode, grid, cathode and if necessary screen. It is really more convenient if a separate small unit with insulating case and matching sockets is made to house the additional components, i.e. bias battery, potentiometer, resistors and capacitors. A 1kΩ anode load resistor is connected as shown (Fig. 4) and coupled via a capacitor of sufficient capactance—to minimize phase shift—to the Y-amplifier of the oscilloscope. For grid bias it is simpler to use an 18V tapped bias battery and to return the valve cathode to chassis. If a double-triode is being tested both the anode and grid of the other half of the valve could be left unconnected or the grid returned to chassis as a precaution. The full voltage of the 6·3V transformer or audio oscillator may well be needed to drive the oscilloscope X-amplifier if this is rather insensitive. The 10kΩ potentiometer across it provides a smaller voltage for the grid input. The internal 'scope linear timebase is switched off and the 'scope used as an XY plotter. To minimize safety problems with a.c./d.c. equipment it is necessary for the equipment and the oscilloscope to be supplied by separate double-wound transformers in accordance with SHW928 (H.M.S.O.) and a battery-powered audio oscillator is from this point of view preferable to an extra 6·3V transformer.

M. G. Scroggie's circuit shows a single valve amplifier between the valve under test and the 'scope Y plates. If the oscilloscope has its own Y-amplifier this may be used provided it has an odd number of stages; otherwise a transformer is needed to bring the signal proportional to *RlIa* into phase with *Vg*. It is also desirable to minimize phase shift in all couplings to prevent a thin ellipse being shown in place of a single line for the characteristic. Calibration of the graticule is carried out by the usual methods. ■

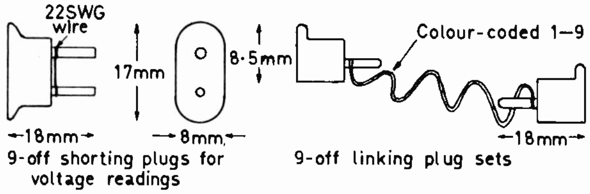


Fig. 3: Plugs for use with the monitors. Shorting plugs on the left, linking plug sets on the right, both using PK29D non-reversible two-pin plugs.

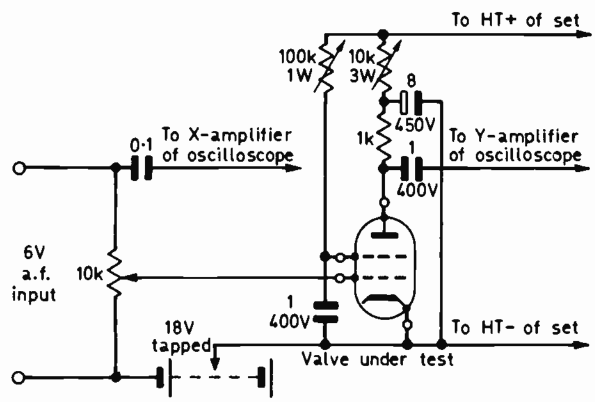


Fig. 4: Circuit for use with an oscilloscope to plot valve characteristics.

UHF RECEPTION PROBLEMS

K. ROYAL

THE u.h.f. television plan not only embraces the siting and power of transmitters but also takes into account the receiving end in terms of receiver sensitivity, image (second-channel) rejection, aerial gain, directivity, front-to-back ratio and so forth. With all these factors properly taken into account the vast majority of viewers can expect adequate reception quality of both monochrome and colour signals.

THE UHF PLAN

Two main features of the plan are that the transmitters are cosited, with identical power for each channel of the local group, while receiving aerials should have a gain approximately equal to or better than that provided by a Yagi array of eight or more elements. Clearly however it cannot be said that all viewers will require aerials of exactly the same characteristics; but the plan is based on a minimum aerial gain. It rarely matters much whether the minimum is exceeded, but it certainly does if it is not reached. It is far easier to secure a good picture by disposing of unwanted signal than by endeavouring to improve a poor picture by boosting a weak signal.

Until the full plan has been completed there will be areas outside the normal range of a single u.h.f. transmission or group of transmissions, while as the plan unfolds some areas will be in range of only one or two stations of the local group which will ultimately—in phase 1—cater for the three main programmes (i.e. BBC-1, BBC-2 and ITV), all in colour of course. Already there are areas in which the three programmes can be obtained and viewers within these areas are in a position to take full advantage of phase 1 of the plan. Viewers not yet in range are attempting to receive more distant groups of stations with varying degrees of success. This is certainly not a bad thing provided it is remembered that reception under such conditions can never be as good as when it is from a local group of channels—this applies especially to colour—and that reception conditions are commonly more critical over relatively long-distance u.h.f. paths than over normal paths up to the optical horizon.

CO- AND ADJACENT-CHANNEL PROBLEMS

It is useful to know something about u.h.f. propagation because when the plan is complete the u.h.f. bands will be handling thousands of sound and vision carriers (to say nothing of colour subcarriers!) which receiver front-ends and aerials will have to discriminate against to avoid co-channel and possibly adjacent-channel interference troubles. Although the plan expects receiver front-ends and aerials to afford protection against co-channel interference problems, the *main* u.h.f. stations are engineered to yield a service area protected against co-channel interference to a signal level of 70dB (ref. 0dB equals 1μV/m) while the protection relative to the low-power satellite stations is 80dB.

Some of the latest receivers with low-noise transistor tuners and high-gain i.f. channels working in conjunction with good aerial systems are capable of providing quite decent pictures and good sound from signal levels significantly below the protection limits. This is why it is possible to secure acceptable mono and colour reception from transmitter groups well removed from the local areas they are designed to serve when the aerial is accurately beamed to the distant transmitters. In the Devon area for example quite a few viewers are obtaining consistently fair pictures from a transmitter group located as far afield as Cornwall. This is fair enough for the time being but when the local Devon group of transmitters go

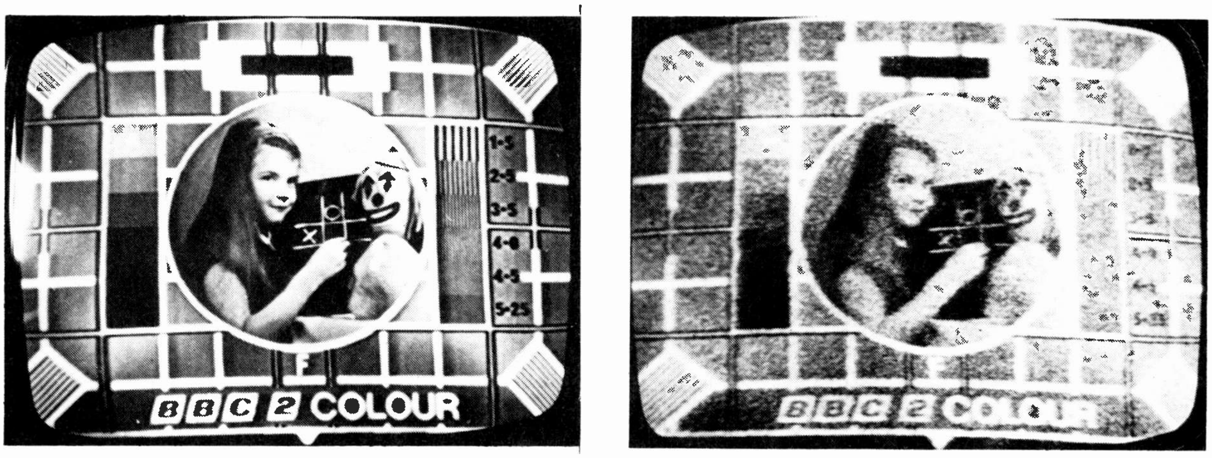


Fig. 1: (a) Channel 24 reception over 100 miles. (b) Channel 33 reception over 200 miles. An ordinary commercial dual-standard receiver was used for these tests.

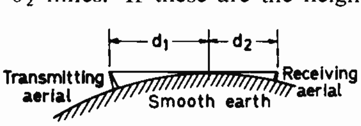
on the air not only will the aerials need to be changed but a different orientation will be necessary. The aerial will need to be changed because near and adjacent transmitter groups operate in different bands of frequencies, this being a feature of the engineered service area protection just mentioned.

It might be possible to obtain good reception from the local group when it starts merely by reorientating the array previously used for the more distant group, *but this would be very bad practice* because an aerial not correctly tuned and designed for the channel group it is receiving invariably exhibits spurious response lobes at various off-beam angles and frequencies and since these could coincide with the paths and frequencies of the signals from distant station groups the problems of co-channel and possibly adjacent-channel interference would be aggravated. Indeed, it has been suggested that for many viewers the limitation on receiving good pictures will eventually seldom be the actual signal strength available but rather the presence of co-channel and sometimes adjacent-channel signals.

UHF PROPAGATION

When u.h.f. was first contemplated it was considered by many that the range of reception would be limited almost to that of light-wave propagation. Thus it was suggested that beyond the optical horizon the signal field would diminish so rapidly that co-channel interference problems as they are known on the v.h.f. channels and Band I in particular would be far less severe. While this has proved to be the case to some extent there are nevertheless many reports of really long-distance u.h.f. reception that have resulted in some serious rethinking, particularly with respect to co- and adjacent-channel interference. Fig. 1(a), for example, shows the reception obtained by the author over a path of some 100 miles on channel 24 while (b) shows the reception over a 200-mile path on channel 33. These signals are not consistent and depend considerably on tropospheric and hence weather conditions, but they do reveal dramatically that signals from distant transmitters could interfere with those of a local group if the aerial system for the latter is of the incorrect type or badly installed. The author is currently receiving consistent channel 28 signals over a path of some 60 odd miles, which is not only beyond the optical horizon but with a hill range between!

In Fig. 2 *d*1 represents the horizon distance from the top of the transmitting aerial and *d*2 from the top of the receiving aerial. Excluding the effects of refraction and diffraction (i.e. assuming an essentially homogeneous medium) the horizon distance in miles is equal approximately to 1·22 times the square root of the aerial height in feet. Thus the horizon distance at say 1,300ft. is about 42 miles and at 30ft. about 6½ miles. If these are the heights of the aerials then



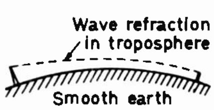


Fig. 2 (left): Defining the optical horizon: d1 + d2 represents the line-of-sight distance between the two aerials.

Fig. 3 (right): The troposphere produces wave refraction or "bending" so that waves follow the curved surface of the Earth.

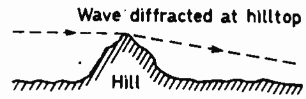


Fig. 4: Diffraction is when the wave is bent downwards after passing over the top of an obstruction.

a sufficiently powerful light at the top of one would be seen by an observer at the top of the other. This is because light waves travel in straight lines through a homogeneous medium.

Radio and light waves are both of the electromagnetic family but while the light frequency band ranges from about 3·8 × 10^{14}Hz to 7·9 × 10^{14}Hz the television waves cover from about 0·4 × 10^{8}Hz to 9 × 10^{8}Hz. Light waves are thus of much smaller wavelength than radio waves. With increasing wavelength the refractive effect of the Earth's atmosphere (called the troposphere in this context) becomes more apparent and the waves tend to bend round the curved Earth as shown in Fig. 3. Diffraction also becomes more apparent and the waves are bent back to Earth after passing over a hill for example, as shown in Fig. 4. Notice the difference between refraction and diffraction in Figs. 3 and 4.

Radio waves in the v.h.f. and u.h.f. regions are also refracted and the net result is that television signals are normally propagated over distances somewhat greater than those set by the optical horizon. The excess distance is related to the wavelength, however, for the bending becomes less as the wavelength is reduced (frequency increased).

Numerous tests have been conducted to show how wave bending diminishes with decreasing wavelength. An example is shown in Fig. 5 in which waves in Band I at 50MHz are compared with those in Band V at 800MHz. It can be seen that up to the optical horizon the two reduce in signal field fairly consistently while beyond the horizon the 800MHz field falls away much more rapidly than the 50MHz field.

The bending assumes a "standard troposphere", which can be based on assuming an increase in the Earth's radius of some 25 to 35 per cent depending on the signal wavelength. The refractive index decreases with the height above Earth due to variation of pressure, temperature and moisture content. Weather changes can influence the index however, and during a spell of anti-cyclonic conditions the index can vary to increase the reception range. This results from temperature inversion in the lower atmosphere which tends to inhibit convection and it must always be remembered that even in the u.h.f. bands distant signals can sometimes come romping in which is why the aerial experimenter and installation technician must always ensure the maximum discrimination against co- and adjacent-channel signals from distant transmitters.

RECEIVING AERIALS

This brings us to the aerial itself. Within the

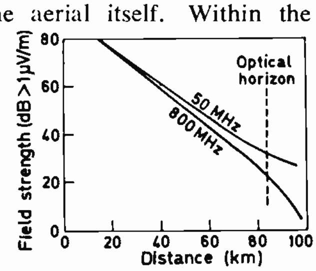


Fig. 5: These curves show that beyond the horizon distance a u.h.f. wave is less aided by the Earth's atmosphere than a v.h.f. wave of similar power.

optical horizon a fairly simple array can often yield good reception of the three programmes. But it pays in the long run to choose an aerial just a little better than required by the prevailing signal field to provide a margin to cater for progressive fall in the efficiency of the receiver and general deterioration of the aerial system due to weathering and air pollution over the years. Moreover although one may be in the effective optical horizon, large buildings and local masses of metal can significantly impair the strength of the signal picked up. Sometimes therefore an elaborate array might be required even fairly close to a transmitter group. Aerial altitude can also be very important in poor reception areas even fairly close to the transmitter.

Reputable aerials are designed to have a bandwidth adequate to embrace all the channels of a local group with constant gain within 3dB over the group. Some early arrays failed to meet this specification and viewers stuck with these are experiencing significant unbalance between the received signals over the three channels of a local group. This symptom is not always caused by poor aerial design, however, for a number of reports have been received since the advent of BBC-1 and ITV in the u.h.f. spectrum of this same effect even with good arays designed to meet the BREMA parameters on u.h.f. aerials.

Some have attributed the effect to an unbalance of powers radiated from the transmitter but this is certainly not true. The three prime reasons for the effect are: (1) direct and reflected signals have phase differences which are not exactly the same over the three channels, (2) signal transfer differences tend to occur over the local group spectrum due to various types of "mismatching", and (3) signal "suck-out" can occur at certain frequencies due to the close proximity to the aerial of metal of dimensions critical to some of the frequencies of the channel group. Let us look at these in turn.

Under certain v.h.f. reception conditions—especially in difficult or fringe areas—a wide swing in input signal voltage is exhibited when the array is moved upwards, downwards or sideways. Indeed it has long been the practice of keen aerial riggers to sample the signal at different places around a building to find the strongest signal before fixing the aerial system permanently.

The idea is to find a location for the aerial where the reflected waves are in phase with the signal waves proper. When this happens maximum signal is induced in the aerial and maxium signal voltage appears at the input to the set.

The same sort of thing can occur at u.h.f. but here the smaller wavelengths mean that the maxima and minima points are closer together so the array does not have to be moved so far to find an optimum location. When the two signals are in phase they add together and when they are in anti-phase they tend to cancel. The former gives the maxima and the latter the minima points. With v.h.f., however, we have only one channel per aerial to worry about, while with u.h.f. there are three channels. So if we maximise like this for one channel the phasing is obviously not going to be optimised for the other two channels owing to the differences in frequency.

With regard to (2) standing waves can occur on the coaxial downlead when there is a mismatch at the aerial or set (or both) and this too can result in cancellation effects within the local group spectrum

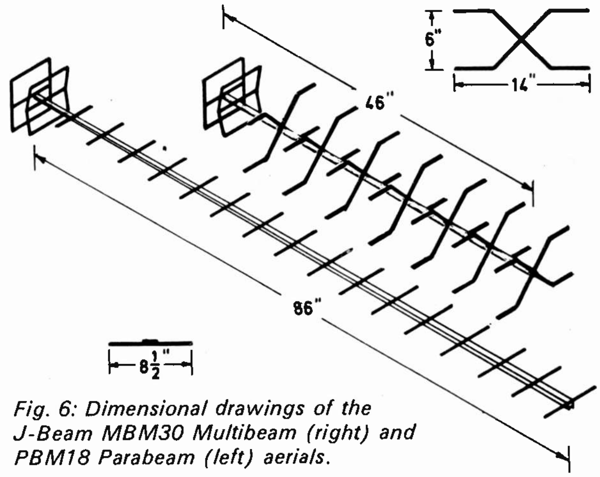


Fig. 6: Dimensional drawings of the J-Beam MBM30 Multibeam (right) and PBM18 Parabeam (left) aerials.

thereby causing a reduction in signal transference at one frequency relative to the others.

The signal "suck-out" effect (3) is akin to tuned circuit absorbtion and this has been known to occur when an item of metal close to an aerial has dimensions tuning it to a channel half wavelength or multiple thereof. This tends to put a dip in the aerial response at the absorption frequency.

CURING UNBALANCE

In connection with the first problem Mr. B. Sykes, Chairman of the J-Beam Aerial Group, writing in a recent issue of *Electrical and Electronic Trader* has pointed out that apart from the apparent solution of installing more than one aerial, each optimised for a particular channel, the nearest compromise is to use a stacked array with more than one aerial in the array. A series of tests was conducted by J-Beam Aerials to compare the well known Parabeam and Multibeam arrays—the latter also in two and four multiple versions—in terms of signal balance over the three channels of a local group. The results are shown in Table 1 and dimensional drawings of the PBM18 Parabeam and MBM30 Multibeam are given in Fig. 6. In spite of the PBM18 and MBM30 aerials having identical gain and similar bandwidth characteristics (as measured under laboratory conditions) it was found that under field conditions the MBM30 yielded significantly better channel balance (see Table 1).

Mr. Sykes attributed this to the "multiple elements" of the Multibeam as opposed to the ordinary director elements used with the Parabeam array (see Fig. 6), the former giving the characteristics of a stacked array with a consequent larger area of signal capture. In the Table aerial 2 MBM46 is a stack of two MBM46s and aerial 4 MBM46 is a stack of four

Table 1: Sound Carrier Signal Strengths in a UHF Channel Group.

J-Beam aerial type	*Signal strength of sound carrier in μV*		
	BBC-2	*ITA*	*BBC-1*
PBM18	130	330	260
MBM30	190	280	280
MBM46	260	390	390
2 MBM46	340	580	480
4 MBM46	470	660	600

MBM46s, correctly phased and matched to a single feeder.

Tests were made of the signals picked up by each separate aerial in the stacked arrays, and it was found—as expected—that both the signal voltage and the signal phase differed between them but that the net results when the array was properly phased to the common downlead were reflected in far enhanced channel balance.

There would seem to be little doubt therefore that in difficult reception areas where reflections result in channel unbalance the solution lies in the use of stacked arrays or multiple-director type aerials which embrace a larger volume of space than the more conventional single, in-line Yagi aerial.

Signal unbalance resulting from standing waves along the coaxial downlead can sometimes be corrected, or at least the unbalance reduced, by adjusting the length of the feeder to the set by about one inch at a time, testing for balance after each cut. This is a protracted exercise since the coaxial plug has to be reconnected after each cut to ensure optimum signal transfer at u.h.f., but it can lead to worthwhile results in bad cases of unbalance.

When feeder standing waves stem from mismatching at the tuner or aerial the feeder itself could be of poor quality with impedance discontinuities along its length or the u.h.f. aerial may be placed too close to a "bundle" of other aerials on a shared chimney stack. This latter can reflect an impedance change at the feeder connecting point of the dipole. In the tuner the necessary mains isolating capacitors and the static discharge resistors at the aerial socket encourage a degree of mismatching, thereby changing the signal transfer conditions over the spectrum of the local channel group. This can be aggravated by the use of poor-quality feeder and by mismatching at the aerial.

Signal "suck-out" should encourage re-appraisal of the aerial mounting. If the aerial is in the roof-space—which is not a very good home for a u.h.f. array—it might be under the influence of mains wiring, water pipes or other aerials in the roof-space or, indeed, on the roof the other side of the tiles! A curious thing seen by the author recently was a u.h.f. aerial secured to the pole on the roof by the last director! The aerial was thus looking straight into the pole which was metal. If this sort of mounting fails to delete u.h.f. reception entirely, it will almost certainly result in channel unbalance.

OBTAINING OPTIMUM SIGNAL

Other reports have indicated the need sometimes to alter the aerial bearing slightly to get the best pick up of one channel of a local group, this giving the impression of lack of transmitter co-siting. The stations *are* co-sited so this is not the cause of the effect. It would seem that some aerials are prone to a shift of polar response over the channel group bandwidth. Thus on one channel maximum pick up

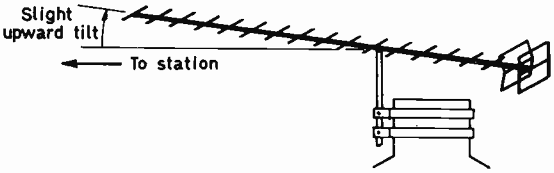
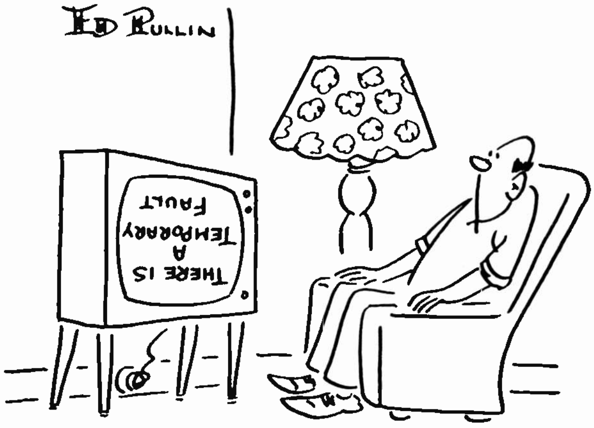


Fig. 7: Tilting the aerial as shown here can improve reception at distant sites.



may occur several degrees from that of another channel of the same group. The solution to this problem is to orientate the aerial on a bearing which gives the best average pick up of the three channels or to change the aerial for one of better design. An aerial whose symmetry of directional characteristics tends to change over the local channels would possibly be a poor performer when it comes to the rejection of co- and adjacent-channel interference.

Reception over long-distance paths can often be improved by tilting the aerial slightly upwards as shown in Fig. 7. The plane of polarisation of the signal rarely changes appreciably under free-field conditions but if the signal passes through metal window frames for example (not a very good way of receiving u.h.f. signals incidentally!) the plane of polarisation is then sometimes encouraged to shift and the aerial will pick up a greater amount of signal if it too is tilted to correspond to the polarisation.

Quite an amount of u.h.f. signal can be lost through a poorly connected coaxial plug, especially if the installation man has failed to solder the inner conductor. If your u.h.f. signal is below standard check the coaxial plug at the first opportunity.

In conclusion it must be stressed that conditions for the best colour reception are even more critical than those for good monochrome reception. A roll-off of aerial response in the subchannel region will delete the colours and possibly bring on bad colour noise, while bad phase shifts, although not changing the hues due to the PAL action, will add patterns to the picture and also reduce the saturation. It is best to aim for signal at least 6dB above that required for good monochrome reception when running a colour set.

In very poor reception areas a set-side booster can often improve the overall performance but this should be designed to pass all the channels of a local group. The design should concentrate on maximum linearity to avoid crossmodulation components due to beats of the multiplicity of carriers fed to the input transistor.

Serious experimenters and all aerial installation men should be equipped with a field strength meter to measure the signal at the feeder fed to the receiver and to see the results of adjustments made to aerials and preamplifiers, for these days the a.g.c. and a.c.c. in receivers are so good that quite wide changes in signal level are not easily discernible on the picture—apart possibly from a rise in noise level as the signal is reduced. ■

DX-TV

CHARLES RAFAREL

As this is my last column for 1970 it would seem appropriate to make a summary of DX-TV conditions for the year. The past year has been a very poor one for both SpE and Tropospheric reception. The pattern of SpE reception was at least the regular one we have come to expect each year, with the first three to four months at the usual low level. We got the first good SpE openings in May—in fact they started in my area on the 1st, and the following four weeks were quite good: we seemed all set for a good season. Our hopes were somewhat dashed when the first two weeks of June proved to be poor ones again. The third one however was good but conditions dropped again in the last week.

July was a very erratic month. There were some good days but the majority were below the standard we expected and we began to realise that with the SpE season half over 1970 was certainly going to be a disappointing one. The results in August were generally mediocre and although I was away for most of September the results of other DX friends showed that this pattern continued. Since I returned to the screen at the end of September there has been comparatively little SpE and my efforts have had to be redoubled to get anything for a daily log!

Trop-wise there have been relatively few openings for the past year: there was a good one in September but as usual I missed it, being on holiday then. The others have been far from excellent.

In all, 1970 must go down in my records with the woeful distinction of being the worst for me in 10 years of DXing. So it's forward to 1971 with hope! The log for December was a struggle against adverse conditions and the signals were largely of very short duration. Some may well have been m.s. and not SpE. But here it is:

1/12/70	USSR R1, Pol/MT test card Poland or Hungary.
2/12/70	Czechoslovakia R1.
3/12/70	USSR R1.
4/12/70	Czechoslovakia R1, Spain E2.
5/12/70	USSR R1.
6/12/70	USSR R1.
7/12/70	Austria E2a.
8/12/70	USSR R1, Czechoslovakia R1.
9/12/70	USSR R1.
10/12/70	Spain E2.
11/12/70	USSR R1, Czechoslovakia R1.
12/12/70	USSR R1, Austria E2a.
13/12/70	USSR R1 and Belgium E2 (yes SpE).
14/12/70	Czechoslovakia R1.
15/12/70	Czechoslovakia R1.
16/12/70	USSR R1.
17/12/70	USSR R1.
18/12/70	USSR R1, Czechoslovakia R1.
19/12/70	USSR R1, Czechoslovakia R1, Austria E2a.
20/12/70	Sweden E2.
21/12/70	Austria E2a.
22/12/70	Czechoslovakia R1, Pol/MT test card R1 Poland or Hungary, Austria E2a, Spain E2.
23/12/70	Czechoslovakia R1, Pol/MT test card Poland or Hungary.
24/12/70	Czechoslovakia R1, Spain E2.
25/12/70	USSR R1.
26/12/70	USSR R1.
27/12/70	USSR R1.
28/12/70	Czechoslovakia R1.
29/12/70	Czechoslovakia R1.
30/12/70	Czechoslovakia R1.

The most remarkable thing here was Belgium Ruislede E2 via SpE on 13/12/70. The test card was at excellent strength for two to three minutes and this was of course extremely short-skip SpE.

The Trops have been very poor and in my area even France suffered badly with the coming of snow towards the end of the month. Belgium E2 was about earlier as a weak Trop. I go to Paris for the New Year celebrations but feel I shall not be missing good DX as I often do!

NEWS

Poland: We have been seeing captions from Poland marked "TVP 1" and this would indicate that there is now a second chain, most probably u.h.f. (like the new Czech service), but we have no news yet as to transmitters and channels. This new service should certainly be a possible here when one remembers the recent Czech reception on u.h.f. that we reported and the earlier East German u.h.f. results, so watch out for it!

France: From my own reception and other DXers' reports ORTF are still transmitting the 625-line positive test card on v.h.f. at times. No official news as yet that the first chain is going 625, but it looks as if this may well be the case.

Austria: The ORF test card has been seen on Ch.E3, I hear. This looks like a new Band I transmitter.

Once again we have news of "super DX-TV" via Roger Bunney from his contacts in the States and Thailand. First from the States Fred McCormack of Des Lacs, North Dakota, and his Trop u.h.f. opening of 19/9/70. At 09.30 local time he received WLKY-32 Louisville Indiana over 1,035 miles, and at 10.29 WKYT-27 Lexington, Kentucky over 1,105 miles, both identified by captions and subsequently confirmed by the stations concerned. These Trop u.h.f. distances must as far as I know be considerably in excess of anything achieved so far this side of the Atlantic. The second report is a TE/F2 one from Glenn Hauser in Thailand who received Aramco TV Dahran Saudi Arabia on Ch.A2 at 20.33 to 21.20 local time on 2/10/70, with test pattern and subsequent programme. Video was poor but the sound was good. He is still receiving signals from the USSR, China, India Delhi Ch.E4 and Pakistan Karachi Ch.E4, and notes that on 25/9/70 Delhi was almost "snow free".

Roger says that when you look at our logs we seem to be "just playing" at DX-TV! I think however the geographical location must be the answer. Anyway, good DX-TV for 1971!

YOUR PROBLEMS SOLVED

★ Requests for advice in dealing with servicing problems must be accompanied by a 10p (2s.) postal order (made out to IPC Magazines Ltd.) the query coupon from page 235 and a stamped, addressed envelope. We can deal with only one query at a time. We regret that we cannot supply service sheets or answer queries over the telephone.

BUSH TV56

There is no sound or vision although the raster is there all right. Before this occurred there was lack of height. The PL81 and PY81 were replaced, also the two PY82 h.t. rectifiers, and a check on the tuner unit has been carried out.—C. Garrett (Lowestoft).

We are pretty certain that the trouble you describe is due to a tuner unit fault although you should also check the i.f. stages and their voltage supplies. In the tuner, check the valves and the valvebase voltages, particularly the voltage at the screen of the PCF80 mixer. The lack of height could be due to a failing PCL83 timebase valve or a change in value of one of the resistors in this part of the circuit—say the 1MΩ resistor to pin 1 of the PCL83.

PYE V310

The sound is OK and the raster appears normally but is quite faint, building up to a good picture. I can get just enough contrast but the picture swings slowly up and down by about half an inch every 10 seconds.—G. Shaw (Keighley).

The breathing symptoms you describe suggest that there is a heater-cathode leak in the PCL82 field output valve. Also check the main and secondary smoothing.

RGD RV202

There is loss of detail in peak white parts of the scene. When the brightness control is turned up the peak white tends to go negative (i.e. grey). The set is at present working with the contrast control at the maximum setting. The video amplifier and i.f. valves have been replaced.—J. Shelton (Hayes).

These fault symptoms suggest a change in value of a component in the video stage or that the h.t. to the video anode is reduced. Check the 4·7kΩ anode load resistor R57 and the choke L47 connected across R60 (8·2kΩ) in the anode circuit. Also check the screen feed resistor R51 (3·9kΩ) to pin 9.

GEC BT304

The problem is lack of width—2in. each side. The fault developed gradually over a period of two weeks. On switching on the picture comes in to fill the screen but then immediately shrinks inwards. Operating the brilliance control makes the picture balloon. The h.t. and screen supplies to the line output valve are correct but the voltage at the tube first anode is only 300V. The line output, boost diode and e.h.t. rectifier valves, the line output transformer and most of the components associated with it have been changed.—L. Butterfield (Leamington).

If you are sure that the h.t. supply is OK and the line output valve screen feed resistor the correct value then it appears that the trouble is lack of drive to the line output valve. Check the line oscillator valve V14 (Z329), its anode load resistor R89 (150kΩ) and the coupling and charging capacitors C108 (0·01μF) and C106 (120pF).

PHILIPS G19T210A

The audio output transformer burnt out and was replaced along with the cathode components of the audio output valve. The sound is very distorted however and from time to time a 50Hz buzz on sound occurs. This can be temporarily cured by pressing the tuner unit buttons repeatedly. The fault occurs on both standards. The audio valve has been checked and found to be OK. A second fault has now developed. After about 10 minutes the picture reduces to a single spot in the centre of the screen along with complete loss of sound.—C. Baker (Barmouth).

The fact that the picture and sound both fail after about 10 minutes suggests that an h.t. dropper section is becoming open-circuit with heat. This could be the right side section of the dropper R1542 118Ω if the valves remain alight or R1541 30Ω on the left side if the valves go out. As far as the sound distortion is concerned check the PCL82 valvebase voltages. If pin 2 is higher than 15·2V check the PCL82 (again), and the coupling capacitor C2025 if you are sure that the bias resistor R2100 (470Ω) is the correct value and that its decoupler has not shorted.

GEC 2014DS-T

I have a viewable picture but cannot increase or decrease the contrast on 405 lines. The u.h.f. picture is not quite as good but I can get contrast variation on this standard.—R. Goldman (Rochester).

Check R52 (2·7MΩ) which connects from the contrast control slider at PL2-6 to the a.g.c. line at PL1-4 on the left-hand side of the i.f. printed board.

PYE V700D

The line lock is very unstable and has to be adjusted every few minutes. Alteration of the contrast or brilliance makes the picture break up. The picture tends to pull to the left, the right side becoming smeared. The sync separator and video amplifier valves have been changed without improvement. I would like to change the flywheel discriminator diodes, but these are a single unit marked R3-2D and replacements seem hard to get.—T. Dingwall (Leicester).

A frequent cause of your trouble is failure of the electrolytic which decouples the h.t. feed to this part of the circuit. This is C43, a section of the 16+16+16μF electrolytic block on the screen side of the chassis in the top corner above the PCL85. The R3-2D discriminator can be replaced by two M3 or BA155 diodes.

BUSH TV125

The sound and e.h.t. are OK but the screen is brightly illuminated and the brightness and contrast controls have no effect. In a darkened room a very faint image can be discerned. All valves have been tested by substitution.—J. Lambert (Birmingham).

The usual cause of this trouble is that the 10kΩ anode load resistor of the upper left PCF80 video amplifier valve is faulty. Check this. Alternatively the tube might be faulty, with a heater-cathode or grid-cathode short.

ULTRA 6614

There was no e.h.t. but this was restored by replacing the line output transformer. Now however although sound and vision are perfect there is almost unbearable line whistle. The transformer has been examined for security of the individual parts and appears to be satisfactory.—K. Winstone (Southall).

This problem is symptomatic of there being a large air bubble trapped in the windings during manufacture. We suggest that if your wiring to the transformer is sound you return it to the supplier for replacement under warranty.

Aerial Problem

I wish to receive Harlech TV on channel 8 from Presely, which uses horizontal polarisation, but am getting interference from RTE Leinster although these transmissions are vertically polarised. The receiver is located in S.E. Ireland. The Harlech signal is usually sufficiently strong to maintain a stable picture but when it fades the RTE signal breaks the picture up. The interference is always present as a pattern on the picture. A chimney-mounted Yagi is used and the RTE signal arrives almost broadside on to it.—S. Watfield (Willesden).

In theory because of the opposing polarity of the transmissions there should be no interference. In practice, however, the aerial can never be perfect and there is always some change in polarisation due to signal reflections from nearby objects. As Telefis lies broadside to the maximum pick-up direction for Harlech you should be able to rotate the aerial very slightly to find a perfect null in the response. If this proves impossible because of the design of the aerial —there will for example be too many pick-up nodes on a Yagi with more than six or seven elements— you should try screening the aerial from the RTE side. This screen should be of metal, mounted farther than two feet from the array, and earthed.

KB QV20

The scan lines are about ⅛in. apart and there are two images in the horizontal plane. All valves have been tested and the hold controls appear to be OK. — L. Stitchforth (Sheffield).

We suggest you check the time-constant components in the grid circuit (pin 9) of the PCF80—the line timebase blocking oscillator. These are R64 680kΩ and C58 300 pF. If necessary then check the line hold control itself, R65 500kΩ.

REGENTONE Ten-4

There is picture shrinkage on this model. When first switched on the picture goes in and out and as it warms up the margin at the bottom of the picture increases reaching a maximum value of 2in. after about an hour's use. The PCL82 field timebase valve has been changed.—H. Mole (Malvern).

First check the bias resistor to pin 2 of the PCL82, R60 330Ω, then check C51 0·01μF in the field linearity feedback network.

ULTRA 6619

There is an intermittent fault on this set—sound reduced to about half volume, usually starting with a small plop in the loudspeaker though sometimes the onset is gradual. The sound quality is not affected. Full sound can be restored by channel changing and is more frequent when the set is first switched on.— F. Daniels (Poole).

There is little doubt that the fault is due to a faulty capacitor. We suggest you change the bias electrolytic C68 and then if necessary the couplers in the audio circuit—C66, C65 and C80.

MURPHY V310

The line hold has to be readjusted every time the set is switched on. I have fitted a new PL36 in the line timebase but am a little uncertain about the line oscillator.—G. Carling (Lowestoft).

This set employed a rather unusual line timebase in which the output valve also acted as oscillator with a winding on the line output transformer connected between its screen and grid circuits to provide a blocking oscillator action. A specially selected 30P4 line output valve coded MR must be used. A PL36 will not last very long.

BAIRD 604

To improve the contrast a new PCL84 was fitted, but the effect is that the contrast appears to be too far advanced and the contrast control has no effect. The heater of the new valve heats instantly on switching the set on and the valve generally runs very hot. If I put the old PCL84 back the contrast control becomes operative again.—J. Harper (Southampton).

We feel that the bias on the PCL84 is upset. This could be due to the cathode circuit 500μF electrolytic shorting, thus shorting out the 330Ω bias resistor and over-running the valve.

PYE TV1 PIONEER

The bottom of the picture started to creep up after about half-an-hour's viewing, leaving a gap of about ½in. This was some 18 months ago. The PCL85 was replaced, also its cathode bypass electrolytic, and this appeared to solve the problem. The fault reappeared about a year ago and the PCL85 was again replaced, but the very bottom of the picture is slightly elongated. There is plenty of width but it appears that the PCL85 is being over-run.—E. Kirk (Grennock).

There are two cathode bias resistors (56 and 390Ω) in the field output stage. Check the value of these. Then ensure that the coupling capacitor C82 (0·1μF) at the anode of the triode section has no leakage.

FERGUSON 506T

The set is all right for about an hour then all of a sudden the picture goes completely—without any warning or fading away. The raster and sound remain. The vision valves have been replaced and the coil biscuit studs cleaned.—F. Rawlings (London E5).

The trouble is caused by an improper connection to the choke (an open coil) to the left of the PCL84 video amplifier. If you resolder the ends of the coil carefully you will probably find that the trouble does not recur.

GEC 2010

This set suffers from lack of height. There is a black strip at the top and bottom which gets wider as the set warms up.—G. Donfall (Cardiff).

First check the PCL85 (PCL805) field timebase valve. If this is OK check the supply to the height control from the boost h.t. line. This is via a 1·2MΩ resistor (R132) which may have gone high-resistance.

PYE V200

The trouble with this set is no vision, though the sound and raster are normal and the brightness circuit functions. All the valves have been tested and found to be OK. R13 is badly discoloured.—G. Ivall (Brentwood).

R13 is the video amplifier bias stabilising resistor and its value is 39kΩ (1W). Your problem seems likely to be in this area. Replace R13 and check its decoupler and the video output valve. Then check the vision detector diode (OA70 or OA90) inside the adjacent final i.f. transformer can—the can side slides off for servicing.

FERGUSON 3600

When there is a dark scene the sound increases in volume to twice the level and then returns to the normal level when a light scene reappears. The a.g.c. line seems to be all right because on changing channels, one of which is much stronger than the other in this area, the picture remains the same, and there is no aircraft flutter. The contrast control works normally but the local-distant control has little effect. The sync separator valve has been changed and the resistors in the a.g.c. line checked, but still the sound varies with picture content.—A. Longford (London SE4).

Replace C77, the capacitor which couples the video signal to the grid of the sync separator. This 0·1μF capacitor is probably leaky.

RGD 619

The picture is perfect for about an hour after which there are symptoms of line pulling which get worse if the set is left running. At the same time the field begins to jitter. The circle on the test card looks like a cogwheel. The sync separator and line oscillator valves have been renewed and the push-button tuner mechanism carefully adjusted and tuned.—R. Dice (Wolverhampton).

We suggest that you check R35 (27kΩ) the stabilising resistor connected from the h.t. line to the cathode of the video amplifier and R46 (120kΩ) the screen feed resistor in the sync separator circuit.

ALBA T1435

The trouble is persistent hum which is still there when the aerial is unplugged. It can sometimes be removed for a short period by rapidly manipulating the channel switching buttons.—A. Ellis (Ryde).

The two large electrolytic capacitors on the right-hand side of the chassis are joined together (common negative connection) by a thick wire which is connected to the metalwork above. If you drill a small hole in the lower chassis flange, screw an earthing tag to this and connect a stout wire from the tag to the existing earth wire of the capacitors then the hum should be eliminated.

HMV 1890

The picture is normally good. However after a few minutes the picture judders up and down giving a doube image. Manipulation of the hold controls does not cure the problem.—J. Walmsley (Preston).

As the judder occurs a little while after switching on we doubt whether the fault is a valve failure, though it would be an idea to check the field timebase valves (PCL82 and ECC82). Disconnect the v.d.r. across the primary of the field output transformer and power the receiver. If the fault has cleared (the picture height will be increased) replace the v.d.r. If not, check the insulation of the output transformer. If this is OK check the feed components from the sync separator to the field oscillator. Also check the boost capacitor (C64). If these are OK we would suspect a fault in the field scan coils.

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TELEVISION, MARCH, 1971

TEST CASE

99

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

? *The symptom on a Philips Model 1758U was line pulling at the top of the picture. The line lock was fairly strong, as also was the field lock. Subsequent examination revealed that the extent of the symptom could be altered by adjusting the level of the aerial signal. It disappeared almost completely at low input and became very severe at high input, the pulling then occurring with diminishing intensity down the field.*

Having experienced similar trouble as the result of impaired sync separator action, the separator letting through a degree of picture signal along with the sync pulses, attention was first directed to this area of the circuit. The valve was changed and the critical components tested for value and insulation resistance, but no fault was evident.

Examination of a test card under the fault condition revealed ringing effects on the frequency gratings, so it was thought that perhaps the vision i.f. had drifted in alignment due to a valve or capacitor fault. A quick check of the valves—by substituting a test set known to be in good condition—and of the alignment indicated however that all was well in the i.f. channel.

What important part of the circuit had been overlooked? See next month's TELEVISION *for the answer and for a further item in the Test Case series.*

SOLUTION TO TEST CASE 98

Page 186 (last month)

The vision overload symptom of last month is typical of so-called lock-out. It will be recalled that it was present only on the 625-line standard. The a.g.c. system of many valve sets is of the mean-level type, the control potential being obtained from the grid of the sync separator valve. Towards peak modulation on 625 lines the transmitted scene is dark (opposite to 405 lines) and although the d.c. component of the signal will be relatively high under this condition the average a.c. component is low. Thus the a.g.c. bias is reduced and the gain of the i.f. channel is enhanced. This can result in the sync pulses being clipped and the lock-out condition holding the gain high irrespective of the setting of the contrast control.

To avoid this many dual-standard sets incorporate an anti-lock-out diode connected between the 625-line detector output and the a.g.c. line. This tends to conduct when the detector output is high and the a.g.c. bias low, thereby providing a bias which supplements that from the sync separator. In this way the onset of lock-out is avoided. The anti-lock-out diode in the receiver of last month's Test Case was open-circuit and a replacement completely cured the trouble.

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