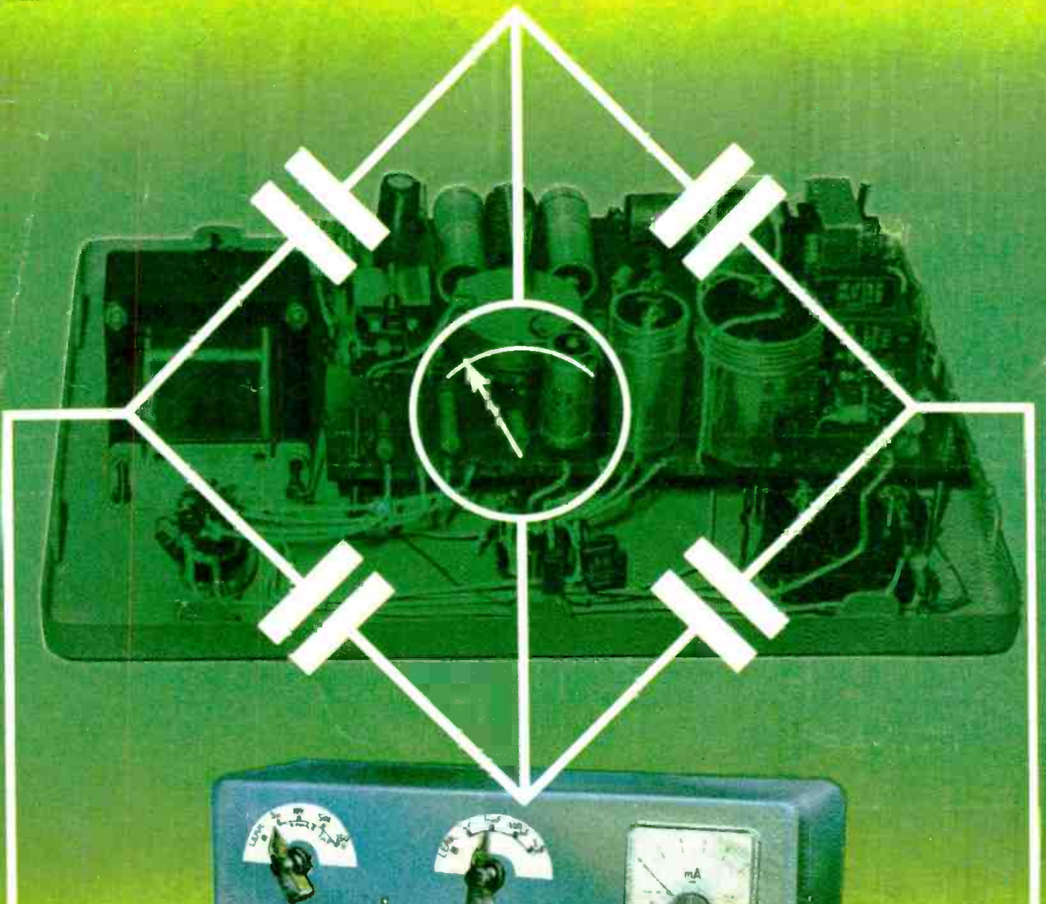
PRACTICAL
TELEVISION
3/0
FEBRUARY
1970

CAPACITOR TESTER



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1FD1	6/6
1FD9	4/3
1G6	6/-
1H5GT	7/-
1L4	2/6
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1LN5	8/-
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6/30L2	12/6
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6BQ5	4/9
6BQ7A	7/-
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6BS7	16/6
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6BZ6	6/-
6C6	3/9
6C9	14/6
6CD6G	19/6
6CH6	6/-
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6CW4	12/-
6D3	7/6
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6F1	8/9
6F6	12/6
6F6G	4/-
6F12	3/3
6F13	3/6
6F15	10/-
6F18	7/6
6F23	13/3
6F24	11/9
6F25	13/-
6F28	14/-
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6G6G	2/6
6H6GT	1/9
6J5G	3/9
6J6	3/-
6J7G	4/9
6J7GT	6/6
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6K7GT	4/6
6L1	19/6
6L6GT	7/9
6L7GT	12/6
6L18	6/-
6L19	19/-
6LD20	9/6
6N7GT	6/6
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6P25	12/-
6P26	12/-
6P28	25/-
6Q7	8/6
6Q7G	6/-
6R7	11/-
6R7G	7/-
6SA7GT	7/-
6SC7GT	6/6
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6SH7	3/-
6SJ7	6/6
6SK7GT	4/6
6SQ7GT	7/6
6U4GT	12/-
6U7G	7/-
6V6G	3/6
6X4	4/3
6X5GT	5/-
6Y7G	12/6
7B6	10/9
7B7	7/-
7C6	6/-
7F8	12/6
7H7	5/6
7R7	12/-
7V7	5/-
7Y4	6/6
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10C1	12/6
10C2	10/-
10D1	8/-
10D2	14/7
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12AC6	7/-
12AD6	6/-
12AE6	7/6
12AT6	4/6
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12AU7	4/6
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12AX7	4/6
12AY7	9/9
12BA6	6/-
12BE6	5/9
12BH7	6/-
12E1	17/-
12J7GT	6/6
12K5	10/-
12K7GT	5/9
12Q7GT	4/6
12SA7GT	6/9
12SC7	4/-
12SG7	3/-
12SH7	3/-
12SJ7	4/6
12SK7	4/9
12SQ7GT	7/6
14H7	9/6
14S7	15/-
18	12/6
19AQ5	4/9
19H1	40/-
20D1	13/-
20D4	20/5
20F2	14/-
20L1	13/-
20P1	17/6
20P3	18/-
20P4	18/6
20P5	18/-
25L6GT	5/6
25Y5	6/-
25Y5G	8/6
25Z4G	6/-
25Z5	7/-
25Z6G	8/6
30C1	6/6
30C15	13/-
30C17	16/-
30C18	11/6
30F5	16/-
30FL1	15/-
30FL12	16/-
30FL14	12/6
30L1	8/3
30L15	13/9
30L17	15/6
30P4	12/-
30P4MR	17/6
30P12	13/9
30P19	12/-
30PL1	15/-
30PL13	15/6
30PL14	15/-
30PL15	15/-
35A3	9/-
35A5	15/-
35D5	12/6
35L6GT	8/6
35W4	4/6
35Z3	10/-
35Z4GT	4/9
35Z5GT	6/-
50B5	6/3
50C5	6/3
50CD6G	43/3
50L6GT	9/-
72	6/6
85A2	8/6
85A3	8/-
90AG	67/6
90AV	67/6
90CG	34/-
90CV	33/6
90C1	16/-
150B2	14/6
150C2	5/9
301	20/-
302	16/6
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306	13/-
807	11/9
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7475	4/-
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A3042	15/-
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AC2PEN/DD	19/6
AC6PEN	4/9
AC/PEN (5)	19/6
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AC/TH1	10/-
AC/TP	19/6
AC/VP2	10/6
AL60	15/6
ARP3	7/-
ATP4	2/3
AZ1	8/-
AZ31	9/6
AZ41	7/6
B36	6/6
BL63	10/-
CL33	18/6
CV6	10/6
CY1C	10/6
CY31	7/6
D63	5/-
D77	2/3
DAC32	7/-
DAF91	4/3
DAF96	6/6
DCC90	10/-
DD4	10/6
DF33	7/9
DF91	2/9
DF96	6/6
DF97	10/-
DH63	6/-
DH76	4/6
DH77	4/-
DH81	10/9
DH101	25/-
DH107	17/11
DK32	7/3
DK40	10/-
DK91	5/6
DK92	9/-
DK96	7/-
DL33	6/-
DL35	4/9
DL92	5/9
DL94	5/9
DL96	7/-
DL810	9/6
DM70	6/-
DM71	7/6
DW4/350	8/6
DW4/500	8/6
DY86	5/9
DY87	5/9
E80F	24/-
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E88CC	12/-
E180F	17/6
E1148	10/6
EA50	1/6
EA76	13/-
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EAC91	3/-
EAF42	8/9
EB34	7/6
EB41	4/6
EB91	2/3
EBC41	9/6
EBC81	5/9
EBC90	4/-
EBC91	5/6
EBF80	6/9
EBF83	8/-
EBF89	6/3
EBL21	11/-
EC53	12/6
EC54	6/-
EC70	4/9
EC86	12/6
EC88	12/-
EC92	6/6
ECC31	15/6
ECC32	4/6
ECC33	31/6
ECC34	29/6
ECC40	9/6
ECC81	3/9
ECC82	4/6
ECC83	4/6
ECC84	5/6
ECC85	5/6
ECC86	8/-
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ECC189	9/6
ECC804	12/6
ECC807	27/-
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ECF82	6/6
ECF86	9/-
ECF804	42/-
ECH21	12/6
ECH35	5/9
ECH42	10/-
ECH81	5/9
ECH83	8/-
ECH84	7/6
ECL80	6/6
ECL82	6/-
ECL83	9/-
ECL84	12/-
ECL85	11/-
ECL86	8/-
ECLL800	30/-
EF22	12/6
EF36	3/6
EF37A	7/-
EF39	5/-
EF40	8/9
EF41	10/-
EF42	3/6
EF54	10/-
EF73	6/6
EF80	4/6
EF83	9/6
EF85	5/3
EF86	6/3
EF89	5/-
EF91	3/3
EF92	2/6
EF97	10/-
EF98	10/6
EF183	6/-
EF184	6/-
EFP60	10/-
EH90	7/6
EL32	3/6
EL33	12/-
EL34	9/6
EL37	17/3
EL41	10/3
EL42	9/9
EL81	8/-
EL83	6/9
EL84	4/9
EL85	7/6
EL86	8/-
EL91	2/6
EL95	5/3
EM71	14/-
EM80	7/-
EM81	7/6
EM84	6/6
EM85	11/-
EM87	7/6
EY51	7/6
EY81	7/-
EY83	8/3
EY84	7/6
EY86	6/6
EY87	6/6
EY88	7/6
EY91	3/-
EZ35	5/-
EZ40	7/6
EZ41	8/6
EZ80	4/6
EZ81	4/9
EZ90	4/3
FW4/500	6/6
FW4/800	10/-
GZ30	7/-
GZ32	9/-
GZ33	12/6
GZ34	10/-
GZ37	14/6
HABC80	8/-
HL41DD	19/6
HL42DD	8/-
HN309	27/4
HVR2	8/9
HVR2A	8/9
IW3	5/6
IW4/350	5/6
IW4/500	6/-
KT2	5/-
KT8	34/6
KT41	19/6
KT44	20/-
KT61	12/-
KT63	4/-
KT66	17/3
KT74	12/6
KT76	12/6
KT88	29/-
KTW61	8/6
KTW62	10/-
KTW63	5/9
L63	3/9
LN152	6/6
LN309	9/-
LN319	15/-
LN339	15/-
LZ329	6/6
ME1400	14/9
MHL4	12/6
MHLD6	7/6
MU12/14	4/-
MX40	12/6
N78	40/3
N108	27/10
N308	17/6
N339	25/-
P61	2/6
PABC80	7/3
PC86	10/3
PC88	10/3
PC95	8/3
PC97	8/6
PC900	8/3
PCC84	6/3
PCC85	6/6
PCC88	9/9
PCC89	9/6
PCC189	10/6
PCF80	6/6
PCF82	6/3
PCF84	8/-
PCF86	9/-
PCF801	7/-
PCF802	9/-
PCF805	11/6
PCF806	11/6
PCF808	12/6
PCL82	7/-
PCL83	9/-
PCL84	7/6
PCL85	9/-
PCL86	8/6
PCL88	15/-
PEN36C	15/-
PEN45	7/-
PEN45DD	12/-
PEN46	4/-
PEN453DD	19/6
PENA4	19/6
PEN/DD 4020	17/6
PFL200	12/6
PL33	19/6
PL36	9/6
PL81	7/3
PL81A	10/6
PL82	6/6
PL83	6/6
PL84	6/6
PL302	12/-
PL500	13/-
PL504	13/6
PL508	27/10
PL509	28/9
PL802	15/-
PM84	7/9
PX4	14/-
PY32	10/-
PY33	10/-
PY80	6/-
PY81	5/3
PY82	5/-
PY83	5/9
PY88	6/9
PY301	12/6
PY800	7/6
PY801	6/9
PZ30	9/6
QQVO3/10	27/6
QS75/20	10/6
QS150/15	9/6
QVO4/7	8/-
R10	15/-
R11	19/6
R16	34/11
R17	17/6
R18	9/6
R19	6/6
R20	11/9
R52	7/6
RK34	7/6
SP42	12/6
SP61	3/3
TH4B	10/-
TH233	7/-
TP2620	8/9
UABC80	6/-
UAF42	9/6
UB41	6/6
UBC41	8/6
UBC81	7/-
UBF80	5/9
UBF89	6/9
UBL21	9/-
UC92	5/6
UCC84	8/-
UCC85	6/9
UCF80	8/3
UCH21	9/-
UCH42	13/-
UCH81	6/6
UCL82	7/-
UCL83	10/-
UF41	10/-
UF42	9/-
UF80	6/9
UF85	6/9
UF86	9/-
UF89	6/9
UL41	10/6
UL46	12/6
UL84	6/6
UM80	6/6
UR1C	10/6
UU5	7/-
UU8	14/-
UU9	7/3
UU12	4/9
UY1N	9/-
UY21	9/6
UY41	7/-
UY85	5/9
U10	9/-
U12/14	7/6
U16	15/-
U17	5/-
U18/20	10/-
U19	34/6
U22	7/9
U25	13/-
U26	11/9
U31	6/-
U33	29/6
U35	16/6
U37	34/11
U45	15/6
U47	13/-
U49	11/9
U50	5/6
U52	4/9
U76	4/9
U78	4/3
U107	18/3
U191	12/6
U251	14/6
U281	8/-
U282	8/-
U301	11/-
U329	14/6
U403	6/6
U404	7/6
U801	19/6
U4020	6/9
VP4B	10/6
VP13C	7/-
VP41	7/6
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VR105	5/-
VR150	5/-
VT61A	7/-
VU111	7/3
VU120	12/-
VU120A	12/-
VU133	7/-
W76	5/9
W101	26/2
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W729	10/-
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X61	5/9
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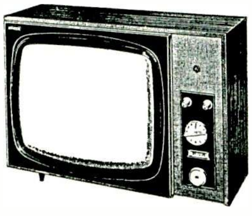

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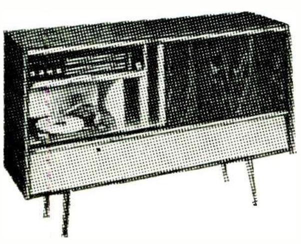

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1H5GT	7/3	19BG6G	17/6	DK96	7/3	EL33	8/9	PCL83	10/-	UC92	5/-
1N5GT	7/9	20F2	13/6	DL35	5/-	EL34	9/6	PCL84	7/6	UCC84	7/-
1R5	5/9	20P3	11/9	DL92	5/9	EL41	11/-	PCL85	9/-	UCC85	7/3
1S5	4/3	20P4	18/6	DL94	6/-	EL84	4/9	PCL86	8/3	UCF80	7/3
1T4	2/9	25L6GT	5/-	DL96	7/3	EL90	4/6	PENA4	12/6	UCH42	12/-
3S4	5/9	25U4GT	11/6	DY86	5/9	EL500	12/6	PFL200	11/9	UCH81	6/3
3V4	6/-	30C1	6/6	DY87	5/9	EM80	7/6	PL36	9/9	UCL82	7/-
5Y3GT	5/9	30C15	13/-	EABC80	6/6	EM81	7/6	PL81	7/9	UCL83	11/6
5Z4G	7/6	30C17	16/-	EAF42	10/-	EM84	6/9	PL82	6/6	UF41	10/6
6/30L2	12/-	30C18	14/-	EB91	2/3	EM87	7/6	PL83	6/6	UF80	7/-
6AL5	2/3	30F5	16/-	EBC33	8/-	EY51	7/6	PL84	6/6	UF85	6/9
6AM6	2/9	30FL1	13/9	EBC41	9/6	EY86	6/6	PL500	13/-	UF89	6/9
6AQ5	4/6	30FL12	14/6	EBF80	6/9	EZ40	8/-	PL504	13/6	UL41	10/9
6AT6	4/-	30FL14	14/9	EBF89	6/3	EZ41	8/-	PL508	23/6	UL44	20/-
6AU6	4/6	30L1	6/6	ECC81	3/9	EZ80	4/6	PM84	7/6	UL84	7/-
6BA6	4/6	30L15	14/-	ECC82	4/9	EZ81	4/9	PX25	10/6	UM84	6/6
6BE6	4/9	30L17	15/6	ECC83	7/-	GZ32	8/9	PY32	10/-	UY41	7/6
6BJ6	8/6	30P4	12/-	ECC85	5/-	GZ34	9/9	PY33	10/-	UY85	5/9
6BW6	13/-	30P12	13/9	ECC91	3/-	KT61	8/9	PY81	5/3	VP4B	10/-
6F13	3/6	30P19	12/-	ECC804	12/-	KT66	16/-	PY82	5/3	W119	7/-
6F14	9/-	30PL1	13/9	ECF80	6/6	N78	17/6	PY83	5/9	Z77	2/9
6F23	14/3	30PL13	15/6	ECF82	5/9	PABC80	7/-	PY88	6/9		
6F25	13/-	30PL14	15/6	ECH35	6/-	PC86	10/3	PY800	7/6	**Transistors**	
6J6	3/-	35L6GT	8/6	ECH42	13/6	PC88	10/3	PY801	6/9	AC107	3/6
6K7G	2/6	35W4	4/6	ECH81	5/9	PC96	8/6	R19	6/6	AC127	2/6
6K8G	2/9	35Z4GT	5/-	ECH83	8/3	PC97	8/6	R20	12/6	AD140	7/6
6L18	6/-	6063	12/6	ECH84	7/6	PC900	7/6	U25	13/-	AF115	3/-
6SN7GT	4/3	AC/VP2	10/-	ECL80	7/-	PCC84	6/6	U26	12/-	AF116	3/-
6V6G	3/3	AZ31	9/6	ECL82	6/9	PCC85	6/-	U47	13/6	AF117	3/3
6V6GT	6/6	B729	12/6	ECL83	8/6	PCC88	9/-	U49	13/6	AF125	3/6
6X4	4/3	CCH35	13/6	ECL86	8/-	PCC89	10/6	U78	4/3	AF127	3/6
6X5GT	5/9	CL33	18/6	EF37A	6/6	PCC189	11/6	U191	12/6	OC44	2/3
7B7	7/-	CY31	6/9	EF39	4/9	PCF80	6/6	U193	8/6	OC45	2/3
7C6	6/9	DAC32	7/3	EF41	10/9	PCF82	6/6	U251	14/6	OC71	2/6
10F1	14/-	DAF91	4/3	EF80	4/6	PCF86	11/6	U301	10/6	OC72	2/6
10F18	7/-	DAF96	7/3	EF85	5/3	PCF200	13/6	U329	14/6	OC75	2/6
10P13	15/6	DF33	7/9	EF86	6/3	PCF800	13/6	U801	19/6	OC81	2/3
12AT7	3/9	DF91	2/9	EF89	5/3	PCF801	6/9	UABC80	6/6	OC81D	2/3
12AU6	4/9	DF96	7/3	EF91	2/9	PCF802	9/-	UAF42	10/3	OC82	2/3
12AU7	4/9	DH77	4/-	EF94	4/6	PCF805	14/-	UB41	6/6	OC82D	2/6
12AX7	4/9	DK32	7/6	EF183	5/9	PCF808	14/9	UBC41	9/-	OC170	2/6

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ESSEX. Tel. 01-550 7441

Postage on 1 valve 9d. extra. On 2 valves or more, postage 6d. per valve extra. Any Parcel Insured against Damage in Transit 6d. extra.

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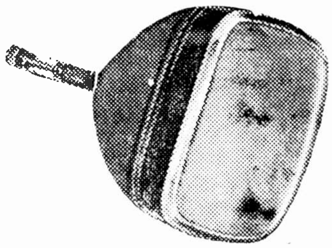

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- ★ Each tube is rebuilt with a completely new gun assembly **and** the correct voltage heater.
- ★ Each tube comes to you with a guarantee card covering it for two years against all but breakage.
- ★ Each tube is delivered **free** anywhere in the U.K. and insured on the journey.
- ★ Each tube is rebuilt with experience and know-how. We were amongst the very first to pioneer the technique of rebuilding television tubes.

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Tel. 01-689/7735

Please note: Components are sold in packs, quantities per pack are shown under each heading. Prices are per piece of each value.

TUBULAR CAPACITORS (3's)

·001	400v.	8d.
·0022	600v.	8d.
·0033	600/1500v.	8d.
·0047	600/1500v.	8d.
·01	400v.	8d.
·022	600v.	8d.
·033	600v.	9d.
·047	600v.	9d.
·1	600v.	10d.
·22	600v.	1/8d.
·47	600v.	2/3d.
·01	1000v.	1/1d.
·022	1000v.	1/1d.
·047	1000v.	1/6d.
·1	1000v.	1/6d.
·22	1000v.	2/3d.
·47	1000v.	3/3d.
·001	1500v.	1/6d.

WIRE-WOUND RESISTORS (3's)

10 watt rating, suitable for mains dropper sections.

1	Ohm	1/9d.
10	Ohms	1/9d.
13	,,	1/9d.
25	,,	1/9d.
33	,,	1/9d.
50	,,	1/9d.
87	,,	1/9d.
100	,,	1/9d.
150	,,	1/9d.
220	,,	1/9d.
330	,,	1/9d.
1K	,,	1/9d.
2·2K	,,	1/9d.
3·3K	,,	1/9d.
4·7K	,,	1/9d.

PULSE CERAMICS (3's) 12KV

100pf	22pf	1/1d.
120pf	47pf	1/1d.
180pf	68pf	1/1d.
250pf		1/1d.

Tubular type for use in Scan correction circuits and Line Outputs.

CERAMICS (6's)

500pf	8d.
680pf	8d.
820pf	8d.
1000pf	8d.
1500pf	8d.
3000pf	8d.
5000pf	8d.

RECTIFIERS

Silicon Mains (3's)

Westinghouse S10AR2	6/6d.
BY127 Mullard	5/3d.
BY105 Mazda	7/0d.
BY327	5/6d.

CONTACT COOLED FULL WAVE

75ma	12/8d.
100ma	13/8d.
150ma	16/8d.

CO-AXIAL PLUGS

Bakelite top	10d.
Egen metal	1/4d.
Single point (car radio)	2/0d.

SLIDER PRE-SETS (3's)

100K	1/6d.
1 Meg	1/6d.
2·2 Meg	1/6d.

JACK PLUGS

Chrome standard	4/0d.
Standard	3/0d.
3·5mm. metal	3/0d.

DIN PLUGS (3's)

3-pin	1/10d.
5-pin	2/2d.
Sockets	1/0d.

BIAS ELECTROLYTICS (3's)

25mfd	25v.	1/4d.
50mfd	25v.	1/6d.
100mfd	25v.	1/9d.
250mfd	25v.	2/8d.
500mfd	25v.	2/8d.
1000mfd	12v.	5/0d.
1000mfd	30v.	4/9d.
2000mfd	25v.	6/0d.
2500mfd	30v.	8/0d.
3000mfd	30v.	8/6d.
5000mfd	30v.	9/3d.
25mfd	50v.	1/7d.
50mfd	50v.	1/10d.
100mfd	50v.	2/3d.
250mfd	50v.	3/4d.
500mfd	50v.	4/0d.
2000mfd	50v.	8/0d.
2500mfd	50v.	9/6d.

SMOOTHING ELECTROLYTICS

Wire ended, 450v. working.

1mfd	1/3d.
2mfd	1/4d.
4mfd	2/0d.
8mfd	2/4d.
16mfd	3/0d.
32mfd	4/2d.
50mfd	4/8d.
8/8mfd	3/6d.
8/16mfd	4/8d.
16/16mfd	4/6d.
16/32mfd	5/0d.
32/32mfd	4/9d.
50/50mfd	7/0d.
50/50/50mfd	8/0d.

CANNED ELECTROLYTICS

100/200mfd	10/6d.
100/400mfd	14/0d.
200/200mfd	15/0d.
200/200/100mfd	18/6d.
200/400/32mfd	15/6d.
100/300/100/16	16/6d.
100/400/32mfd	15/6d.
100/400/64/16	18/6d.

SKELETON PRE-SETS (3's)

25K	Vertical	1/4d.
50K	,,	1/4d.
100K	,,	1/4d.
250K	,,	1/4d.
500K	,,	1/4d.
1 meg	,,	1/4d.
2 meg	,,	1/4d.
500K	Horizontal	1/4d.
680K	,,	1/4d.
1 meg	,,	1/4d.

CARBON FILM RESISTORS

½ watt and 1 watt.

The following values are packed in cartons of *six of each value.* Price 2/6d. per carton.

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 and 1 watt versions.

***Special for Philips TV's:**

8·2M 2-watt, 4/6d. per pack.

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SUB-MINIATURE ELECTROLYTICS (3's)

1mfd	18v.	1/6d.
2mfd	18v.	1/6d.
4mfd	18v.	1/6d.
5mfd	18v.	1/6d.
8mfd	18v.	1/6d.
10mfd	18v.	1/6d.
16mfd	18v.	1/6d.
25mfd	18v.	1/6d.
32mfd	18v.	1/6d.
50mfd	18v.	1/8d.
100mfd	18v.	1/8d.
200mfd	18v.	2/0d.

THERMISTORS (3's)

Miniature	1/6d.
TH1	2/4d.

RADIO/TV GLASS FUSES

1 amp, 1·5 amp, 2 amp, 3 amp.
Per dozen 3/0d.

MAINS FUSES

2 amp, 3 amp, 5 amp, 13 amp.
Per dozen 5/0d.

TERMINAL STRIPS

2 amp	2/3d.
5 amp	2/10d.
15 amp	5/9d.

DOUBLE DIODE RECTIFIERS (3's)

Bush/Murphy/BRC etc.
Line/frame timebases etc.

3 leg	6/3d.
4 leg	6/3d.
5 leg	6/3d.

VOLUME CONTROLS

Standard spindle with flat.

Double pole switch	4/0d.
Without switch	3/0d.

(One per pack)

5K, 10K, 25K, 50K, 100K, 250K, 500K, 1 meg, 2 meg.

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RECORD PLAYER CARTRIDGES

ACOS: GP67/2g.	High gain general purpose Mono	16/8d.
GP91/SC.	Stereo-compatible replacement	22/0d.
GP91/3SC.	High gain version of above	22/0d.
GP94/1SS.	Stereo cartridge	37/9d.

GENERAL PURPOSE REPLACEMENT FOR TC8's etc.

High gain, plenty of output (Jap.)	19/10d.
Stereo version	37/9d.

SERVISOL AND ELECTROLUBE PRODUCTS (Nett trade)

Servisol aerosol can	12/6d. nett
Electrolube 2AX aerosol	14/0d. nett
Servisol Freezit	9/6d. nett
Electrolube No. 1 Snorkel	18/0d. nett
Electrolube 2GX Grease	8/4d. nett
Servisol Aero-Clene for tape heads	10/6d. nett
Servisol Aero-Duster	10/6d. nett

REPLACEMENT STYLI

TC8	4/6d.
GC8	4/6d.

RADIO AND TELEVISION VALVES

British made valves normally supplied.

DY86/7	9/1	EY86/7	9/1	PCL86	11/4
DY802	9/1	EZ80	10/10	PD500	31/7
EABC80	12/8	EZ81	8/2	PFL200	15/9
EB91	8/2	EZ90	9/3	PL36	13/7
EBC90	10/10	GZ34	13/7	PL81	11/4
EBF80	10/10	GY501	15/9	PL81A	14/6
EBF89	10/10	PC86	12/6	PL82	10/10
ECC81	10/0	PC88	12/8	PL83	13/8
ECC82	10/0	PC97	9/1	PL84	8/7
ECC83	10/0	PC900	12/8	PL302	13/7
ECC804	15/4	PCC84	10/0	PL504	18/1
ECH81	14/6	PCC88	16/8	PL508	20/4
ECH84	12/8	PCC89	13/7	PL509	31/7
ECL80	9/6	PCC189	13/7	PY33	12/2
ECL82	12/8	PCC806	15/9	PY81	9/0
ECL83	13/4	PCF80	11/4	PY800	9/0
ECL84	11/4	PCF86	13/7	PY801	9/0
ECL86	12/8	PCF87	18/1	PY82	8/4
EF80	9/6	PCF801	13/7	PY83	13/7
EF85	12/8	PCF802	13/7	PY500	20/4
EF86	16/4	PCF805	14/11	UABC80	13/7
EF89	10/10	PCF806	13/7	UCH81	13/7
EF183	12/8	PCF808	14/11	UCL82	12/8
EF184	12/8	PCL82	11/4	UCL83	14/6
EH90	13/7	PCL83	13/4	UL41	14/6
EL34	10/0	PCL84	11/4	UL84	12/8
EY51	13/7	PCL85	11/4	UY85	9/0

ALL MAZDA/BRIMAR TYPES IN STOCK.

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All orders must exceed 50/0d. in value otherwise postage and packing will be charged at 5/0d. per invoice. Components must be ordered in multiples as packed.

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PRACTICAL
TELEVISION

VOL 20 No 5
ISSUE 233

FEBRUARY 1970

WISHFUL THINKING

HERE we are, taking the first steps into the brand new year of 1970, the start of a new decade. How is it going to turn out for us enthusiasts of television?

Although many of the signs point to obvious trends and developments it is more fun to ponder on what we would *like* to see rather than what we *expect* to happen. So here is a short starter list to get things going.

To set makers: we hope that the development costs of getting colour TV production lines moving have still left enough in the sock to think about producing one or two true portables. So far it has been left to a competitor from Japan to make the running. Surely such a product would be worth while from the sales point of view.

To the BBC and ITA: hats off to the engineering divisions of both organisations, nothing here but unstinted praise. The programme planners are another story. In our naive way we still think that BBC-1, BBC-2 and ITA should provide *alternative* services. What happens more often than not is throat cutting competition in which the viewer suffers. As an example, most viewers have their own preferences for certain *types* of programme—be it comedy, drama, current affairs, etc.—yet we have the common instances of even BBC-1 and BBC-2 showing similar *types* of programme simultaneously so that viewers preferring that kind of entertainment have their quota cut by half. More co-ordination, that's what we want.

To the Government: two simple requests—ease off the HP restrictions and the crippling deposits on colour TV hire.

To retailers: if you have no colour sets, get 'em. If you have them, read the convergence instructions in the manuals and place the sets where people can see a decent picture.

To readers: No complaints here, we'd just like to see more of you!

W. N. STEVENS, *Editor*

THIS MONTH

THE NEXT ISSUE DATED MARCH WILL BE PUBLISHED FEBRUARY 20

Prices are those current as we go to press. All correspondence intended for the Editor should be addressed to Fleetway House, Farringdon Street, London, E.C.4. Address correspondence regarding advertisements to Advertisement Manager, Fleetway House, Farringdon Street, London, E.C.4. Address enquiries about back numbers to Back Numbers Dept., Carlton House, Great Queen Street, London, W.C.2.

TELETOPICS

COLOUR TV DELIVERIES BUILDING UP

Although deliveries during September of 17,000 colour television sets, compared with 10,000 last year, show the first indication of the expected increase in deliveries to the trade, the effect of the poor first half-year still leaves deliveries 13% down on the first nine months as a whole compared with 1968, according to the Economic and Statistical Division of BREMA.

Monochrome deliveries are maintaining a rate at an overall level just below that of last year, although figures for the third quarter (347,000) are 16% below the same period in 1968 (414,000).

There have been reports of shortages of colour TV sets in various parts of the country. Production at present is estimated to be running at about 6,000 sets a week and is expected to rise. Many setmakers however are complaining of a shortage of essential components—a general complaint in Europe and the USA at present.

JAPANESE COLOUR TV PRODUCTION

There was a sharp increase—70% up during 1969 compared to the previous year—in colour TV set production in Japan, and it is expected that total for the year will rise to four million. As a result of this all main Japanese tube producers are at present planning to increase their production of colour tubes.

NEW AEROSOLS

Electrolube Ltd. has introduced a new silicone grease, Electrolube SG-4, in 12oz. aerosol form. It is heat-resistant and highly water-repellent and applications include moisture-proofing electrical systems, preventing corona discharge and protecting insulation against such discharge. Each aerosol costs 9s. 9d.

A range of five new aerosols has been introduced by Altham Electronics Ltd., Victoria Mill, Pollard Street, Manchester 4. EHT Seela is a waterproof, heat-resistant insulator with dielectric strength in excess of 20 kV, for use with e.h.t. transformers and h.t. circuits generally, to prevent shorting after soldering on printed circuits and as a core locking compound. It is also useful for weatherproofing TV aerial feeder connections and as an anti-rust, anti-tarnishing agent. Trade price is 10s. 6d. Kontact Kleena is a highly penetrating cleaning and degreasing agent with anti-static properties, trade price 7s. Freeza is an instant cooling spray for locating intermittent component faults and protecting transistors when soldering, trade price 9s. 6d. Dusta removes dirt from inaccessible places in electronic and electro-mechanical equipment, trade price 9s. 6d. Golden Disc is an anti-static gramophone record cleaner, trade price 5s. 3d.

VIDEOCASSETTE PLAYER FROM SONY

Sony are planning to introduce a new videocassette player which will reproduce videocassette recorded programmes in colour or black-and-white with high fidelity sound. It is hoped to introduce the player late this year at a retail price in the range $265-280 in Japan and about $350 for export. The playback time is about 90 minutes using magnetic tape that can be re-recorded some 100 times. A separate adapter is planned to enable broadcasts to be recorded off-air. The cassette can be stopped and removed in mid-programme. Sony envisage commercial firms providing recordings on the "pay-TV" principle. For this the cassette would have a built-in counter to record the number of times the cassette is played. The export price of the off-air recording adaptor would be about $100. The horizontal resolution is about 300 lines on monochrome and 200 lines on colour.

FRENCH COMPETITOR TO THE SHADOWMASK TUBE?

Following their previous acquisition of Société France-Coulers which is developing a new grill-type colour tube as a rival to the shadowmask tube, Thomson-CSF is to acquire control of CIFTE, a black-and-white tube manufacturer. Plans are under consideration to produce the new colour tube at the rate of 250,000 a year. The tube has been under study in the USSR, where over 1,000 of the new tubes have been produced at a pilot plant.

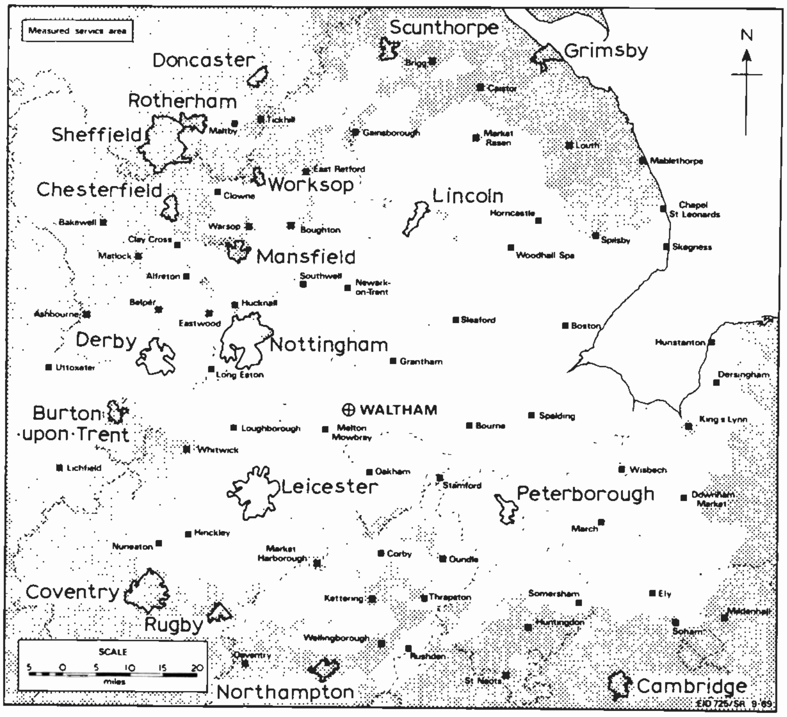
NEW FROM BELLING-LEE

The Harrier transistorised broadband amplifier is announced by Belling and Lee Ltd., Gt. Cambridge Road, Enfield, Middx. The amplifier provides six outlets at a nominal gain of 6dB each from a single aerial input and covers Bands I, II, III, IV and V. Belling and Lee have also introduced a new range of coaxial cables for TV line distribution systems.

The new broadband amplifier uses silicon planar transistors which are less prone to cross-modulation than the germanium transistors used in earlier designs. Cross-modulation has become more noticeable since the introduction of the additional u.h.f. channels.

NEWS FROM THE BBC

The approximate service area of the **Waltham** u.h.f. transmitter is shown in the accompanying map. The BBC-2 service is on channel 64, horizontally polarised. Use a group C aerial. Maximum vision e.r.p. is 250kW. BBC-1 will be on channel 58 and ITA on channel 61.



BBC-2 from **Bilsdale,** Yorkshire, started on November 24th on channel 26 with horizontal polarisation. The other channels assigned to the station are 23, 29 and 33, and a group A aerial should be used.

BBC-2 from **Mendip** started on December 1st on channel 64 (group C aerial) with horizontal polarisation. The other channels assigned to this transmitter are 54, 58 and 61. A relay station at Ilchester Crescent serves **South Bristol,** transmitting on channel 46 with vertical polarisation (group B aerial). The other channels assigned to this station are 40, 43 and 50. A further relay station to serve **Bath** will open shortly.

It is planned to start transmitting BBC-1 on u.h.f. from the relay stations at High Wycombe, Hertford, Guildford and Tunbridge Wells in early 1970, followed by Reigate and Hemel Hempstead.

The BBC-1 colour u.h.f. service from **Black Hill,** Central Scotland, started on December 13th on channel 40 with horizontal polarisation.

COLOUR TUBE TYPE RATIONALISATION

Following the merging of the Mazda and RCA colour tube production interests in the UK into Thorn Colour Tubes Ltd., the sale of RCA colour tubes in the UK has now been discontinued and all tubes made by Thorn Colour Tubes for domestic receivers will be sold under the Mazda brand name. At the time of the merger the RCA range consisted of nine types and the Mazda range of four types, with RCA using Pro Electron nomenclature (A63-16X etc.) and Mazda their own nomenclature (CTA2550 etc.). This combined range of 13 types has now been reduced to four and the Mazda nomenclature discontinued. The new range is as follows: A49-11X 19in. Rim I: replaces A49-15X, A49-18X, CTA1950. A49-191X 19in. Rim III: replaces A49-120X, A49-200X, CTA1951. A55-14X 22in. Rim III: replaces A55-141X, CTA2250. A63-11X 25in. Rim I: replaces A63-13X, A63-16X, A63-17X, CTA2550.

GDS 700V 6A TRANSISTOR

GDS (Sales) Ltd. announce that they can now supply the Motorola MJ9000 power transistor which features 700V *V*ces and 325V *V*ceo ratings, $1{\cdot}1\mu$sec maximum fall time and 2V maximum *V*sat, both measured at 6A collector current. The transistor is capable of carrying up to 10A continuous *I*c. Also announced is the Motorola MJ8400 which is rated at 1400V *V*ces and 600V *V*ceo, with $1{\cdot}1\mu$sec maximum fall time at 3A. Both transistors are ideally suited for use in c.r.t. deflection systems including colour TV and radar displays.

CASSETTE VIDEOTAPE RECORDER

The development of a casette videotape recorder capable of recording and playing back through a TV receiver both black-and-white and colour programme material is being undertaken by the Philips group in co-operation with Sony and Grundig. A prototype has been built and a tentative date of some time in 1972 suggested for the availability of the recorder in the shops. It is intended that the machine will be about the size of current sound recorders while the cassettes will be roughly the size of a paperback book.

LATEST ITA TRANSMITTERS

The ITA u.h.f. transmitters at **Rowridge** and **Dover,** both transmitting Southern Television programmes, are now in operation. Dover is on channel 66 (group C aerial horizontally polarised) and Rowridge on channel 27 (group A aerial horizontally polarised).

Scottish Television is now being transmitted from **Black Hill** on channel 43 (group B aerial horizontally polarised).

The **Aviemore, Inverness,** relay station was taken into service on November 29th. It is transmitting on channel 10 with horizontal polarisation.

MULLARD DATA BOOK

We hear from Mullard that stocks of their 1969 Pocket Data Book are now exhausted. It is therefore regretted that no further orders can be accepted. Preparations for the 1970 edition are in hand and a further announcement will be made in due course.

LINE OUTPUT STAGE HARMONIC TUNING

TELEGENIC

MENTION third harmonic tuning to most people and they invariably squirm internally. It seems, understandably perhaps, that the difficulty of following the basic operation of a line output stage is enough. Add the seeming complexity of harmonic tuning and the already strained understanding breaks down. However we should not flinch from trying to clarify this apparently obscure matter, which actually is not so difficult as it appears to be. The basic problem arises out of the construction of the line output transformer, and once the problems involved here are appreciated the whole matter becomes reasonably clear.

The Characteristics of the Line Output Transformer

The positions of the main winding and the e.h.t. overwinding have on the modern line output transformer changed from being on the same limb as each other to being on separate limbs on the transformer core. This change has been made to provide better control of the leakage inductance that is present because these two windings are not the same physical size: all the magnetic flux that is produced cannot link them both. This leakage inductance also has stray capacitance which is present as if it physically existed. The leakage inductance and stray capacitance are indicated by L and C in the approximate equivalent circuit of the transformer shown in Fig. 1. The e.h.t. overwinding in this circuit is L1 and the main winding L2. The leakage inductance L is represented in the position shown because the overwind is made narrow in comparison to the main winding and the leakage flux is therefore in series with the overwind.

The main winding representation L2 also includes the line deflection coils and any width or linearity circuitry between the two. All this has a stray capacitance C2 across it and this will also include some physical capacitance. C1 represents the load capacitance which includes that of the e.h.t. rectifier, any e.h.t. smoothing and the c.r.t. capacitance.

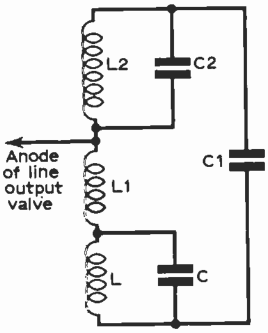


Fig. 1: Equivalent circuit of the line output transformer. L1 represents the e.h.t. overwinding and L2 the main winding, i.e. primary and secondary autotransformer wound, and also the coils and any inductive components used between them. L is the leakage inductance between the main winding and the e.h.t. overwinding.

Operation of the Line Output Stage

During the scan time when the line output valve is conducting a current is built up in L2. As soon as the line output valve conduction ceases, a large half-sinusoid of voltage is induced into L2 and L1—this is the flyback pulse. This pulse is rectified to provide the e.h.t. and is also the essence of the efficiency diode operation.

Now none of this flyback pulse is originated in L because it does not physically exist as a winding and cannot therefore have a voltage induced into it. However the pulse is sent into L as a shock potential from L1 and L2 so that L and C are sent into a damped oscillation. If this oscillation is not sufficiently damped it will continue into the next scan period causing ringing on the left-hand edge of the raster. This is because some of the oscillation would inevitably appear across the main winding L2 and therefore in the deflection coils.

C2 incidentally controls the rate at which the flyback pulse is originally produced and is therefore the limiting factor on flyback time.

The ringing effect is reduced to a minimum by arranging the circuit so that the frequency of oscillation of LC is an odd harmonic of the flyback pulse frequency. When this is done the oscillation voltage will be at the zero point at the beginning of the next line scan period.

Third Harmonic Tuning

Third harmonic tuning is adopted because this harmonic gives additional benefits. Fig. 2 shows how the voltages in the windings of the transformer add to produce the e.h.t pulse for rectification. The oscillation voltage of LC—because of the winding directions—begins in antiphase to the flyback pulse across the overwinding and as a result the e.h.t. pulse actually produced has as shown a higher maximum value, resulting in a higher e.h.t. voltage.

The voltage across the main winding however is modified in a different way—see Fig. 3. This voltage is in fact the voltage at the anode of the line output valve and it can be seen that the resultant here is smaller that the original. This is because in this case the oscillation voltage begins in the same phase. This lower anode voltage means that the power developed by the valve can be increased proportionately and this is important with modern

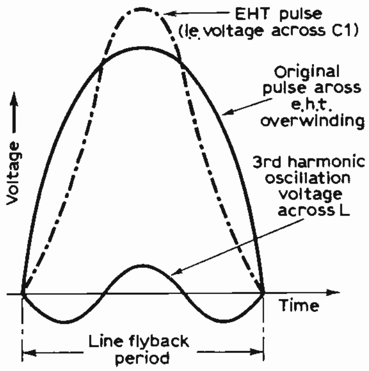


Fig. 2: Resultant e.h.t. voltage pulse obtained with third harmonic tuning.

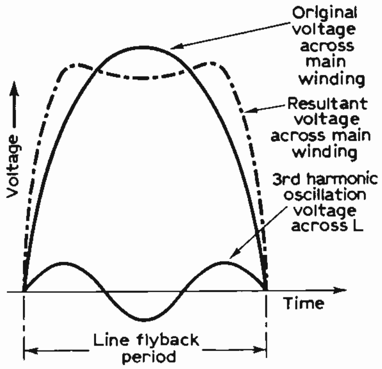


Fig. 3: Resultant voltage across the main winding with third harmonic tuning.

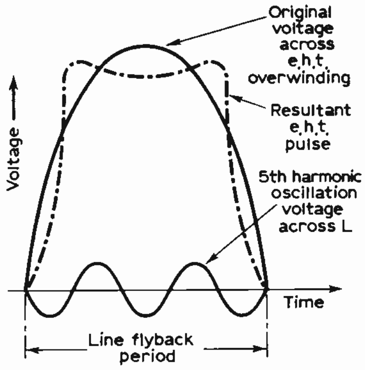


Fig. 4: E.H.T. pulse formation with fifth harmonic tuning.

picture tubes of 110-degree scanning angles where greater scanning power is required.

Third harmonic tuning in this kind of valve stage leads therefore to greater scanning power being available and to a larger e.h.t. voltage.

To accomplish third harmonic tuning of L and C—the manufacturer's problem and not the serviceman's—the position of the overwind can be varied, thus varying L. Neither L nor C exists physically so that fine tuning of the frequency can only be achieved by external components on the other windings. The position giving best tuning has been found to be with the main winding and the e.h.t. overwinding on separate limbs. Dual-standard receivers employing different flyback times on the two standards include a coupling coil between the windings which can be switched in and out of circuit. This changes the value of L as appropriate to give the correct third harmonic tuning frequency.

Practical Circuits

Some receivers using 90-degree picture tubes used third harmonic tuning but the real use has been with the modern cult of wide-angle tubes.

It is very difficult to see into the designer's mind when considering the line output stage in many receivers. There always seem to be so many more components than are really necessary, and because the essential features of third harmonic tuning are within the windings of the line output transformer itself one can glean little about this from practical circuit diagrams.

However, because there is so little information available on the precise function of every component within a line output stage a practical circuit example (from the Bush TV125 series) is given in Fig. 5 with the function of each component described in Table 1. This should help readers in determining

Table 1: Line output stage components (see Fig. 5).

Component	*Function*
V4	Line output pentode
V5	E.H.T. rectifier diode
V6	Efficiency (boost) diode
L1	Anti-parasitic r.f. choke
L2	Width control
L3	Line linearity control
L4 L5	Line deflection coils
L8 L9	Anti-parasitic r.f. chokes
C19	V4 screen decoupling
C23 C24	Boost reservoir capacitors
C29	Secondary tuning of l.o.p.t.
C30	Additional tuning of l.o.p.t. secondary on 625
C31	L.o.p.t. primary tuning
C33	Coupling capacitor—anode V4 to l.o.p.t.
C34 C35	S-correction capacitors
C36	Additional S-correction for 405
C42	Boost smoothing capacitor
R28	V4 screen dropper
R40	Damping on l.o.p.t. primary tuning
R43	Smoothing resistor on boost h.t. line
R44	Line linearity coil damping
R46	V5 heater swamp resistor for 625 lines
T1	Line output transformer
winding	
1– 4	Secondary, feeding line deflection coils
5– 8	Primary, with boost overwind
7– 9	E.H.T. overwind
10–11	Coupling coil for 3rd harmonic tuning on 625 lines
12–13	E.H.T. rectifier heater winding
S2	Part of standards switching
Section D	Changes secondary coil tapping to maintain correct match on 625 lines
Section C	405 position: connects additional S-correction capacitor in feed to deflection coils 625 position: connects additional coil in circuit to adjust leakage inductance for 3rd harmonic tuning

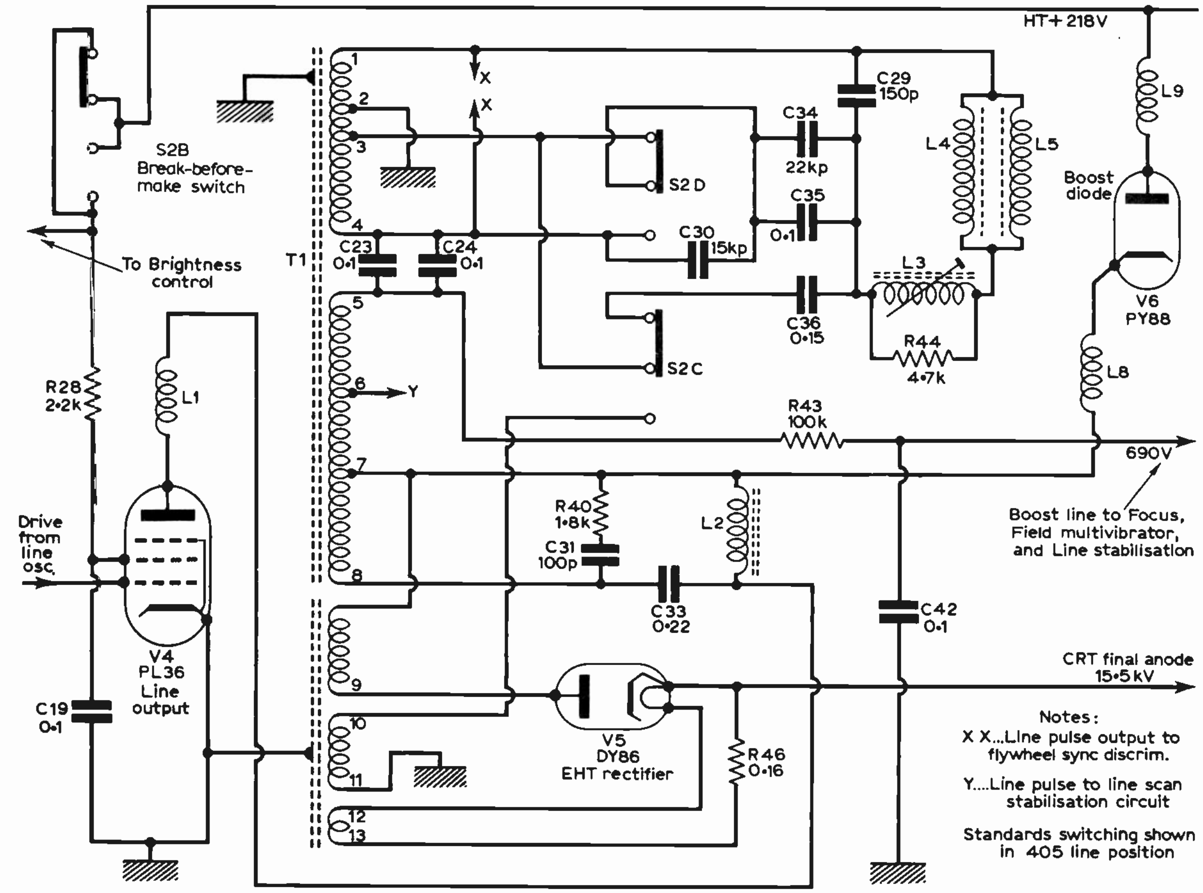


Fig. 5: Circuit of the line output stage used in the Bush TV125 series of receivers.

the function of components in similar dual-standard output stages.

E.H.T. Multipliers

With the use of e.h.t. multipliers increasing in receivers — particularly in colour receivers — the demands on the line output stage have also changed. Consider the use of an e.h.t. voltage tripler circuit producing an e.h.t. of 25kV for a shadowmask tube. The pulse driving the tripler circuit must have a peak amplitude of about 8·5kV. We are therefore dealing with an e.h.t. pulse only half the amplitude of that encountered in the conventional receiver circuit. This reduction means that the overwind producing the pulse can be made with lighter insulation and can therefore be laid *on to* the main winding producing a tight coupling. The leakage inductance is then much smaller and the need for third harmonic tuning—to prevent ringing on the raster—is eliminated.

Unfortunately this system gives poor e.h.t. regulation with changes in c.r.t. beam current, because of the large current/short time pulse drawn from the primary capacitance during flyback. The result of this poor regulation is to give changes in scan amplitude when the beam current changes. So once more the overwind finds itself on a separate limb to the main winding. The leakage inductance is again increased and so some kind of harmonic tuning must be used to prevent raster ringing.

We have seen though that third harmonic tuning gives a high-peaked e.h.t pulse. This would defeat the object of moving the winding because the more peaked the pulse the poorer the regulation, and although the regulation obtained with a monochrome tube—when using a diode rectifier—is acceptable it is not with the higher beam currents of the shadowmask tube. It should also be remembered that the peak permissible anode voltage on a 25kV shadowmask tube is only 27·5kV, which means that the e.h.t regulation must be better than 10%.

Fifth Harmonic Tuning

Fifth harmonic tuning matches both the problem of regulation and the need for harmonic tuning. Fig. 4 shows the resultant e.h.t. pulse shape with this form of tuning (the equivalent circuit of Fig. 1 still applies). It can be seen that the top of the pulse is much flatter and the regulation is therefore better. The condition to prevent raster ringing is still observed, with the oscillation voltage being at zero at the end of flyback time.

Summary

Third harmonic tuning reduces the power dissipation of the line output valve and increases the effective e.h.t. voltage—both important factors with the use of 110-degree picture tubes.

—continued on page 215

DX TV

CHARLES RAFAREL

A MONTHLY FEATURE FOR DX ENTHUSIASTS

The latest reception period has shown a quite unexpected improvement over last month, not as was anticipated in Tropospheric results but strangely enough in SpE.

I will deal with the Trops first. The promise of even better reception in November was not forthcoming after the good openings in October. The stable weather conditions did not persist and in fact deteriorated seriously with gale force winds, rain, etc. The results of this were that for all intents and purposes Trop reception was nil.

The slight F2 activity noted last month in the way of USA paging stations and USSR forward scatter signals has fizzled-out too except for some slight USSR signals on the 9th and 12th November.

SpE however offered pleasant surprises. The early part of the month was rather poor but things improved after the first week, conditions building up during the rest of November to reach a peak towards the end. The best reception here was of TV2 Finland Ch.E2 on the 25th and 29th. The signal on test card on the 25th was of exceptional strength and clarity, but even more interesting for me is that this was the first signal from Finland in 1969. I recall that Finnish reception is often rather unusual: some three to four years ago after no signs of it suddenly it appeared at great strength at mid-winter in January. So for those DXers who have not yet had it remember it can be a winter signal.

Now to the current log of SpE reception here for the period 1-30/11/69.

1/11/69 Sweden E4.
6/11/69 West Germany E4.
8/11/69 USSR R1, Sweden E4.
10/11/69 Sweden E4.
12/11/69 Czechoslovakia R1 and R2, West Germany E2 and E4, Sweden E4 and Poland R1.
13/11/69 Czechoslovakia R1 and Poland R1.
14/11/69 Czechoslovakia R1.
15/11/69 Italy IB.
17/11/69 Italy IB.
18/11/69 USSR R1 and Italy IB.
19/11/69 Czechoslovakia R1 and West Germany E4.
20/11/69 Sweden E4 and West Germany E4.
25/11/69 Finland E2.
26/11/69 West Germany E2.
27/11/69 West Germany E2, Sweden E2 and E4.
28/11/69 USSR R1, Czechoslovakia R1 and Poland R1.
29/11/69 Finland E2, West Germany E2 and E4, Holland E4 (bursts of short-skip SpE).
30/11/69 Sweden E2, West Germany E2 and Belgium E2 (bursts of short-skip SpE).

We have further news that Rumania is at times using the EBU "black rectangle" type test card and also a TVR caption during the programmes. I hope that this information will help in identifying some DXers' unidentified signals.

There was very large sun-spot and solar flare activity reported from the Athens observatory on 18-19th during the Apollo 12 shot. This should have produced some noticeable SpE results during the following 48 hours but nothing exceptional was noted here. I am wondering if other DXers had better luck? Likewise the predicted Leonid meteor showers of 15-17th did not produce any significant results. (The next periods are the Geminids 9-14th December and the Ursids 20th-22nd December, so I will be hopefully watching for something here.)

There is a new Swedish u.h.f. station operating on Ch.24, location as yet unknown. It appears that the Swedish u.h.f. chain is rapidly being expanded and more should follow soon.

We also have some news of Swiss TV from P. Beard of Folkestone who has been there on business. I quote what he says about Swiss colour TV: "Many of the programmes put out in colour by SBC are relays of the West German ZDF 2nd chain as the Swiss are not yet fully equipped studio-wise for their own colour." In this context he goes on to say: "On occasions I noticed that the test card put out originated in West Germany so this could lead to some misidentification should we receive SBC before their network is complete." It looks as if we must be careful here if we receive West German test cards on u.h.f. or Bands I/III as it is just possible that the station is in fact in Switzerland. Or perhaps I am being too optimistic!

Nemesis u.h.f.-wise is about to overtake me here in my area. Whilst I write these lines and send them to the Editor on 1st December the dreaded ITV transmitter is due to go on test on Ch. 27, soon to be followed by BBC-1 on Ch.31, both from Rowridge. All the horrible details next month!

READERS' REPORTS

D. Boniface of Ripon, Yorks, reports reception of a "TB" caption on Ch.R2. This is a new one to me and it poses the interesting question as to whether it could be of Bulgarian origin. His log for the Tropospheric opening about the 18th October is really excellent, so comprehensive that I am going to give it in full except for the BBC/ITA stations.

France: Lille F8a, Brest Ch.21, Nancy Ch.29, Metz Ch.34 and Reims Ch.46.

Holland: Smilde E6 and Ch.47, Markelo E7, Lopik Ch.27, Goes Chs.29 and 32 and Wieringemeer Chs.39 and 45.

—continued on page 207

Workshop HINTS

by VIVIAN CAPEL

AT ONE time a can of carbon tetrachloride or a similar volatile switch cleaner could be found in every workshop. These have largely been superseded by more sophisticated aerosol preparations but there are still uses to which carbon tet. can be put which have nothing to do with switch cleaning so that a can is still a useful thing to have in the workshop if obtainable.

Increasing Friction

With most mechanisms the object is to reduce friction as much as possible to prevent wear and to facilitate easy operation. This, however, is not always so. An example is the automatic-brake trip mechanism on record-playing equipment. Here a degree of friction is required to move the trip lever which cannot be directly coupled. Lack of friction caused by oil or grease getting on the friction surface or the surface becoming polished with use can cause failure of the mechanism to trip.

An application of carbon tet. to the surfaces will greatly increase the friction. This it does by completely removing all traces of grease and oil even if these cannot be seen. Various other metal-to-metal friction surfaces which may be encountered in autochangers and similar mechanisms can be treated in this way.

Where it is necessary to clean out old and dirty oil or grease from bearings and pivots carbon tet. is very effective in leaving the surfaces clean and dry for the fresh lubricant.

Welding Plastic

One characteristic of carbon tet. which many engineers have found disastrous is its ability to dissolve certain types of plastic material. More than one plastic cabinet has been ruined by attempts to clean it with this liquid!

This same property can however be turned to advantage. Where a cabinet is cracked or broken a strong and invisible weld can be made with its use. The carbon tet. should be applied with a camel-haired painting brush (see Fig. 1) to both edges to be joined. Care must be taken to avoid getting any surplus liquid on the outside of the case where it will show, but there is no need to be particular over the inside. The trick is to apply it in such a way that there is plenty on the inside edge but only the minimum on the outside, remembering that when the edges are brought together some liquid will squeeze out.

The easiest way of doing this is to approach the work from the inside so that the point of the brush which carries the minimum amount of liquid is toward the outside. Application should be done as quickly as possible as the carbon tet. dries very rapidly, after which the surfaces can be brought together. It is essential that they are positioned correctly the first time otherwise a messy joint will result.

Slight pressure can be used to make the surfaces combine but as they are soft too much pressure could make them deform. The weld will be dry in a few minutes, but if it is to be subject to any stress or strain leave it for an hour or more so that the plastic can thoroughly harden.

On very thin cabinets where the jointing edge is narrow and therefore rather weak it can be reinforced on the inside. To do this apply some carbon tet. on the inside surface along the length of the weld after it has set. The softened plastic can then be worked or kneaded with a screwdriver blade (see Fig. 2) into a ridge, using material from both sides of the weld. When it is dry the ridge will add considerably to the strength of the join. If carried out carefully and in the manner described the join will be almost imperceptible from the front.

The knack of good jointing comes with experience so it is a good idea to practise on some old broken plastic parts if they are available.

Screw Plugs in Plastic

Damaged plastic cabinets, fittings and c.r.t. masks are often encountered but are not always the result of a fracture. Fixing screws which are tapped into the plastics are sometimes found to be loose because the threads in the plastic material have been stripped. Overtightening is usually the cause of this.

The screws generally employed are of the self-tapping variety but of a special type somewhat different from the normal metal self-tappers: ordinary bolts are also used, the threads being cut in the fixing hole before insertion of the bolt.

The proper remedy is to drill out the hole so that a screw or bolt of the next size up can be tapped in. However it is not always convenient to do this. A suitable screw of the special self-tapping type of the right gauge and length may not be available, or it may be difficult to drill the hole in the required position. Furthermore a larger screw may not pass through the part to be fixed, so the hole in this would also have to be enlarged.

An alternative treatment is to plug the existing hole and use the original screw. This can be done with a short length of systoflex sleeving (see Fig. 3) cut just to fit the hole. The gauge is not too critical as it is not necessary to fit the hole perfectly. The secret is to slit the sleeving up one side before inserting it in the hole. When the screw is then screwed home the sleeve will expand and open out to fit into the contours of the hole and allow the screw to make a tight fit. The screw can be tightened well but as before it should not be overtightened.

Slipping Cord Drives

This is another problem involving friction. It is quite a common fault to find that the pointer or

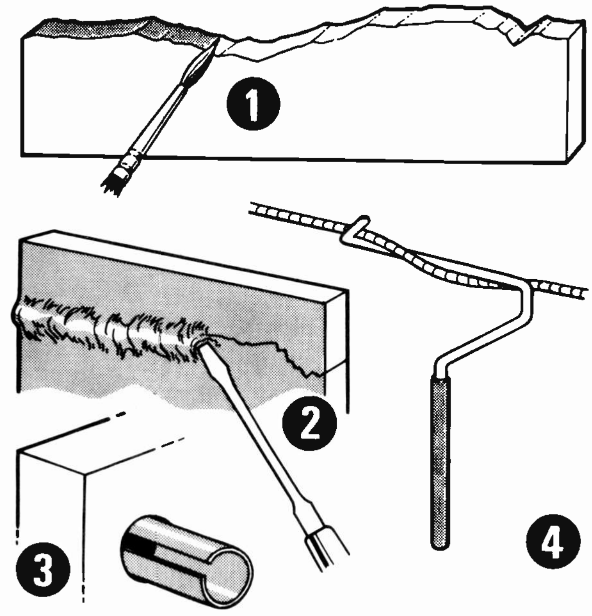


Fig. 1: Applying carbon tetrachloride to a surface to be welded using a camel-haired brush held so that it faces the inside, non-visible surface of the case being repaired. Fig. 2: Working up a ridge on the inside surface with a screwdriver blade to reinforce the weld. Fig. 3: Inserting systoflex sleeving to plug a screw hole that has stripped threads. Note slit side. Fig. 4: Simple wire pointer with red p.v.c. covering taken from p.v.c. cable. A single twist of the drive cord will hold the pointer firm yet allow it to be easily slid along for calibration.

gang capacitor moves but slowly when the tuning knob is rotated or in some cases comes to a complete stop at some point on the scale. The trouble is due to insufficient grip being exercised by the drive spindle on the drive cord, thus being unable to overcome the friction of the pulleys and gang. It could be that this friction is excessive and this probability can be quickly dealt with by applying a few drops of oil to the gang bearings and also to the pulley wheels.

If trouble is still experienced the tension of the drive cord should be checked. Over a period the cord will stretch and while this will be taken up by the tension spring in the drum of the gang capacitor the point is eventually reached where it cannot take up any more slack. The next step then is to examine the spring. It should be pulled well out from its anchoring point. If it appears almost closed the cord has stretched and needs shortening. Care must be taken not to shorten it too much. Tying a couple of knots in it near where it is tied to the spring will generally do the trick.

Even when the tension is good it may well be found that slipping is taking place. This may be due to the drive spindle becoming polished or the drive cord slippery, perhaps because of having collected some oil at some time. Replacing the cord will probably cure this but there is an easier way. Obtain some rosin as used by string instrument players to treat their bows. This can be bought at any music shop. Break a small flake off the block and powder it with a screwdriver blade. This should then be rubbed along the affected part of the cord. Providing the tension is good a positive non-slipping drive will result.

Fitting Cord Drives

Another tip involving cord drives concerns fitting them. Difficulty is often encountered when trying to run a complicated drive because the cord jumps off pulleys and drums while it is being fed over the next part of its run. This is especially so if the drive consists of wire rather than cord, since this is springy.

First of all pull the part already done taut. This means turning the gang capacitor to one extremity of its travel. The cord or wire can then be retained in its position by putting a dab of wax on the last pulley. After this the next part of the run can be carried out without having to worry about the previous part. It is not necessary to remove every trace of wax when the job is complete, only the surplus.

Actually a lump of wax is a useful thing to have in the workshop for cord drives, sealing aerial coils on ferrite rods, coil cores and many other uses. A wax of medium hardness when at room temperature is the best as the sealed cores etc. can then be readjusted if necessary later. A hard wax such as sealing wax is unsuitable as it needs heat to soften it and damage to components can result by such application.

If no supply is to hand a small quantity can sometimes be obtained by scraping some off a wax capacitor.

Scale Pointers

Scale pointers vary in size, shape and mounting methods. A common type consists of just a length of stiff wire bent into shape with a horizontal section around which the cord is twisted. A lost or damaged pointer can be replaced by one made up according to this pattern (see Fig. 4). These have the advantage of being easily slid along the drive cord so that if calibration must be carried out with the chassis in position in the cabinet because the scale is mounted in the cabinet such a pointer can be moved to its correct position without much difficulty.

Red is a favourite colour for the pointer and if one has to be made up or if the old one has lost some of its colouring a nice effect can be obtained by stripping off a length of p.v.c. insulation from a red mains cable conductor and fitting it over the pointer. Warming the pointer and p.v.c. may make this operation a little easier.

TO BE CONTINUED

VIDEOSCOPE TUBE

A reader tells us he has a limited number of DG7-32 oscilloscope tubes available at £6 each plus postage, and also one Mumetal shield. Requests addressed to The Editor, Practical Television, Fleetway House, Farringdon Street, London, E.C.4, will be forwarded.

fault finding FOCUS

S. GEORGE

A DETAILED LOOK AT COLOUR TV RECEIVER LUMINANCE CIRCUITS

ON both colour and monochrome reception colour TV receiver luminance stages basically fulfil normal video requirements but with the following essential differences. (1) The video output amplitude must be greater than for black-and-white receivers, i.e. in the region of 100V or 140V including sync pulse content. (2) A delay line is incorporated to ensure coincident Y and colour-difference registration or overlay at the tube face. (3) As the lumen efficiencies of the red, green and blue shadowmask tube phosphors differ the drive to the three cathodes must be proportioned so that their combined effect produces a white raster. (4) Brilliance control is achieved by varying the luminance output pentode anode current, either by varying its screen grid potential or its control grid bias. (5) Beam limiters are usually incorporated to prevent excessive signal strength or over-advanced brilliance control settings causing excessive e.h.t. beam currents. (6) Flyback blanking is generally achieved in the cathode circuit of the luminance output pentode by means of a transistor which cuts off the cathode current during these periods. (7) Wavetraps are included to reject the chrominance subcarrier and are sometimes rendered ineffective on monochrome to preserve video h.f. response.

Philips G6 Chassis

Now to look in detail at two representative luminance circuits to see how these requirements are met in practice. The first example, shown in Fig. 1, is from the Philips range. Following current monochrome and colour practice this uses a phase-splitter Tr1 immediately following the v.h.f./u.h.f. vision detector. The positive-going output from the detector diode is applied to Tr1 base, the 405 output being developed in similar phase across the 680Ω emitter resistor R6. The 625 collector load is rather more involved, consisting of a series combination of R4 and L1 which is in parallel with a series circuit comprising the luminance delay line, R3, a 6MHz tuned circuit, two matching coils and R5.

The delay line delays the wideband luminance signal by 0·85μsec to ensure registration at the screen with the relatively narrowband colour-difference signals, the value of R3 being selected to take up variations in delay line impedance. The 6MHz tuned circuit both prevents the intercarrier sound signal intruding into the output stage and provides signal coupling to the sound i.f. amplifier. The matching coils L4 and L5 in conjunction with the shunt capacitor C2 and series resistor R5 present a generally constant impedance to all luminance frequencies.

It will be seen that although the 405 output is d.c. coupled to the grid of the PFL200 luminance output pentode the 625 output is a.c. coupled. Diode D1 however reinserts the d.c. component on 625 and as its anode is returned to the slider of R13 in the valve's cathode lead the brilliance level is equalised on both systems. The cathode potential is stabilised by a zener diode to maintain constant d.c. operating conditions which are particularly important in luminance stages.

Luminance Response

The anode load of the PFL200 comprises a series-parallel *LCR* combination designed to maintain an overall linear response over the video/luminance ranges. As in monochrome receivers the h.f. response is preserved by the inclusion of compensating coils (L2 and L3) while the response towards l.f. is maintained by a 50μF capacitor C4 in parallel with the two 1·5kΩ resistors R15 and R16. From high to medium frequencies the reactance of this capacitor is so low that it virtually short-circuits the resistors as far as the signal is concerned, but at low frequencies when its reactance rises to become comparable to or greater than their sum value the total load impedance rises proportionally. At very low frequencies this rise in load impedance is offset by C3 not fully decoupling the screen grid to give an overall linear response.

Grey-scale Tracking

As mentioned earlier it is necessary to proportion the three cathode drives from the luminance output stage—this is done in conjunction with varying c.r.t. first anode voltages—to produce a net white raster. Adjustment of such drives must not affect the c.r.t. d.c. working voltages so the drive potentiometers, arranged as rheostats, are connected between the luminance pentode anode and the junction of a fixed potential divider so that at blanking level the voltages at these two points are equal. In this Philips chassis resistors R20, R21 and R22 constitute the potential divider, the drive controls being connected between the pentode anode (via L3, R19) and the junction of R20 and R21 with the sliders feeding the appropriate cathodes.

On colour reception the red drive control is shorted out by switch S1 so that the full output amplitude is applied to the red cathode. On monochrome when S1 switches over the red drive is reduced according to the control setting and the blue drive is increased

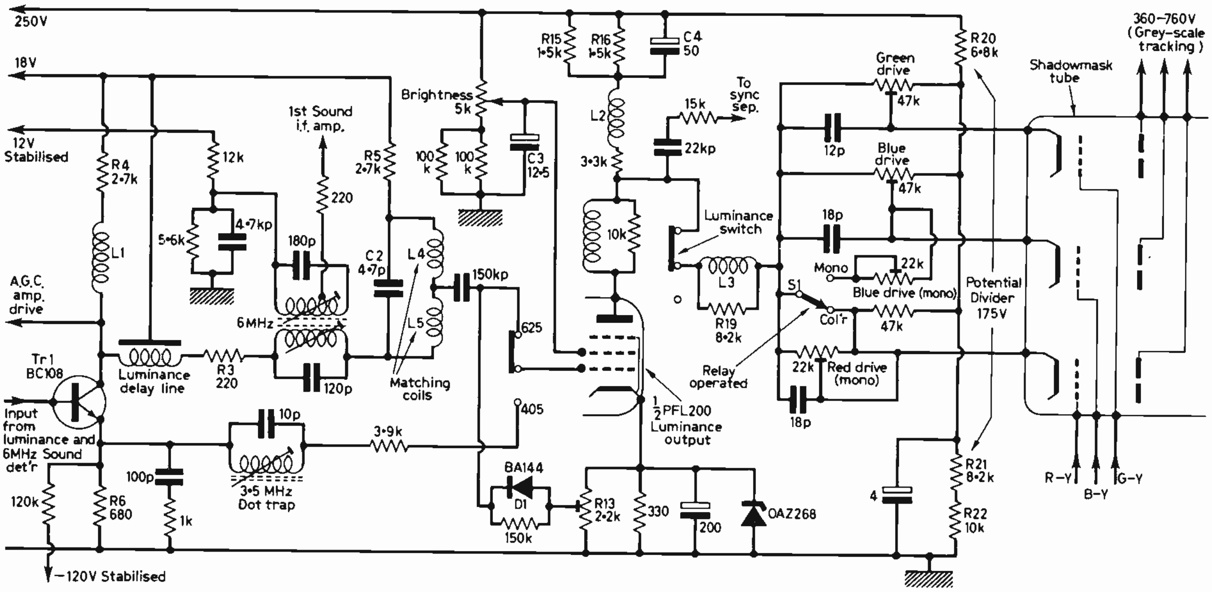


Fig. 1: Complete circuit of the luminance stages in the Philips G6 colour chassis.

to produce a white more closely resembling that seen on monochrome receivers. This switch is relay-operated by the anode current of a PCC85 triode, termed "auto. white shift", whose grid is d.c. connected by a v.d.r. to the anode of the PCC85 colour-killer triode (see Fig. 2). When colour bursts are present the anode voltage of the colour-killer triode rises and as this is directly coupled to the grid of the relay triode the latter is driven into grid current raising the anode current sufficiently to operate the relay. The result of all this is that on colour reception white is reproduced as closely conforming to Illuminant D while on monochrome a slightly blue-white is obtained.

The small picofarad-value capacitors shunted from one end of each drive control (Fig. 1) to the slider maintain h.f. response at optimum irrespective of control setting and brilliance is varied by adjusting the screen grid voltage since this directly varies anode current and therefore anode voltage.

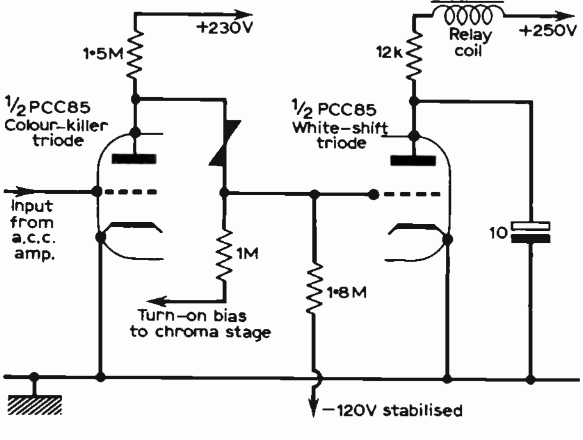


Fig. 2: The auto. white shift circuit used in the Philips G6 chassis (see also Fig. 1 above). On colour reception the burst signal is detected by a separate a.c.c. demodulator and amplified by an a.c.c. amplifier stage which also controls the colour-killer triode. This in turn also controls as shown here the auto. white shift circuit.

Flyback Suppression

Flyback suppression in these models is achieved by applying high-amplitude negative-going pulses to the three c.r.t. first anodes. These pulses must be of high amplitude since first anode voltage variations produce a smaller effect on beam current than do equivalent changes in grid or cathode voltage. For this reason it is necessary to be able to vary the first anode voltage from 360-760V to achieve optimum grey-scale tracking. Line flyback pulses of sufficient amplitude (–600V) are directly tapped from the line output transformer but the field flyback pulses need amplification, clipping and shaping by a separate triode circuit before being applied to the tube first anodes.

GEC-Sobell Circuit

The second example of luminance circuitry is from the GEC-Sobell-Masteradio range of models and incorporates the more usual luminance pentode cathode flyback blanking. The circuit, Fig. 3, also shows the c.r.t. beam limiting arrangement used in this model. There are two luminance stages between the vision detector and the PL802 output stage, a transistor phase-splitter coupled to an emitter-follower, the latter driving both the luminance pentode and a transistor video clipper which in turn feeds a conventional PCF80 sync separator.

Tr1 is the video phase-splitter, again with positive-going input from the v.h.f./u.h.f. vision detector and resulting in the 405 output being developed in similar phase across the 560Ω emitter resistor while the 625 output with phase reversed is developed across the 1k collector resistor. A 5k potentiometer shunted across this emitter resistor taps off the required degree of drive for an a.g.c. sampling transistor and thereby sets the sensitivity on 625. On 625 the a.g.c. is proportional to sync pulse amplitude but on 405 it is related to the back-porch amplitude. A feed is there-

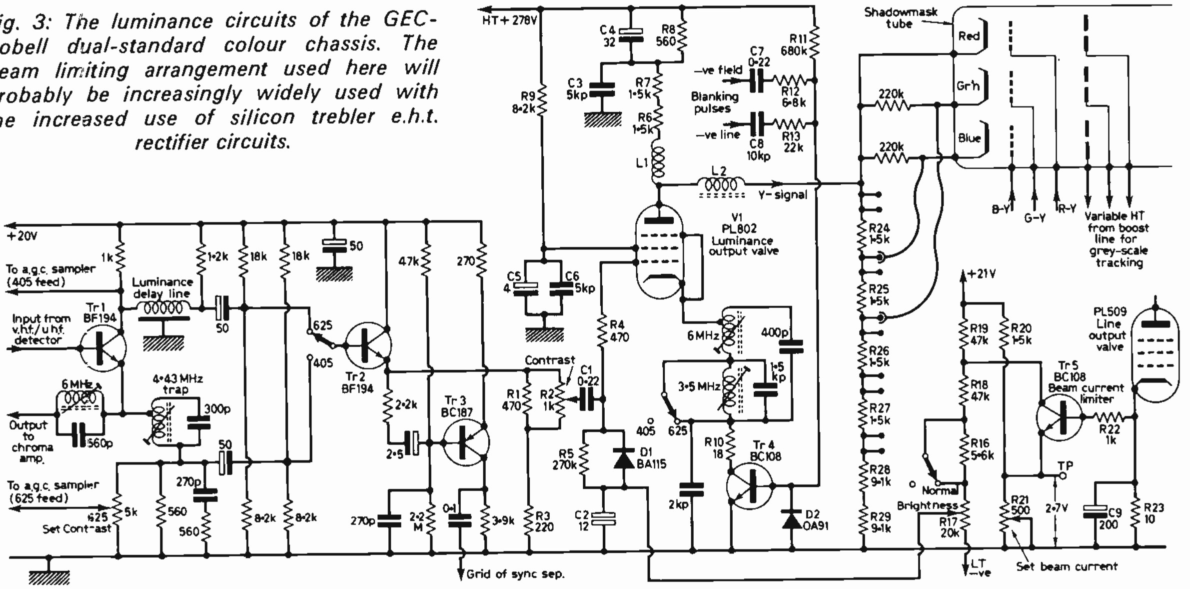


Fig. 3: The luminance circuits of the GEC-Sobell dual-standard colour chassis. The beam limiting arrangement used here will probably be increasingly widely used with the increased use of silicon trebler e.h.t. rectifier circuits.

fore also taken from the collector to provide a 405-video signal from which the back-porch signal amplitude can be gauged. The video load on 625 is a 1k resistor with output fed via the usual delay line to the system switch.

High-level Contrast Control

A.C. coupling is employed to the second stage, Tr2, on both systems, the output being tapped from its emitter and taken to the luminance pentode grid via the high-level contrast control R2. High-level contrast control was first used in Pye monochrome receivers in the form of a potentiometer shunted directly across the video pentode anode load and was later employed in many Bush-Murphy models. This method cannot be followed exactly in colour receivers due to the necessity for maintaining constant grey-scale tracking so the high-level contrast control is placed in the grid circuit of the luminance pentode where it enables the required degree of signal amplitude to be tapped off. High-level control has the advantages that contrast variations do not affect chroma signal strength, sound strength, sync separator input or the degree of a.g.c. applied to the controlled stages while as the signal is at maximum up to the control point valve, transistor and circuit noise is swamped

Tr3 is a video clipper driving a conventional valve sync separator with the signal developed across its collector load and in this way frees the video-luminance circuitry from the input capacitance and loading unavoidably imposed by this valve.

Signal Feeds

The chroma signal is taken from Tr1 emitter via a 6MHz rejector while a 4·43MHz trap in series with the emitter load introduces negative feedback to remove this frequency from the luminance information developed across the collector load. The signal from the emitter-follower Tr2 is developed across the contrast control R2 and capacitively fed via C1 to the luminance pentode PL802 grid with d.c. restoration effected by diode D1 whose anode is returned to the slider of the brilliance control. Wave-traps in the cathode lead of the pentode are for 6MHz intercarrier rejection on 625 and 3·5MHz dot rejection on 405, the latter trap being shorted out on u.h.f. The cathode lead is then returned via an 18Ω resistor and a BC108 transistor to chassis.

Flyback Blanking

This transistor is fully conductive or bottomed during line scan by heavy forward bias applied to its base by R11 from the h.t. rail, resulting in only 0·45V being measurable across its emitter-collector leads. Negative-going flyback pulses then reverse bias the transistor during these periods to cut off the transistor and valve current. When the pentode anode current ceases its anode voltage rises to almost h.t. rail level and the c.r.t. cathode voltages are similarly raised to momentarily black-out the tube. Diode D2 protects the transistor by conducting on pulse peaks thereby limiting their amplitude which might otherwise exceed the maximum permissible reverse base-emitter voltage.

Shaping the Response

At high and medium frequencies the pentode anode load comprises R6, R7 and L1 since the top of R7 is "earth" to signals at these frequencies due to the low reactance of C4 to the h.t. rail and C3 to chassis. (The h.t. rail is earthy to all signals except those of very low frequency by virtue of the various h.t. smoothing and decoupling capacitors.)

The pentode screen is decoupled by C5 (4μF) and C6 (5kpF). At high frequencies their combined value offers a low reactance and thereby eliminates negative feedback at this point. However at lower frequencies this is no longer so and a degree of negative feedback is introduced due to the screen voltage varying with the grid signal voltage but in opposite phase. Similarly at lower frequencies the reactance of C3 and C4 rises above their low h.f. values and R8 is then no longer "shorted" to signals, thereby raising the total impedance of the video load (at l.f.).

Selection of decoupling component values in this way can tailor the l.f. response as peaking coils can tailor the h.f. response to produce the required overall shape. These capacitors and associated resistors must therefore not be regarded as pure decouplers: they play a vital part in determining l.f. response.

CRT Drive Adjustments

The luminance output is d.c. coupled to the potential divider R24-R29 via L2 and following general practice the red gun is driven at full amplitude, the degree of green and blue drive being adjustable by tapping points on the potential divider for optimum grey-scale tracking.

Beam Limiting

In the previous circuit, brilliance control was effected by varying the pentode screen grid voltage but in this model it is achieved by varying the control grid bias by means of a potentiometer linked to a transistor beam limiter which is used to ensure that excessive signal strength or brilliance control settings cannot cause excessive tube beam currents. The sensing point of the e.h.t. consumption is the potential, normally about 2·8-2·9V, developed across a 10Ω resistor in the cathode lead of the PL509 line output pentode.

The beam limiter Tr5 is normally held non-conductive as its base is linked by a resistor to this point giving a base-chassis potential of 2·7V while the emitter is also held at 2·7V by the associated resistor network and the setting of the 500Ω potentiometer in its emitter lead. Thus with both base and emitter at the same potential to chassis there is no forward bias and the transistor is cut-off.

The brilliance control R17 is connected at one end to a negative l.t. supply and at the other end via a limiting resistor to the junction of R18 and R19 which feeds the transistor collector. On normal e.h.t. current demand the transistor is biased off and imposes no loading on the circuit. If the e.h.t. demand is excessive however the voltage developed across the PL509 cathode resistor rises above the normal value and forward biases the transistor which conducts, increasing the current drain through R19 to lower the positive potential at the brilliance control. This increases the effective negative bias applied to the luminance pentode control grid thus reducing the luminance pentode current and raising its anode voltage to bias back the shadowmask tube.

Beam limiting is also used in the Philips chassis (later versions) but operates via the a.g.c. circuitry. The arrangement shown in Fig. 3 is widely used but uncommon in one respect: in most chassis the e.h.t. current is sampled at the grid of the e.h.t. stabilising triode. However the GEC chassis uses a low-impedance solid-state voltage trebler e.h.t. system with v.d.r. stabilisation, a stabilising triode not being necessary with this system.

Other Makes

The BRC fully-transistorised models employing RGB video drive have no separate luminance output stage as such. Instead the Y and colour-difference signals are matrixed in three separate video output stages which modulate the tube from the cathodes only. This leaves the grids free for brilliance stabilisation and flyback suppression. Apart from this however and a few minor modifications the two examples of luminance output stages described are representative of those used in other models.

In conclusion mention should be made of the arrangements used in some models to switch out or render ineffective the chroma wavetrap in the luminance circuitry to maintain video h.f. response unimpaired on monochrome. These arrangements were described in an earlier article in this series, see the November 1969 issue of PRACTICAL TELEVISION.

Servicing

Servicing of luminance circuits presents little more difficulty than conventional video circuits, complete signal loss, reduced gain or impaired resolution being generally due to stock monochrome faults, e.g. burnt up resistors due to pentode short-circuits, dried electrolytics, value change in current-carrying resistors, printed circuit disconnections and the odd transistor failure.

The main additional possibility of impaired resolution is a disconnected or open-circuit picofarad-value capacitor associated with one of the drive controls, but this could soon be localised by observation of individual gun definition.

SERIES TO BE CONTINUED

NEW SETS

There has been a lull in the introduction of new models following the releases during the Trade Shows last August and summarised in our December issue. However we now have details of the **Marconiphone** models fitted with the new BRC/Thorn 1500 single-standard monochrome chassis. These are the 20in. Model 4800 at £68, the 24in. Model 4801 at £74 14s. and the 17in. portable Model 4803 at £63 12s.

DX-TV

—continued from page 201

Belgium: Wavre E8 and E10, Genk Ch.44, Rivière Ch.52 (our first report on this one I think).
Denmark: Sydjaelland E6 and Vestjaelland E10.
Norway: Oslo E6 and Bergen E9.
Sweden: Uddevalla Ch.30.
Eire: Dublin B7 and IH.
W. Germany: Koblenz E6, Grosser Feldberg E8, Hamburg E9 and Chs.30 and 40, Harz West E10, Harz Wald E11, Eutin Ch.21, Bremen Ch.22, Lübeck Chs.23 and 33, Lingen Ch.24, Minden Ch.26, Dusseldorf Ch.29, Eiderstedt Ch.31, Ostfriesland Chs.33 and 43, Niebull Ch.34, Kiel Chs.35 and 55, Flensburg Ch.39, Schleswig Ch.45, Cuxhaven Ch.48, Bungsburg Ch.50 and Aurich Ch.53. I make that 48 stations which is really most commendable. For good measure he had 10 British u.h.f. stations as well.

Our colour DX expert P. Beard of Folkestone sent a further CDX report for October. He notes good colour from Holland again Chs.29, 31 and 32, also colour from West Germany on Chs.28, 30 and 35 plus black-and-white on Chs.23, 27, 29, 32, 34, 35, 43 and 50.

waveforms in COLOUR receivers

PART 8

GORDON J. KING

Last month we investigated the chroma channel of a PAL decoder. We saw that the Y signal, sync and colour bursts are deleted in the chroma amplifier stages, leaving pure chroma at the input to the PAL delay line circuitry. However, the bursts (about 10Hz of the otherwise suppressed subcarrier, transmitted during the line sync back porch period) are very important parts of the composite signal and in the PAL system have two prime functions. One, they phase the subcarrier generator signal, and two they identify the lines which have a $-V$ component and those which have a $+V$ component. In practice they are also used for other purposes such as operating the colour killer in the chroma channel, the 4·43MHz notch filter in the Y channel (some models only) and the a.c.c. (again, some models only).

The Burst Channel

Figure 1 shows the area in which we are at the moment interested. In the first stage of the chroma channel a tuned circuit resonated to the subcarrier frequency (4·43MHz) is often included. This effectively "highlights" the bursts, so to speak, and passes them on to the burst gate. Figure 2 recalls the nature of the composite signal, showing a burst on the back porch following the line sync pulse. Figure 3 shows a line sync pulse with its associated burst, the picture information (or most of it) having been deleted, while Figure 4 shows the location of the burst on the porch in better detail as the result of X-expansion at the oscilloscope.

The burst gate stage is commonly a transistor used as a switch and normally biased to the "off" position. It is turned on once each line by a gating pulse which is often derived from the line output stage and is carefully timed to occur only for the duration of the burst. Some sets incorporate a special burst gate generator stage, the gating pulses then being derived more accurately from the line sync pulses actually on the Y signal. For example, a simple transistor stage might be arranged to "trigger" during each positive-going line sync pulse, resulting in pulses at the collector of the stage which after processing and timing are highly suitable for working the burst gate. It must be stressed that the gate timing is of paramount importance, for if the gate is operated (i.e. switched on) before or after the burst period the subcarrier generator will run wild at worst or fail to phase correctly at least. A typical gating pulse is shown in Fig. 5, while the burst signal at the output of the gate is shown in Fig. 6.

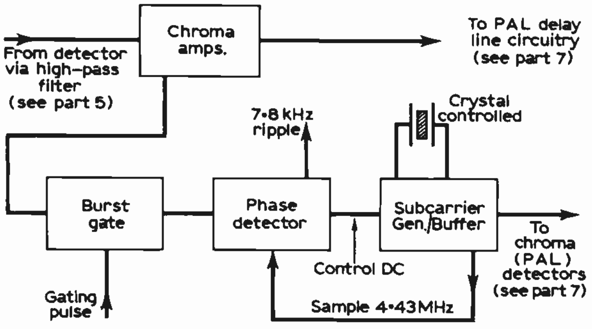


Fig. 1: Block diagram of the burst channel, subcarrier generator and phasing arrangements.

Subcarrier Generation

Before we deal with the phase detector (Fig. 1) let us look at the subcarrier generator/buffer section of the block diagram. This commonly consists of two stages, the subcarrier generator proper and a following amplifier stage in emitter-follower mode which, owing to its relatively high input impedance, has minimal shunting effect on the generator while delivering the subcarrier signal at low impedance. The subcarrier is conveyed to the V and U detectors through the PAL alternate line switch (about which more anon) and the 90-degree phase shifter (see Part 7 last month).

The subcarrier signal is generated by a fairly simple oscillator circuit whose frequency is controlled pretty accurately by a crystal. However in spite of the fairly tight crystal control the *phase* of the locally-generated subcarrier can differ from that of the transmitter's subcarrier, and since very accurate phasing is essential for correct chroma demodulation a scheme of automatic frequency/phase correction is essential in colour sets. This is where the bursts come in. These come from the transmitter's subcarrier generator so that they reflect very accurately (in fact, perfectly) the frequency and phase of the real subcarrier otherwise suppressed at the transmitter. Thus if the locally-generated subcarrier (in the set) is locked in frequency and hence phase by the bursts perfect recreation of the suppressed subcarrier is achieved.

Phase Detector

The phase detector stage plays a major role in this respect. It consists essentially of a pair of diodes in a discriminator circuit, the circuit receiving both the bursts from the burst gate and a sample of the locally-generated 4·43MHz signal from the buffer (Fig. 1). Now a characteristic of such a circuit is that when the two signals applied to it are correctly phased the diodes are effectively "in balance" and no external current flows. However should the phase of the two signals tend to vary, i.e. become unbalanced, a current flows in one direction or the other depending on the relative

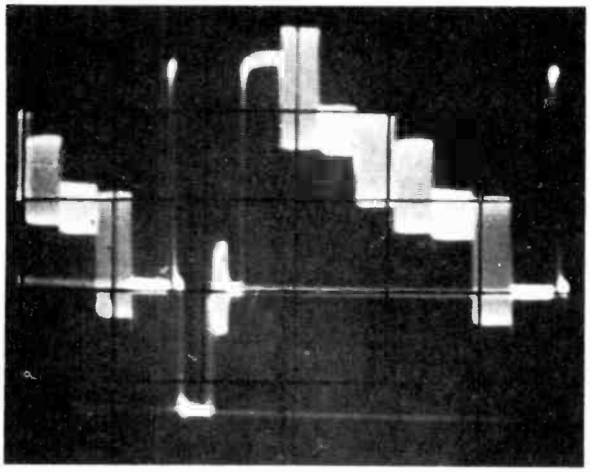


Fig. 2: Composite colour signal, showing the burst signal on the back porch of the line sync pulse.

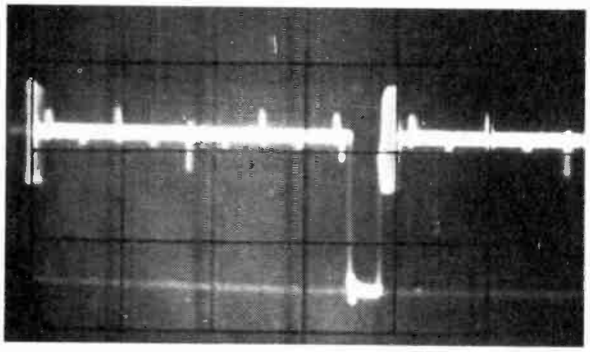


Fig. 3: Line sync pulse with its associated burst; most of the picture information has been deleted.

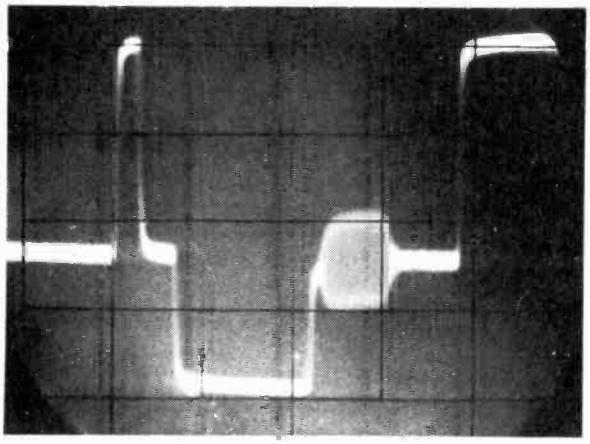


Fig. 4: Position of the burst on the sync pulse back porch shown in detail as a result of 'scope X expansion.

phasing and a d.c. potential is developed across a load resistor. The polarity of the potential depends on which way (plus or minus) the phase of the locally-generated subcarrier signal differs from that of the processed bursts, while the magnitude of the potential depends on the angle of phase difference. The potential thus provides a control for keeping the phase of the locally generated subcarrier signal accurate.

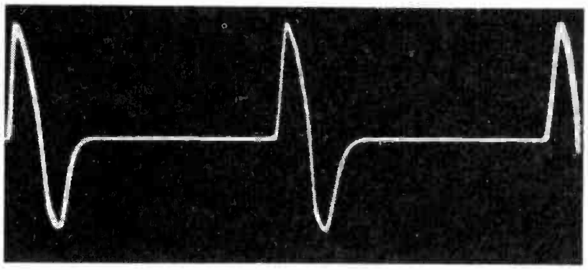


Fig. 5: Typical burst-gating pulse.

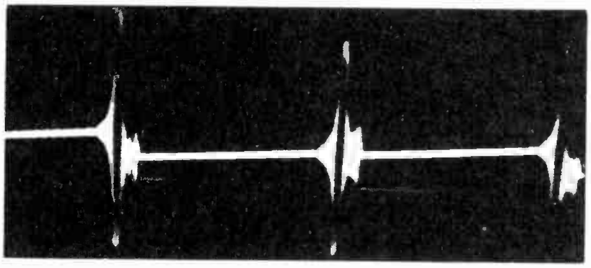


Fig. 6: Burst signal at the burst gate output.

Actual control of the oscillator phase is achieved by a capacitance-diode, sometimes called a *varicap*, connected in series with the oscillator's crystal. The varicap diode is a junction diode designed to exploit the capacitance which exists across the depletion layer of a reverse-biased pn junction. All junction diodes in reverse conduction exhibit capacitance between their leadouts but the varicap is designed for the least loss, giving a reasonable value of Q (i.e., goodness).

Although a crystal controls the frequency of an oscillator within close limits (frequency being dependent on crystal cut and accuracy on temperature and other factors) it is possible to vary the frequency and hence phase within a narrow margin by regulating the capacitance associated with the crystal, and this is what the varicap does. A pair of varicaps is sometimes employed, the two being in series with the d.c. reverse-bias which is applied at their junction. To get the oscillator running nominally at the correct frequency an adjustable d.c. potential (from a potentiometer) is fed to the varicap system in reverse-bias direction through the phase discriminator. Phase control is then achieved by the plus or minus potential produced by the discriminator (or phase detector) itself. The nature of the subcarrier at the buffer output is shown in Fig. 7.

Filter-derived Subcarrier

At this juncture it is noteworthy that instead of the conventional phase-locked oscillator system we have just looked at some sets are taking up an idea that was originated with the US NTSC system. This is to use a narrow-band crystal filter into which amplified burst signals are fed. Owing to the very high-Q value of the filter each burst causes a "ringing" waveform and each train of bursts is sustained for the whole of one line period with the amplitude of the output signal holding constant to within 1% over the 64μsec period. This scheme avoids the subcarrier generator/buffer department and has the advantage of the subcarrier disappearing completely when the set is presented with a black-

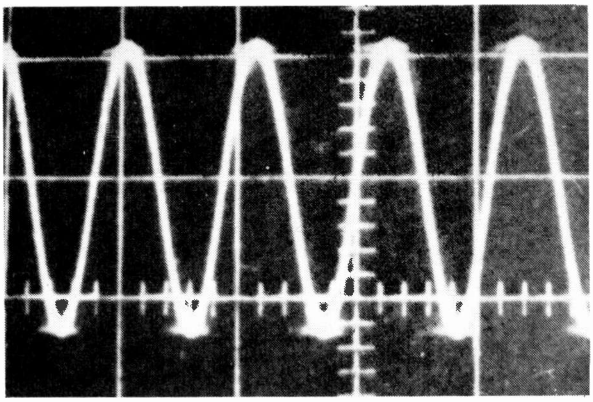


Fig. 7: The regenerated subcarrier at the output of the buffer stage indicated in Fig. 1.

and-white transmission, that is when the transmission is devoid of colour bursts. Moreover the PAL alternating V phases are more easily identified line-by-line.

The Swinging Burst Signal

Let us now take up the subject of V phase identification. When the V phase swings line-by-line from negative to positive, back to negative and so on, the V chroma detector must be phased to match the V signal input on each line. If for example the V detector is phased for +V when the input is −V then colours complementary to those seen by the camera will be displayed by the receiver. It is imperative therefore that the V detector PAL-switch receives information to tell it what V phase is being transmitted so that it can organise itself accordingly and thus switch in correct V phase synchronism line-by-line.

This information is carried by the bursts and is in addition to the information which we have just considered for locking the phase of the subcarrier generator signal. This additional or PAL-switch synchronising information is added to the bursts merely by causing their phase to change 45 degrees line-by-line at the transmitter in synchronism with the 180-degree line-by-line change of the V chroma signal. The idea can be quickly appreciated by studying Fig. 8. The top set of vectors shows the V chroma on the positive phase and the bottom set on the negative phase; these two sets of vectors can thus represent respectively the signal on one line (line N) and the signal on the next line (line N+1). The signal on line N+2 will of course be the same as on line N.

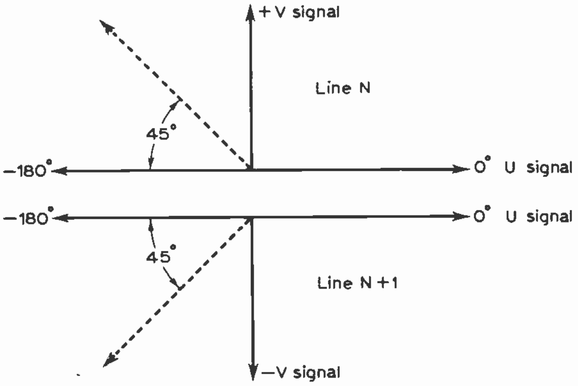


Fig. 8: Showing how the burst signal swings ±45 degrees either side of the U axis line-by-line in synchronism with the V chroma signal phase alternations.

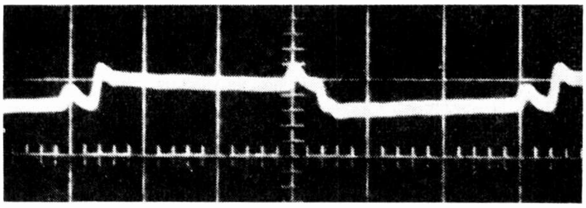


Fig. 9: The nature of the ripple signal at the output of the phase detector as a result of the swinging bursts.

The U chroma signal always remains fixed in phase (since this signal is not phase-alternated—only the V chroma signal is) and the phase swing of the bursts line-by-line is relative to the U chroma. At line N the burst is +45 degrees and at line N+1 −45 degrees. The bursts thus swing line-by line by plus and minus 45 degrees.

It is often asked how the bursts, since they are swinging in this way, can possibly phase-lock the subcarrier generator signal. The answer to this—given to avoid a spate of correspondence on the subject!—is that the bursts as such do not phase-lock the subcarrier oscillator. It is the potential produced by the phase detector which does the locking, and since the bursts are swinging *equally either side* of the U chroma datum the *mean level* of the phase detector's potential corresponds to the correct subcarrier phase. In other words the potential produced by the phase detector is the same as that which it would produce—from the phase-locking point of view—if the bursts held steady along the U chroma axis. The fact that the bursts are swinging equally either side thus has no adverse influence on their phase locking attributes.

However the phase detector itself is sensitive to the swings since they effectively represent phase modulation on the burst carrier. The waveform in Fig. 9 shows the sort of signal due to the swinging bursts that is produced by the phase detector. The d.c. for the subcarrier generator control is the *mean* of this signal and can thus be considered as being steady.

Now the signal—of the type shown in Fig. 9—from the phase detector is commonly called "ripple", and having in mind the way in which it is geared to the V chroma phase alternations (Fig. 8) at the transmitter is is not difficult to realise how it can identify the phase of the V signal line-by-line at the V detector. The V detector phasing is switched line-by-line by alternating the phase of either the subcarrier signal or the V signal fed to it (there are two signals fed to each chroma detector as we saw last month). The PAL-switch performs this operation and we shall be looking at the signals associated with this in a subsequent article. For now it is sufficient to know that the ripple signal is used to synchronise the PAL-switch (operated at line frequency) after processing. It also produces the colour killer bias. bias (sometimes) for operating the subcarrier trap in the Y channel, and is generally used for a.c.c. purposes. I shall be going into these aspects of the ripple signal next month.

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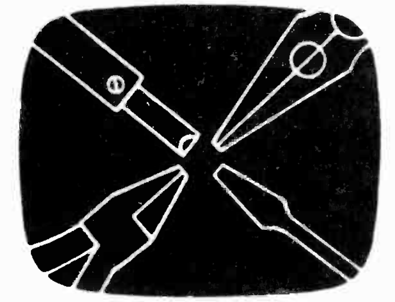


SERVICING television receivers

L. LAWRY-JOHNS

PHILIPS 210 CHASSIS

RECEIVERS using the 210 chassis include the G19T210A, G23T210A, G19T211A, G23T211A, G19T212A, G23T212A, G19T213A and G19T214A. The differences are in tube size and cabinet presentation. These receivers are dual-standard models with a hybrid circuit of nine valves, eleven transistors and seven diodes. Four of the transistors are used in the integrated v.h.f./u.h.f. tuner unit which features six push buttons any one of which can be set up to any channel on 625 or 405 or v.h.f. relay on 625. Apart from these buttons there are two other controls on the front of the cabinet, brilliance and volume, the latter featuring a " pull on, push off " switch.

The receiver is adequately protected by fuses and drop-out resistors. The fuses consist of a 1·5A mains supply cartridge, a similar 1A in the solenoid switching circuit, and a thermal spring-off device on the right side of the dropper, this being designed to divorce the h.t. rectifier from the h.t. supply circuit in the event of R1542 becoming overheated.

In addition to these protective devices there are two safety resistors, R1547 and R2145. These are of a special type which fuse readily when their rating is exceeded. The spacing of R2145 from the panel (about ¼in.) must be observed.

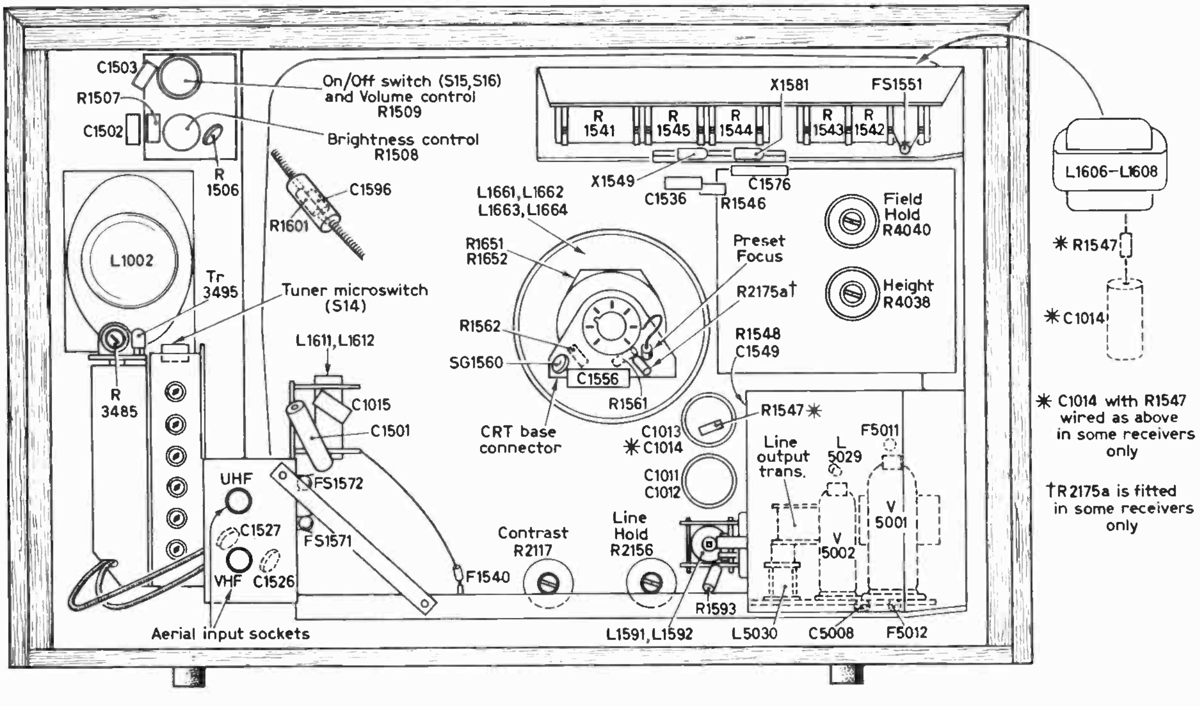
There is also a spark gap protector wired on the c.r.t. base connector.

Servicing Notes

When replacing drop-off resistors do not wrap the wires round the connecting tag. Merely present the wire to the tag and solder so that in the event of any subsequent overheating the resistor will again drop out.

In the event of all the push buttons being found pushed in they may be released by depressing the third button from the top (BBC-2) farther in. Do not attempt to alter the rear setting of these buttons when the button to be altered is depressed (selected).

It is important to note that the dropper sections are in different circuits and are at different potentials. This can be misleading if the circuit is not to hand when servicing in the field. It is essential to study the circuit and understand the function of each



✱ C1014 with R1547 wired as above in some receivers only

†R2175a is fitted in some receivers only

Fig. 1: Rear view of a typical receiver in this series, the Philips Model G19T210A.

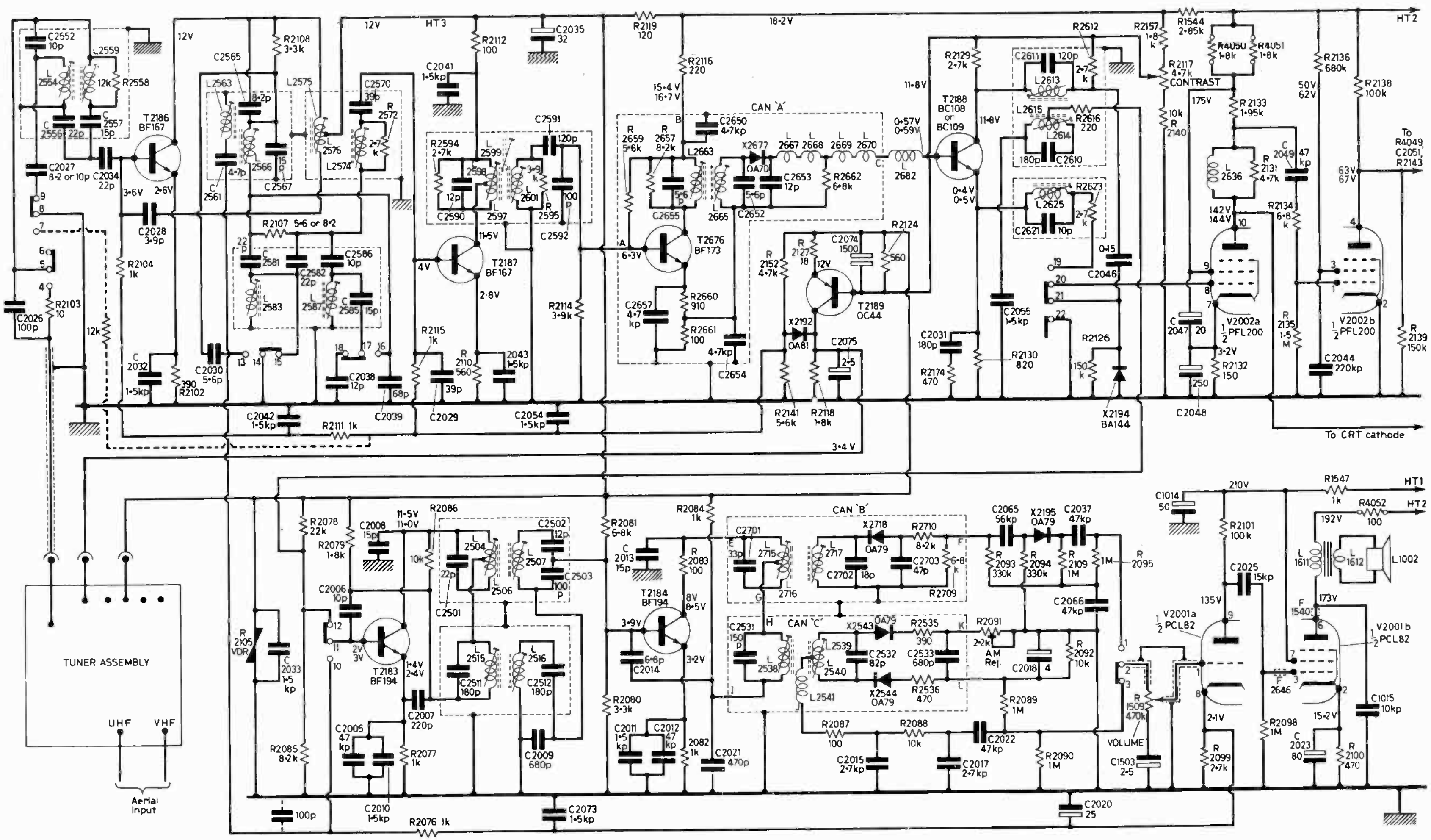


Fig. 2: Circuit diagram of the receiver stages of the chassis.

Circuit variations; *In some receivers T2183 and T2184 are type BF184; T2186 and T2187 may be type BF196—R2118 is then 1·2kΩ; T2189 is a BC187 or BC186 on some chassis with R2140 5·1kΩ, R2152 3·9kΩ and R2157 2·2kΩ or 2·7kΩ; C2046 may be 1μF, X2192 OA91, X2194 BA115, X2195 AA119, R2102 330Ω, R2110 470Ω and R2111 220Ω.*

Error; *The modification capacitor between pole 10 of the system switch and chassis should be shown as 10pF not 100pF.*

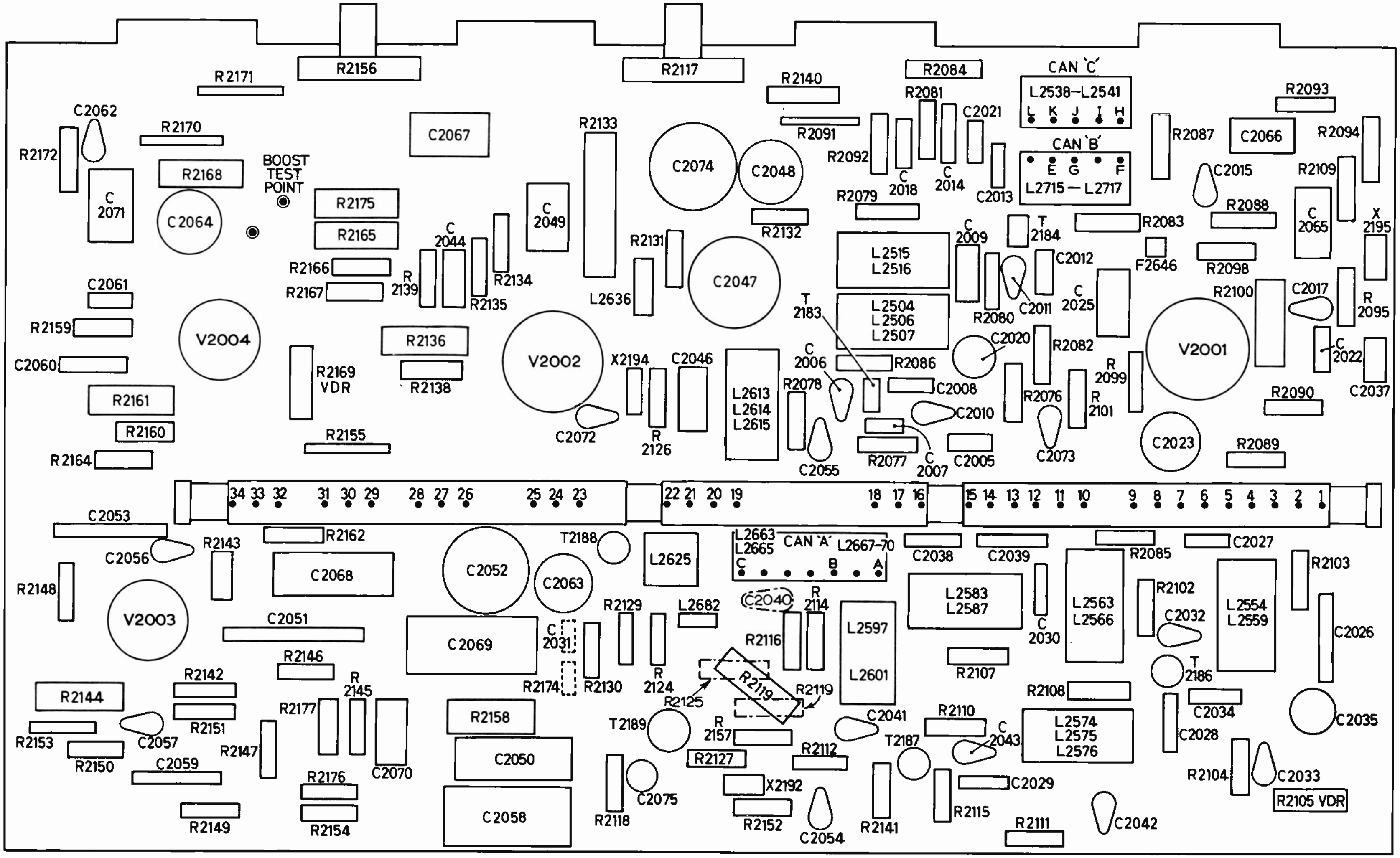


Fig. 3: Layout of the i.f. and line timebase printed panel. Note that two different Can A assemblies have been used. Where L2682 is in the position shown, R2119 occupies the position above shown solid and R2662 and C2650 (see circuit) are incorporated in the can. Where L2682 is not used R2119 occupies the position shown in broken line above and C2040 and R2125, also shown in broken line above, replace R2662 and C2650. These components are in the same positions electrically but C2040 is 1,500pF. C2031 and R2174 are mounted on the print side of the board.

BRC 1400 CHASSIS

This was covered in our December 1969/January 1970 issues. We have since learnt that the value of the smoothing section R135 of the mains ballast resistor was incorrectly shown in the service manual and on our circuit diagram. It should be 1·7kΩ not 1·5kΩ. Also we have some additional models that were fitted with this chassis. These are the **HMV** 2640, **Marconiphone** 4619B and 4620B, and the **Ultra** 6655.

section as this is probably the first part of the receiver which will require attention.

Viewing from the rear, the left-side section is R1541. This is at a.c. mains potential and is between the 1·5A fuse and the input to both diodes (h.t. and heater circuit rectifiers). The value of this is 30Ω.

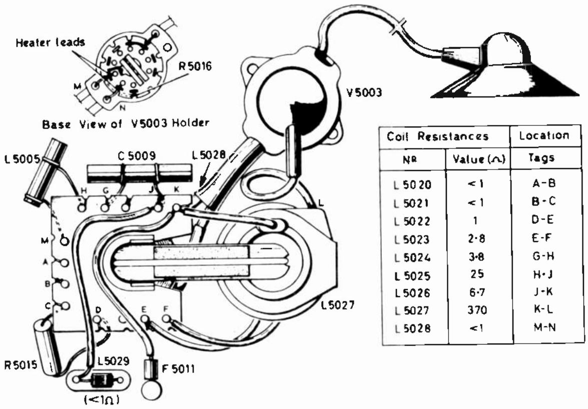
The second section from the left is R1545. This is the heater circuit dropper and the potential here is negative d.c. This is the section most likely to be found open-circuit. When it is no heater current can flow and the set will be dead except for the presence of h.t. at all parts. Shunting a 125Ω section across R1545 will restore normal conditions. The replacement section must be adequately rated and securely wired as well as soldered.

The third section is R1544 which is an h.t. smoothing resistor and is at positive d.c. potential. Its value is most important since it controls the supply to the transistors. Damage will be caused by the accidental connection of a resistor of less than the specified 2·85kΩ (or 2K85) value across the tags of this resistor if it is suspected of being open-circuit—or rather if it is found to be open-circuit. The two right-side sections are the more normal smoothing resistors of 148Ω (R1543) and 118Ω (R1542) respectively, these again being at positive d.c. potential.

To sum up: when trouble is experienced in the supply circuits, whether heater or h.t. or both, concentrate on the outer sections and have a clear idea of the function of each section and its value. Bear in mind that if the heaters are not alight it is the second section from the left that is most likely to be at fault and that the value of this is 125Ω.

Weak Print

Another common cause of trouble in these receivers, at least in the writer's experience, is breaks in the printed tracks where or near where the component leads are soldered. It would appear that vibration can cause any relatively heavy component such as a fairly large capacitor to break away from the print underneath. This can lead to the appearance of varying fault symptoms, some of which can be quite misleading. The most recent example of this was when one of these receivers showed symptoms of pronounced vision buzz on sound accompanied by a hum bar on the picture, which also showed flyback lines and weak field lock. An open-circuit smoother was suspected but slight movement of the upstanding yellow capacitor C2074 at the rear centre (in the a.g.c. amplifier circuit) cleared the symptoms completely. Resoldering the underside connection with a short length of wire along the track completely cured the trouble (shades of small transistor radios with their edge-type volume controls breaking away from their flimsy tracks inside).



Coil Resistances		Location
Nº	Value (Ω)	Tags
L5020	<1	A-B
L5021	<1	B-C
L5022	1	D-E
L5023	2·8	E-F
L5024	3·8	G-H
L5025	25	H-J
L5026	6·7	J-K
L5027	370	K-L
L5028	<1	M-N

Fig. 4: Line output transformer assembly.

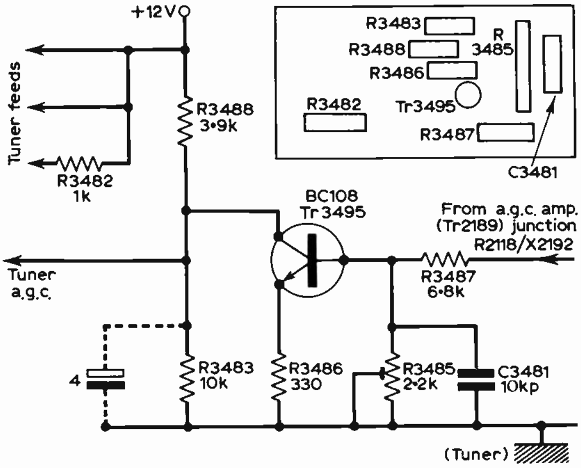


Fig. 5: A.G.C. inverter stage fitted in receivers using a tuner unit with germanium transistors.

Cross-modulation

Quite often it will be found that a newly installed receiver will show signs of sound-on-vision and/or vision-on-sound. The maker's suggestion is to fit a 12kΩ resistor from the junction of R2111 and R2115 to tag 7 of the system switch. A convenient mounting point is to the unused points between the contrast and horizontal hold controls. The effect is to place the 12kΩ resistor across R2141 when switched to 405. Other suggestions are to wire a 10pF capacitor from tag 10 of the system switch to chassis in order to stabilise T2183, and to fit a 4μF capacitor across R3483 to more thoroughly decouple the a.g.c. at the inverter where this is fitted (with a germanium tuner).

DC Resistances

Loudspeaker 3Ω; system switching solenoids L1591 and L1592 33Ω each; field output transformer L1606 9Ω, L1607 260Ω, L1608 1100Ω; audio output L1611 280Ω, L1612 0·5Ω; field coils L1661 and L1662 20Ω each; line coils L1663 and L1664 4·5Ω total; line linearity coil L5030 0·5Ω.

CONTINUED NEXT MONTH

BOOK REVIEW

SERVICING WITH THE OSCILLOSCOPE,
by Gordon J. King. Published by Butterworth & Co. Ltd., London. 176 pages, 8½ by 5½in. Price 28s. Hard covers.

THIS BOOK, based on a series of articles that appeared in *Electrical & Radio Trading,* has its emphasis on television receiver servicing. With the added complications of colour, it is inevitable that the professional engineer comes to find his oscilloscope the most useful tool at his command. There are indeed a number of tests that can be made in no other way except an inspection of the colour television waveform.

The idea that the scope is simply a means of portraying what other test gear can register is quite firmly scotched by Gordon King who is at great pains to stress the instrument's versatility. Lavishly illustrated with photographs taken directly from the screen while undertaking tests—no specially rigged demonstrations for this strictly practical author—and augmented by line drawings of specimen hook-ups and some circuitry, the ten packed chapters should prove of immense value to professional and amateur alike.

An introductory chapter lays the ground, explaining oscilloscope functions and facilities and emphasising some of the limitations, leading directly to a second chapter on general applications. After this we begin specialising: Chapter 3 deals with video waveforms, Chapter 4 with synchronising waveforms and Chapter 5 with timebase waveforms. In all cases the fault condition is displayed and details of the test methods and interpretations are given with meticulous care. It is almost as if the author had determined to write a treatise for his favourite nephew; as readable as a friendly letter.

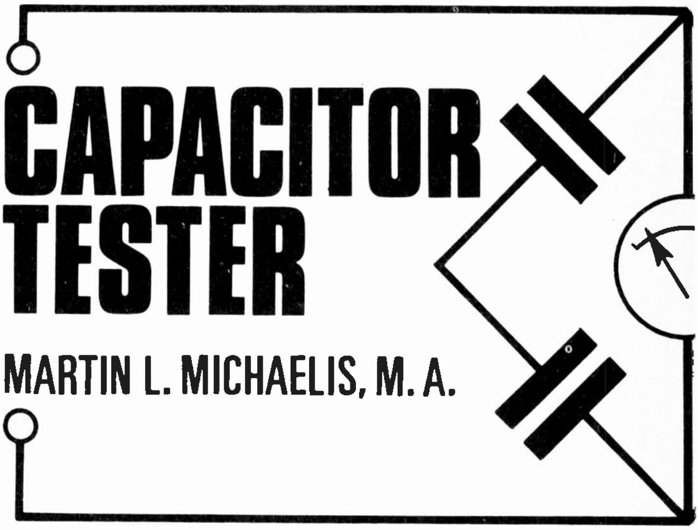
Chapters follow on tests for hum, distortion and response, leading to alignment procedures and then to colour television waveforms. For those who have only read desultorily about colour and resolve to meet that hurdle " when the time comes" Chapter 8 is a reminder that the time is here. Much can be learned about colour TV techniques in reading about tests made on the receivers.

The final chapters will also be of intense interest to the modern-minded, discussing quite deeply the principles and tests of stereo radio and high-fidelity equipment. Once again some very revealing traces are illustrated. This is not just another book on the oscilloscope: the author is that rare bird—a practical man who can pass on his knowledge in an interesting way. I have no hesitation in recommending *Servicing with the Oscilloscope.* *H.M.*

LINE OUTPUT STAGE TUNING

—continued from page 200

The increasing use of voltage multipliers for e.h.t. derivation means lower peak voltages on the line output transformer. Fifth harmonic tuning used in these cases gives better e.h.t. regulation at the expense of extra power dissipation in the line output stage. This is allowable with the development of higher dissipation pentodes such as the PL509 (pa max=30W) but is a problem inhibiting the wider use of transistor line output stages at present. ■



CAPACITOR TESTER

MARTIN L. MICHAELIS, M. A.

THIS instrument has been specially designed for the service engineer. It provides clear and rapid readings of capacitance values, leakage conditions if any, and changes of capacitance and leakage with applied voltage, thus revealing at once the more subtle faults in defective capacitors which often give rise to perplexing symptoms in equipment coming into the workshop for repair. This capacitor tester is not intended to be a precision laboratory unit for exacting research and development, although it may certainly be used for virtually all amateur design work and several professional projects too. It provides clear assessments whether or not the capacitance values of components in the 5% or worse tolerance classes lie correctly within the nominal ranges, whether or not these capacitance values are stable with respect to applied voltage, and whether or not the insulation is intact.

A very large range extending from about 50pF to 1000μF is covered in only four subranges. Each range theoretically commences from zero capacitance and is calibrated numerically from 0·05 to 1000. The range switch selects the capacitance units represented by these numerical values, namely 1000pF, 0·01μF, 0·1μF or 1μF respectively.

SCALE LAW ADOPTED

The calibrated potentiometer VR1 is not used as a variable resistor in one bridge arm but as a potentiometer in one bridge branch, with fixed limiting resistors R2 and R3 at the respective ends of the track. This produces an approximately logarithmic scale law extending over more than four usable decades with a *linear-track* potentiometer. The actual departure from the logarithmic law is such that the decade falling into the centre of the potentiometer track is nearly linear and thus gives nearly as good resolution as an ordinary linear bridge. The scale law described is ideal for making the checks and measurements on capacitors required in equipment servicing.

A given unknown capacitor gives a balance reading somewhere in all ranges for which a thousand times the range unit value is at least as great as the actual capacitance value. In practice this means that *all* practical capacitors of any type and any capacitance value from zero or a few picofarads up to a thousand microfarads give a clear balance reading somewhere within the highest range, so that an approximate capacitance determination can be made at once without range searching. If this first balance reading does not lie in the scale-centre or higher, i.e. if the actual capacitance of the component being tested is less than about 5μF, the range switch may now be switched to lower ranges to bring the balance point to the scale-centre decade (5 to 50 capacitance units) where final readings can be taken with optimum accuracy virtually equivalent to a conventional linear bridge. Thus all capacitance values from 5000pF to 50μF can be brought into this centre decade by suitable range selection and only small capacitances from 50 to 5000pF must be measured in lower decades, or large capacitances from 50 to 1000μF measured in higher decades, in each case subject to somewhat poorer resolution. However, the type of bridge excitation and balance detection used in this circuit give extremely clear and sharp dips of the meter reading throughout the entire range from 50pF to 1000μF.

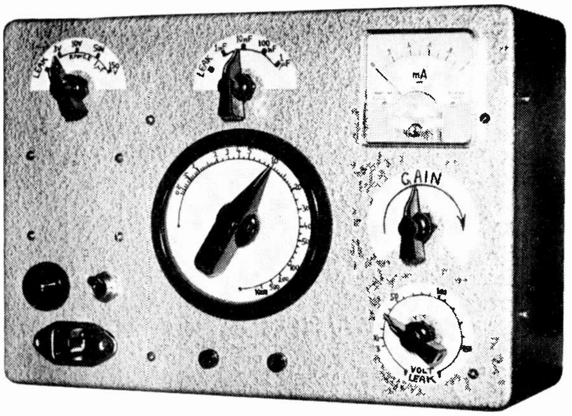
If the amplifier gain control VR3 is set to give about 20% full scale meter deflection at any arbitrary *balance point* taken in any range with any test capacitor it will not require readjustment for most other measurements throughout the coverage of this instrument. For optimum search operation however the gain control may be adjusted initially to give half-scale meter deflection somewhere off-balance in the selected range, then sweeping the calibrated potentiometer rapidly to locate the approximate sector containing the balance point (sharp dip of meter reading), and finally moving slowly into this balance sector, increasing the gain progressively to maintain at least 20% f.s.d. meter reading.

Note that if insufficient amplifier gain is used the meter will dip right to zero as the true balance point is approached, and will remain at zero for a considerable sector containing the true balance point before it rises again on the other side. On the other hand if excessive amplifier gain is used the meter reading may not dip at all, staying put at about 80% f.s.d., or it will dip weakly and erratically (often several closely spaced dips in rapid succession) in the region greater than half-scale deflection. These incorrect gain settings can be recognised at once according to the following criteria. Switch to the highest range and locate the balance dip with any or no capacitor connected. The gain setting is too low if the meter dips below 20% f.s.d., and too high if it does not dip below 40% f.s.d. It should dip to about 20% f.s.d. for sharpest balance readings.

APPLIED VOLTAGES

The bridge is operated with an a.c. input voltage whose fundamental frequency is the 50Hz mains frequency and whose peak amplitude is restricted to about 4V by D1 and D2. These zener diodes serve a much more important function than mere voltage limiting however, as will become clear later.

A pair of capacitors form an a.c. voltage divider in one bridge branch in each range, e.g. C1 and C8 in the highest range. The capacitance ratio is about 10:1 in each range. Thus the applied a.c. voltage across the test capacitor is roughly 7·5V peak-to-peak when the balance reading lies near the zero end of the scale, dropping to about 80mV peak-to-peak



when the balance point lies near the 1000 units end of the scale, regardless of range.

Electrolytics are measured in the top-end region of the scale so that their capacitance readings are actually taken with vanishingly small applied alternating voltages. Many conventional commercial bridges measure large-scale electrolytics under similar conditions, without making any further provision for proper d.c. polarisation. It is maintained that satisfactory capacitance readings can be obtained for electrolytics in an ordinary a.c. bridge without any form of d.c. polarisation provided the applied alternating voltage is kept sufficiently small.

Having read this on the face of it surprising assertion in various sources of information the author tested its validity in the course of designing the instrument published here. It was found that healthy, properly formed electrolytics invariably gave correct capacitance readings with pure applied a.c. not greater than 1-2V peak-to-peak without any form of d.c. polarisation. However, many electrolytics which had been stored for lengthy periods and whose dielectric had deteriorated gave quite erratic readings under these conditions. When these capacitors were then charged up to even a fraction of the nominal d.c. working voltage, discharged again, and remeasured with pure a.c. the correct readings were obtained in a stable manner. A few samples still gave somewhat erratic readings of capacitance under pure a.c. conditions. These showed rapid re-deterioration of the dielectric when returned to the shelf for further storage, whereas healthy samples maintain their reformed dielectric for at least a week.

From these observations it may be concluded that d.c. polarisation is not essential for capacitance measurements of healthy electrolytics in a conventional a.c. bridge, but facilities for simultaneous variable d.c. polarisation provide valuable criteria for assessing the extent of temporary or permanent damage to the dielectric through prolonged storage, dryout in consequence of excessive heat developed in equipment, or other adverse influences.

DC POLARISATION

S2B provides in positions 1 to 4 four respective d.c. polarising voltages of about 3, 10, 50 and 150V which are applied simultaneously during capacitance measurements *in the highest range (1μF scale unit) only*. In the other three capacitance ranges no d.c. polarisation is applied to the test capacitor but S2 must be set to any one of the voltage positions because its other wafer connects the meter to the balance amplifier in these positions, or to the leak-test circuit in the fifth position.

Thus range 2 extends from zero to 100μF *without* d.c. polarisation while range 1 extends from zero to 1000μF *with* selectable d.c. polarisation. Both are suitable for measuring the capacitance values of small to fairly large electrolytics. If such a component in a piece of television equipment is suspect, e.g. an h.t. decoupling electrolytic, disconnect and discharge it. *First* switch the tester to range 2 (no d.c. polarisation). *Then* connect the suspected electrolytic to the tester and take a capacitance reading. Now switch to range 1 (with d.c. polarisation) after first having selected 3V polarisation. Take a new capacitance reading. Repeat up to all polarisation voltages within the nominal working voltage range of the electrolytic capacitor. Then discharge the capacitor and remeasure in range 2 (no d.c. polarisation).

If there are any significant mutual differences between any of these readings the condition of the dielectric has permanently deteriorated and it is wise to replace the electrolytic even if it shows no obvious leakage fault. In particular, serious deterioration may be assumed if the *final* a.c. capacitance reading differs significantly from the polarised capacitance readings. Electrolytics failing the test described may well be the cause of a number of elusive *intermittent* faults whose symptoms when they appear suggest faulty electrolytics but when no obvious faults can be found in the electrolytics during the long spells of normal performance of the "faulty" equipment.

REVERSE POLARISATION

As a matter of interest the behaviour of healthy electrolytics with reverse d.c. polarisation was also briefly studied, by connecting the electrolytic the wrong way round to the *C*x terminals and taking readings in capacitance range 1 and in the leakage test function. It was found that a healthy electrolytic gives at most slight leakage and quite normal stable capacitance readings up to some 3 to 10% of nominal forward value reverse polarisation, whilst at some voltage around this limit the component reverts abruptly to a short-circuit. Even when operated for quite considerable periods with the resulting sustained short-circuit current, subsequent correct-sense polarisation immediately restores a good stable dielectric and correct capacitance, passing the tests described above.

Permanent damage through reverse polarisation short-circuit current seems to be a function of the total reverse charge passed, i.e. the extent of the resulting electrolysis. Excessive reverse currents can also produce overheating and may burst the casing explosively. Brief reverse polarisation short-circuit currents of reasonable magnitude usually do no permanent damage to an electrolytic.

However it is not permissible to exploit the basic ability of an electrolytic to function up to about 3-10% of nominal working voltage with reverse polarisation since breakdown may take place suddenly and without warning anywhere in this range. Recently the author was consulted by a company which was having trouble with certain modules in their marketed equipment. These worked well when new but more than 50% failed after less than 100 working hours, always a certain electrolytic giving trouble. Often this electrolytic was not damaged or destroyed but merely caused the circuit to "stick" in certain states and, once jumped over again by artificial means, correct operation was restored for long periods before the next "sticking" breakdown occurred. These modules were basically slow timebases and careful investigation carried out by the author revealed that the electrolytic in question, an 8μF 350V type, was normally swept between about zero and +200V by a sawtooth waveform of correct polarisation polarity, but the flyback always went to about −1·2V reverse polarisation to overcome the silicon threshold voltages of a diode and base-emitter junction of a transistor connected in series to trigger flyback termination. Occasionally the reverse polarisation was unable to reach −1·2V before breakdown of the electrolytic insulation so that the flyback was not terminated, the circuit stuck in the low state and recharge could not commence. The author advised this client to use a small microfoil capacitor instead of an electrolytic in this position and there has been no trouble since.

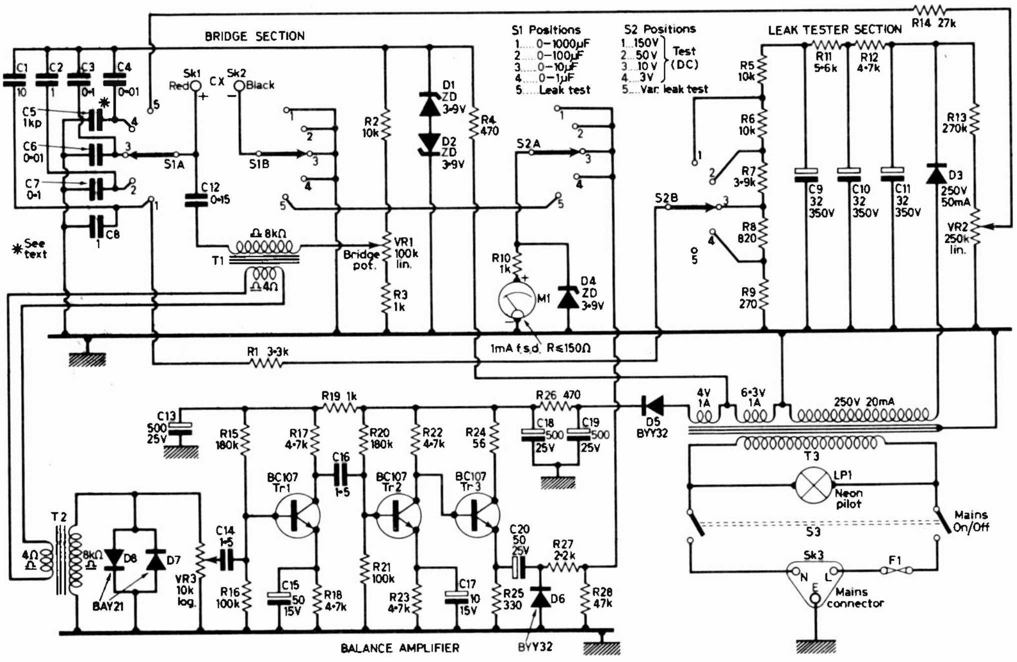


Fig. 1: Circuit diagram of the capacitor tester.

LEAKAGE TESTS

The purpose of a capacitor leakage test is to measure the leakage current flowing as steady d.c. through the capacitor when a certain d.c. voltage is *sustained* across the capacitor. The basic circuit for this purpose consists of the capacitor, a milliammeter and a d.c. voltage source connected in series, but there are a number of refinements necessary to derive a practical circuit.

The basic circuit can lead to destruction of the meter if the capacitor possesses a short-circuit or low-resistance leakage fault. Thus it is necessary to include series resistance such that the meter current is not excessive (i.e. not much greater than full-scale deflection) in the event of the test capacitor being a dead short-circuit. This series resistance brings two new problems. First of all any actual leakage current causes a voltage drop across it, so that the effective capacitor voltage for which the leakage current reading is taken is significantly less than the applied source voltage. And secondly the finite series resistance can lead to embarrassingly long time-constants. The meter will always give an initial reading due to the charging current, decaying away exponentially to zero as the capacitor reaches full charge. If there is no leakage the meter reading will drop to zero; otherwise it will decay exponentially to the leakage current which then persists indefinitely.

The voltage drop problem is less serious because the errors it introduces can easily be reduced to within normally acceptable tolerance limits, but the time-constant problem is very important because if suitable remedies are not devised it can prolong the time required for taking a leakage current reading beyond all reasonable limits. In practice we must await the elapse of a period equal to at least five times the circuit time-constant before a capacitor may be considered as fully charged (residual charge deficit less than 1%).

We are using a 1mA meter and test voltages up to 150V, so that the series resistance would have to be about 100kΩ to avoid meter damage in case of short-circuit faults. A 100μF electrolytic would give a time-constant of 10 seconds in this circuit, so that significant charging current would persist through the meter for 50 seconds before a leakage current reading could be assessed. For a 1000μF electrolytic we would have to wait nearly 10 minutes

★ components list

Resistors:

R1	3·3k Ω
R2	10k Ω 1%
R3	1k Ω 1%
R4	470 Ω 1W
R5	10k Ω 2W
R6	10k Ω 2W
R7	3·9k Ω 1W
R8	820 Ω
R9	270 Ω
R10	1k Ω
R11	5·6k Ω 2W
R12	4·7k Ω 2W
R13	270k Ω 1W
R14	27k Ω
R15	180k Ω
R16	100k Ω
R17	4·7k Ω
R18	4·7k Ω
R19	1k Ω 1W
R20	180k Ω
R21	100k Ω
R22	4·7k Ω
R23	4·7k Ω
R24	56 Ω
R25	330 Ω
R26	470 Ω 1W
R27	2·2k Ω
R28	47k Ω

All ½W and 10% unless otherwise stated

VR1	100k Ω lin. (substantial size)
VR2	250k Ω lin.
VR3	10k Ω log.

Miscellaneous:

F1	Mains fuse, 0·5A medium delay
LP1	Panel mounting neon pilot lamp, 220V a.c.
S1, S2	Each 2-pole 5-way paxolin
S3	Double-pole toggle mains switch
Sk1, Sk2	Insulated wanderplug sockets, Sk1 red, Sk2 black
Sk3	Three-pin mains connector
T1, T2	Two identical miniature output transformers, typically 8k Ω/4 Ω/100mW, see text
T3	Small mains transformer, 250V 20mA, 6·3V 1A, 4V 1A typical, see text

Meter, 1mA f.s.d. moving-coil, Ri less than 150 Ω (any smaller value usable)

1 scale with large pointer knob approx. 4 in. diameter, 4 pointer knobs, material for cabinet, solder, wire, tags, bolts etc.

Capacitors:

C1	10μF 500V paper
C2	1μF 500V paper
C3	0·1μF 500V paper
C4	0·01μF 500V paper
C5	See text. Value 1000pF with strays. 820pF ceramic in prototype
C6	0·01μF 500V paper
C7	0·1μF 500V paper
C8	1μF 500V paper
C1-C8	should be best available quality and trimmed for accurate capacitance ratios (see text)
C9	32μF 250V el.
C10	32μF 350V el.
C11	32μF 350V el.
C9-C11	any values 16-50μF suitable—use highest value for C11 if unequal values used
C12	0·15μF 500V paper (or greater up to 0·5μF)
C13	500μF 25V el.
C14	1·5μF 100V microfoil (2μF 25V el. usable, +ve to Tr1 base)
C15	50μF 15V el.
C16	1·5μF 100V microfoil (2μF 25V el. usable, +ve to Tr1 collector)
C17	10μF 15V el.
C18	500μF 25V el.
C19	500μF 25V el.
C20	50μF 25V el.

Semiconductors:

Tr1-Tr3	BC107 or similar (β100-500)
D1, D2	3·9V (approx.) zeners, 25mA or greater
D3	Selenium or silicon h.t. rectifier, 250V a.c., greater than 50mA d.c.
D4	As D1, D2
D5, D6	Small silicon l.t. rectifiers, typically 24V a.c., 250mA d.c.
D7, D8	Any small silicon signal diodes

before being able to take a leakage current reading. If we consider 5 seconds to be the maximum charging delay still acceptable, we see that the 100kΩ circuit as it stands is acceptable only for determining the leakage currents of capacitors up to 10μF. For small capacitances there is no problem, the meter just giving a brief kick and then immediately reading zero or any leakage current present.

To obtain quick leakage current readings for any capacitance value, even for several thousand microfarads, a system of temporary manual source voltage boost has been adopted. Suppose we wish to measure the leakage current with a sustained voltage V across the capacitor. If we start by applying a source of voltage of $n \times V$ volts, where n is a large factor, say 5 or more, the capacitor will not take five times the circuit time-constant but only a fraction $1/n$ (approximately) of the circuit time-constant to reach the desired charge voltage V. Thus after a very short time we can cut back the charging source voltage from $n \times V$ to V, whereupon the meter drops back immediately to the leakage current.

The practical circuit based on this principle operates as follows. R13 and VR2 form a voltage source with mean impedance 100kΩ and continuously variable from zero to about 150V. S1 and S2 must both be set to the fifth position marked "leak". This connects the meter in series with the Cx terminals and a limiting resistor R14 across the source voltage between VR2 slider and chassis. Maximum possible charging or short-circuit current can flow when VR2 slider is at the top of the track. R13 limits this current to just over 1mA so that the meter is fully safeguarded in this mode even if R14 were omitted.

However, let us assume for a moment that R14 is omitted and that a healthy capacitor of substantial size connected to the Cx terminals has now charged up to the voltage selected at VR2 slider or some large fraction thereof. If VR2 is now suddenly turned back to zero so that the slider is at the chassis end of the track the meter is left connected as a short-circuit across the charged capacitor. Thus the pointer slams back hard against the zero end stop, the large current surge can burn out the meter coil and the bottom end of the track of VR2 may also be burnt out. These dangers are obviated by including R14 which restricts the maximum possible discharge current to about 6mA. Most of this is taken up by D4 in the forward direction operating as an ordinary diode with some 600mV silicon threshold, so that the actual reverse meter current is restricted to some 60% of the normal 1mA f.s.d. rating. It would appear to be satisfactory on first sight to use an ordinary silicon rectifier diode for D4, but this still fails to protect the meter in case an already charged capacitor is connected to the Cx terminals inadvertently with incorrect polarity. The meter is protected in this case also when D4 is a zener diode. R10 is needed to convert the meter to a 1V f.s.d. voltmeter and for proper operation of D4 in both its functions. For balance detection in the *C*-measurement function we actually need a 3V f.s.d. voltmeter, and R27 here provides the necessary additional series resistance.

LEAKAGE READINGS

To take a leakage reading for a small-value capacitor set VR2 to zero, connect the capacitor to the *C*x terminals, turn up VR2 to the desired test voltage and take a reading. For all capacitance values up to 10μF a leakage current reading is obtained at once or within 5 seconds. The meter reads the leakage current directly on its normal scale of 1mA f.s.d. Adequate accuracy in relation to the voltage drops is given for purposes of general assessment as long as the leakage current is less than 0·5mA so that the meter reading remains in the bottom half of the scale. The smaller the reading the more accurate it is in this respect.

We are concerned chiefly with non-electrolytic capacitors when measuring capacitances up to 10μF. With the maximum available test voltage of 150V a leakage current reading of half-scale, viz. 0·5mA, implies a leakage resistance of 300kΩ which may be considered as fully defective insulation for a non-electrolytic capacitor. If the half-scale reading is obtained or exceeded with smaller test voltages this implies even smaller leakage resistance and thus all the more reason for discarding the capacitor in question. Thus a leakage reading greater than half scale for a test voltage within the nominal voltage of the capacitor is always a clear indication of defective insulation in a non-electrolytic capacitor.

At the other extreme, a leakage current of 0·01mA is clearly detectable with the meter and if this is obtained with the 150V test voltage it implies a leakage resistance of 15MΩ. This is the very minimum value which may be classed as sound for a non-electrolytic capacitor. Thus a really good non-electrolytic capacitor should give no detectable leakage current reading whatsoever for any test voltage within its nominal range. Note that non-electrolytics tend to be destroyed if test voltages greater than the maximum nominal working voltage are applied. Some modern microfoil capacitors are rated for only 60V or 100V, and special ceramic types giving very large capacitances in extremely small volumes are rated for only 25V. Do not rely on the self-healing properties of microfoil capacitors since these are often dubious once voltages well above the nominal limit are applied!

LEAKAGE OF ELECTROLYTICS

Contrary to the behaviour of non-electrolytics, electrolytics normally suffer no damage if attempts are made to apply excessive voltage of correct polarity, or reverse voltage, provided the circuit resistance is high enough to limit the current to a small value if and when temporary breakdown takes place. A breakdown current of 1mA is normally harmless for several minutes in all except microminiature electrolytics. Thus it is hardly likely that low-voltage electrolytics can be damaged in the leak test with this instrument, even if VR2 is turned up to the full 150V and/or the electrolytic is inadvertently connected to the *C*x terminals with incorrect polarity. In these cases the meter reading will stay put at some large value indicating high leakage under the given conditions, but the capacitor will still be found to be intact provided proper operating conditions are restored without undue delay.

Whenever we are unable to take direct leakage readings as described above due to high-capacitance values giving large charging time-constants, we are almost invariably dealing with electrolytics and the fact that these normally tolerate temporary excess voltage breakdown under conditions of current limiting makes the boost method described below eminently suitable for quick assessment of their leakage current without any significant danger of possible destruction.

To explain the operating procedure let us consider as a typical example the leakage current determination for a 1,000μF 6V electrolytic. Even good electrolytics, especially high-capacitance ones, may show quite large leakage currents up to 1mA and more when operated close to the maximum nominal voltage. This is not to be considered as a fault although its absence is a feature of really good electrolytics. For normal purposes it is better to use test voltages of 30 to 50% maximum nominal rating for assessing the dielectric condition of an electrolytic capacitor.

Under these conditions the performance should be similar to that of non-electrolytics, i.e. good electrolytics should show little or no detectable leakage current. Values up to 0·25mA may be acceptable—particularly for very large capacitance values—but readings of 0·5mA and greater are grounds for rejection. Thus an appropriate test voltage for our example is 3V. The time-constant in seconds is roughly a tenth of the capacitance in microfarads as a general rule for this instrument, so that we expect a charging time-constant of about 100 seconds. If we want to get a reading within five seconds, i.e. a twentieth of the time-constant, we must use a voltage boost factor of 20, i.e. use a starting voltage of 60V. Thus first set VR2 to zero, connect the 1,000μF 6V electrolytic and then advance VR2 to 60V. The meter will move at once to full scale, and after about 5 seconds it will have dropped by 1/20th of the initial reading, indicating that 1/20th of the charging process to 60V has been completed, i.e. that the capacitor is now charged to the desired 3V. Now turn down VR2 so that the meter pointer drops without delay until the meter reading is exactly zero. The reading against the scale of VR2 is now about 3V, i.e. the voltage to which the electrolytic has actually been charged. Now watch the meter pointer for a few seconds. If it stays put at zero there is no significant leakage. If it commences to rise there is leakage present. Next decide the maximum acceptable leakage current for the intended application, say 100μA. Carefully turn up VR2 again through a small angle to the point where the meter now reads the chosen acceptance limit of 100μA. Again watch the pointer for a few seconds. If it drops the actual leakage current is less than 100μA. If it rises the actual leakage current is more than 100μA and the capacitor must be discarded for the envisaged application.

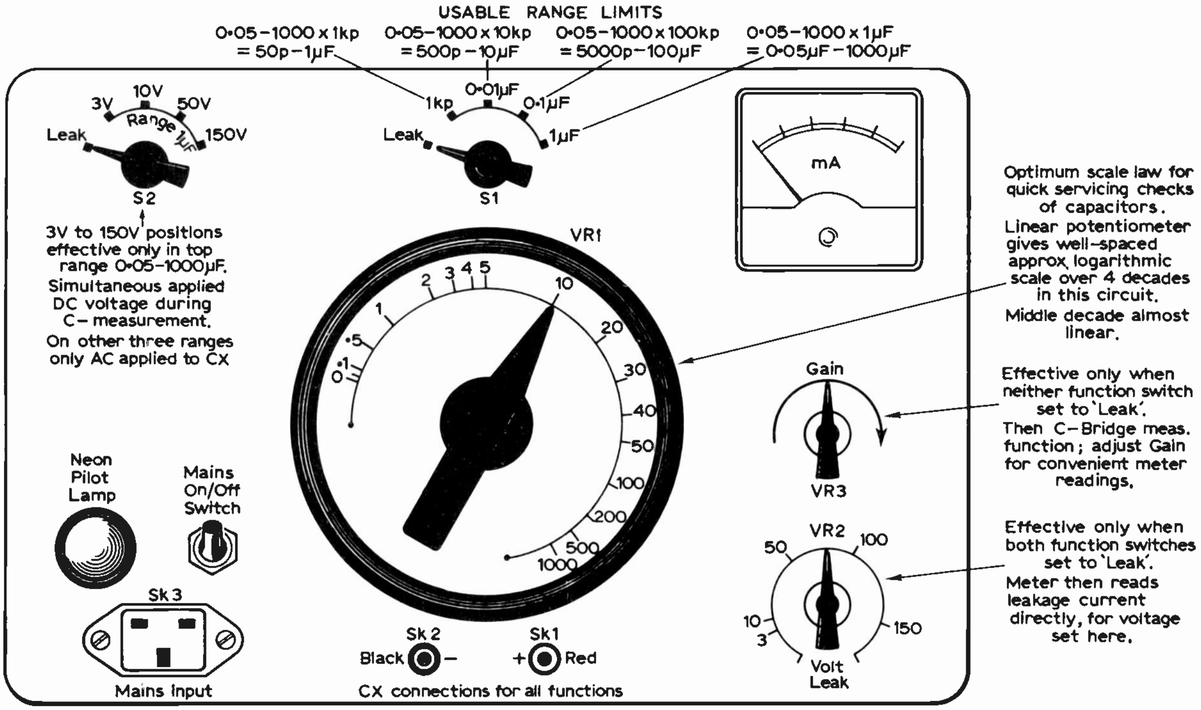


Fig. 2: Front panel layout and details of the controls and ranges.

It is permissible to skip the zero reading and go directly to the acceptance limit test from the initial boost voltage setting. With this method it is possible to obtain an assessment whether the actual leakage current is smaller or greater than a chosen limit within a few seconds even for the largest-value electrolytics likely to be encountered. Suitable test voltages are 3V for nominal 6V electrolytics, 6V for 12V rating, increasing roughly proportionally up to 150V for 450/550V electrolytics. Leakage currents exceeding 0·5mA under these conditions are normally grounds for suspicion or rejection.

Thirty per cent of nominal rating is an adequate voltage for reforming the dielectric of any electrolytic so that samples showing excessive leakage may be left connected at this setting for a while. If no significant improvement is evident after a few minutes the dubious capacitors should be discarded or at least not used in equipment required to give reliable performance.

CAPACITOR FAULTS SUMMARY

Leakage tests are indispensable in conjunction with bridge capacitance measurements because it is not possible to detect all common capacitor faults encountered during equipment servicing if relying on either a leakage test or a capacitance measurement alone. Normally it is advisable to commence with a leakage test and only if this is satisfactory to proceed to a capacitance measurement.

Apart from obvious short-circuit faults (very high leakage test readings) or open-circuit faults (very low or zero capacitance readings) a number of more subtle fault conditions can arise. These consist almost entirely of various forms of unstable conditions in the dielectric. If such instability is present in the dielectric of an electrolytic capacitor it is detected by erratic capacitance readings in the a.c. bridge without additional d.c. polarisation, persisting even after temporary d.c. polarisation, so that proper capacitance readings are obtained only when d.c. polarisation is also applied. Such faults in electrolytics need not be accompanied by excessive leakage current and thus may not even be indicated during the leakage test.

An unstable dielectric—often puncture damage caused by brief application of excess voltage at some earlier time—in a non-electrolytic capacitor normally does not affect the stability of capacitance readings, which are correct under pure a.c. and polarised conditions, nor need this fault be evident in the leakage current test at very low test voltages. It is usually revealed by a sudden abrupt appearance of high leakage current at some test voltage well below the nominal rating.

Small decoupling capacitors in the i.f. strips of TV receivers have been known to develop this type of fault, probably through surge voltages arising before the valves have warmed up and drawn current, or through temporary short-circuits inside the valves or at the valveholder pins through careless application of meter test prods. The damaged capacitors may give quite correct capacitance readings in a bridge, and negligible leakage current readings with test voltages up to about 50V (nominal rating 250-500V), so that simple testers pass them as in order and a lot of time may be lost looking for other non-existent causes of the short-circuit known to be present from voltage measurements at the valve pins of the running receiver. In fact a capacitor with this kind of fault possesses a voltage-threshold leak which normally becomes apparent well below 150V. Thus all capacitors whose nominal rating exceeds 150V should be subjected to a leakage test at 150V.

CONTINUES NEXT MONTH

TRANSISTORS IN TIMEBASES

PART 6 THE THYRISTOR IN TV

H. W. HELLYER

Colour television receiver design is bringing into prominence several devices which have not previously played a part in television receiver operation. Amongst these the *thyristor* will probably be of considerable importance.

The thyristor—which is also known as the *silicon controlled rectifier* (s.c.r.)—is a three-junction, three-terminal semiconductor rectifier which blocks flow of current in both directions but can be triggered so that current flows in the forward direction while still being blocked in the reverse direction. Thus it behaves as a switched rectifier. The main power connections are made to the anode and cathode terminals, just as with a normal rectifier, but a trigger signal can be applied to the third *gate* electrode.

The thyristor is switched into conduction when both the gate and the anode are positive with respect to the cathode. If the anode goes negative with respect to the cathode the thyristor switches off. In the triggered state the characteristics are similar to those of an ordinary silicon rectifier diode. The trigger signal is a small current pulse and when the device is switched on it remains on until the load current is reduced to nearly zero when it automatically switches off. The great advantage of the device is that an alteration of the triggering time with respect to the input waveform gives control over the power delivered to the load circuit.

HOW THE THYRISTOR WORKS

Now to how it works, which can be simply explained with the aid of Fig. 1. This shows at (a) the basic four-layer, three-junction pnpn structure. Fig. 1 (b) and (c) show how this basic four-layer structure can be regarded as two transistors, an npn one and pnp one, so arranged that the collector of one drives the base of the other and with the gate terminal connected to the base of the npn transistor and the collector of the pnp one—it is the connection for base drive that starts the operation however.

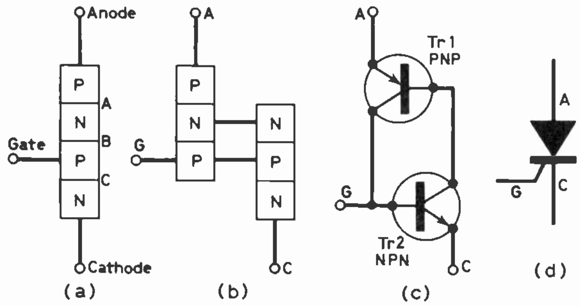


Fig. 1 (a) Basic pnpn thyristor arrangement with gate connection. At (b) and (c) are shown the two-transistor analogy. (d) Circuit symbol.

Let us consider three possible operating conditions. The first condition is where the anode is negative with respect to the cathode—forgetting the gate for the moment. In this condition junctions A and C—see Fig. 1 (a)—are reverse biased and no current flows through the thyristor.

The second condition is where the anode is positive with respect to the cathode and the gate is at cathode potential. In this condition junctions A and C are forward biased but junction B is reverse biased—or, to look at it from the analogy of the two transistors shown in Fig. 1 (c), Tr2 is without base bias and is thus off—so that again no current flows. However if the voltage across the device is great enough avalanching across junction B will occur and current will then flow through it.

The interesting condition however is the third, with the anode positive with respect to the cathode and the gate also positive to the cathode. Tr2 emitter junction is thus forward biased so that this "transistor" conducts, feeding current to Tr1 base so that this second "transistor" also conducts. The point to note here is that when Tr1 conducts it feeds current to Tr2 base: thus both "transistors" are conducting and the thyristor continues to conduct even if the gate bias is removed. Hence all that is needed to switch the thyristor on is a brief pulse at the gate. The thyristor then remains on until the operating conditions approach our first condition—anode negative with respect to cathode—when the device switches off.

The advantage of the thyristor will now be apparent. If we use it as the mains h.t. rectifier the point during the positive input a.c. waveform at which it conducts can be controlled to give us control over the mean d.c. output. If, then, we can control the timing of the triggering pulse, we can achieve stabilisation of the output.

THYRISTOR CHARACTERISTICS

Before we look at some practical circuits let's take a brief look at the electrical characteristics of the thyristor, borrowing from information published by Texas Instruments Ltd. for our facts. The electrical characteristics are shown in Fig. 2. The curve shown at (a) looks very much like the curve of a zener diode except that the forward conducting state is not quite so steep and the reverse avalanche breakdown curve is also more rounded than we would expect to find with a zener diode. Looking now at the application of a sinusoidal waveform and its effect—Fig. 2 (b)—we see that as the voltage increases in the forward direction no load current flows until the trigger pulse is applied to the gate. At this point, B, current flows through the thyristor and follows the shape of the applied waveform through what is left of the positive half-cycle. During the negative half-cycle there is virtually no current flow (except for a small reverse leakage current) so that from C and D and back to A the voltage across the thyristor follows the applied input but the current from the device is negligible. Clearly by varying the position of B on the time scale the proportion of the forward half-cycle used to provide current is also varied and control of the mean rectified d.c. thus achieved.

In Fig. 1 we saw the thyristor as a pnp and an npn transistor coupled together with, as (b) brings out, a common collector junction B. In our third operating condition, with the anode and gate positive with respect to the cathode, junction A is forward biased (i.e. positive on the p side), junction B reverse biased (the anode is more positive than the gate), and junction C forward biased. So A is biased as Tr1 emitter junction, C as Tr2 emitter junction while B is the reversed-biased collector junction for both "transistors". Let's concentrate on the currents passing through junction B.

As junction B is reverse biased there will be a small leakage current Ico. The current through junction A is equal to the main current through the device, I, which is also the current through the load. Because this current also flows through junction B the effective current at this point will be $\alpha_1 I$ (α_1 is the forward current gain of the pnp transistor Tr1). But I also flows through junction C and we therefore also have a collector current through junction B equal to $\alpha_2 I$, where α_2 is the gain of Tr2. So the total current through B is $Ico+\alpha_1 I+\alpha_2 I$.

The total current at any point through such a series circuit must be I. So we can express the statement that the total current I equals the sum of the above three currents in another way:

$$I=\frac{Ico}{1-(\alpha_1+\alpha_2)}$$

If the sum within the brackets of the lower line is small, I will be small—somewhere near the leakage current. The s.c.r. then has a high impedance or in other words the reverse-biased junction B blocks the applied voltage. If the sum of the two αs approaches unity however the current through B goes up, and when unity is reached this current suddenly rises to the upper limit determined by the external load. If this change in α value is sudden the device changes from the high-impedance blocking state to a hard-on conducting state.

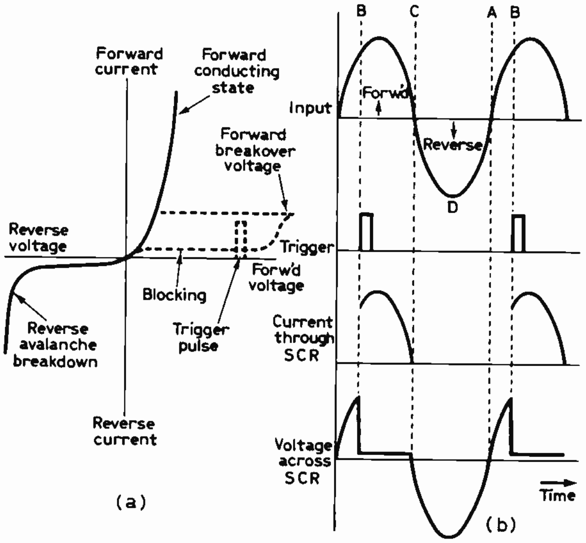


Fig. 2 (a) Basic thyristor characteristics. (b) Operation of the thyristor as a rectifier.

TRIGGERING

To increase α rapidly a small current can be fed to the base of Tr2 to increase its emitter current. This takes advantage of one of the features of a silicon transistor—its gain is small with low emitter current but rises quickly as emitter current is increased. If we feed a small triggering current It into the base of the npn transistor it will be amplified, appearing at the collector as $It\beta_2$ where β_2 is the common-emitter current gain of Tr2. When this current flows into the base of Tr1 it is amplified again, becoming $It\beta_2\beta_1$ at the collector. When $\beta_2\beta_1$ is greater than unity the system is regenerative and the thyristor triggers, but the actual values of β depend on the trigger current. A small current between trigger gate and cathode will set things going.

If there is no trigger but the applied voltage is steadily increased the leakage current Ico rises until a point is reached where the α sum is sufficiently great to instigate triggering. This is the so-called "self-breakover" (see Fig. 2(a)) point. The other way round, with reverse voltage applied, the device acts a single pn junction and the voltage it can handle is limited by the avalanche breakdown of the junctions.

APPLICATIONS

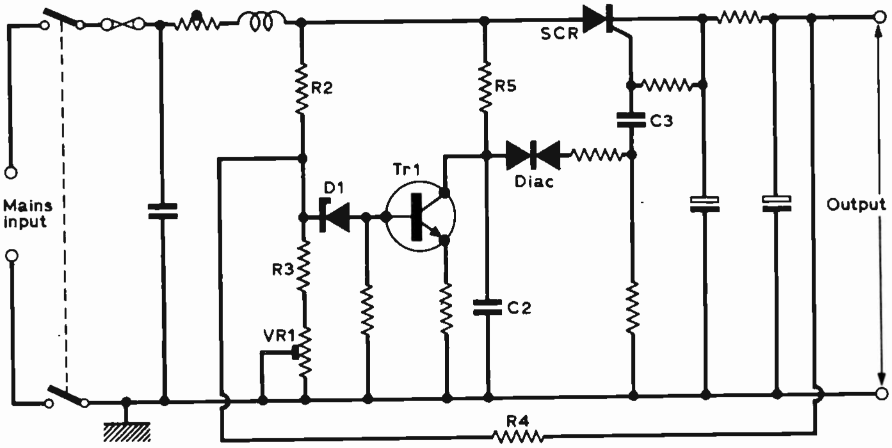
Applications of the thyristor include lighting circuits where solid-state dimmers are an obvious development. Whereas earlier dimmers had to use fairly heavy wirewound variable resistors dissipating a lot of heat as they handled the unwanted power, the thyristor, with its ability to handle from full power down to about 10 per cent and its rapid switching action, simply prevents the power from being developed through the load circuitry so that there is no heat loss—and no wastage. Thyristors selling at less than £5 can be used to control lighting circuits with a full-power rating of as much as 600W. It is an incidental bonus of the thyristor that it aids colour television viewing since this needs some adjustment of room lighting intensity for best conditions.

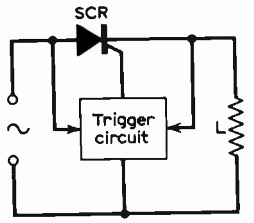
Speed control of motors, temperature control of heating elements and the more efficient use of flood lamps are among other uses the thyristor has found. But as far as we are concerned its prime importance

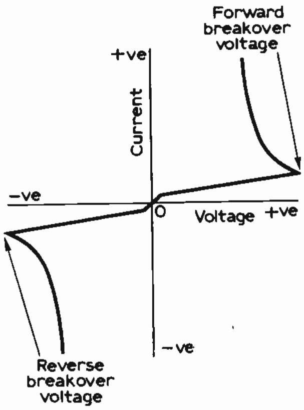
Fig. 3 (right): Mullard stabilised thyristor power supply circuit for all-transistor colour receivers.

Fig. 4 (below left): Block schematic diagram to show the basic feed paths in the circuit shown in Fig. 3.

Fig. 5 (below right): Diac characteristic curve. As can be seen the device is bi-directional, conducting in either direction once the breakover voltage has been reached.







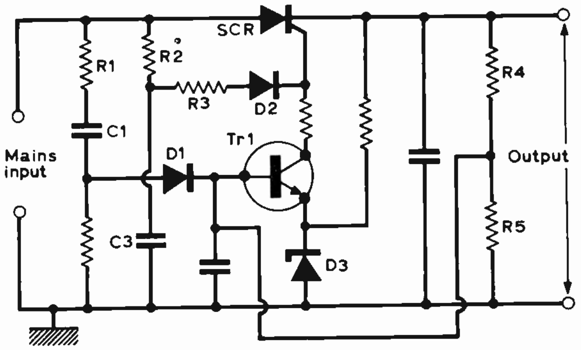


Fig. 6: Transistor-controlled thyristor power supply, with stabilisation, by Rank-Bush-Murphy.

is its great help to the designer of a colour TV set who wants a regulated power supply without heat and current losses but with excellent stability.

THYRISTOR POWER SUPPLY CIRCUITS

To return then to the practical side of things, a thyristor power supply circuit for an all-transistor colour receiver as suggested by Mullard Ltd. will provide an h.t. of 200V from a 220V a.c. mains input without a transformer, and the output can be stabilised against both mains supply variations and load changes by a simple control circuit. An all-transistor receiver requires a stabilised h.t. line because of the mode of operation of the line output stage where the transistors are used as switches being driven, as we have seen in previous parts, from fully off to hard on and vice-versa rapidly to avoid excessive dissipation. With this mode of operation it is not possible to use the type of e.h.t. stabilisation used with valved line output stages, using a v.d.r. in a feedback loop, and to avoid variations in picture width, called "breathing", it is necessary to operate the line output stage from a stabilised h.t. line.

The complete Mullard circuit is shown in Fig. 3. The output is stabilised by altering the triggering time of the thyristor as the mains input voltage or load current vary. The basic idea is shown in simplified block diagram form in Fig. 4, where the a.c. input is applied to the thyristor (SCR) in series with the load *L*, and a trigger circuit fed with the mains signal and a reference signal fed back from the output is used. In the complete circuit we see yet another device, the diac, which is used to control the triggering. The diac is a three-layer (pnp) device which is thus equivalent to a pair of diodes connected back-to-back. It therefore blocks current in either direction. However when the voltage across it reaches a certain level, the breakover voltage, avalanching occurs across the junction which is reverse biased and the device then conducts. The characteristic is shown in Fig. 5, and it will be appreciated from the foregoing that as Fig. 5 shows the device is bidirectional, conducting in the forward direction when the forward breakover voltage is reached and in the reverse direction when the reverse breakover voltage is reached. In Fig. 3 the Mullard diac type BR100 is used, this having a nominal breakover voltage of 32V. The basic triggering action is as follows: on switching on C2 charges via R5 from the a.c. mains. When the voltage across it reaches the breakover voltage of the diac, the diac conducts, discharging C2 and feeding a current pulse via C3 to the gate of the thyristor SCR which is thus also switched on and feeds current to the load.

STABILISATION

Stabilisation is achieved by transistor Tr1 which as can be seen is connected across the charging capacitor C2 and is thus used to control its rate of charge. The transistor is biased by the network R2, R3 and VR1 across the mains and the d.c. feedback via R4 from the output. Thus the base bias of Tr1 varies with changes in the mains input voltage and

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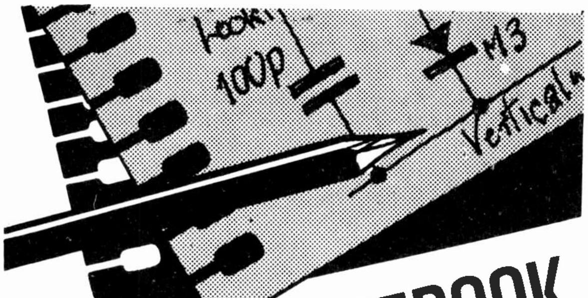


SERVICE NOTEBOOK

G. R. WILDING

Weak Line Sync

A Tendency for vertical lines near the top of the picture to quiver—especially noticeable on the test card—was the fault in a v.h.f.-only 19in. Marconiphone receiver. Very careful adjustment of the line hold control would just remove the symptom, but it reappeared as set temperature increased.

The trouble of course was weak line sync and though this particular effect is not usually due to a defective valve we nevertheless tried a new EF80 sync separator, ECC804 blocking oscillator and PCL84 video pentode. As field lock was good the last valve was a remote possibility, but we had to be certain before getting involved in time-consuming voltage and component checks which generally involve removing the chassis or printed circuit panels. It is a good rule never to remove a chassis, particularly in an oldish set, if this can possibly be avoided.

Valve replacement produced negligible improvement so having the service manual to hand we commenced checking sync separator voltages. These were almost exactly as specified. We next noticed that the sync feed to the ECC804 was by a 25pF capacitor and shunted it with a 100pF capacitor which happened to be the smallest we had in the component kit. Line quiver immediately stopped and the range of the line hold control greatly increased.

It is usually possible to improve or strengthen line hold by increasing the value of the sync feed capacitor, but this is generally at the expense of field interlace. Especially in direct-sync circuits where there is no a.f.c. discriminator between the sync separator and line oscillator the coupling capacitor can feed line pulses back to the field generator to upset interlace, and on more than one occasion we have found really bad line pairing to be due to an oversize line sync coupling capacitor having been fitted in a misguided attempt to improve the line sync when the real fault was completely different.

Sync feed capacitors must therefore be kept to specified value. If it seems necessary to raise their value you can be sure a fault exists elsewhere. Fortunately in our case on snipping out the original and fitting an exact replacement the weak line hold completely vanished.

Bush-Murphy VHF Tuners

There must be many tens of thousands of Bush-Murphy models with v.h.f. permeability push-button tuners and over the years they have proved to be extremely reliable units. Tuning on both bands is effected by a long nylon core with several copper sections which moves through the in-line r.f. and oscillator coils, switch contacts only being operated when Bands are changed by station selection.

On rare occasions and generally only after persistent misuse this nylon rod fractures and renders the tuner completely inoperable. If you come across one of these models and find it impossible to tune to a station you will know the nylon rod is broken.

To replace it first completely remove the tuner from the cabinet—a particularly simple operation since only a few screws and no unsoldering is involved, all connections to the main chassis being by plugs and sockets. On removing the top cover it will be found that partly dismantling the unit from one side will permit the broken sections to be shaken out, while a replacement which costs only a few shillings can be fitted almost as quickly. No special tools are required but when reassembling and before tightening the side securing screws make sure that the sliding switch contacts can move fully under the fixed contacts on both Bands.

The only other trouble experienced with these tuners—as with all types—is poor contact on the Band switch. After brushing or blowing out all surface dust, lightly scrape the sliding contacts to remove ingrained dirt and oxidisation. A hard plastic trimmer screwdriver is ideal for this purpose since it will not cause scratches. To expose all the sliding contact area it is usually necessary to hold the switch in a midway position between Bands I and III. Avoid putting pressure on the fixed contacts and after spraying with proprietary cleaning fluid operate the switch several times and finally apply a thin smear of contact lubricant.

Dark Picture

The report was a very dark picture on a KB 11in. Featherlight portable. This proved to be due to inability to sufficiently increase the brightness level—on no-signal the screen was completely black. In all monochrome receivers the brilliance is varied either by holding the c.r.t. cathode voltage constant and varying the grid voltage or vice versa.

In older models with the video pentode directly coupled to the c.r.t. cathode the most common cause of inability to raise the brilliance level to its full value was the video pentode passing less than normal anode current. This could be due to failing valve emission or an increase in valve bias brought about by a decrease in the value of the resistor often connected from h.t. to the valve's cathode to stabilise the cathode voltage. The cathode bias resistor itself seldom *increases* in value.

However in this modern receiver a.c. coupling is employed from the video pentode to the c.r.t. cathode. After removing the light plastic cabinet—only two screws are involved—we first checked the cathode and grid voltages of the c.r.t. as obviously either the former was too high or the latter too low. To identify positively the c.r.t. base connections I find

SERVICE ACTION: NO EHT
(Conventional valved receivers)

Check by drawing an arc at the c.r.t. anode. Usually it is unnecessary to remove the anode connector: inserting a long thin screwdriver blade under the plastic cover will enable an arc of adequate length to be heard.

(a) Having established zero or very low e.h.t., if a large arc can be drawn from the e.h.t. rectifier anode replace this valve. Where solid-state triplers are used (as in BRC models) the most common cause of failure is breakdown of one of the "stick" rectifiers, usually very evident by the sparking and characteristic odour. The remedy is to replace the complete plug-in tripler unit.

(b) When valve replacement fails to restore e.h.t., remove the c.r.t. anode connector in case a short or heavy leak exists inside the tube from the final anode to a chassis connected point.

(c) If still no e.h.t., check rectifier valveholder and connections.

No arcs obtainable at e.h.t. or line output valve anodes

(a) If line output valve anode overheats, replace line generator.

(b) Should this fail to restore results check and concentrate on the generator stage.

(c) If the pentode screen grid winding glows, replace the boost rectifier (possible internal disconnection or short-circuit across heater).

(d) Check that miniature Barkhausen chokes—usually mounted on top-cap connectors—are not open-circuit.

Only small arcs obtainable

(a) Replace line output pentode.

(b) Replace e.h.t. rectifier (in case of internal short-circuit).

(c) Replace boost rectifier.

(d) Check h.t. rail voltage, especially if a valve or old type metal h.t. rectifier is employed.

(e) Remove boost rectifier top cap. If longer arcs can then be drawn, the boost reservoir capacitor is short-circuit.

(f) Check for ample screen grid voltage.

(g) Check for shorting third harmonic tuning and other capacitors shunted across the line output transformer.

(h) Disconnect scan coil feed in case of winding short-circuit.

(i) Check boost reservoir capacitor is not open-circuit or disconnected.

(j) Compare winding resistance values of line output transformer with published figures. Note however that because of wire variations slight reductions from the values given must not be regarded as a certain indication of a partial short-circuit. Similarly, nearly correct resistance readings do not necessarily imply a perfect winding since even one or two shorting turns will seriously affect the transformer action. Resistance reductions are only fully conclusive as a fault indication when the disparity exceeds the makers' tolerance limits.

it best to remove the connector and locate the small spline from which the electrode numbering commences and continues in a clockwise direction. There was normal cathode voltage on pin 7 but the grid voltage on pin 2 was virtually non-existent.

There were several components that could be at fault, an open-circuit feed resistor, short-circuit decoupling capacitor or even the brilliance control itself. We first checked that there was no short-circuit from the c.r.t. grid to chassis caused by a defective decoupler. There was no short-circuit present so we went straight to the brilliance control to make sure that it was being supplied with adequate voltage from the boost rail There was no voltage present and on referring to the circuit diagram we found that the only possible cause was the 3·9MΩ resistor (R176, page 23, October PRACTICAL TELEVISION) feeding the top of the control from the boost rail. This was found to be completely open-circuit and on replacing it we obtained normal brilliance control.

On occasion—and in any type of set—we come across the opposite type of fault, i.e. inability to fully black out the raster so that what should be totally black areas have a "milky" appearance. Where the c.r.t. is d.c. coupled excessive video pentode anode current will make it necessary to reduce the brilliance control setting below its normal position. When turning the control to minimum still fails to kill the raster the fault is generally due to interelectrode leakage in the tube. However before condemning it make quite sure that the values of all the resistors associated with the brilliance control have not changed.

Dropper Resistors

PROBABLY the most commonly used components in TV servicing are wire-wound resistors used as replacement h.t. surge limiters or as sections of heater droppers, and it is worthwhile mentioning several important points about this usage.

In most cases surge limiters and heater circuit droppers are wound on the same former and as the tag connections become heavily oxidised after years of service I find it best to use the testmeter on a.c. and tap along each section till the break is located. If an ohmmeter is used with the set cold this contact oxidisation often proves to be almost an insulator to the small meter current unless each tag is scraped, but the high a.c. voltage always pierces the worst surface deposit.

A second point is that the resistor winding may be in two separate sections and when the wire is heavily coated what could be assumed to be an open-circuit section may be the dividing space between them.

Most surge limiters are of course placed between the "live" a.c. supply and the rectifier anode, but in many Bush and Murphy receivers the surge limiters are placed between the rectifier cathode and the reservoir capacitor and are linked with other resistors which provide feeds at various voltage levels to the smoothing electrolytics. Thus the surge limiter plus smoothing resistor sections in these models will carry d.c. and be electrically isolated from the heater dropper section(s) wound on the same former. Fig. 1 shows the complete dropper circuitry of the Bush TV141 series.

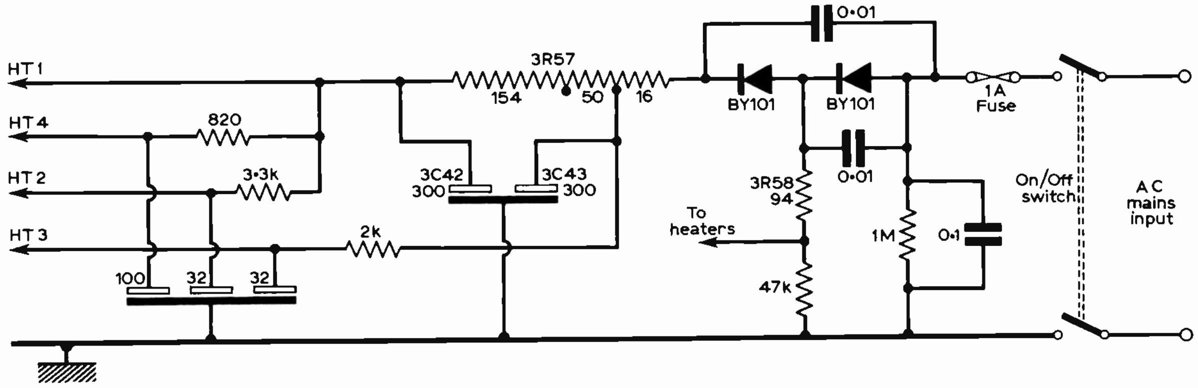


Fig. 1: In most receivers the mains dropper resistor is a multi-tapped power type with one or more sections in series with the heater chain and the rest acting as h.t. surge limiters. This is not always the case, however. In the example shown here, used on the Bush TV141 series, the heater circuit and surge limiting/smoothing sections are electrically separate, though wound on the same former.

As almost the entire UK is now on 240V a.c. mains supplies the heater dropper resistor is untapped, although it must be added that this receiver will operate to design performance on actual voltages between 220 and 255V a.c. However if the receiver is to be habitually operated on less than 220V a.c. a simple modification kit is available to ensure that the valves are operated in accordance with manufacturers' requirements. This emphasises that it is almost as harmful constantly to operate valves just *under* as *over* normal voltages.

In the circuit the 16Ω section of 3R57 is the surge limiter supplying the reservoir capacitor 3C43 (300μF) the other sections being smoothing resistors feeding the various h.t. outputs. An interesting point with this circuit is that if either of the rectifiers goes short-circuit the electrolytics will still be protected from a.c.

When soldering in replacement sections on a multiple resistor it is generally necessary to use high melting point solder, particularly if the tag connections are above the component and therefore subject to rising heat. Most normal soldering irons are ineffectual with h.m.p. solder and it is usually necessary to revert to a solid type for this purpose, but in any event make sure that the replacement leads first make good mechanical connection on to well-scraped contacts.

On occasion the value of an open-circuit wirewound type gets completely burnt off and if the manual is not to hand this presents a problem. My practice is to lightly scrape the insulating layer from the centre of the component and measure the ohmage, if any, from this point to either end. In most cases it will be found that continuity is preserved to one end and by doubling its value a very close approximation to the original value can be made.

Philips Style 70

There was field collapse on one of these receivers but, most unusually, the horizontal line on the screen was displaced well below the normal midway position. At first we assumed that the set owner had been misadjusting the presets and shuffle plates in a misguided effort to restore vertical amplitude, but on removing the back we found the paint seal on the latter to be unbroken.

We then noticed a distinct smell of component overheating, but inspection of the resistors on the timebase panel showed that they were all running normally warm. On next touching the field output transformer mounted at the rear of the panel we found it distinctly hot and rapidly switched off. We then found what amounted to a dead short-circuit between the transformer primary tag leading to the PCL85 pentode anode and chassis, and on removing the three-pin plug to which it is attached from the top of the timebase panel we found that the short remained.

Clearly the short-circuit was in the transformer itself, either from primary to earthed core or from primary to earthed secondary. We then realised that the latter was the case, the displaced horizontal line being caused by the flow of h.t. from the primary via the secondary to the scan coils.

On removing the transformer from the chassis we confirmed this and also found that by moving the primary lead-out wire we could occasionally remove the short-circuit. As is always the case the secondary was wound on top of the primary; but the primary lead-out wire was taken out between the two for extra strength and its insulation had broken down.

We found we were able to fully extract the shorting lead-out wire and were able to secure it to the outside of the transformer with insulation tape. On refitting the transformer we obtained normal height and this continued on test for some time at normal temperature. The set has been back in service for several weeks and given complete satisfaction.

TO BE CONTINUED

FILM SHOW

The annual *Practical Television/Practical Wireless* Film Show will be held this year at Caxton Hall, Caxton Street, London S.W.1 (Great Hall Site) on Friday March 6th, 1970 at 7.15 p.m. for 7.30 p.m. The title of the film this year is *Something Big in Microcircuits* and the lecture will be given by Ian Nicholson of Mullard Ltd.

ICONOS

UNDERNEATH THE DIPOLE

"*We are working to establish a tutorial tradition in the American film such as exists in architecture, music, medicine and law,*" said George Stevens Jr., Director of the American Film Institute, when he recently announced the establishment of a centre for advanced film studies at Greystone, a lush estate in Beverly Hills, California. "*The 55 rooms of the mansion will be refurbished to accommodate projection facilities, film study rooms, sound recording and mixing facilities. There will be a library and a full range of 16mm. and 35mm. equipment, also provision to use motion-picture stages as required*" was the caption beneath an aerial photograph of yet another grandiose American College of Art.

Almost every University in the USA already has its own motion-picture school, a division which usually includes electronic aids and television. It is in the last two categories that such a school can become a useful part of a University. But with many of the great Hollywood studios now closed the career possibilities for a young potential D. W. Griffiths, Fritz Lang or David Lean seem improbable. But what about the admission requirements? It has been announced that although it is expected that "*as many applicants for fellowship of this academy will be University-trained film graduates, no previous academic degree is required for admission. Ideally, Fellowship candidates should have achieved a basic level of technical proficiency and already demonstrated their talents in one or more areas of film making.*"

At this point one must note that a very large proportion of television programmes pumped out from hundreds of American stations at all hours of the day and night originate from colour motion-picture film, not from videotape. To this huge output must be added immense footages of advertising commercials, the standard of which is distinctly below that made by the highly professional TV advertising specialists in London. Of course, American humour and TV taste may differ from ours. Nevertheless the possible eminence of graduates in feature film making is a mirage in the USA just as it is in Britain. By 1975 it is not improbable that both nations will be over-run by hopeful students of all the arts!

THE BBTA

This is another set of initials for us to remember, standing for the British Bureau of Television Advertising. This organisation has published a 32-page booklet about the history of television. *Puck's Promise*, a name based on the character in *Midsummer Night's Dream* who promised to put a girdle round the earth in forty minutes—this flight of fancy of 350 years ago (and lasting that time) is now virtually reduced by the astronauts to four seconds and is already regarded by us all with complacency.

By 1929 the BBC was achieving low-definition television pictures using an early Baird mechanical system, transmitted from the 2LO mast then on the roof of Selfridge's store. Baird reported to the Postmaster-General in 1931 that 1,000 "Baird Televisors" had been sold at 25 guineas each but that about ten times as many people had built their own sets.

ELECTRONIC NOSTALGIA—1931

Progress was rapid. The Baird system (240 lines and 25 sequential fields per second) using an intermediate film delay system was in competition with the Marconi-EMI system (405 lines and 50 fields a second, interlaced) at the Alexandra Palace television studio and transmitter. Of course the 405-line system was adopted and the BBC's public transmissions, the first service in the world, commenced in 1936.

How awful those early pictures were, particularly the flickery sequentially-scanned pictures of the Baird system. The then Baird Company was a small organisation which accomplished a great deal in a short time. EMI, spending about £100,000 a year on research and with a formidable team headed by Schoenberg and Blumlein, devoted their energies mainly to the studio side and the development of the Iconoscope TV camera, forerunner of the Emitron, whilst Marconis developed the transmitter side. The Baird Company had plenty of know-how on mechanical television devices and this eventually led to the establishment of Cinema Television Ltd. which concentrated on big-screen television projection and also high-quality telecine apparatus. This resulted years later in the excellent Cintel flying-spot film telecine equipment now under the wing of the Rank Organisation.

THE NIPKOW SAGA

It is difficult today to visualise what faced the pioneers whose most reliable early television efforts were restricted by mechanical devices and whizzing Nipkow discs. Still more difficult is it for us to understand the faith that was then placed in the use of an intermediate studio film. Taking down from my bookcase *Television Today—Practice and Principles Clearly Explained*, published by George Newnes Ltd. in 1932, I became engrossed in the many articles written by eminent specialists such as Capt. A. G. D. West (Chief Engineer of Baird Television), H. J. Barton Chapple, Dr. Alfred Gradenwitz (Fernseh Television), F. J. Camm (Practical Wireless), L. M. Myers (Marconi) and others. In an article on *The Arrival of High-definition Television* Capt. West referred to three methods of high-definition scanning then considered practical: the studio spotlight scanner; the intermediate film apparatus and the electronic image camera "each of which is capable of transmitting an equally good high-definition picture in its respective sphere of usefulness." The most important contribution to progress at that time was apparently the ultra-sensitive photoelectric cell "which converts light variations into variations of electric current, used on cinema projectors for reproducing sound on film." They had in fact only just replaced the selenium cell.

EARLY SCANNING SYSTEMS

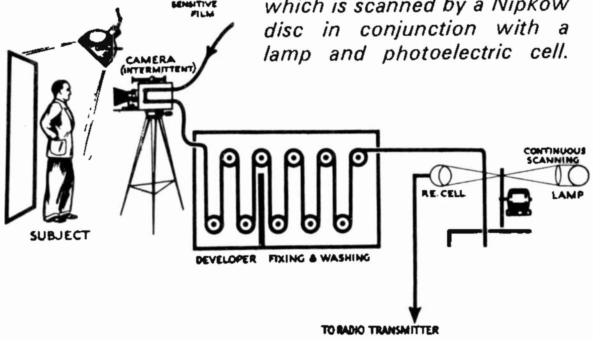
Capt. West then described spotlight scanning, in which the beam from a high-intensity arc traverses the scene (and the persons therein) with a spot of light moving in parallel lines until the subject is completely scanned. This had previously been achieved with a 30 line picture at 12½ fields per second but, due to more intense light and more sensitive photocells, reached 180 lines at 25 fields a second.

The intermediate film process comprised a cine camera used to photograph both picture and sound on film which was immediately developed, fixed and washed within a period of ten to thirty seconds and used as a completed negative of picture and sound for transmission, using a continuous motion-film telecine.

The third method was the electronic-image camera, later known as the Farnsworth image dissector, an early method of controlling (by electrostatic and magnetic methods) the motions of electrons from an image displayed within the tube by a lens. The Farnsworth camera was insensitive; that was the trouble at that time.

FERNSEH-AG TV SYSTEM

Baird were not the only television development company interested in the use of film as an intermediate system for television camera work. Fernseh A.G. of Darmstadt, Germany, were rapidly developing a number of different methods, of which this was one. *Television Today* (1932 vintage) included diagrams of two alternative cine camera and film systems, one somewhat on the same lines as Baird's but a second one using a continuous loop of blank motion-picture film which was coated with a photographic emulsion, exposed in the cine camera, developed, washed and fixed then scanned for transmission. It continued with another washing, emulsion removal, film again dried, resensitised and its loop course through this elaborate contraption continued. Time from exposure to transmission was about 45 seconds. Time between removal of the emulsion until the film, resensitised, can be run through the camera again is about three minutes. The total length of the loop was about 164 ft. using standard perforated films running through the apparatus at about half normal speed.



An early TV system devised by Baird with intermittent film which is scanned by a Nipkow disc in conjunction with a lamp and photoelectric cell.

These very early developments were brought to my mind when listening recently to a British Kinematography Sound and Television Society lecture in which Dr. Schreiber of the Fernseh Company described "The New Fernseh W.R.B. Colour TV Camera". It brought home to me the extent of the technological progress that had been made by Fernseh.

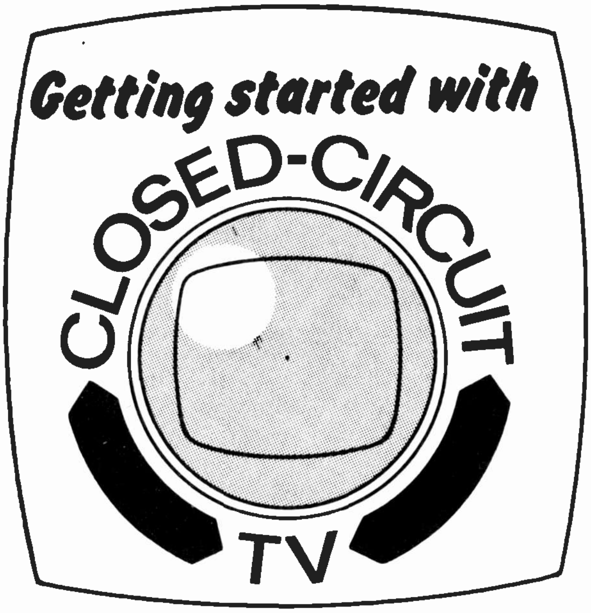
It is interesting and worthwhile to take a look back at historical milestones. I am not suggesting that we should return to crystals with cat's whiskers or 1912 type Marconi magnetic detectors (with soft iron wire loops transported by clockwork driven motors). Crystal control and magnetic recording are both very much with us today, after being forgotten in their original form.

SPECIAL EFFECTS

There must be many ingenious audio-visual devices of fifty years or so ago which failed to achieve success then but might be the germ of an idea which could be redeveloped. Take the magic lantern projectors of seventy-five years or more ago as demonstrated at the London Polytechnic. Using double or triple lanterns and limelight illuminants, lecturers achieved delicate dissolving effects from slide-to-slide added to which supplementary background scenes and moving effects could be introduced with the third lantern. These were the bi-unial or tri-unial lanterns, magnificently ornate with their shining brass and polished mahogany, and were the beginning of special effects for the cinema and television.

A few weeks ago *Charley's Aunt*, that old theatrical chestnut farce, appeared on BBC-1 with Danny La Rue as the pseudo aunt and Coral Browne as the real one. Produced by Cedric Messina and directed by John Gorrie, this was given an entirely new look with the phoney Auntie looking quite real, glamorous and full of charm, instead of the part being played like a pantomime dame. There was a lengthy scene in a car travelling along a road, with Coral Browne and Elaine Taylor conversing and, of course, the attractive scenery passing by. The moving background was so good that I wondered which of the BBC's special effects methods had been used: electronic overlay; electronic inlay; rear projection of film on a screen; ditto with front projection; film travelling matte; Dunning process or what? All are systems which might give the desired effect in a studio with the two actresses sat comfortably in a stationary car (which would be manually rocked).

To my surprise the BBC informed me that the scene was shot "for real", with a film camera car actually running by the side of the car which was seen in the television picture, and that it had been filmed (16mm.) on a smooth road near Oxford. The dialogue sound was post-synchronised afterwards by the actresses watching themselves on a screen. At one time—long before talkies—this was the only way of obtaining this kind of scene in a moving vehicle. This was achieved in 1906, when the Sheffield Photo Company made a film of a convict's escape from a moving railway train (Manchester, Sheffield and Lincolnshire Railway) in *The Life of Charles Peace*. That was a milestone, too, exhibited in travelling fair kinematograph side shows for many years and now in the archives of the British Film Institute.



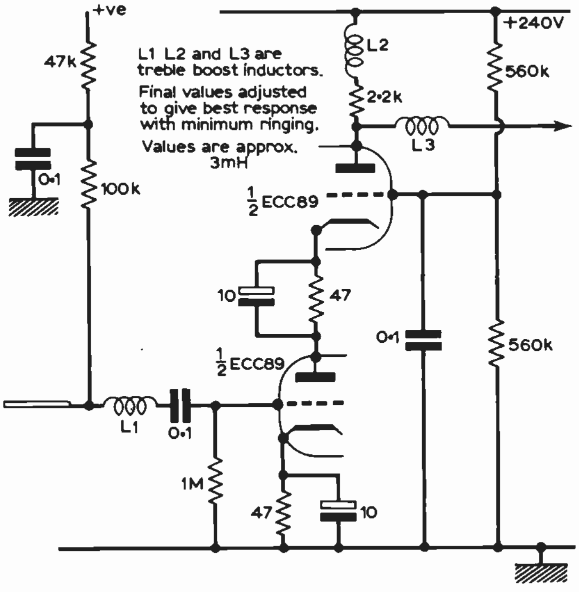
Getting started with CLOSED-CIRCUIT TV

PART 4

I.R.SINCLAIR

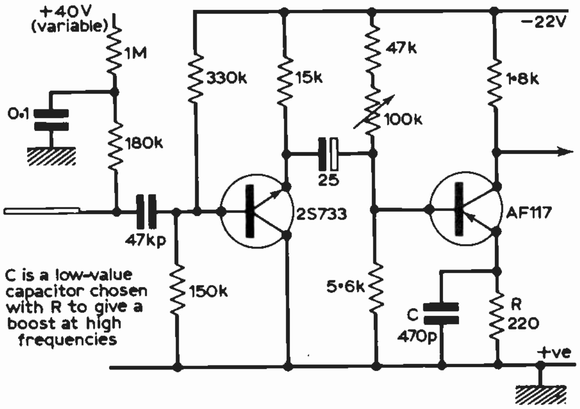
THE task of the video amplifier in the CCTV camera is to receive the signal from the target of the vidicon and amplify it sufficiently to drive a cable of 75Ω impedance with a video waveform of 1V peak-to-peak video plus, if composite syncs are used, another 0·3V of sync pulse. There is of course no reason why the amateur should be lumbered with these standards, but it is decidedly useful to work to them because of the possibility of using any professional equipment which may come on to the surplus market.

The output current at the target of a vidicon under average scene conditions, correctly illuminated, is about 0·2μA. In addition to this the capacitance of the target to earth, with some allowance for stray capacitance, is about 15pF. If, using a valve amplifier, we have a load resistor of 2kΩ so as to obtain a —3bB point at 5MHz the signal voltage at the start of the amplifier would be only 0·4μV. This is about thirty times *less* than the noise voltage in a low-noise resistor of 2kΩ at room temperature, although the effect of noise on a picture signal is not so bad as the bare noise comparison suggests. Clearly however a low-value load resistor is out of the question when a voltage amplifier is to be used.



L1 L2 and L3 are treble boost inductors. Final values adjusted to give best response with minimum ringing. Values are approx. 3mH

Fig. 1: Valve video input stage.



C is a low-value capacitor chosen with R to give a boost at high frequencies

Fig. 2: Transistor video input stage.

A load of about 220kΩ gives a signal output of 40μV. This is much more reasonable though still perilously near the noise level. So obviously the first stage of any video amplifier must use low-noise high-stability resistors and a low-noise amplifier, cascode preferably if valves are to be used. The −3dB point for a 220kΩ load is 53kHz so massive boosting of the higher frequencies is required later in the amplifier to compensate for this.

A typical valve input circuit is shown in Fig. 1. This is essentially the cascode stage as used in most v.h.f. TV tuners but for CCTV camera work special quality valves such as the Mullard E88CC perform better than their receiving-valve equivalents (ECC88, etc.).

An input stage using a transistor is shown in Fig. 2. A silicon npn transistor is used connected as an emitter-follower so that the impedance presented to the target is not too low. As the transistor acts

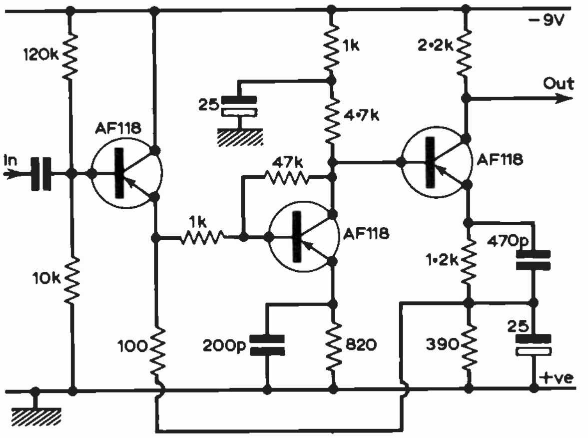
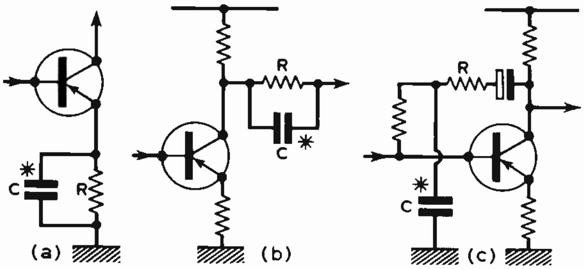


Fig. 3: Transistor video amplifier incorporating frequency correction for wide bandwidth.



Approx: $CR=\frac{1}{\omega}$ where $\omega = 2\pi fc$ fc = freq. of correction
When more than one correcting circuit is used, staggered values of fc should be used

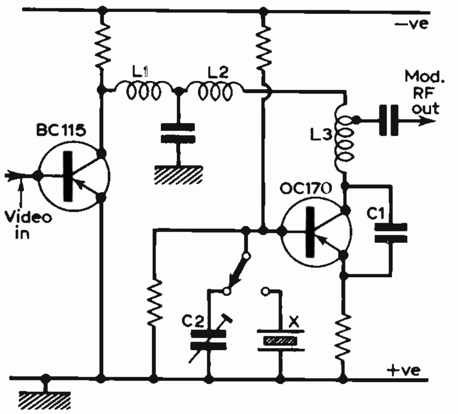
Fig. 4: Frequency correction arrangements. (a) Selective emitter decoupling. (b) Selective coupling. (c) Negative feedback compensation.

as a *current* amplifier the effect of the impedance on the frequency response at the target is less but the voltage at the output will be no more than the voltage determined by the load impedance at the input and will still require voltage amplification, though the problem of voltage amplification while preserving frequency response is made easier by the low output impedance of the emitter-follower. The following voltage amplifier is a completely conventional pnp stage.

A transistor circuit in which some frequency correction is made in the earlier stages is shown in Fig. 3. This amplifier has a very wide bandwidth and is particularly suitable for non-interlaced scanning where the monitor can cope with bandwidths of 12MHz.

Frequency Correction Circuits

Typical frequency correction circuits are shown in Fig. 4. The use of cathode or emitter resistors which are decoupled only at the higher frequencies is popular but they cannot be used when a negative feedback loop encloses the stage. Selective coupling in which a coupling resistor is bypassed by a capacitor of low value is also used (b), with the same care needed regarding feedback loops. Frequently both methods are used together, as in the circuit used in the Pye Lynx camera, one stage correcting the middle video at about 500kHz and the other correcting in the 4-5MHz region. Note that the use of a current-amplifier first stage eases the problems of the load resistor.



L1 and L2 are RF chokes.
L3 is wound to resonate at the desired frequency.
C1.....2–4p
C2.....5–50p
X......Crystal whose 3rd overtone (or higher) is in the band desired.
Actual values depend on frequency range used

Fig. 5: Simple oscillator/modulator circuit.

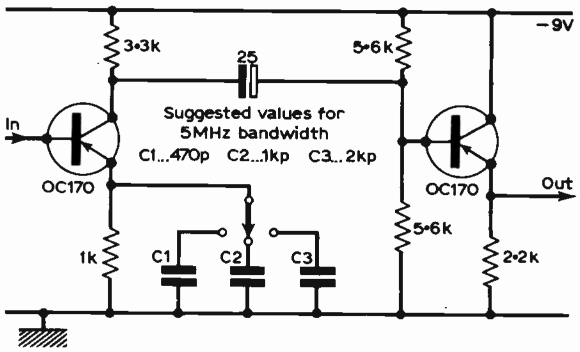


Fig. 6: Equalising circuit.

Gain and Noise

When a valve amplifier is used it is extremely difficult to obtain a good signal-to-noise ratio at high gain unless specialised valves of the Nuvistor (RCA trade mark) type are used. Transistor amplifiers are rather better in this respect since a silicon first stage can give current amplification of about 60 times, converting the 0·2μA target signal to a 12μA signal (if the emitter load permits) at an expense in frequency response which depends on the input impedance of the transistor. This current signal, fed into another transistor whose output is taken as a voltage signal across a collector load, is sufficient to give a voltage output of 1V with only one more stage of voltage amplification. From this point of view transistor amplifiers are clearly preferable.

RF Outputs and Equalising

If the video signal is to be fed to a commercial TV set instead of to a monitor it may be more convenient to use a modulated r.f. output rather than to try to modify the receiver to work at video frequency only. The r.f. used should preferably be as far as possible removed from the locally received broadcast frequencies to avoid interference with nearby sets. Comparatively simple oscillator and modulator circuits can be used, as in Fig. 5, because large modulation depths are not needed. Care must be taken to avoid overloading the r.f. circuits of the receiver; an attenuator fitted in a screened box at the receiver is usually needed. For video bandwidths of up to 5MHz Band I frequencies can be used but for higher bandwidths Band III frequencies are better. It is wise to avoid Band IV and V (BBC-2) frequencies because of the difficulties of avoiding interference. The 45MHz channel 1 should also be avoided because of its closeness to the i.f. of most receivers.

Unless conventional signals of fairly small bandwidth are being used several modifications will be required to the receiver. These will be dealt with in the next part.

Note that in 405-line working the modulation is positive with the sync tips at zero r.f. amplitude. In 625 operation negative modulation is used with the sync tips at maximum r.f. amplitude. In receivers the detector diode is switched in polarity or the final i.f. transformer connections are switched to preserve the same sense of video signal to the video amplifier of the receiver.

If the video output from a camera is to be fed to the monitor by a long cable some equalisation of

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AW43-89
AW47-90
AW47-91
MW43-69
MW43-64
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MW53/20
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AW-53-80
AW53-88
AW53-89
AW59-90
AW59-91
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C17/5A
C17/7A
C17/AA
C17/AF
C17/FM
C17/HM
C17/SM
MW/53-80
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C19/10AP (T)
C19/AK
C21/1A
C21/7A
C21/AA
C21/AF
C21/KM
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C21/TM
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C23/10A
C23/AK
C23/AKT (T)
CME1402
CME1702
CME1703
CME1705
CME1706
CME1901
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CME1903
CME1905
CME1906 (T)
CME1908
CME2101
CME2104
CME2301
CME2302
CME2303
CME2305 (P)
CME2306 (T)
CME2308
CRM173
CRM212
CRM211
17ARP4
17ASP4
17AYP4
21C2P4
21DKP4
23SP4
171K
172K
173K
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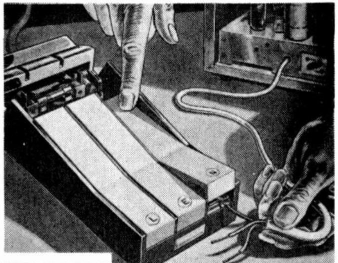

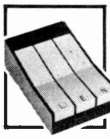

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the signal will be necessary because the cable losses are greater at high video frequencies than at low. The equalisation takes the form of a high-frequency boosting stage, preferably at the output to the cable. If a camera is to be used permanently with a long cable this can be done by using the existing high-frequency correction. If different cable lengths are to be used at different times a corrective stage with switched compensation should be used. The actual values of the time-constants used in the circuit of Fig. 6 depend of course on the video bandwidth used.

Equalisation is not needed when r.f. carriers are used because the difference between the lowest and the highest frequencies carried by the cable is not so great. Cable losses may be high however, of the order of 6dB per 100ft. of cable, and this loss may call for the use of repeater amplifiers at intervals.

NEXT MONTH: MONITORS FOR CCTV

WAVEFORMS IN COLOUR RECEIVERS

—*continued from page 210*

To conclude this article let us have another look at the filter-derived subcarrier system, especially relative to the swinging bursts. This is sometimes called a *passive subcarrier generator* because no active oscillator is employed. A simple crystal filter circuit is adopted of the kind found in the i.f. channel of some communications sets. When properly neutralised a filter like this with a quartz crystal exhibits an incredibly high value of Q, often approaching 10×10^3. Thus when bursts are passed into it all the sideband components of the signal (these, incidentally, can be considered as being produced by a carrier—the bursts at 4·43MHz—modulated by a squarewave at line frequency) are deleted, leaving only the carrier at 4·43MHz at a constant amplitude. It is this signal which then constitutes the subcarrier for the V and U chroma detectors.

However, with the PAL system the problem of the swinging bursts has to be resolved. This does not arise with the NTSC system of course since the bursts in this system are held in constant phase and all is well provided the filter has a sufficiently high Q value to remove all the sidebands. One way of getting over the PAL problem is to incorporate a switch (see Fig. 10) between the burst gate and the crystal filter to introduce a 90-degree phase shifter on alternate lines, in this way presenting the filter with a burst signal from which the "swing" has been removed. This is not a difficult practical problem and the 90-degree phase shifter switch can be operated from the same switching circuit that operates the PAL V detector switch. The phase shifter has the effect of shifting the position of the now non-swinging bursts by 45 degrees from the U chroma axis, but this is of little moment since simple rephasing at the chroma detectors will neutralise the error.

Ripple is produced by the alternate-line switching of the 90-degree phase shifter (this being at 7·8kHz since it takes two lines) and can be detected to provide the ident signal for V chroma phasing. When the ident is correct the 7·8kHz sideband signals add together and when incorrect they cancel out so that phasing is automatically correct. More will be said about this next month.

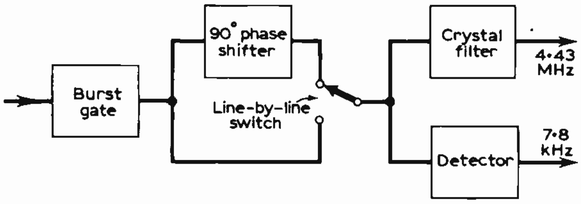

Fig. 10: How the ripple is removed from the burst signal when a passive subcarrier regenerator is used.

CONTINUED NEXT MONTH

TRANSISTORS IN TIMEBASES

—*continued from page 224*

the feedback voltage applied to it. Its current varies accordingly and this adjusts the current available for C2 to charge, altering its charge rate and hence the triggering time for the diac. As a result the transistor stabilises against both mains variations and output load changes. The zener diode D1 compensates for the effect of temperature on the emitter current of Tr1.

Another stabilised thyristor power supply circuit, used in Rank-Bush-Murphy models, is shown in simplified form in Fig. 6. Here the transistor Tr1 is used to trigger the thyristor. The mains input is fed via the phase shift network R1, C1 and the diode D1 to the base of Tr1, which is also fed with a feedback signal from the potential divider R4, R5 across the output. Its emitter voltage is held constant by the zener diode D3. The clipped mains waveform appearing at Tr1 collector is used to trigger the thyristor. The circuit R2, R3, C3 and D2 modifies the conduction time of the thyristor if the mains input voltage varies.

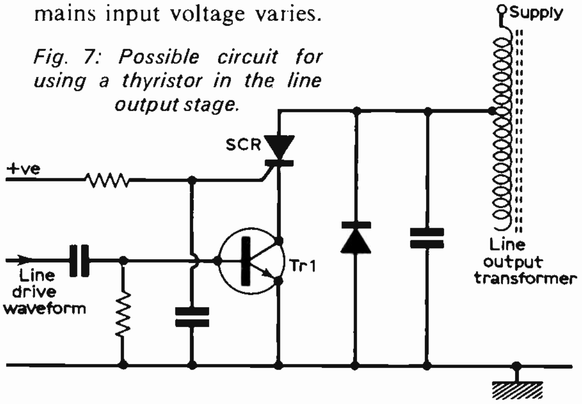

Fig. 7: Possible circuit for using a thyristor in the line output stage.

As the thyristor is such an efficient switch there have been suggestions at various times for using it in the line output stage to control the output current. One suggested circuit is shown in Fig. 7. Because the gate is much less efficient as a means of switching off a thyristor than of switching it on, cathode control rather than gate triggering is used. In the circuit shown the gate is held at a positive potential and a transistor is connected in series with the cathode. The drive waveform is applied to the base of the transistor and when this is driven into conduction the thyristor cathode is effectively grounded so that it switches on.

TO BE CONTINUED

YOUR PROBLEMS SOLVED

Whilst we are always pleased to assist readers with their technical difficulties, we regret that we are unable to supply service data or provide instructions for modifying equipment. We cannot supply alternative details for constructional articles which appear in these pages. WE CANNOT UNDERTAKE TO ANSWER QUERIES OVER THE TELEPHONE. The coupon from page 237 must be attached to all Queries, and a stamped and addressed envelope must be enclosed.

GEC BT1748

After this set has been switched on for about 15 seconds the anode of the boost diode becomes red hot. I have tried a new valve but the fault persists.—E. Lawrenson (Lancashire).

Remove the e.h.t. rectifier valve from its position and switch on the receiver again. If the boost diode still glows red hot check the boost capacitor and the line output valve. If it does not glow replace the rectifier with a new one.

If all these are OK try to get a spark from the anode top cap of the line output valve. If there is none check the screen grid volts on the valve and the bias on the control grid. If all these are OK then there is either a short circuit from the cathode of the boost diode to chassis or the line output transformer has gone faulty.

Try not to run the boost diode too long when making these tests, otherwise it will have to be replaced again.

EKCO T354

The screen is not illuminated. When the set is switched on all the valves light up and the sound, which is perfect, comes on. When the line whistle comes on it sounds normal but within three seconds a beat-note is superimposed on it. When the line whistle first comes on the e.h.t. rectifier heater lights up but when the beat-note appears it goes out. The spark from the e.h.t. winding on the line output transformer is less than ⅛in. at any time after switching on.

I have tested the U191, U26, PL36, 30PL13 and the h.t. rectifier. The 30FL1 was replaced as it was useless.—A. Coxhall (Middlesex).

There may be a short on the e.h.t. lead or in the c.r.t. and if this is the case disconnecting the e.h.t. lead will relight the U26. Alternatively suspect a faulty boost capacitor or open-circuit U26 heater winding on the line output transformer.

FERGUSON 3647

I am having trouble with the picture height (BBC-1 and BBC-2). Adjusting the preset potentiometer R104—the height control—brings the picture back to normal size, but in a week's time it reduces in size so that there is about 1in. gap at the top and bottom of the screen. I then have to constantly readjust R104. I have changed V9 but this has not changed anything.—D. Allen (Gloucestershire).

Your Ferguson, as you have observed from the circuit numbers you quoted, uses the BRC chassis series 1400.

Generally when the height begins to fail in this way on a receiver it is either the field oscillator or the field output valve dying or the boost capacitor beginning to break down and changing value in the process. Try these. The boost capacitor is C105 (0·22μF).

If these are OK check the value of the height control potentiometer and its series resistor R103 (330kΩ) and the cathode components C81 and R102.

We presume that the raster width is not also changing. If it were the line output valve would be suspect—therefore reducing the boost voltage.

FERGUSON 36479

The fault is lack of width but only on BBC-2. I have changed the PFL200 but without any improvement. Both BBC-1 and ITV channels are OK.—A. McMillan (Surrey).

The lack of width on 625 can only be caused by a fault within the line output stage itself. First check the 625 S-correction capacitor and its associated switching (C96—0·1μF). If this is not at fault check the line stabilising v.d.r. (Z2) and its smoothing capacitor C108. Check that the boost volts on 625 are 690V. If they are not check R60 (620kΩ).

PYE 23UF

The picture has shrunk top and bottom approximately 1½in. and the linearity controls R79, R82, R84 are set for maximum height and amplitude. I have tried substituting new valves for V9 (PCL84) and V18 (PY800) but to no avail. The fault is evident on Band I (405 lines) and I cannot check if it exists on 625 lines as there is no workable signal in this area.—R. Purdy (Brighton).

Check for change in value of R83 (1·2MΩ) in series with the hold control.

MURPHY V530

After the set has been on for about half-an-hour the picture jumps up and down intermittently about 1in. After about 15 minutes it is perfect for the rest of the evening's viewing. The controls on the set are adjusted correctly and I get a good strong signal and a picture free from interference. — E. McKone (Sussex).

Check for excessive h.t. due to the mains tap being incorrectly set and look around the 30P12 and 6/30L2 in the field scan amplifier. These are on the upper chassis to the right of the tube as viewed from the rear.

FERGUSON 406T

After this set has been operating for about half-an-hour the picture disappears leaving a brilliant raster with normal sound.—I. Nagill (N. Ireland).

The trouble is associated with the coils near the PCL84 video amplifier. Clean off and resolder the wire ends of the double-wound coil to the right of the valve and the single coil above it.

PHILIPS 1768U

There is sound but no raster. I have changed or substituted the following components: (capacitor and resistor values as shown in Newnes *Radio and Television Servicing* 1957-58) PY81, PL36, EY86, PY82 (2), boost capacitor C57 (0·039μF) and C63 (0·018μF). The line timebase seems to be working as I can hear the 10kHz whistle fairly loudly and it fluctuates when I rotate the line hold control.

The EY86 does not light up at all. The h.t. rail voltage is OK and I have checked all through the receiver and timebases. The voltages on the valves are all near perfect including the screen-grid voltage on the PL36. The only discrepancy is that the boost voltage and the first anode voltage on pin 10 of the tube base are nowhere near 480-500V as stated in the service data.

I have checked the tube volts on the base while rotating the brilliance control and voltage is as service data states—0-170V dependent on the setting of the control. I have removed the anode e.h.t. lead to see if valve EY86 would light up but to no avail.—F. Malpass (Staffordshire).

This symptom certainly appears to be caused by shorting turns in the line output transformer. However before you contemplate changing this make sure that *all* the associated components are in good order. You at least know that the generator itself is working, so you can concentrate on the output stage. Your letter implies that you have already checked many components in this area. Low boost volts is a by-product of transformer trouble, incidentally.

MURPHY V280

Can you say how to replace the U25 e.h.t. rectifier valve in this receiver. It appears to be inside the line output transformer canister.—L. Barnard (Lancashire).

Usually it is necessary to replace the whole transformer but some readers have managed to open up the canister, drain off the oil and replace the valve, making an air-tight seal again afterwards.

ULTRA BERMUDA 6628

I have recently fitted a u.h.f. aerial. When I use the 625-line switch on the side of the set and tune in the picture is very snowy and blurred. After ten minutes to half-an-hour it becomes a beautiful picture which may last about an hour. After this time it becomes slightly snowy again. Recently I have replaced the following valves: PL500, PY801, EF183, EF184 and PCF808. The PL500 was necessary as the picture went narrow.—J. Cunningham (Lancashire).

Your Ultra Bermuda uses the Thorn 900 chassis and UHFT2 valved tuner. This is almost certainly what is at fault from the way you have described the trouble.

Unfortunately apart from changing the valves—PC88 and PC86—we would not recommend any work on this tuner because of the dangers involved in upsetting component positions and therefore the tuning circuits. It should be returned to the service depot through an Ultra dealer.

Before doing this however you should check that the mains voltage tapping is correct, that the h.t. voltage is right and that the connections out of the tuner and the aerial input are firm. It might also be advisable to try another receiver on your u.h.f. aerial if this is possible. All this is of course to be done after the tuner valves have been changed.

PYE V510

The picture height has failed and there is just a bright line across the tube about ½in. wide.—L. Bowker (Sheffield).

Check the PCL82 field output valve at the top of the right-hand printed panel.

REGENTONE Ten-17

On switching on, the field timebase takes some minutes before the picture becomes stable and field hold is liable to become lost for brief periods (10 seconds) after the set has been operating satisfactorily for periods of 30 minutes or so. The picture expands and contracts regularly in the vertical direction making it very difficult to read printed matter on the screen. The period of this motion is about one second and it is most pronounced at the bottom of the screen. The field linearity controls do not provide enough adjustment to obtain a satisfactory picture—it is always cramped at the bottom. The picture tends to defocus on peak-white levels.—L. Dore (Lancashire).

Some of your trouble could be caused by excessive hum (mains ripple) in the field timebase circuits. The pulsating picture is in fact the symptom of high residual hum in the set beating with the now asynchronous working at the transmitters. At one time the field sync used to be locked to the 50Hz mains grid. This is no longer the case so residual hum in the set shows as the picture ripple symptom. You might have to improve the set's smoothing or some of the ripple might be caused due to a heater-cathode failure (or leakage) in one (or more) of the field or vision valves. Test this possibility. Weak field valves and low h.t. voltage (or e.h.t.) could be responsible for the non-linearity and defocusing symptoms.

FERGUSON 3639

The sound is perfect but there is no vision. R25, R26 and R27 get too hot, R25 melting solder on the printed circuit board. I have changed V4 and V5 without success and I wonder if capacitor C24 could be shorting.—M. Collyer (Middlesex).

A short in C24 could encourage the overheating as mentioned but we feel that V5 is taking excessive current for some other reason. A C24 short-circuit would not totally remove vision anyway. The vision i.f. stage could be oscillating, this being rectified by W2 and reflecting a positive potential on V5 control grid. Alternatively, you could have a short between L7 and L8. Check along these lines if C24 is OK which we feel it is.

BUSH TV105

There are three images in the horizontal plane. The line and field hold controls seem to operate satisfactorily but the picture will not settle into one image horizontally. I have had all the valves checked and those that were below par have been replaced.—S. Byfield (Birmingham).

Try interchanging the two ECC82 valves. Adjust the preset line hold (compression trimmer) if necessary. If still defective replace capacitor C72 (0·005μF) —observe voltage rating—on the panel to the left of the line output screened section. It is toward the front end of this board.

COSSOR CT1972A

The inside core of the u.h.f. tuner has fractured. Can you say how this can be removed for examination?—B. Harrell (Lancashire).

First remove the u.h.f. tuner from its mounting and then remove the detachable side cover from the tuner without damaging the copper foil. This will give you access to the broken core, the locking compound of which should be softened with a little methylated spirit before attempting to remove it.

EKCO T436

About three months ago the picture suddenly started coming in by about 2in. each side of the screen with the set adjusted for normal viewing. The sound remained completely unaffected and the picture quality and strength remained good. The picture has remained like this up to the time of writing.

The following effects have been noted: on turning up the brilliance the picture slowly starts to fill the screen completely, and with the brilliance at maximum a picture can still be discerned at the edges of the screen while the centre of the screen is a uniform light grey. Flyback lines are not noticeable. It was also found that turning up the brilliance increased the height of the picture to the same extent as the width although no excessive shrinking of the picture in the vertical plane had been observed when the fault developed.

When the brilliance was set at maximum and the contrast turned down to minimum a fair picture entirely filled the screen with a grey patch in the middle of the picture. Choice of channel also affected the picture width—BBC-1 widening it slightly.—A. Troup (Scotland).

Try replacing the PL36 line output valve located at the lower end of the right-hand chassis.

BUSH T57

Recently a 2in. gap has appeared at the top of the screen and the height adjustment will not correct this. I have tried changing several valves which might appear to be suspect but without effecting any improvement.—H. Nagle (Surrey).

There is a resistor across one half of the field coils in your receiver and this, if faulty, might cause the effect. It is more likely however that the set-up needs adjustment. Because it is a bit unusual for this model we tabulate it below (all adjustments should be made on a test card).

Centring Picture: Set the height control so that the raster edges are within the mask. Adjustment of the lever at the rear of the focus unit will be required to centre the picture. Move the lever in a horizontal direction to achieve a vertical displacement of the picture. To alter in a horizontal direction, a vertical movement is needed.

Squaring Picture: To square up the picture in the mask adjust the deflection coil assembly by rotating it on the picture tube neck until the edges of the raster are parallel to the sides of the mask. The knurled screw under the coils must be released to enable the coils to be moved.

Field Form (TC1): This should be adjusted for best overall linearity. It may be necessary to recentre the raster as above after adjustment.

Picture Height: Adjust picture height (VR3) until the bottom and top of the picture are coincident with the edges of the mask.

Focus: Focusing may now be necessary. This is achieved using the lever on the left of the focus housing. Adjust for optimum focus in the central area of the test card.

If this set-up fails to centre the raster sufficiently and the resistor mentioned above is OK it would be suspected that a d.c. potential is somehow getting on to the field coils. This might possibly be by leakage in the field output transformer—although this is extremely unusual.

AMBASSADOR TV20CC

The first sign of a fault was the fuse blowing. When I tested the set I saw the bottom section of the voltage dropper get red hot very quickly. According to the service sheet this part of the dropper is connected to MR2. I cannot obtain a spare metal rectifier so could you say if there is an alternative to this component.—G. Whitfield (Lincolnshire).

A silicon diode of the BY100 type can be used to replace the h.t. rectifier. However the rectifier may not be at fault (it usually gives off an obnoxious smell if it is) and the h.t. line should be checked for faults.

FERRANTI 17T6

The picture trembles all the time and after a short while it begins to slip. When locked it remains OK for a short period of time then the rolling starts again. I have replaced all the valves without success.—H. Close (N. Ireland).

We suggest you replace the 0·05μF sync coupling capacitor from pin 7 of the video amplifier. Check the components associated with the EB91 interlace diode and the resistors associated with the height and hold controls. The blocking oscillator transformer T1 may be faulty.

PYE V110

I was given this receiver with a "no picture" symptom. On inspection I found that the EY86 was not lighting up and there was lack of e.h.t. EY86, PL81, PY81 and the screen feed resistor on the PL81 were replaced with no improvement. As a last resort a new line output transformer was tried. The e.h.t. returned and EY86 lit up. The resulting picture was lacking in width however with no control of brilliance. This was traced to a faulty brilliance control and on replacing the potentiometer the brilliance varied normally.

The h.t. measures 250V. Removing the width sleeve on the deflection coil still leaves a narrow raster which is also accompanied by cramping on the right side of the screen.—D. Jhalera (London, N.W.6).

You may possibly have fitted the incorrect line output transformer since two types have been fitted to this particular receiver. You can overcome your troubles by fitting a pulse capacitor of somewhere between 20 and 120pF between the top caps of the PY81 and PL81.

FERGUSON FR20

The picture with test cards and normal programmes shows no evidence of ghosting or overshoot but sudden movements of the camera as occur during outside broadcasts cause multiple ghost images both in and out of phase. This is particularly noticeable in the televising of football matches when the centre line of the playing field for example shows normal when the camera is stationary but on fast panning these multiple images occur and disappear again as the camera stops moving.

What puzzles me particularly is that when the camera pans to the left the images occur to the left of the true image i.e. against the left to right movement of the electron beam.—K. Madge (Hertfordshire).

There are two reasons for this effect. One is microphony in some camera systems—especially on some outside versions—and the other is related to the persistence of the target area of the camera and picture tube in the set. The effect is not uncommon and it is hardly likely to be due to a fault in your set.

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PRACTICAL TELEVISION, FEBRUARY 1970

TEST CASE

87

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.

? *Picture definition on a Thorn 850 chassis was significantly below normal but by carefully adjusting the fine tuner it was possible to optimise the picture which was then almost normal. The sound was not unduly affected by the fault and both line and field locks remained good even when the picture definition was very low.*

It was concluded that the vision i.f. channel was misaligned, possibly due to a change in the value of a fixed capacitor across an i.f. winding or rejector coil since the tuning slugs had not been altered by unskilled hands. However a visual check of the overall i.f. channel alignment failed to reveal the defect.

It was later found that by altering the position of the surplus coaxial lead at the rear of the set the symptom could be reduced or worsened; but a check of signal strength at the aerial—with a signal strength meter and different set—indicated that all was well here. Finally the tuner valves were replaced but the symptom remained.

What would be a likely cause of this trouble? See next month's Practical Television *for the solution to this problem and for a further test item in the Test Case series.*

SOLUTION TO TEST CASE 86
Page 188 (last month)

Hanover bars (or blinds) often occur in PAL-D sets when the PAL delay line matrix is misaligned. The adder and subtractor matrix network receives chroma signals direct *and* via the PAL delay line. For correct operation of this part of the circuit the delayed signal must be of amplitude equal to that of the direct signal and to obtain this condition the majority of colour sets embody a preset resistor (or preset resistor *and* variable inductor and/or capacitor). If the delayed signal amplitude is below that of the direct signal, or vice versa, Hanover bars will mar the picture significantly even when there is no phase distortion on the signal or in the system.

The delay line is generally driven by a driver stage to provide the gain necessary to combat the losses in the line relative to the direct unattenuated signal, and the idea is to adjust the preset very carefully until the bars fade away. It is desirable though to check the adjustment with the service manual. The intermittent effect referred to in Test Case 86 would indicate trouble in the PAL delay line driver or in a component associated with the matrix.

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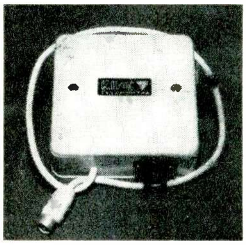

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