TELEVISION

3'6 (17½ new pence)

NOVEMBER 1970

SERVICING · CONSTRUCTION · COLOUR · DEVELOPMENTS

versatile IC 'SCOPE PREAMPLIFIER

ALSO:-

FLASHOVER PROTECTION ▪ 625 CONVERSION UNIT ▪ PAL CHROMA DETECTION

RST Express Mail Order Service

(Open Daily to Callers Mon.-Fri. 9 a.m.-5.30 p.m., Sat. 9 a.m.-1 p.m. 2.30 p.m.-5 p.m.)

SPECIAL OFFER!

NEW MULLARD TV TUBES TYPE AW 43-88 at £4-0-0

RE-CONDITIONED TUBES FROM STOCK:

12"—**£4-0-0**	19" TWI PANEL **£9-10-0**
14"—**£4-0-0**	21" MONO **£6-10-0**
17"—**£4-5-0**	23" MONO **£6-10-0**
19"—**£6-0-0**	23" TWIN PANEL **£10- 0-0**

ANY TYPE OF NEW TUBE SUPPLIED . . . PRICES ON APPLICATION

CARRIAGE ON ALL TUBES 12/6 EACH

RST RENOWNED FOR OUR UNBEATABLE SERVICE

(ALL ORDERS DESPATCHED THE SAME DAY AS RECEIVED)

VALVES AS PER LIST:—

DAF91	4/6	EBC41	9/9	EF41	10/-	EY51	7/6	PCC189	10/6	PL36	10/9	U191	13/9	5V4G	8/-	6K7G	2/-	30C17	16/-
DAF96	7/6	EBF80	7/6	EF80	4/6	EY86	7/-	PCF80	6/9	PL81	9/6	U801	23/6	5Y3GT	6/-	6K8G	3/-	30F5	17/-
DF91	4/-	EBF89	6/6	EF85	7/-	EZ40	9/-	PCF86	9/-	PL82	8/6	UABC80	6/6	5Z4G	7/-	6L6G	7/9	30FL1	15/-
DF96	7/6	EBL31	27/6	EF86	6/6	EZ41	9/6	PCF200	16/-	PL84	7/-	UAF42	10/6	6/30L2	15/-	6P25	22/6	30L15	17/-
DK91	6/-	ECC81	6/-	EF89	5/6	EZ80	5/6	PCF201	15/6	PL508	29/-	UBC41	9/3	6AT6	4/9	6Q7G	6/-	30L17	17/-
DK92	9/-	ECC82	5/9	EF91	3/6	EZ81	5/6	PCF800	15/-	PL509	29/-	UCH42	10/6	6BA6	5/-	6SL7GT	6/-	30P4	22/6
DK96	7/9	ECC83	6/3	EF98	15/-	GY501	15/-	PCF801	9/9	PL802	16/6	UCH81	7/-	6BE6	5/-	6SN7GT	5/6	30P19	15/-
DL94	6/9	ECC85	5/-	EF183	6/6	GZ32	10/-	PCF802	9/9	PY32	10/9	UCL82	7/6	6BJ6	9/-	6V6G	4/6	30PL1	16/-
DL96	7/9	ECH35	11/6	EF184	7/-	GZ34	11/-	PCF806	13/-	PY33	10/9	UCL83	10/-	6BR7	17/-	6X4	4/6	30PL13	18/6
DY86	6/-	ECH42	13/-	EL33	12/6	KT61	22/6	PCH200	12/6	PY81	5/9	UL41	12/-	6BR8	12/6	6X5G	4/6	30PL14	15/-
DY87	6/6	ECH81	5/9	EL34	10/6	KT66	30/-	PCL82	7/9	PY82	5/3	UL84	7/-	6BW6	14/6	7B7	7/6	35W4	4/6
DY802	12/6	ECL80	7/-	EL41	11/-	KT88	34/-	PCL83	10/3	PY83	7/-	UU8	21/-	6BW7	13/-	7C5	22/6	50C5	6/3
EABC80	6/6	ECL82	7/-	EL42	11/6	PC86	11/6	PCL84	8/6	PY500	18/6	UY41	8/6	6C4	5/-	7C6	15/-	50CD6G	31/-
EAF42	10/-	ECL83	10/3	EL84	4/9	PC88	11/6	PCL85	9/3	PY800	9/6	UY85	6/6	6CD6G	24/-	7H7	6/6	80	7/6
EAF806	17/6	ECL86	9/-	EL95	7/-	PC97	8/9	PCL86	9/3	PY801	9/6	OA2	6/3	6CH6	7/6	7S7	45/-	807	9/-
EB91	3/-	ECLL800	30/-	EM81	12/6	PC900	8/6	PD500	29/-	R19	7/9	OB2	6/-	6F23	16/-	7Y4	8/6	813	75/-
EBC33	8/6	EF37 A	7/-	EM84	7/6	PCC84	6/6	PFL200	14/-	U25	15/6	5R4GY	10/6	6J5G	4/-	10F1	14/9	866 A	15/-
		EF39	8/-			PCC89	10/6			U26	15/6	5U4G	5/6	6J7G	6/-	30C15	15/-	872 A	57/6

Postage First Class 9d. per Value (Orders Over £5 Free)

Transistors as per List:

2N1302	4/-	AC129	7/6	AD161	7/6	AFY19	22/6	BC149	5/-	BF195	5/-	NKT217	8/4	OA211	10/-	OC36	12/6	OC82 D	5/-
2N1303	4/3	AC187	5/-	AD162	7/-	AFZ11	8/-	BC157	4/-	BF196	5/6	NKT224	4/9	OAZ200	11/-	OC41	4/6	OC83	4/6
2N1304	4/9	AC188	6/-	AF114	6/6	AFZ12	10/-	BC160	12/6	BF197	5/6	NKT274	4/9	OAZ208	6/6	OC42	5/-	OC84	4/9
2N1305	5/-	ACY17	6/-	AF115	5/9	BC107	3/-	BCY31	8/9	BFX12	5/6	NKT277	4/9	OAZ210	6/6	OC44	4/-	OC114	7/6
2N2147	16/6	ACY18	4/-	AF116	6/6	BC108	3/-	BCY32	10/-	BFX35	19/6	NKT403	9/9	OAZ242	4/6	OC45	3/3	OC122	10/-
2N2160	14/-	ACY19	5/-	AF117	4/6	BC109	3/-	BCY33	5/-	BFX88	5/-	NKT404	12/6	OAZ246	4/6	OC71	3/-	OC123	10/-
2N2369 A	5/-	ACY20	5/-	AF118	12/-	BC113	6/-	BCY34	5/-	BFY24	9/-	NKT713	7/6	OC16	10/-	OC72	4/6	OC139	5/-
2N2696	6/3	ACY21	4/6	AF119	4/-	BC115	6/6	BD121	19/-	BFY50	5/-	NKT777	7/6	OC19	7/6	OC74	6/-	OC140	7/6
2N2926	3/-	ACY22	4/-	AF124	5/-	BC116	8/-	BD123	22/6	BFY51	4/6	OA5	3/6	OC20	20/-	OC75	5/-	OC141	15/-
2N3055	14/6	ACY27	5/-	AF125	5/-	BC118	6/6	BD124	12/-	BFY53	4/-	OA10	3/6	OC23	12/6	OC76	5/-	OC169	6/-
2N3705	4/-	ACY28	4/-	AF126	5/-	BC121	4/-	BF115	5/6	BSX27	10/-	OA70	1/6	OC24	12/-	OC77	5/-	OC170	5/-
2N3819	8/-	ACY39	9/6	AF127	4/6	BC122	4/-	BF117	10/-	BSX60	18/6	OA71	2/-	OC25	7/6	OC78	5/-	OC171	6/-
AAZ12	5/-	ACY40	3/-	AF139	6/-	BC125	13/6	BF167	5/-	BSY51	10/-	OA79	1/9	OC26	6/-	OC78 D	5/6	OC172	7/-
AAZ13	3/-	ACY41	5/-	AF178	9/6	BC126	13/-	BF173	6/-	BY100	4/-	OA81	2/-	OC28	12/6	OC81	5/-	OC200	5/6
AC107	5/6	ACY44	7/6	AF179	11/-	BC140	11/-	BF181	7/6	BYZ11	9/-	OA90	1/6	OC29	12/6	OC81 D	4/-	OC201	8/6
AC126	4/-	AD140	11/-	AF180	12/-	BC147	3/9	BF184	7/6	BYZ12	8/-	OA200	2/-	OC30	8/-	OC81 DM	4/-	OCP71	19/6
AC127	5/-	AD149	12/-	AF181	8/-	BC148	2/9	BF185	6/-	NKT213	6/4	OA202	2/-	OC35	10/-	OC81 M	5/-	ORP12	12/6
AC128	4/6			AF186	9/-			BF194	3/6			OA210	6/6			OC82	5/-	18111	2/6

(Postage Free on all Transistors)

All Valves and Transistors Brand New and Fully Guaranteed

Send S.A.E. for Lists of Valves, Tubes, Transistors. 6,000 Types Listed

RST 16 WELLFIELD RD., LONDON, S.W.16

MEANS SERVICE **Phone: 01-769 0199**

SEMICONDUCTORS

continued

GET873	2/6	NKT773	5/-
GET880	6/-	NKT781	6/-
GET887	4/-	NKT10339	6/6
GET889	4/6	NKT10419	6/-
GET890	4/6	NKT10439	7/6
GET896	4/6	NKT10519	6/6
GET897	4/6	NKT20329	9/6
GET898	4/6	NKT80111	15/6
MAT100	6/-		
MAT101	6/-	NKT80112	19/6
MAT120	6/-		
MAT121	6/-	NKT80113	22/6
MJ400	21/6		
MJ420	22/6	NKT80211	18/6
MJ421	22/6		
MJ430	20/6	NKT80212	18/6
MJ440	19/-		
MJ480	19/6	NKT80213	18/6
MJ481	25/-		
MJ490	20/-	NKT80214	18/6
MJ491	27/6		
MJ1800	48/6	NKT80215	18/6
MJE340	12/6		
MJE520	17/6	NKT80216	18/6
MJE521	17/6		
MPF102	8/6	OC20	15/-
MPF103	7/6	OC22	10/-
MPF104	7/6	OC23	10/-
MPF105	7/6	OC24	11/6
MPS3638	6/6	OC25	10/-
NKT0013	9/6	OC26	6/6
NKT124	8/6	OC28	12/6
NKT125	5/6	OC29	15/-
NKT126	5/6	OC35	8/-
NKT128	5/6	OC36	12/6
NKT135	5/6	O341	4/6
NKT137	6/6	OC42	5/-
NKT210	6/-	OC44	4/-
NKT211	6/-	OC45	2/6
NKT212	6/-	OC46	3/-
NKT213	6/-	OC70	3/-
NKT214	4/6	OC71	2/6
NKT215	4/6	OC72	2/6
NKT216	7/6	OC74	6/6
NKT217	8/6	OC75	4/6
NKT219	6/-	OC76	4/6
NKT223	5/6	OC77	5/6
NKT224	5/-	OC78	5/-
NKT225	4/6	OC81	4/-
NKT229	6/-	OC81D	4/-
NKT237	7/-	OC83	5/-
NKT238	5/-	OC84	5/-
NKT240	5/6	OC139	6/6
NKT241	5/6	OC140	6/6
NKT242	4/-	OC169	4/8
NKT243	12/6	OC170	6/-
NKT244	3/6	OC171	6/-
NKT245	4/-	OC200	6/6
NKT261	4/-	OC201	9/6
NKT264	6/-	OC202	9/6
NKT271	4/-	OC203	6/6
NKT272	4/-	OC204	8/6
NKT274	4/-	OC205	8/6
NKT275	4/-	OC207	12/6
NKT281	4/-	OCP71	8/6
NKT401	17/6	P346A	4/6
NKT402	18/-	T1834	12/6
NKT403	15/-	T1843	8/-
NKT404	12/6	T1844	2/6
NKT405	15/-	T1845	3/6
NKT406	12/6	T1846	3/6
NKT451	12/6	T1847	3/6
NKT452	12/6	T1848	3/6
NKT453	9/6	T1849	3/6
NKT603F	6/6	T1850	4/6
NKT613F	6/6	T1851	3/6
NKT674F	6/-	T1852	3/6
NKT677F	6/-	T1853	6/-
NKT713	5/-	T1860	6/-
NKT717	8/6	T1861	6/-
NKT734	5/6	T1P29A	13/6
NKT736	7/-	T1P30A	15/-
		T1P31A	16/6

STYLII

ACOS	Sapphire	Diamond
GP59	2/6	7/6
GP65	2/6	7/6
GP67	2/6	7/6
GP73-1	6/6	9/6
GP73-2	6/6	9/6
GP79	2/6	7/6
GP81-1	2/6	7/6
GP91-1	6/6	9/6
GP91-2	6/6	9/6
GP91-3	6/6	9/6
GP91-1Sc	6/6	9/6
GP91-3Sc	6/6	9/6
HGP37	2/6	7/6
B.S.R.		
BSR C1 (ST3)	6/6	9/6
BSR TC8H	2/6	7/6
BSR TC8M	2/6	7/6
BSR ST8	6/6	9/6
BSR ST9	6/6	9/6
BSR ST10	—	9/-
BSR X1M	6/6	9/6
BSR X1H	6/6	9/6
BSR X3M	6/6	9/6
BSR X3H	6/6	9/6
BSR X5H	6/6	9/6
BSR X4H	6/6	9/6
COLLARO		
Collaro Studio 'O'	2/6	7/6
Collaro-Ronett TX88	2/6	7/6
Collel SK1	2/6	7/6
Dual CDS2/CDS3 (DN2)	6/6	9/6
Dual CDS/320 (DN3)	6/6	9/6
ELAC KST9 (PE10)	6/6	9/6
ELAC KST9 (PE1B)	6/6	9/6
ER5MB	6/6	9/6
ER5MX	2/6	7/6
ER5 SB	6/6	9/6
ER60 Stereo	6/6	9/6

GARRARD	Sapphire	Diamond
EV26 Stereo	2/6	7/6
GC2	2/6	7/6
GC8	2/6	7/6
GCE12	2/6	7/6
GCS10/1	2/6	7/6
GCS10/2	2/6	7/6
S 1—2—3	6/6	9/6
TS1	6/6	9/6
TS2	6/6	9/6
TS3	6/6	9/6
GOLDRING		
CM50	2/6	7/6
CM60	2/6	7/6
MX1	2/6	7/6
MX2	2/6	7/6
Stereo CS80	2/6	7/6
PERPETUUM EBNER		
PE188	6/6	9/6
PHILIPS		
AG3016	2/6	7/6
AG3063	2/6	7/6
AG3306	6/6	9/6
AG3310/3306	6/6	9/6
AG3400	2/6	7/6
RONETTE BINOFLUID		
BF40	2/6	7/6
DC284	2/6	7/6
SONOTONE		
2T	6/6	9/6
3T	6/6	9/6
8T4A	6/6	9/6
9TA	6/6	9/6
9TA/HC	6/6	9/6
19T	2/6	7/6
20T	2/6	7/6

The Diamond Tip is ·007 in. radius, thus making it compatible to play stereo records on mono equipment without damage to the record; and of course full stereo.

BRITISH MADE

EXPORT ENQUIRIES WELCOMED

CARTRIDGES

ACOS		Inc. P.T. each
GP79		12/6
GP91-1SC	1	21/-
	2- 11	17/9
	12- 49	15/6
	50-500	13/6
GP91-2SC		As above
GP91-3SC		As above
Suitable to replace TC8, etc.		
GP92		26/5
GP93-1		24/9
GP94-1		31/-
GP94-5		36/-
GP95		24/9
GP96		31/6
Acos 104	1- 10	41/10
	11- 25	39/9
	25- 50	38/3
	51-499	35/5

B.S.R.		Inc. P.T each
X3M	S/S	27/9
X3H	S/S	27/9
X5M	S/S	27/9
X5H	S/S	27/9
SX5M	S/S	36/3
SX5H	S/S	36/3
SX5M	D/S	39/11
SX5H	D/S	39/11
X4N	D/S	27/3
RONETTE		
105	S/S	19/10
106	S/S	19/10
DC400	S/S	14/-
DC400SC	S/S	14/-
105	D/S	22/4
106	D/S	22/4
DC400	D/S	16/9
DC400SC	D/S	16/9
SONOTONE		
8TA	D/S	25/-
9TA	D/S	35/10
9TAHC	D/S	35/10

CATHODE RAY TUBES

New and Budget tubes made by the leading British manufacturers. Guaranteed for 2 years. In the event of failure under guarantee, replacement is made without the usual time wasting forms and postage expense.

Type		New £	Budget £
MW36-20			4/10/-
MW36-21			4/10/-
MW43-69Z	CRM171		
	CRM172	6/12/-	4/12/6
MW43-80Z	CRM173	6/12/-	4/12/6
AW43-80Z	CME1702	6/12/-	4/12/6
	CME1703	6/12/-	4/12/6
	CME1706	6/12/-	4/12/6
	C17AA	6/12/-	4/12/6
	C17AF	6/12/-	4/12/6
AW43-88	CME1705	6/12/-	4/12/6
AW47-90			
AW47-91	A47 14W	7/13/4	5/7/6
A47 14W	CME1901	7/13/4	5/7/6
	CME1902	7/13/4	5/7/6
	CME1903	7/13/4	5/7/6
	C19AH	7/13/4	5/7/6
A47 13W	CME1906	10/5/6	8/10/-
A47-11W	CME1905	8/17/3	7/-/-
A47-26W	CME1905	8/17/3	7/15/-
A47-26W/R	CME1913R	9/6/8	

Type		New £	Budget £
A50-120W/R	CME2013	10/17/-	
AW53-80		8/18/8	6/5/-
AW53-88	CME2101	8/18/8	6/5/-
AW59-90			
AW59-91	CME2303	9/11/8	7/4/-
A59-15W	CME2301		
	CME2302		
	CME2303	9/11/8	7/4/-
A59-11W	CME2305		
A59-13W	CME2306	13/13/-	10/19/6
A59-16W	CME2306	13/13/-	10/19/6
A59-23W	CME2305	12/12/-	10/10/-
A59-23W/R		12/12/-	10/10/-
PORTABLE SET TUBES			
TSD217			6/15/-
TSD282			6/15/-
A28-14W		9/3/4	Not supplied
CME1601			7/15/-
CME1602			8/-/-

A discount of 10% is also given for the purchase of 3 or more *New* tubes at any one time.

All types of tubes in stock. Carriage and insurance 15/-.

TRANSISTORISED UHF TUNER UNITS NEW AND GUARANTEED FOR 3 MONTHS

Complete with Aerial Socket and wires for Radio and Allied TV sets but can be used for most makes.
Continuous Tuning, 90/-; Push Button, 100/-.

PLUGS

Jack Plugs and Sockets		Co-Axial Plugs	
Standard Plugs	3/10	Belling Lee (or similar type)	1/3
Standard Sockets	2/6	Add 5d. per doz. p. & p.	

DE BANKS MAGNETIC RECORDING TAPES

POLYESTER Length	Spool Size in.	Price
Standard Play		
600 ft.	5	10/-
850 ft.	5¾	12/6
1200 ft.	7	14/-
Long Play		
210 ft.	3	5/6
450 ft.	4	8/6
900 ft.	5	14/-
1200 ft.	5¾	17/-
1800 ft.	77	20/-
Double Play		
1200 ft.	5	17/6
1800 ft.	5¾	23/-
2400 ft.	7	26/-

EMPTY TAPE REELS

3 in.	1/6
4 in.	1/10
5 in.	2/3
5¾ in.	2/6
7 in.	2/7

CASSETTES

Boxed in Plastic Library Packs

C60	10/6
C90	12/6
C120	17/6

P. & P. 1/6 on all orders.

REBUILT AND NEW TUBES—*TWO YEARS GUARANTEE*

RE-BUILT	BRAND NEW	A FEW SAMPLE TYPES, REMEMBER WE STOCK EVERY TUBE
17" @ £4 14 6	£5 10 0	CME1702, AW43-80, CRM173, MW43-80, MW43-69*, CRM172*, AW43-88, AW43-89, CME1705, CME1703, C17AF, C17SM etc.
19" @ £4 17 6	£5 19 0	CME1903, CME1902, CME1901, AW47-90, AW47-91, A47-14W C19AH, C19AF, C19A.
21" @ £7 5 0	£8 10 0	CME2101, AW53-88, AW53-89, CRM211*, CRM212*, MW53-20*, MW53-80*.
23" @ £7 5 0	£8 19 0	CME2303, CME2301, AW59-90, AW59-91.

ALL PRICES ARE NETT. · * NEW ONLY. NO REBUILDS

TWIN PANELS 19" CME1906 A47-13W } £10 1 0 23" CME2306 A59/13W } £14 1 0

EVERY TUBE IN STOCK INCLUDING 11", 12", 16" PORTABLES, PANORAMA & RMGUARDS + Philips Tvette and KB Featherlight etc. TERMS: CASH WITH ORDER. CARRIAGE ANYWHERE IN GT. BRITAIN 10/6 per Tube

HOT-LINE ORDERS Tel: 01-567 5400/2971 TRADE ONLY

CARBON FILM RESISTORS

¼ 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 ¼ watt and 1 watt versions.
*Special for Philips TV's:
8·2M 2-watt, 4/6d. per pack.

SUB-MINIATURE ELECTROLYTICS (3's)

1mfd	18v.	1/8d.
2mfd	18v.	1/8d.
4mfd	18v.	1/8d.
5mfd	18v.	1/8d.
8mfd	18v.	1/8d.
10mfd	18v.	1/8d.
16mfd	18v.	1/8d.
25mfd	18v.	1/8d.
32mfd	18v.	1/10d.
50mfd	18v.	1/10d.
100mfd	18v.	1/10d.
200mfd	18v.	2/3d.

THERMISTORS (3's)

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

RECTIFIERS

Silicon Mains (3's)

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

VOLUME CONTROLS

Standard spindle with flat.

Double pole switch	4/7d.
Without switch	3/6d.

(One per pack)
5K, 10K, 25K, 50K, 100K, 250K, 500K, 1 meg, 2 meg.

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.	9d.
·0022	600v.	9d.
·0033	600/1500v.	9d.
·0047	600/1500v.	9d.
·01	400v.	10d.
·022	600v.	11d.
·033	600v.	11d.
·047	600v.	11d.
·1	600v.	1/-d.
·22	600v.	2/-d.
·47	600v.	2/10d.
·01	1000v.	1/1d.
·022	1000v.	1/1d.
·047	1000v.	1/8d.
·1	1000v.	1/8d.
·22	1000v.	2/8d.
·47	1000v.	3/8d.
·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.
37	,,	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.

BIAS ELECTROLYTICS (3's)

25mfd	25v.	1/6d.
50mfd	25v.	1/8d.
100mfd	25v.	1/11d.
250mfd	25v.	3/0d.
500mfd	25v.	3/8d.
1000mfd	12v.	6/0d.
1000mfd	30v.	5/9d.
2000mfd	25v.	7/0d.
2500mfd	30v.	9/0d.
3000mfd	30v.	9/6d.
5000mfd	30v.	10/0d.
25mfd	50v.	1/8d.
50mfd	50v.	2/0d.
100mfd	50v.	2/6d.
250mfd	50v.	3/8d.
500mfd	50v.	4/6d.
2000mfd	50v.	9/0d.
2500mfd	50v.	10/6d.

SMOOTHING ELECTROLYTICS

Wire ended, 450v. working.

1mfd	1/6d.
2mfd	1/6d.
4mfd	2/3d.
8mfd	2/6d.
16mfd	3/0d.
32mfd	4/6d.
50mfd	5/0d.
8/8mfd	4/0d.
8/16mfd	5/0d.
16/16mfd	5/0d.
16/32mfd	5/0d.
32/32mfd	5/0d.
50/50mfd	8/0d.
50/50/50mfd	10/0d.

CANNED ELECTROLYTICS

100/200mfd	12/6d.
100/400mfd	16/6d.
200/200mfd	16/0d.
200/200/100mfd	18/6d.
200/400/32mfd	18/6d.
100/300/100/16	18/6d.
100/400/32mfd	18/6d.
100/400/64/16	21/0d.

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.

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TELEVISION

SERVICING·CONSTRUCTION·COLOUR·DEVELOPMENTS

VOL 21 No 2
ISSUE 242

NOVEMBER 1970

GETTING GOING WITH COLOUR

About eighteen months ago Charles Curran, Director-General of the BBC, predicted that the Corporation would be in considerable financial difficulties if there were not two million colour television licences by 1974. It now looks as though this target will be reached by the end of 1972—two years ahead of schedule—and if nothing drastic occurs to upset this rate of progress we should be approaching the *four* million mark by the end of 1974.

Even so we are still a long way from the progress being made in other major industrial countries such as Germany where, after launching colour television in parallel with the UK, over a million receivers a year are currently being produced—three times the UK rate. In Japan production is over six million colour receivers a year!

One of the main obstacles preventing our home industry achieving production rates at these levels is surely the Government restraint on consumer spending. The new Chancellor must be persuaded to relax the controls—gradually—while production capacity is being built up. This would be of considerable help in withstanding pressures from imports and would also enable us to capitalise on the export opportunities which the advent of PAL single-standard receivers present.

At the risk of being accused of raising an old bogey, it should be stressed that action on this front should not be long delayed. Already many UK manufacturers find it uneconomical to produce their own transistor portable radio receivers. Tape recorders and audio equipment from overseas have made considerable inroads in the UK market. And judging from a tour round the recent trade shows it seems that before long we are going to see a steady and possibly considerable influx of foreign portable television receivers on the UK market. We spoke to several manufacturers about this and the response was usually on the lines "we don't think it would pay us to make them". It sounded like an epitaph.

Unless those in power heed these words and what they imply there may come a day when a second line will be added: "Here lie the remains of the UK radio and television industry"!

W. N. STEVENS, *Editor*.

THIS MONTH

THE NEXT ISSUE DATED DECEMBER WILL BE PUBLISHED NOVEMBER 23

TELETOPICS

WORLD'S FIRST AUTOMATIC COLOUR CAMERA

Marconi introduced at the International Broadcasting Convention (on which a report will appear in our next issue) the first automatic colour TV camera which eliminates the lengthy manual alignment and colour balancing routines. These are replaced by a fully automatic, computer-controlled correction system which operates at the touch of a button. The sensitivity of this three-tube camera, the Marconi Mark VIII, is in normal operation comparable with most monochrome cameras and is claimed to be at least twice as high as current colour cameras. It has a standard light operating figure of 750 lux (75ft.-candles) but usable pictures can be obtained at as low a figure as 50 lux.

While only three tubes are used—to give minimum size and weight—the camera, with its automatic registration and equalised colour lag, gives a performance of the standard previously associated with four-tube types. The camera is designed to use new versions of the English Electric Leddicon lead-oxide camera tube but can also be fitted with the Philips Plumbicon tube. The tube deflection coils are constructed in the form of printed circuits on cylindrical glass tubes to provide optimum accuracy and stability in the registration of the pictures from the three tubes. A push-button control on the c.c.u. or control panel provides complete and fully automatic alignment of the pictures from the three tubes while accurate colour balancing of the three output signals is initiated by a second push-button to provide a true white and thus ensure maximum colour fidelity over the full colour spectrum.

Amongst several new introductions by EMI at the IBC was a new three-tube colour camera, the 2005, which has been developed from the internationally successful 2001 and incorporates auto-centering (see *Teletopics*, July 1970) as a standard facility. Other features include effective built-in bias lighting to reduce lag at low-light levels, mixed viewfinder feed for superimposing external pictures over the camera picture and electronic field-of-view indication on the viewfinder. The camera has a "stand-by" mode including remote capping which extends tube life and exempts tube/hour charges on hired tubes. An integral diascope for camera alignment is available.

NEW SHADOWMASK TUBE

Mullard have introduced the first 26in. shadowmask tube to appear in the UK, type A66-120X. It is a protected type with supersquare presentation and is basically a larger version of the Mullard 22in. shadowmask tube introduced last year. The deflection angle is 92°, overall length 20¼in., and e.h.t. required 25kV.

TRADE IMPROVEMENT CONTINUES . . .

The rising trend of colour set deliveries to the trade continued during July when 40,000 sets were delivered. Monochrome set deliveries jumped abruptly during July to 150,000, reversing the mild downward tendency of previous months.

BUT MANY SETS FAULTY

The RTRA is at present making an enquiry into the delivery of faulty new sets to dealers. This is the outcome of a report from a large dealer who found that out of 1,500 monochrome sets delivered 19% were faulty on arrival whilst out of 200 colour sets 27% were faulty. This seems to be an extraordinary state of affairs. With an ever increasing number of foreign sets appearing on the market the UK setmakers will be in serious trouble—like the car makers or worse since TV sets can be more easily transported—if they can't devise means of improving their assembly and test methods.

New sets this month are listed in our Radio and TV Show report on a later page.

BATC REACHES 21

Our congratulations to the British Amateur Television Club which came of age at its recent two-day CAT-70 conference at Churchill College, Cambridge. The Club was started by Michael Barlow in 1949 and now has over 1,000 members many of whom have risen to senior positions in professional television. On-air transmissions on the 70cm. Band started in the early fifties with flying-spot scanners and a few iconoscopes as the signal generating units. Members later started to build vidicon cameras and to move into colour. The Club now faces its most serious challenge with the threat of commercial interests in the communications field taking over part or all of its frequency allocation.

WHAT'S NEW?

Solda-Mop from Servisol for desoldering electrical connections and electronic joints quickly, safely and efficiently. Solda-Mop has a 150cm. specially impregnated wick in a plastic dispenser. The wick is placed on the defective joint and the soldering iron then applied, the molten solder being drawn up the wick to leave the joint ready for resoldering. Priced at 14/-d., Servisol Ltd., Cooper's Buildings, Church Street, Liverpool L1 3AG.

Eagle aerials have introduced a new fringe aerial called the Trombone consisting of two eighteen-element Yagi arrays on a common beam with common mounting. Eagle Electronics Ltd., Heath Hayes, Cannock, Staffs.

Motorola have introduced an integrated circuit tuning indicator, type MC1335. In conjunction with a miniature lamb bulb, it is intended for aiding the fine tuning of f.m. radio sets and colour TV receivers. The i.c. is fed with the signal from a phase-sensitive detector such as the ratio detector in an f.m. sound channel.

EMI Electronics have produced a 48-page publication describing their "packaged system" approach to educational TV installations. Copies of the booklet "Closed-circuit Educational Television Packaged Systems" are available free of charge from EMI Television Equipment Division, Blyth Road, Hayes, Middx.

CERAMIC TV BANDPASS FILTERS

We understand that the Mullard Research Laboratories are also working on the "surface-wave" type of i.f. filters for TV receivers that we mentioned last month. Their experimental models consist of a small strip of piezoelectric ceramic about ½ x ¼in. with input and output electrodes. The electrodes are formed by photolithography and each consists of an array of interleaved gold fingers laid down on the surface of the ceramic strip. The electric field set up by the input electrode when a signal is applied to it results in an acoustic surface wave which is picked up by the output electrode and converted back into an electric signal. According to the size and shape of the electrodes some frequencies will reinforce whilst others will cancel, giving a bandpass characteristic with centre frequency determined by the separation between the individual electrode fingers. The experimental models have a slightly narrower bandwidth than predicted, while the insertion loss is greater than with conventional filters. However, one aim is to combine the filter with input and output amplifier chips in a single dual in-line i.c. encapsulation.

LINSTEAD CCTV CAMERA

The inexpensive CCTV camera developed by Mullard, which we described last month, is being marketed by Linstead Electronics, Roslyn Works, Roslyn Road, London, N15 5JB (it is *not* available from Mullard Ltd.). The camera provides an output suitable for feeding a standard professional TV monitor, consisting of a composite video-frequency signal with sync pulse and picture information to CCIR standards. Terminated by 75Ω it can also be used with a standard 405- or 625-line TV receiver but where such a receiver is to be used as a monitor special precautions must be taken to ensure that the receiver is isolated from the mains. Suitable transformers are being made available by Linstead for this application. The camera is available as a working instrument or in kit form. Comprehensive information, including full assembly instructions, is supplied with each kit. The basic kit less tube and lens is available at £45 each net, the complete kit with lens and tube is available at £70, whilst a fully constructed and tested camera is available at £99 17s 6d.

The Linstead closed-circuit TV camera.

NEW ITA STATIONS

The ITA has now brought into service its **Divis** Northern Ireland u.h.f. transmitter. The station carries Ulster Television programmes and is on channel 24. A group A receiving aerial mounted for horizontal polarisation is required. The e.r.p. is 500kW.

The ITA has also brought into operation the first of its three main u.h.f. transmitters for Anglia Television. This is the **Tacolneston** transmitter which is operating on channel 59 (receiving aerial group C) with horizontal polarisation and an e.r.p. of 250kW. The second station at **Sudbury** is expected to be operating shortly on channel 41 (receiving aerial group B) with horizontal polarisation and an e.r.p. of 250kW, whilst the third station at **Sandy Heath** is expected to be in service early in 1971 on channel 24 (receiving aerial group A) with horizontal polarisation and an e.r.p. of 1,000kW.

INDEPENDENT GROUPS DEVELOP TV SETS

News from two independent groups one of whom has developed a colour set and the other a monochrome monitor.

The colour set has been developed by CTC Electronics and is classed as a professional television receiver, fitted with a square 26in. tube. The "Jet Set" is intended primarily for the educational and similar markets but at £338 could make inroads into the domestic market. The set is claimed to have a world lead in that 50% of its circuitry is incorporated in eight integrated circuits. An electronic tuner is used and a double-wound mains transformer fitted. The set is for single-standard operation, and also features a digital clock on the front control panel.

The monochrome monitor has been developed by a group called Cotron who hope to be able to sell it at £155. It features a black-level clamp and regulated power supply and uses silicon transistors throughout with a selenium e.h.t. rectifier. The modular construction is on three printed boards with quick-release fasteners. The preproduction units are fitted with 11in. or 15in. c.r.t.s and operate on the 625/50 or 525/60 line/field standards. The centre resolution is 800 lines with corner resolution of 625 lines. The h.f. response to 8MHz is ±1dB and less than −3dB at 10MHz.

SURPLUS 625 CONVERSION UNIT

DAVID ROBINSON

THE Murphy conversion unit is available from Manor Supplies and is a complete u.h.f. receiver, sound and vision, which may be used to convert almost any 405-line set to 625. It is mounted in a cabinet plinth assembly designed to be screwed to the underside of the receiver cabinet. This makes it ideal for conversions in which it is desired to keep the original cabinet and general appearance of the set unchanged. It can also be used to convert many of the earlier "convertible" models where difficulty has been experienced in obtaining the exact conversion kit required. The overall size of the unit is approximately 24 × 7 × 3 in. excluding the control knobs, which are both for tuning and are marked "fast" and "slow". A horizontal scale is provided marked with the channel numbers from 21 to 68 and an octal plug provides all the necessary connections to the rest of the receiver.

Access to Unit

When the unit has been fitted to the receiver, access may be readily obtained by removing the four feet on the underside and the screws underneath them. The bottom panel can then be removed. Removing a further screw enables the vision i.f. panel to be swung out. There are in fact two printed panels, one for the vision i.f. strip and the other for the video amplifier and sound i.f.

Circuit Description

The aerial signal is passed to a conventional two-valve u.h.f. tuner and then to a three-stage high-gain vision i.f. amplifier. A.G.C. is applied to the first two stages ensuring a wide range of control. As in conventional practice, the sound i.f. signal is passed through this amplifier, though at an attenuated level, to provide the intercarrier sound signal at the vision detector. The video output of the detector, along with the 6MHz intercarrier signal, is directly coupled to the 6F28 video amplifier. The video output is taken via the 6MHz rejector L213 to the appropriate pin on the output plug. The 6MHz signal is passed via a bandpass transformer to the amplifier-limiter V7 (EF184) and to the usual ratio detector.

Setting-up and Testing

Later I will describe the construction of an add-on unit to provide black-level stabilisation. It is useful however to be able to connect the Murphy unit as it stands to the receiver as this facilitates testing the unit itself and the timebases. To do this an octal socket as shown in Fig. 1 is connected to the set to take the connections from the unit.

Next the mains dropper of the set should be changed to the correct value. This is done by adding up the heater voltages of the valves in the Murphy unit, plus those which remain in the original set, subtracting this from the mains voltage and dividing by 0·3 to get an answer in ohms.

When the line oscillator has been set to the correct frequency a picture of sorts should be resolvable and it will then be necessary, unless the set is of the convertible type, to make the usual modifications to the timebases to obtain correct width, height and so on.

In many cases it will also be worthwhile to build a new audio amplifier, as those fitted to most commercial TV sets are not exactly Hi-Fi!

Add-on Unit

The next step is to provide d.c. restoration and a gated a.g.c. system in order to stabilise the black-level of the picture. This could be done exactly as described in my article in the May issue for the GEC i.f. panel, but in the Murphy circuit the video amplifier is directly coupled both to the vision detector and to the output socket, and by using a somewhat different approach it is possible to design the black-level clamping unit as an add-on circuit without the need for any modifications to the Murphy circuit at all.

The circuit of the add-on unit is shown in Fig. 3 and uses two valves, an EB91 and an ECC82. It would be possible to use two semiconductor diodes in place of the EB91 but both of the functions

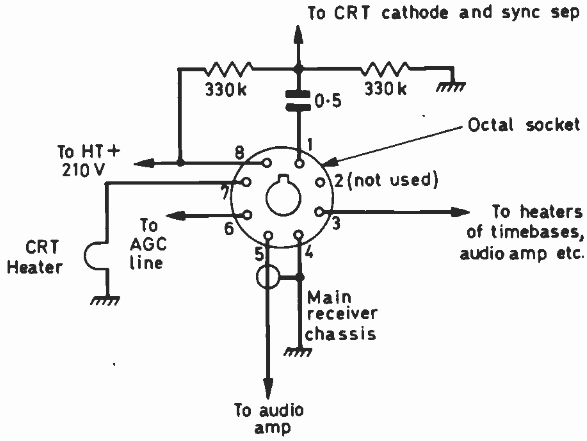


Fig. 1: Socket connections for initial testing.

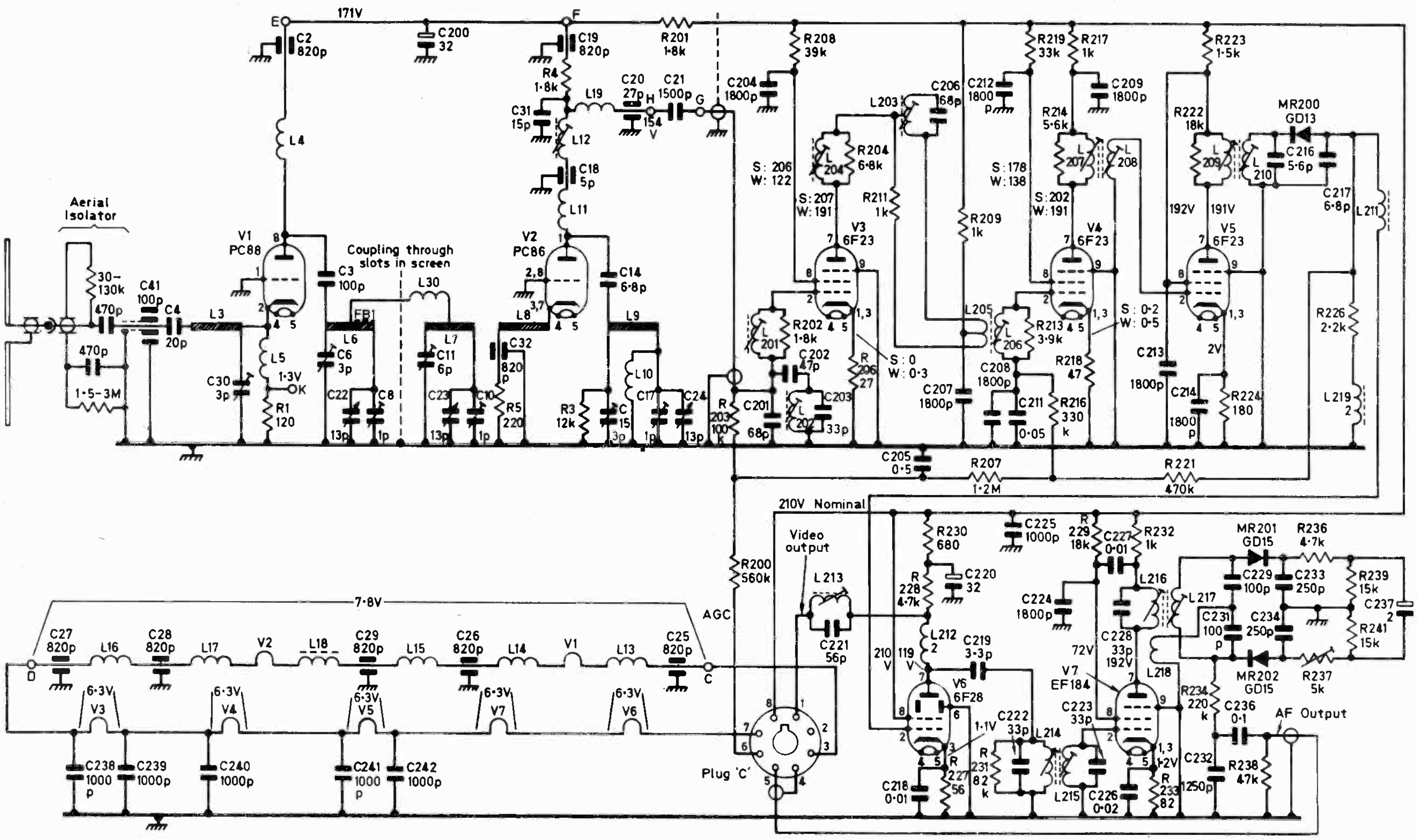


Fig. 2: Complete circuit of the Murphy 625-line conversion unit.

The above unit forms a complete u.h.f. receiver with two-valve continuously-tunable tuner unit, i.f. strip, video amplifier and intercarrier channel. It will thus directly drive the c.r.t. and audio stages of a set to be converted. However a suggested intermediary "black-level clamp" unit is shown in Fig. 3 to improve performance. This provides—to stabilise the black level—d.c. restoration of the video signal and sync-tip a.g.c.

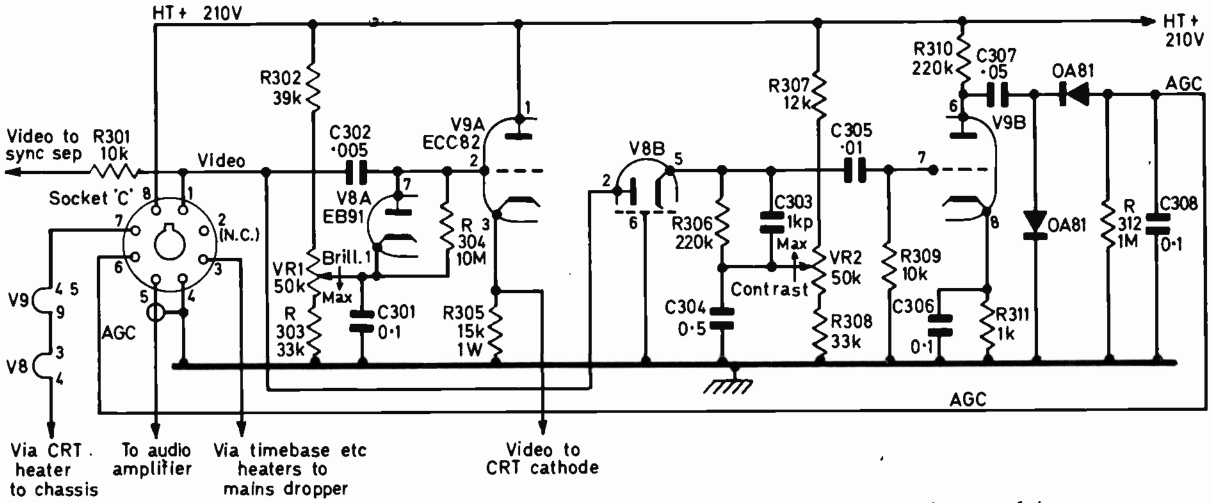


Fig. 3: Circuit of the add-on unit which forms a link between the Murphy unit and the rest of the set.

involved require a very high reverse resistance which cannot be cheaply achieved with semiconductors. I therefore decided to use the valve, which must be in nearly everyone's spares box in any case. OA81 diodes are used for the a.g.c. rectifiers, but another EB91 may be used here if desired.

DC Restorer

The circuit is basically in two sections. The first is the d.c. restoring section, V8A and V9A, the purpose of which is to clamp the tips of the sync pulses to a constant level ready for feeding the composite signal to the c.r.t. This function is carried out by the diode V8A and the capacitor C302. (The components in the tuner unit are numbered R1, R2 etc., those in the i.f. strip R201, R202 and those in the add-on unit R301, R302 etc.) The value of C302 may seem very small for coupling the vision signal, but as it is feeding into a very high impedance the time-constant is still long enough. Increasing the value of C302 merely means that the black level takes a second or two to settle down after adjusting the contrast or tuning.

Video Cathode-follower

Since the d.c. restorer must operate into a high impedance it is followed by a cathode-follower V9A which then feeds the tube. The operation of the circuit is such that the less current there is in the c.r.t. the more there is in V9A. To keep this current to a reasonable level and thus prolong the life of the valve, the c.r.t. grid should be returned direct to chassis (except for any field blanking circuits) and brightness control effected by carrying the bias on the cathode of V8A. Resistors R302 and R303 limit the range of the control, avoiding c.r.t. overdrive and also making adjustment less critical. The values may however need alteration to provide a good range since the brightness depends also on the voltages applied to first and final anodes of the c.r.t.

V8A can momentarily clip the sync pulses if the brightness control is suddenly turned up. To avoid a momentary loss of sync, the sync separator is fed direct from the video amplifier instead of from the cathode-follower.

Gated AGC Circuit

The second section of the add-on unit is the black-level a.g.c. system, using V8B and V9B. The gating diode V8B cathode is biased by the contrast control. This bias is such that only the sync pulse tips, which are the most positive portion of the signal appearing at the video amplifier anode, can pass through the diode. A signal is thus developed across R306 which is a measure of the difference between the bias set by the contrast control and the peak signal amplitude on the anode of the video output valve. This "error signal" is amplified by V9B and fed to the OA81 rectifiers which produce the a.g.c. voltage, the output being filtered by C308. R312 provides a discharge path for this capacitor. The a.g.c. potential is fed to the first two i.f. amplifier stages via pin 6 of the connecting plug.

High-frequency components of the vision signal or noise can pass the interelectrode capacitance of V8B even when it is reverse biased. This would result in a permanent output from the a.g.c. unit which would restrict the maximum gain available and also the maximum contrast which can be had. These effects are removed by C303 which bypasses the stray high-frequency signals without affecting the normal a.g.c. action.

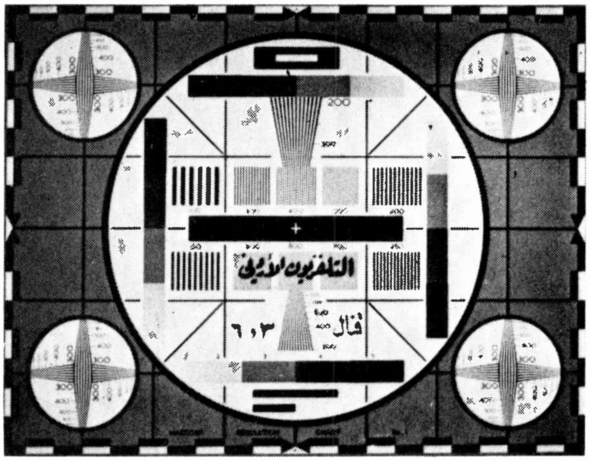
Construction

The black-level clamping unit may be built either on a small subchassis or by clearing away part of the redundant circuitry of the original receiver. It should be kept away from circuits such as the line output stage which produce large pulse radiations, and the wiring around the grid of V9A should be kept short as it is a high-impedance circuit. Stray pickup on the grid of V9B has been minimised by keeping its grid leak resistor to a low value.

This is a very well-built conversion kit and the fact that it is single-standard and does not need any modifications means that a very straightforward yet good quality conversion is possible, while usually the set's original cabinet can be retained with the conversion kit mounted underneath. ■

DX-TV

CHARLES RAFAREL



The Jordanian test card.

ONCE again I have to report adverse SpE conditions. They have not been really bad, the best I can say is that they have been mediocre and I have had to work pretty hard to get some DX every day. Normally my DXing on weekdays is between 07.00 and 09.00, with sometimes a chance to look around between 13.00 and 14.00 plus an evening session from 17.00 onwards. At other times I am at business, though I have longer periods of course at weekends and during public holidays. I point this out in case any DX friends think I am viewing for 24 hours a day! I only wish I was!! I get many reports from other DXers of their reception at other times than these and often regret that I was miles from home at the time. That's the way it goes!

DX-TV is always a challenge. It is not only poor conditions but the limited time available that work against us. I am sure many of us find that evening DXing presents its problems of identification in the absence of test cards. I know nothing more infuriating than a strong long-duration programme—usually a concert with no speech—which fades out just as a caption might have appeared! It happens to all of us and often means that whilst we have patiently waited we have missed something on another channel. The only solution to this would appear to be to use several sets at the same time each tuned to a different channel. I do this myself but alas I do not have enough sets to cover all channels, and even if I did I would be severely criticised for filling the house with them!

The 1970 SpE season must be nearly over now. I doubt if we shall get any further startling openings this year, but one never knows. Here is my SpE log for the period 1/8/70 to 31/8/70:

1/8/70	USSR R1.
2/8/70	USSR R1, Czechoslovakia R1, Poland R1.
3/8/70	Czechoslovakia R1, Norway E2.
4/8/70	USSR R1, Czechoslovakia R1, Poland R1 and R2.
5/8/70	USSR R1, Czechoslovakia R1, Spain E2.
6/8/70	USSR R1, Czechoslovakia R1, Poland R1, Austria E2a, Norway E2, Spain E3.
7/8/70	USSR R1, Czechoslovakia R1, Poland R1.
8/8/70	USSR R1, Spain E3.
9/8/70	USSR R1, test card Poland or Hungary R1, Czechoslovakia R1, Sweden E2.
10/8/70	USSR R1, test card Poland or Hungary R1, Sweden E2 and E4, Norway E2, E3 and E4.
11/8/70	USSR R1, Czechoslovakia R1, Poland R1 and R2, Sweden E2.
12/8/70	USSR R1 and R2, Czechoslovakia R1 (two stations see below), Poland R1 and R2, Norway E2 and E4, Sweden E2.
13/8/70	USSR R1, Czechoslovakia R1, Sweden E2 and E4, Denmark E4, Spain E2.
14/8/70	USSR R1, Czechoslovakia R1.
15/8/70	USSR R1, test card Poland or Hungary R1, Czechoslovakia R1.
16/8/70	Czechoslovakia R1, Spain E2.
17/8/70	USSR R1, Poland R1.
18/8/70	USSR R1 and R2, Czechoslovakia R1.
19/8/70	USSR R1.
20/8/70	USSR R1, Czechoslovakia R1, Norway E2 and E4, Sweden E2.
21/8/70	USSR R1, Czechoslovakia R1, Hungary R1, Poland R1 and R2, Austria E2a, Switzerland E2.
22/8/70	Italy IA, Switzerland E2, West Germany E4, Sweden E2.
23/8/70	USSR R1.
24/8/70	USSR R1, Austria E2a.
25/8/70	USSR R1, Czechoslovakia R1.
26/8/70	USSR R1, Czechoslovakia R1, Austria E2a.
27/8/70	Czechoslovakia R1, Austria E2a, Spain E2.
28/8/70	Czechoslovakia R1, Austria E2a.
29/8/70	USSR R1.
30/8/70	Czechoslovakia R1, Austria E2a.
31/8/70	Czechoslovakia R1.

Czechoslovakia: A number of us have seen a small checkerboard of black, white and grey squares on R1. I first saw this pattern as early as 1964 and identified it as Czechoslovakia. It is now with us again and I am sure it is still Czechoslovakia. It was floating with the Czechoslovakian test card on 12/8/70 as noted above and it looks as if this is the second Czechoslovakian station on R1. At other times it has been alone and very strong.

Denmark: Now I know why this country seems to have been missing this year until I got it on 13/8/70: it is at times using an electronic type card similar to Holland. Keith Hamer of Derby has been of great help here. He reported the

—*continued on page 84*

PAL CHROMA DETECTION

K. C. BRANKSOME

Recent articles have dealt with the basic principles of R−Y signal phase reversal on alternate lines in the PAL colour system, and the techniques used in receivers to carry out the necessary R−Y phase switching on alternate lines of the picture. It is time that we took a closer look at the reasons for R−Y signal inversion on alternate lines, the way in which this enables the B−Y and R−Y colour-difference signals to be separated in the receiver prior to detection, and the practical methods used to carry all this out. We shall be going right up to the demodulation of the colour-difference signals.

But first let us set the scene. The chroma signal, which is transmitted *in addition* to the basic black-and-white (luminance) signal, consists of a subcarrier modulated in quadrature by two colour-difference signals. Modulated in quadrature means simply that the two colour-difference signals are modulated with a 90° phase difference so that they are present together but can be easily separated, in the same manner as the left and right signals in a stereo record track. The technique actually used at the transmitter is that each colour-difference signal modulates a separate carrier, the two carriers being at the same frequency but with a 90° phase difference between them: the two sets of signals are then added together. We shall see later how they are separated again. The two colour-difference signals transmitted are B−Y and R−Y. Three colour-difference signals are required to produce a full-colour picture but the third can be obtained in the receiver by combining the R−Y, B−Y and Y (luminance) signals in certain proportions.

The B−Y and R−Y signals are reduced in amplitude prior to application to the transmitter's modulation circuits in order to avoid the overmodulation that would otherwise occur if two full-amplitude signals were applied at the same time. The R−Y signal is reduced to 0·877 and the B−Y signal to 0·493 of its full strength. Adjusting the gains of the R−Y and B−Y amplifiers in the receiver enables the signals to be simply restored to their correct levels. It is conventional to refer to the amplitude-reduced R−Y signal as the V signal and the amplitude-reduced B−Y signal as the U signal, and it will simplify matters if we stick to V and U for the colour-difference signals in this article.

PAL Delay-line System

Now the basic way in which the PAL system differs from the original NTSC colour system is that in the PAL system the V signal is transmitted with reversed phase on alternate lines, i.e. if on one line it is transmitted as +V on the next it will be −V and so on.

In the PAL-D system so far used by all setmakers in this country a one-line duration (64μsec) delay line is used in the receiver to process the chroma signal, which if U+V on one line will be U−V on the next, and it is with this part of the receiver that we are mainly concerned in this article.

The basic arrangement for U and V signal separation is shown in block schematic form in Fig. 1(a). The chroma signal is fed direct to add and subtract networks and also to the delay line. The output from the delay line, which consists of the chroma signal delayed in time by 64μsec, is also fed to the add and subtract networks. Thus the add and subtract networks are fed with the chroma signal as it is on successive pairs of lines. This, as we shall see, has two results, (a) separation of the U and V signals and (b) cancellation of spurious phase errors in the chroma signal (these can occur in the transmission path for various reasons).

Signal Separation

Figure 1 (b) shows what happens in this arrangement when we have a line with a +V signal. But first one important difference from the arrangement depicted in (a). We can add two voltages, but to subtract two voltages it is necessary to invert the phase of one of them and then to add them. This is the arrangement shown in the bottom part of Fig. 1(b) and (c). All right, so in (b) we've got U+V at the input, and this is fed to both add circuits. Now the previous line would have been U−V, and this is what we get at the output from the delay line. Obviously if this is added to U+V the Vs cancel and we get 2U from the top part of the circuit. In the lower section a 180° phase shift is incorporated which changes the delayed signal to −U+V. In this case the Us cancel to give us 2V. Simple!

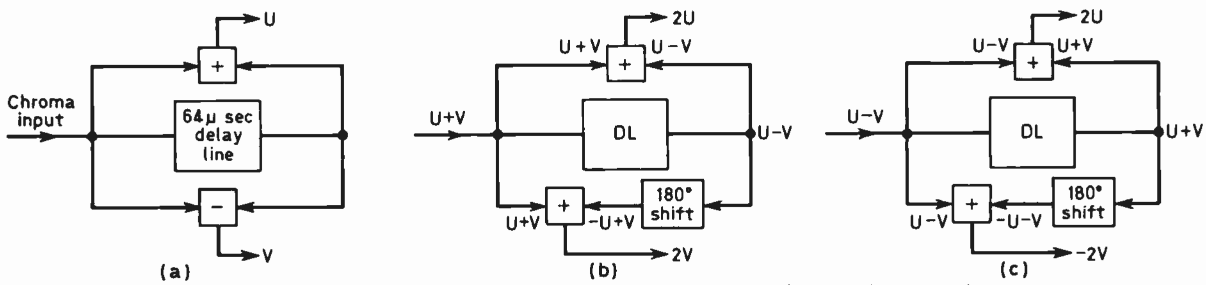


Fig. 1: Principle of operation of the chroma delay-line circuit in a PAL-D receiver.

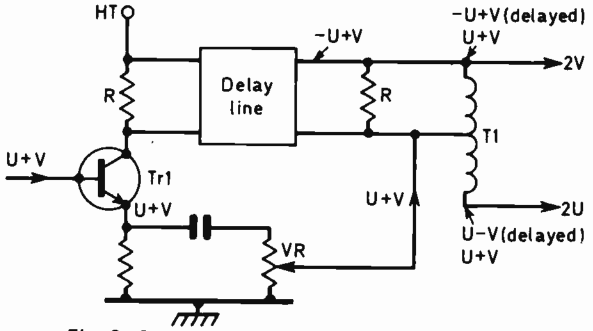


Fig. 2: Commonly used PAL delay line circuit.

Now let's see what happens when as shown at (c) we've got at the input a line with −V. Here U−V is fed to the addition circuits and the delay line output from the previous line is U+V. At the top the Vs again cancel to give us 2U. At the bottom our 180° shifter gives us −U−V, so the Us again cancel but this time we get −2V. How this signal is inverted to give us the correct V (R−Y) output from the V synchronous detector on every line was described in the two articles mentioned at the beginning.

Practical Circuit

Next let's see how all this is carried out in practice. Fig. 2 shows the basic circuit used in the vast majority of UK colour sets, both dual- and single-standard. The circuit consists basically of a driver stage Tr1, which drives the 64μsec delay line from its collector and also provides an emitter-follower direct signal feed, and a centre-tapped transformer T1 which carries out both the addition processes and, as it is centre-tapped, provides the 180° phase-change feature. This is the basic circuit as used with the original Mullard DL1 delay line. Circuits using the later DL1E and DL20 delay lines *look* slightly different but only because in these the transformer T1 is built into the delay line assembly. The circuit action remains the same.

Let's see what happens on a line with a +V signal. At the base of Tr1 we have U+V, and by emitter-follower action this appears at the emitter of Tr1 and is fed to the centre tap on T1, appearing at each end of T1. As there is a 180° phase change between the base and collector of a transistor, we shall have −U−V at Tr1 collector, but this will not appear at the output of the delay line until the next line. On our line the output from the delay line will be −U+V, i.e. the U−V signal from the previous line phase changed by Tr1. So at the top of T1 we've got (−U+V)+(U+V), i.e. 2V. The −U+V signal undergoes a further 180° phase change before appearing at the bottom of T1, so at the lower end of T1 we've got (U−V)+(U+V), i.e. 2U. On the following line with U−V at the base of Tr1 we get U−V at each end of T1 plus −U−V delayed signal at the top and U+V delayed signal at the bottom. The result is 2U again at the bottom but −2V at the top, which is phase changed by the PAL switch in the decoder as described in the articles previously mentioned.

Potentiometer VR in Fig. 2 enables the amplitude of the direct and indirect signals to be equalised in amplitude, while in many circuits a further adjustment is provided so that the phase of the two sets of signals can be accurately matched (see for example Technichart No. 1, page 397, June 1970 issue).

Phase-error Cancellation

So we've seen how the U and V signals are separated by the 64μsec delay line circuit. How is the circuit used to cancel phase errors in transmission, the original purpose of going to all this trouble? To see how this works let's take an example. Suppose the correct chroma signal at a particular point is A in Fig. 3(a). This signal is a combination of proportions of +V and +U. But suppose that a spurious phase shift means that what we actually receive is signal B, i.e. there has been a phase change of 10° towards the V axis. If we demodulated this signal we would get a redder shade than the correct one. Now on the next line the V component of the signal is inverted to −V in the PAL system, which places the signal in the next quadrant as shown in Fig. 3(b). Here A′ is the signal we should receive but because of the 10° phase lag B′ is what we actually get. Here the shift is towards the U axis.

Now if we stick to the correct signals for a moment and invert A′, as we do in the delay line circuit, then add it to A, the result is 2A (or rather the delay line circuit does rather more than this as we have seen, providing us with the separate U and V components that go to make up A).

Returning now to the phase shifted signal B, this is as we have seen received as B′ on the following line. Now if we keep the U component of B′ constant but invert its V component we get the signal shown as B″ in Fig. 3(c): the polarity of the original 10° phase error has been reversed! So if we take a direct and one-line delayed signal after inversion we get B and B″, with complementary phase errors. Adding the two together gives us the correct signal A. This is the basic PAL phase-error-cancelling action. A small price has to be paid: there is a slight loss of amplitude, resulting in a loss of saturation, but this is far less objectionable than a change to an incorrect colour.

All this takes place in the various adding and phase-shifting arrangements in the delay line circuit, so that the outputs it provides are not only separated U and V signals but phase-corrected U and V outputs.

Colour-difference Signals

We've talked about +V and −V signals on succeeding lines because the phase of the V signal is inverted on succeeding lines. It's worth looking just a bit closer into this however because we don't

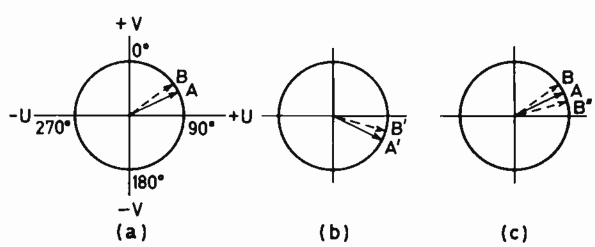


Fig. 3: Principle of phase-error cancellation in the PAL system.

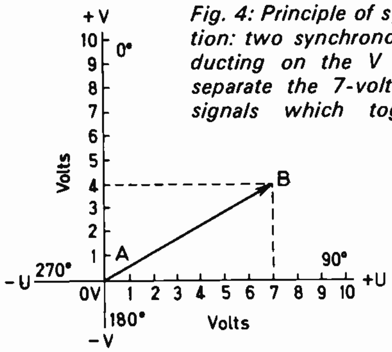


Fig. 4: Principle of synchronous detection: two synchronous detectors conducting on the V and U axes will separate the 7-volt U and 4-volt V signals which together form the composite signal represented by the phasor AB.

necessarily get +U and +V or −V on successive lines. We might get −U and +V, −V on succeeding lines. The point to remember is that these are colour-difference signals and that they can be positive *or* negative at any particular time, that is if we want for example to change from white to red at the c.r.t. what we have to do is to increase the R beam so that we need a positive-going R−Y colour-difference signal (we are talking about detected and amplitude-adjusted signals now, and taking for the sake of this example colour-difference as opposed to RGB c.r.t. drive) while pulling back the blue and green beams, i.e. negative-going B−Y and G−Y signals are required. What all this means is that the phase of the combined U and V signal is continuously moving around the whole four quadrants in Fig. 3 with, and this is the point in PAL, the V component phase changed on alternate lines.

Synchronous Detectors

Following the delay line circuitry are the synchronous detectors (in some receivers preamplifiers are interposed). Since we have signals with no carrier (it will be remembered that suppressed-carrier transmission is used for the chroma signal in the NTSC and PAL systems) locally generated carriers are fed to the synchronous detectors in addition to the U and V signals. The carriers have a 90° phase difference between them so that the U synchronous detector operates on the U axis and the V synchronous detector operates on the V axis to provide accurately decoded B−Y and R−Y colour-difference signals.

The principle of synchronous detection is shown in Fig. 4. The phasor AB represents the received signal. If the square of which this is the diagonal is completed, it will be seen that this phasor as it is called represents the addition of +7V U and +4V V signals. These are the signals that have been quadrature modulated to give AB. Now we have seen that these signals are separated in the PAL system in the delay-line circuitry, but the synchronous detectors themselves can fulfil this function and do so in the NTSC system. Separating the signals prior to detection in the PAL system improves the cross-talk performance, i.e. reduces interference between the signals. It also improves the rejection of luminance signal components in the chroma channel and the signal-to-noise ratio. However, to get back to synchronous detector operation, if the V (R−Y) synchronous detector is switched on briefly at 0° it will see the 4V V signal, i.e. provide an output of 4V, while if 90° later the U (B−Y) synchronous detector is switched on it will see the 7V U signal. In this way the phasor AB is separated into the original 4V and 7V signals.

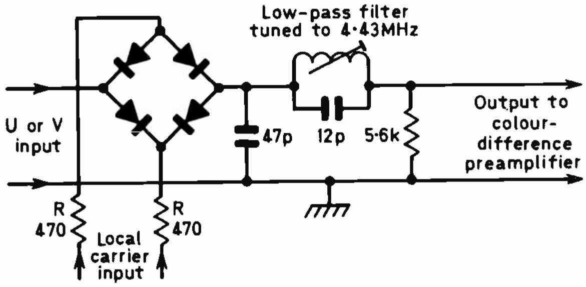


Fig. 5: Diode bridge synchronous detector. The resistors R bias the diodes so that they conduct only on the tips of the sinewave carrier.

There are various synchronous detector arrangements, the diode bridge circuit (Fig. 5) being perhaps the most widely used type when discrete components are used—in the latest chassis using a fair sprinkling of i.c.s synchronous detection is commonly done in the chroma i.c. Synchronous detectors act in the manner of switches, being opened and closed at subcarrier frequency to sample once or twice each subcarrier cycle the amplitude of the chroma signal at that instant. Since with quadrature modulation the V signal is at zero when the U signal is at maximum amplitude and vice versa, if the synchronous detectors are opened at the correct points in each cycle—the V detector at 0° and 180°, i.e. the V axis, and the U detector at 90° and 270°, i.e. the U axis—they provide accurately demodulated U and V video output signals. The local carrier signal provides the switching action, the detector diodes being switched on at the tips of the local oscillator sinewave signal. A low-pass filter in the demodulator's output circuit removes subcarrier (4·43MHz) components from the output. We shall be taking a closer look at practical synchronous detector circuits and their operation next month. ■

AN INTERESTING COLOUR FAULT

A new Pye colour receiver was brought in with a no brilliance fault. Normal d.c. tests quickly proved that the e.h.t. and all the tube voltages were normal, except for the voltages at the three control grids. The readings obtained here were some 30V negative instead of the correct approximately 60V positive. The sound (fully transistorised) was perfectly normal. The three triode clamps, one on each grid, were checked and found to be all right—except for the mysterious negative anode voltage readings. A new colour-difference amplifier panel was then tried, but with the same results.

Use of a 'scope would have helped locate the source of the trouble but one doesn't expect to have to use a 'scope for a simple no brilliance fault. After careful thought I decided to check the main smoothing capacitor, and found that this was open-circuit. The effect of the ripple on the h.t. line was to turn the three clamps into rectifiers, thus producing negative voltages at their anodes. As the type of colour-difference output stage used in this model—employing a PCL84 with the triode as clamp—is commonly used, the same effect may be encountered with other models.—*R.N.*

SERVICING television receivers

L. LAWRY-JOHNS

PYE 40F AND RELATED MODELS—cont.

The Line Timebase

Let us start here by repeating a little of what has already been said. The receiver we are dealing with mainly is the 40F. This has a flywheel line sync circuit, as have the later 67 and 368 series, using the PCL85 triode as a phase splitter. If therefore the trouble is an unlockable picture in a horizontal sense, meaning that the picture can be made to hover around its locking point but cannot be securely locked, first check the PCL85 valve. This can save a lot of time. The line oscillator is an ECC82 (V20) used as blocking oscillator with a control stage. The 36 series did not use an ECC82 in this position, the line oscillator in these being the triode of the PCL85 with no flywheel circuit and feedback from line output transformer and screen grid of the PL500 (see Fig. 7).

If trouble is experienced with the line hold in the 40F and later models and this is not line sync weakness, check the ECC82 and associated components, including R140. Note whether the trouble is common to both 405 and 625 or is confined to one standard. We say this because the controls can become faulty. To digress a moment, it may be said that the controls do tend to give their quota of trouble in these and many other receivers, the main offenders being the small presets (burning out) and the long sliders (changing value).

As far as the 36 series is concerned, line hold troubles can be traced to the PCL85 and also the line output circuit, and the PL500 (PL504) should not be above suspicion. The components from the screen circuit (C110) and the feedback R147 and C119 network may also require attention. One of the other weak links in the 36 series is the 8μF capacitor C117, which tends to short to chassis thus blowing the fuse or rather more confusingly causing the surge limiter R67 to go open-circuit.

Lack of Width

Lack of width is a very frequent source of trouble and although in most cases a new PL504 puts things right this is not always so. The preset width slider controls tend to change value and the PY88 can also loose emission. Other items to check are the correction capacitors, C122 or C123, depending upon which system is in use.

Vertical rulings (striations) down the left side of the screen should direct attention to R159, the damping resistor across the linearity coil. It does have to dissipate a certain amount of heat and tends to go high-value thereby giving rise to vertical rulings.

Inoperative Line Timebase

By inoperative line timebase we mean that the timebase is not producing any e.h.t. and there is no line whistle when switched to 405. The PL504 may be overheating, as may the PY88. The immediate and probably correct conclusion is that the oscillator is not working and thus there is no drive to the output stage. The immediate suspect of course is the line oscillator, V20 ECC82 (or the PCL85 in the 36 series). Check this and associated components.

There are times however when the oscillator is working and drive is applied to the output stage but overheating (to a lesser degree) still takes place. In this case check the PL504 and the PY88 (yes, a faulty efficiency diode can cause the output valve to overheat) and remove the top cap from the DY87. An internal short in this latter valve can cause the output stage to be overloaded, and removing the top cap will prove whether or not this is the case. Another quick check is to take off the PY88 top cap. If this restores timebase working the boost line capacitor C118 has shorted.

If these checks are without positive result and the system switch is working (sometimes it doesn't), check the components associated with the line output transformer and then brood over the probability that the transformer itself is at fault.

When swinging the panel down and up take notice of the proximity of the e.h.t. lead to the PCL85. It is often left touching this valve with the result that the lead is soon melted, arcs to the valve and destroys it. This precaution applies to any receiver with a vertical panel.

Power Supply Circuits

The 40F series has one feature which is not common to any of the others. This is the provision of an autotransformer in the mains input instead of the more usual dropper. A transformer imposes more strain upon a rectifier than a resistor-dropped input and the failure of a rectifier or its associated capacitor is not unusual. Such a breakdown in the h.t. supply will of course blow the fuse and a meter check across the rectifier will (most often) show a short. If it seems in order check the mains input filter capacitor C64 by disconnecting it. A meter check will not always show a short across this capacitor even

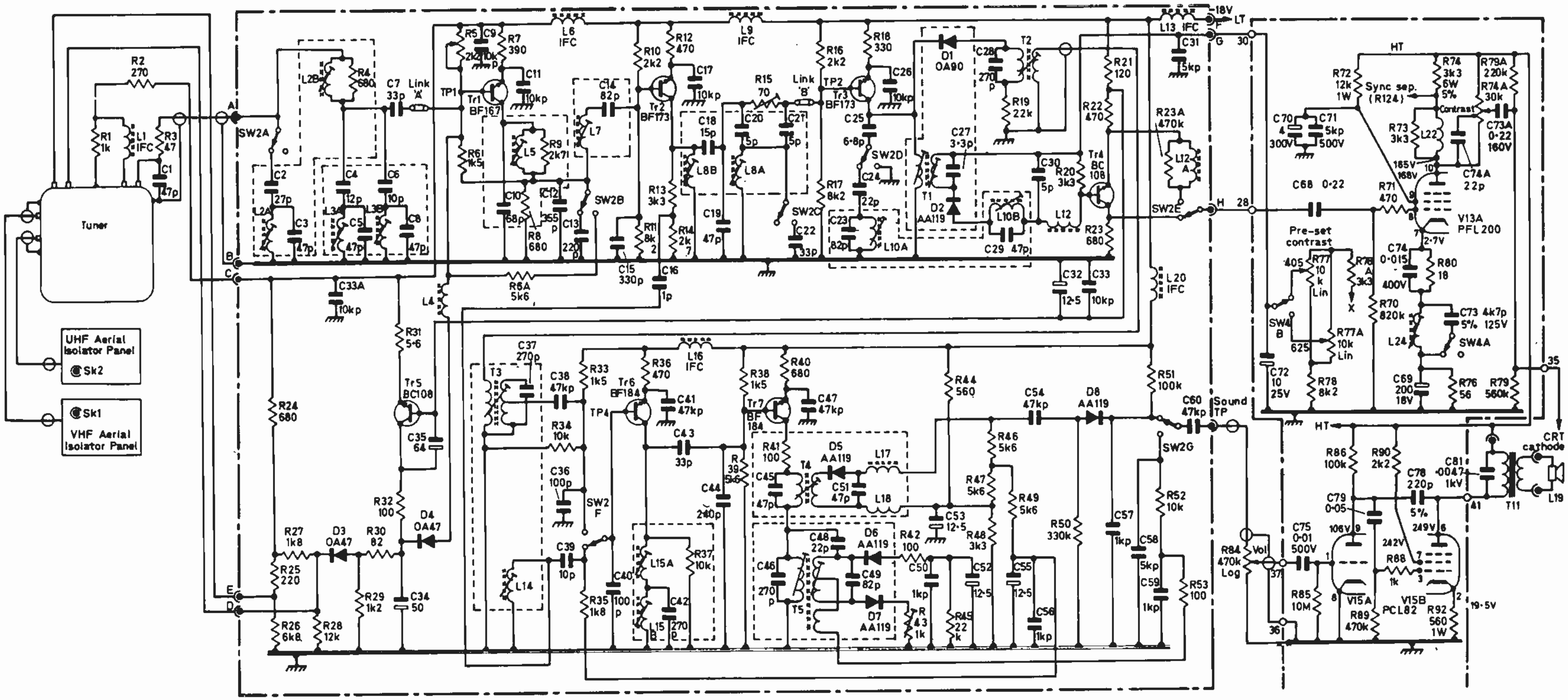


Fig. 4: I.F. strip, video and audio circuits of the 67 chassis. The 368 chassis is very similar except for the video stage which is shown in Fig. 5 (right).

TRANSISTOR VOLTAGE DATA

Code No.	Collector	Base	Emitter
T1	6.75 (8.7)	15.4 (12.7)	16.1 (13.4)
T2	0	13.9	14.7
T3	0	14.4	15.2
T4	9.0 (3.0)	9.3 (14.4)	10.4 (15.25)
T5	17.5 (3.15)	16.74 (17.3)	17.6 (17.75)
T6	0	14.25	15.5
T7	0.5	14.0	14.7
Pin 'D'		12.0 (3.4)	
Pin 'E'		12.9 (4.3)	
Pin 'F'		18.0	

All the above voltage readings are negative with respect to chassis and taken with AVO model 8, no signal input, SW2 in '405' position with pre-set contrast at maximum gain. Readings in brackets are those which differ when the pre-set contrast is set for minimum gain.

In the 368 chassis Tr1 is type BF196, Tr2 and Tr3 BF197, Tr4 and Tr5 BC148, Tr6 Tr7 type BF194. R5 is 4·7k and R6 1·2k.

Modifications:
36, 37: 10μF capacitor added from junction R15 and C32 to chassis.
67 chassis: R103 3W; R112 and R113 100k.
368 chassis: R103 is two 820Ω 1W resistors in parallel; R104 10k; R112 deleted and R113 250k; R128 560k; C100 47pF; R127 1k; R130 18k; R131 15k; R132 1M; C105 220pF; C110 470pF; C124 4700pF; R152 15k; C24 33pF; L11 207MHz rejector coil added between C30 and the junction R20, C31.

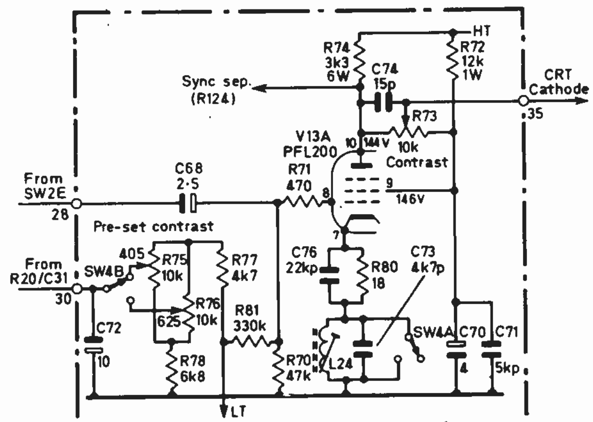


Fig. 5: Video stage, 368 chassis.

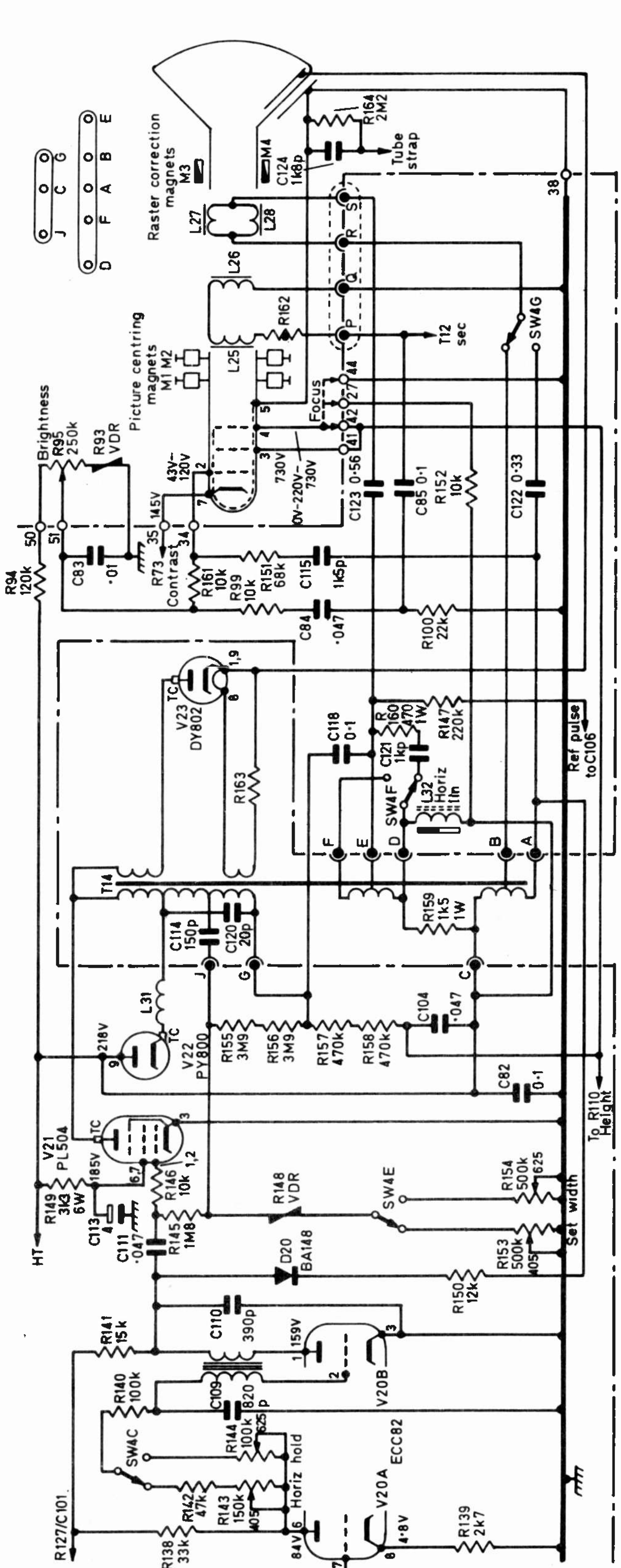


Fig. 6: Line timebase and c.r.t. circuitry, 368 chassis. R140 180k and R142 100k on some chassis depending on blocking oscillator transformer type. Voltages and switching shown for 405-line operation.

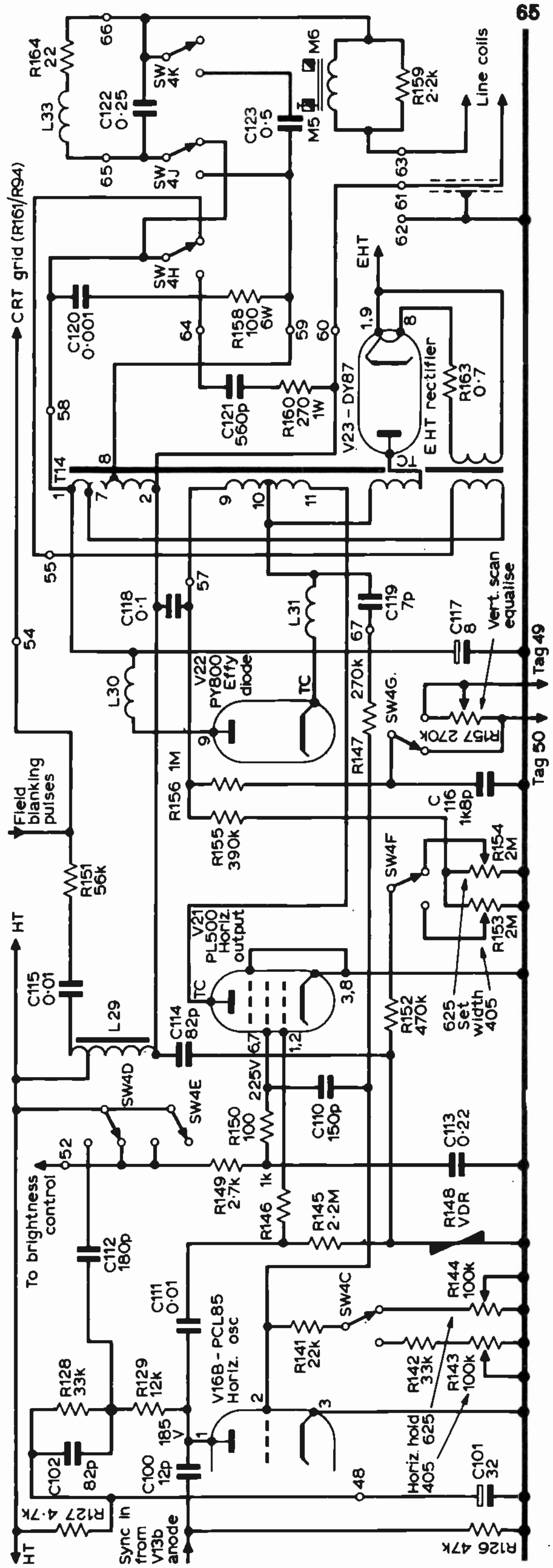


Fig. 7: Line timebase, 36, 37 series. R143 150k in later versions. Switches in 625 position, voltages for 405-line operation.

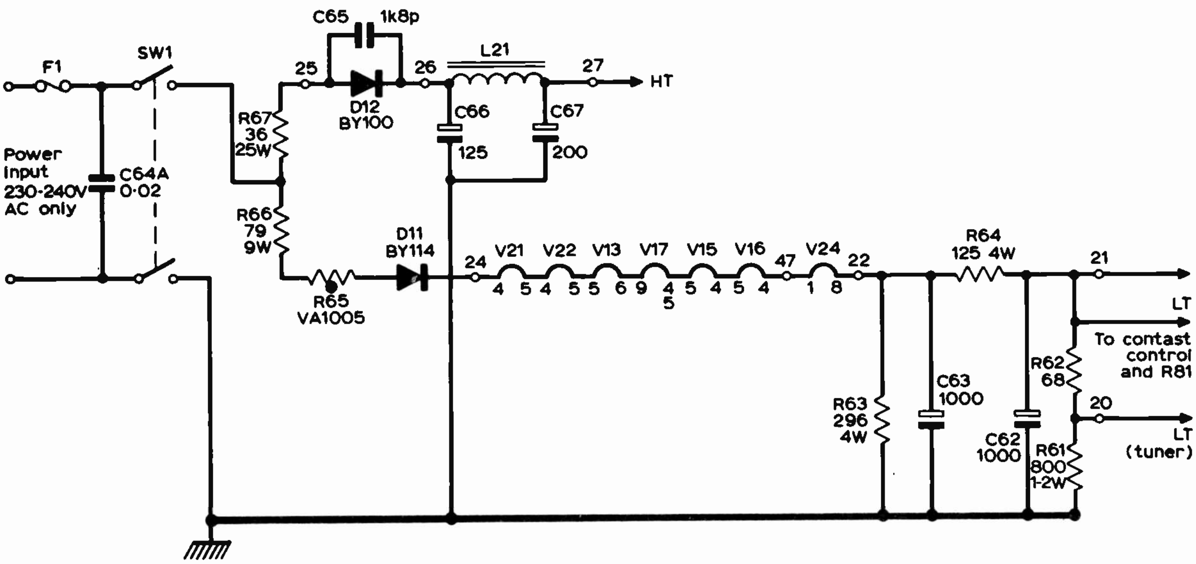


Fig. 8: Power supply circuits of the Pye 36, 37 series.

if it is at fault and disconnecting it is the best way of proving the point.

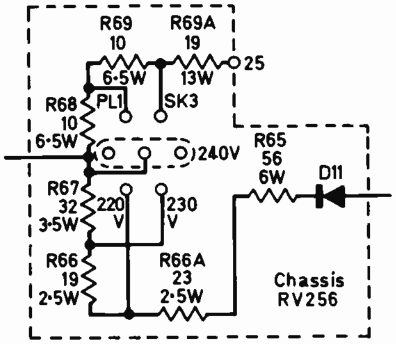
A different set of conditions arises when the heater circuit rectifier shorts (D11). This causes a.c. to be applied to the heater line thus over-running the valves and causing loss of sound and vision due to the supply shorting to chassis through C63. If therefore there are no signals, check the heater glow of the valves and tube and if this is excessive change the heater circuit rectifier. The foregoing applies equally to all models of course as rectifiers can fail whatever their mode of supply.

If all valves light up with no other sign of life it is fair to assume that the supply to D12 is open. This should focus attention upon the 6Ω, 6W surge resistor R69A which may well be found open-circuit. This particular value is only found in the 40F series. Other models have different supply arrangements but this is easily sorted out by the number of tags on the mains dropper on the upper left side; it takes a matter of moments to run along the tags to find which section is open-circuited, using an a.c. voltmeter or neon.

If the valves do not light up and the sections of the dropper are all intact, check the supply through the valve heaters, remembering that the PL504 is the first heater in the circuit, not the PY88.

Video Stage

The detected signals from the OA90 diode (D2) are passed via the switching to the video amplifier section of the PFL200. This valve does not now give a great deal of trouble although it is often responsible for weak contrast, poor sync and a picture which is marred by heavy shading. If the valve is not responsible for these troubles the associated components should be checked, particularly the electrolytics C69 and C70 The back to front resistance of the detector diode should also be checked



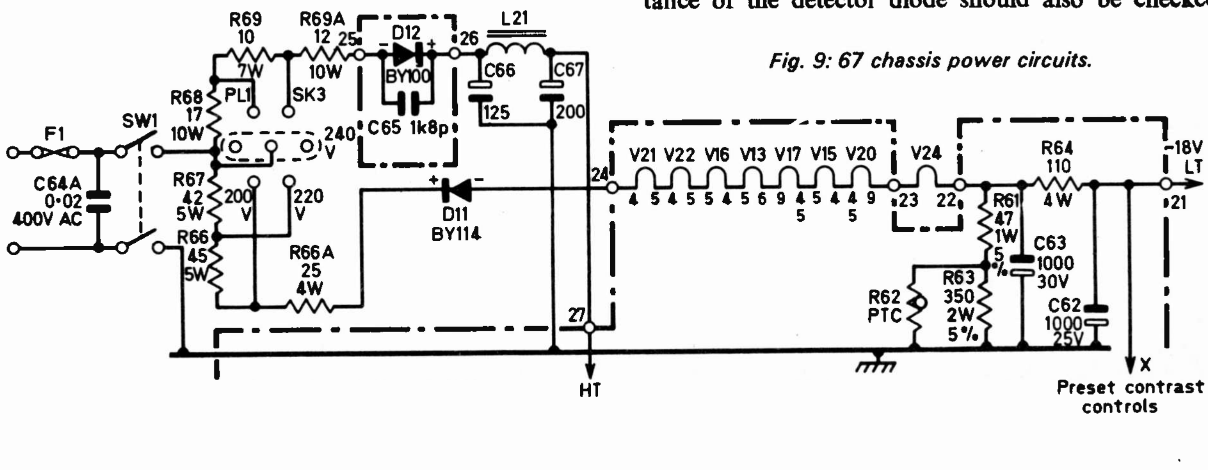


Fig. 9: 67 chassis power circuits.

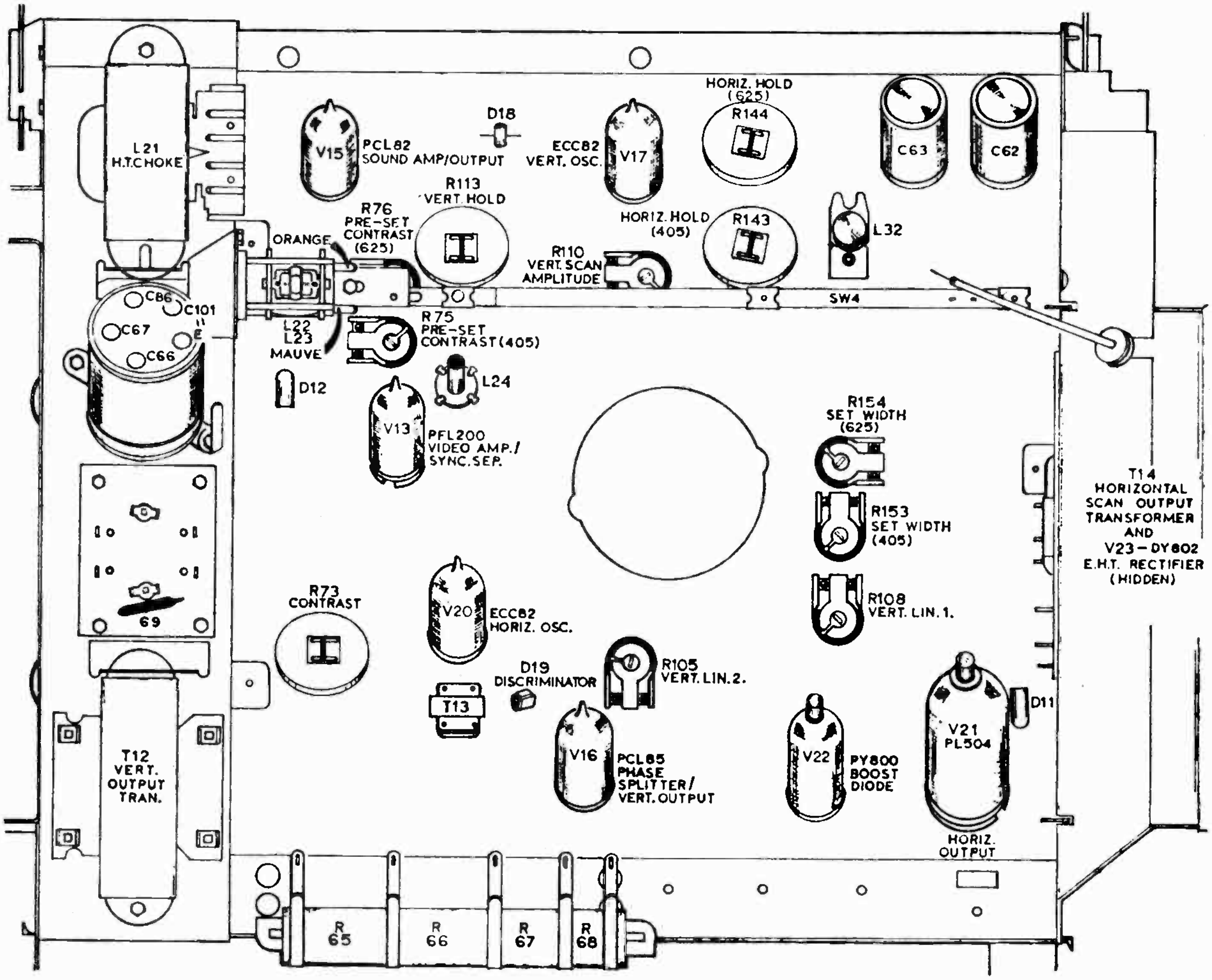


Fig. 10: Layout of the 368 main chassis, shown in the lowered position.

as this can produce similar symptoms, but without the shading.

A misleading symptom is slight shading of the picture with severe pulling in the horizontal sense, leading one to suspect a video fault (which it could be). Before getting too deep into this one check the setting of the preset contrast control. If too far advanced this can produce the symptoms described.

We hasten to point out that the video circuit of the 36 and 40F is a great deal different to that

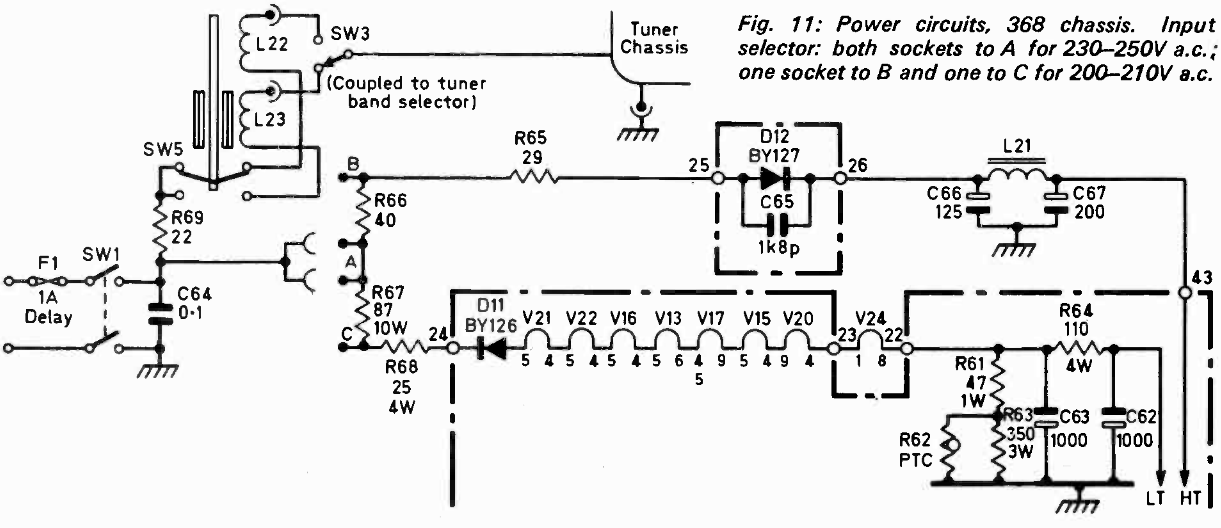


Fig. 11: Power circuits, 368 chassis. Input selector: both sockets to A for 230–250V a.c.; one socket to B and one to C for 200–210V a.c.

of the later 67 and 368 series, and these differ from each other. A video phase-splitter is used in both these later series. which also use high-level contrast controls. The moral is to use the correct circuit in each case and not to rely too much upon one's memory!

The IF Stages

In nine cases out of ten the faults which occur on the small i.f. panel can be traced by taking voltage readings. The readings on the circuit diagram apply to the 36 and 40F series. The later models use a completely different circuit with opposite supply polarity (see Fig. 4 and table beneath).

Where the voltage readings indicate a faulty transistor it may be found that the original is not available. For example the BF164 is replaced by a BF167 and the BF158 and BF159 are replaced by the BF184 and BF185. If in doubt, transistor replacement should be left to an experienced person because of the possibility of damage resulting to the associated circuitry. (The BF158 and BF159 are at present in stock at A. Marshall and Sons Ltd.)

The rule is to study the circuit thoroughly, noting the function of each stage and the voltages to be expected. If weak contrast is the fault check the video stage first and ensure that the contrast control is functioning over its whole range.

Removing Tuner & Control Assemblies

Lower the main panel. Pull off the volume and brightness knobs. Remove the two top nuts and the single nut securing the base of the tuner panel. Remove the single nut securing the volume and brightness panel and withdraw both assemblies from the cabinet.

The whole assembly can be completely disconnected from the timebase panel by unplugging the flyleads, and the i.f. panel removed from the tuner by taking out the two self-tapping screws.

Chassis Removal

Carry out removal as above. Unplug the e.h.t. connector, deflection coils input connector and c.r.t. base connector. Unplug the focus lead and c.r.t. coating earthing lead from the spark protection assembly. Release spark protection assembly from beneath the c.r.t. coating earthing braid. Unplug the leads from sound output transformer to the take-off tags on the main printed panel.

Raise the chassis (approximately to the half-way position) until the slots in the cabinet hinge brackets permit the chassis to be withdrawn. Withdraw chassis, tuner and control panel assemblies from cabinet.

Removing the CRT

Carry out procedures as above then lay the cabinet face down on a soft surface, supporting the cabinet edges so as to clear the tube face from the surface. Remove the deflection coils. Remove the four nuts and washers securing the c.r.t. clamping straps to the cabinet, at the same time removing the coating earthing lead. Lift out the tube. Unclip the flanges of the protective guard from the tube strap, at the same time releasing the tube earthing braid.

COLOUR RECEIVER CIRCUITS

GORDON J. KING

TUNER UNITS—2

The ultimate performance of a colour set—indeed any TV set—depends on the efficiency of the front-end. It is really the most important part of the set. Moreover, it must include the aerial and the feeder connecting the aerial to the r.f. amplifier. The front-end in fact is a proper integration of the aerial system and the tuner and for the best results the integration as a whole must be engineered to provide a satisfactory overall performance. I shall be returning to the problems which can occur due to unsatisfactory integration later, but first let us follow the tuner circuits detailed last month.

It will be recalled that we examined the circuits of u.h.f. only and all-band (u.h.f. integrated with v.h.f.) tuners. The need for a tuner to respond to v.h.f. channels is progressively diminishing as more and more areas of the country are receiving u.h.f. signals in three channels, giving BBC-1, BBC-2 and ITV in both monochrome and colour. All the signals are of course colour-encoded, but the colour multiplex is ignored by monochrome only sets (and by colour ones when the colour control is turned down) which thus display the programme in black-and-white. It is always convenient to keep in mind that a colour set is really nothing more than a fully-fledged monochrome set with extra circuits to process the colour multiplex in such a way as to shade the monochrome display in colour. The whole of the picture *definition* is provided by the monochrome part of the composite signal.

Electronic Tuning

One of the latest front-end advances in this country is the so-called "electronic tuner". In the tuners so far considered resonance over the channels is achieved by some form of mechanical tuning or coil switching arrangement, the latter on the v.h.f. channels. It will be recalled that a capacitor tuning-gang is adopted in all the u.h.f. tuners to resonate the various quarter-wave line tuning sections, some with four sections and at least one with three. The electronic tuner is also based on quarter-wave lines but instead of being resonated over the channels by variable capacitors capacitance-diodes are used.

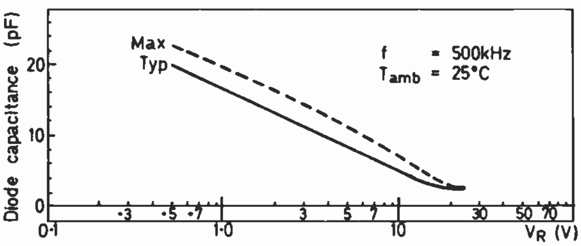


Fig. 1: The capacitance/reverse bias characteristic of a Mullard variable-capacitance diode.

The first British sets to adopt this kind of tuner are those fitted with the Philips G8 colour chassis. Now since the need for mechanical couplings between the gang and the channel tuning control or push-buttons on the front panel is eliminated with electronic tuning, the u.h.f. tuner module can with this system be located almost anywhere in the cabinet or on the chassis. The actual tuning in this system is accomplished by circuit feeds which vary the potential across the capacitance diodes. The control section is thus connected to the tuner proper through a flexible cable system.

Varicap Diodes

Channel selection on the Philips chassis is accomplished by a group of six push-buttons and the required channels are resonated initially by preset potentiometers which merely regulate the potential (i.e. bias) applied to the capacitance-diodes so that they reflect the capacitance required for tuning when the appropriate button is pressed. It was mentioned last month that capacitance-diodes are sometimes used in the capacitor-gang type of u.h.f. tuner for automatic frequency control (a.f.c.). Such diodes exhibit capacitance when reverse biased, and since the depletion layer at the junction *widens* as the reverse bias is *increased*, it follows that the capacitance across the diode *decreases* with *increase* in reverse bias. If the diode is forward biased of course it merely short-circuits the tuned line.

All junction diodes exhibit this capacitance effect but capacitance-diodes (which are in fact junction diodes) are designed to exploit this characteristic. One problem has been in keeping the "dielectric" losses low so that the *Q*-value of the tuned circuit is maintained sufficiently high at u.h.f. Another has been in securing sufficient capacitance change to swing the tuning over the whole of Bands IV and V or at least over the u.h.f. channels which have been allocated for television broadcasting.

The voltage/capacitance characteristic of a Mullard capacitance-diode is shown in Fig. 1. This particular type (BB105) is intended for use in u.h.f. tuners and is supplied to manufacturers in matched triplets or quadruplets to ensure good tracking from 0.5 to 28V. The typical curve reveals that with a reverse bias of 0.5V the capacitance is 20pF, dropping to about 5pF when the bias is increased to 10V. It is noteworthy that the actual range of quarter-wave line resonance provided by a given capacitance swing is somewhat geared to the impedance of the line which in turn is geared to the physical dimensions. It is thus possible to secure the required swing from a capacitor of given capacitance range by adjusting the parameters of the tuning line accordingly. There are other considerations, though, related to *Q*-value and band-

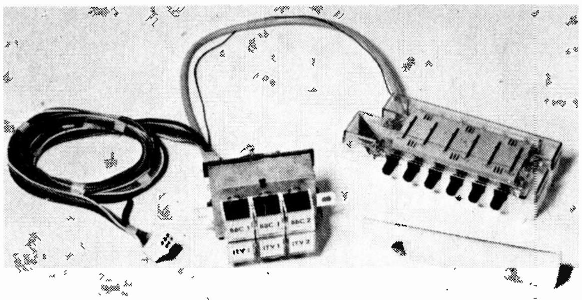


Fig. 2: The capacitance-diode tuner unit used in the Philips G8 single-standard colour chassis.

width. Readers interested in the design of quarter-wave tuning lines should refer to my article entitled *Coaxial Resonators* in the June 1967 issue of PRACTICAL TELEVISION.

Philips Circuit

The overall appearance of the Philips u.h.f. tuner is shown in Fig. 2. The unit with the six preset potentiometers (right) and the control section with the six push-buttons (centre) are separate, and the whole system is connected to the main chassis via a six-pin socket termination. Thus the preset adjustments can be made accessible at the rear of the set, and an advantage so far as the user is concerned lies in the ease by which the channels can be changed. And since there are no mechanical couplings to the selector buttons, merely switch contacts, only a very small amount of pressure is required to operate them.

The tuner circuit features two transistors, a BF262 r.f. amplifier and a BF263 self-oscillating mixer, both npn types. There are four quarter-wave tuning lines with preset capacitors for trimming and each one has its own capacitance-diode. The local oscillator feedback circuit also employs a small coupling line from the main tuned line and there is also a separate capacitance-diode CD5 in this circuit (making five capacitance-diodes in all). As in the other u.h.f. tuners looked at last month, both transistors are in the common-base mode, with the input signal applied to the emitter, and a very interesting aspect of the design is that the a.f.c. potential, derived from a separate phase discriminator picking up signal from the i.f. channel, is applied simultaneously to all the capacitance-diodes, not just to the oscillator tuning diode. This of course enhances the tracking in the event of tuning drift.

It is not intended to show the circuit as a whole since the d.c. parts of it are very similar to those of the tuners depicted last month. The signal parts, however, are certainly worth investigating and these are shown in Fig. 3. Aerial signal is passed through a high-pass filter and thence to a coupling L1B from where it is resonated by line L1A in conjunction with capacitance-diode CD1. The amplified signal is developed across line L2 resonated by capacitance-diode CD2, and a bandpass coupling is formed in association with line L3 and capacitance-diode CD3. The signal is coupled from a suitable impedance point on L3 to the emitter of the self-oscillating mixer Tr2.

The main oscillator tuning is by line L4A in conjunction with capacitance-diode CD4, feedback being by line L4B. A degree of oscillator "control" is also provided by capacitance-diode CD5, which acts to equalise the oscillator voltage over the tuning range. All the capacitance-diodes are in receipt of the control potential, more about which below. The i.f. signal appears at the collector of the self-oscillating mixer and this is resonated and coupled to the i.f. channel through the associated filter network, which is after the style of a pi filter.

Control Circuits

For the capacitance-diodes to operate correctly they must be reverse-biased and this reverse bias must be variable over the required swing. They should also receive an automatic control potential

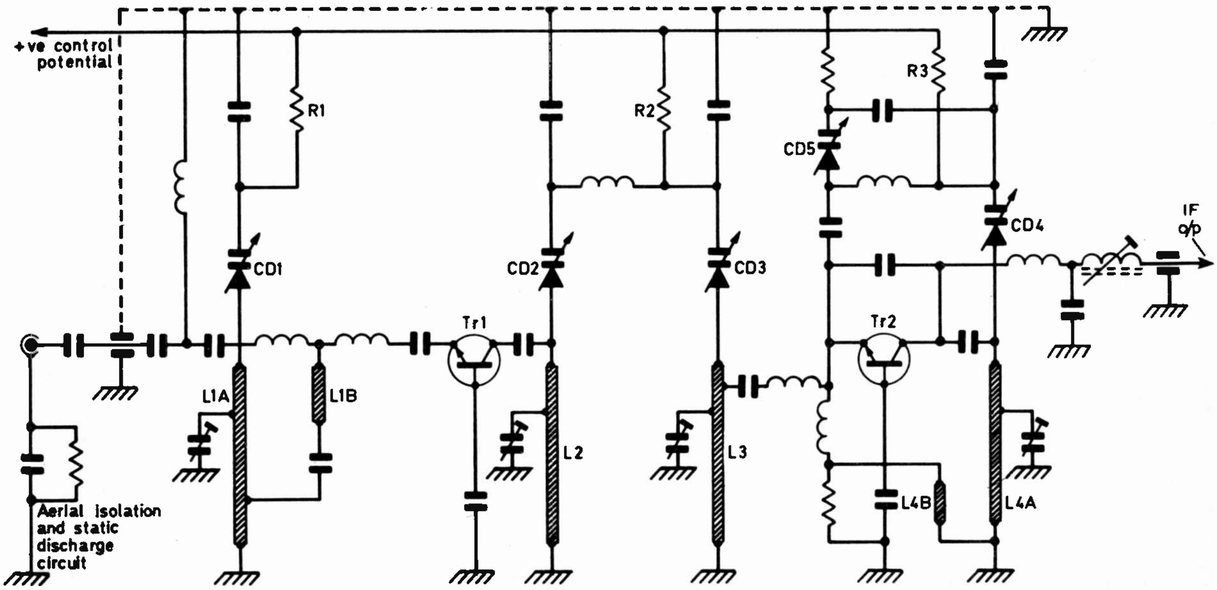


Fig. 3: Skeleton circuit of the Philips capacitance-diode tuner unit.

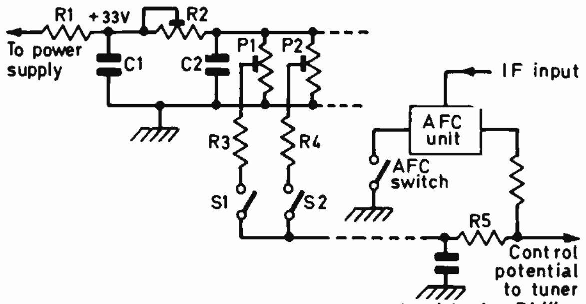


Fig. 4: Basic control arrangement used with the Philips capacitance-diode tuner.

from the a.f.c. discriminator, going more or less positive depending on which way the carrier tends to slip along the response characteristic due to tuning drift.

It will be seen that each capacitance-diode in Fig. 3 has its anode side in d.c. connection with the chassis with the exception of CD5 which from the d.c. point of view can be regarded as being in series with CD4. In order to reverse bias the diodes a positive potential has to be applied to their cathodes. The control potential is thus nominally positive with respect to chassis and is fed to CD1 via R1, to CD2 and CD3 via R2 and to CD4 etc., via R3. It will be appreciated therefore that by adjusting the control potential in a *positive* direction the capacitance of each diode will *decrease*, and that provided the voltage swing is correct the tuner will resonate from the lowest to the highest frequency channel in Bands IV and V.

Figure 4 shows the basic circuit of the control section. Only two of the preset potentiometers and two associated press-button switches are shown. A positive supply from the stabilised power unit in the receiver is fed to the circuit via R1 and R2 in conjunction with the filter capacitors C1 and C2. P1 and P2 are the first two preset potentiometers for channel adjustment and S1 and S2 the related press-button switches. When, say, S1 is closed, the potential set by P1 (note that all the presets are connected in parallel with the supply) is fed via R3 and R5 to the control potential input at the top left of the tuner circuit in Fig. 3. Each preset is initially adjusted in turn to give the required channel at the press of the associated switch.

It will be seen that R2 is also a preset. This is for establishing the correct potential across the presets P1, P2, etc. so that the full tuning range can be achieved.

The a.f.c. unit is also included in Fig. 4. I shall be dealing with this and similar circuits later in the series, but it is noteworthy that in this circuit the control potential just described passes through the loads of the discriminator in such a way that the potential is regulated slightly by the a.f.c. circuit in the event of mistuning. The a.f.c. switch removes the auto control for accurate initial preadjustment.

It must be pointed out that although Philips is the first UK set maker so far as I am aware to introduce a production model using capacitance-diode tuning, many European sets—including some models imported into the UK—have been employing the scheme for some time now. As already mentioned one of the problems has been in obtaining sufficient tuning range, and some of the early European models imported into the UK were unable to cover the channels at the band extremes.

FET Circuits

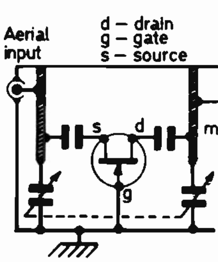
So far in this country bipolar transistors have been used exclusively for tuner applications. However, there seems every likelihood that before very long we shall see the advent of the first British TV tuner employing field effect transistors. The f.e.t. is already rivalling the bipolar transistor in f.m. front-ends at v.h.f., but the problems are a little more involved at Band IV and V frequencies. Suitable devices are nevertheless becoming available and a survey such as this would be incomplete without some small reference to them.

A very basic f.e.t. u.h.f. amplifier circuit with input and output tuning lines is shown in Fig. 5. The supply circuits are not shown but are simply connected via suitable hold-off chokes. The f.e.t. shown is an n-channel junction-gate type and as the p-type gate must be reverse biased the negative supply required for the gate can be connected direct to the gate via a choke designed to block u.h.f. A.G.C. bias can also be applied at this point, f.e.t.s providing very good a.g.c. action. The transistor is shown connected in the common- or grounded-gate mode, which corresponds to the bipolar transistor common-base connection.

Figure 6 shows the circuit of a similarly basic mixer stage, again employing tuning lines. The oscillator circuit generally uses a bipolar transistor but the tuning line and capacitor section of this is included in the circuit. This time the f.e.t. is shown connected in the common-source mode, with input to the gate and the output taken from the drain electrode.

F.E.T.s. have several advantages over ordinary bipolar transistors in u.h.f. tuners which are required to work under conditions of wide dynamic range in terms of signal field. They are generally less easily overloaded than bipolar devices, and this means they can handle a multiplicity of signals in the early stages, which are of relatively poor selectivity, without running easily into intermodulation and cross-modulation difficulties. Their high input impedance in the common-source or -drain configurations allows the use of tuned input circuits without the complications arising from the low input impedance (especially at the emitter) of bipolar r.f. amplifiers. They have remarkably good noise figures and temperature effects are negligible. The square-law transfer characteristic in mixer service ensures low distortion and low noise along with very low third-order harmonic distortion and hence crossmodulation.

TO BE CONTINUED



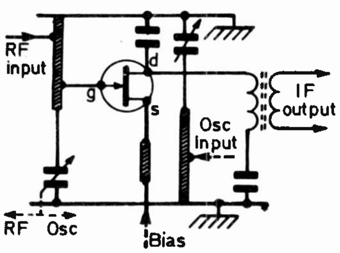


Fig. 5 (left): Basic f.e.t. u.h.f. amplifier circuit.
Fig. 6 (right): Basic f.e.t. u.h.f. mixer circuit.

versatile IC 'SCOPE PREAMPLIFIER PART 1

MARTIN L. MICHAELIS, M.A.

THIS constructional feature illustrates the principles of a.c. amplification with i.c. operational amplifiers. In a previous feature (see PRACTICAL TELEVISION, August 1970) we introduced i.c. operational amplifiers in a general way and discussed in particular their outstanding performance for accurate d.c. amplification. The main justification of using the same operational amplifiers for an essentially a.c. circuit—as in the present feature—is the possibility of accurate d.c. component transfer too, an important function for a preamplifier circuit intended primarily for use in conjunction with oscilloscopes.

Sensitivity

The other advantages of the i.c. operational amplifier over conventional circuits for this purpose are the high open-loop gain, the high degree of immunity with respect to battery voltage changes, the very low current drain permitting economical prolonged operation with very small internal batteries, and the resulting undetectably low intrinsic hum level even when the deflection sensitivity of the Videoscope MV3 has been boosted with this preamplifier by the maximum available factor of 200 to give a sensitivity of 0·5mV/cm. With this maximum sensitivity an r.m.s. signal of about 0.8mV—the level normally obtained from a small moving-coil tape recorder microphone when speaking at normal conversation loudness right across a room—gives a full screen height display on the Videoscope MV3 when its own gain controls are set to maximum (100mV/cm. deflection sensitivity at the Y-input).

Random Noise

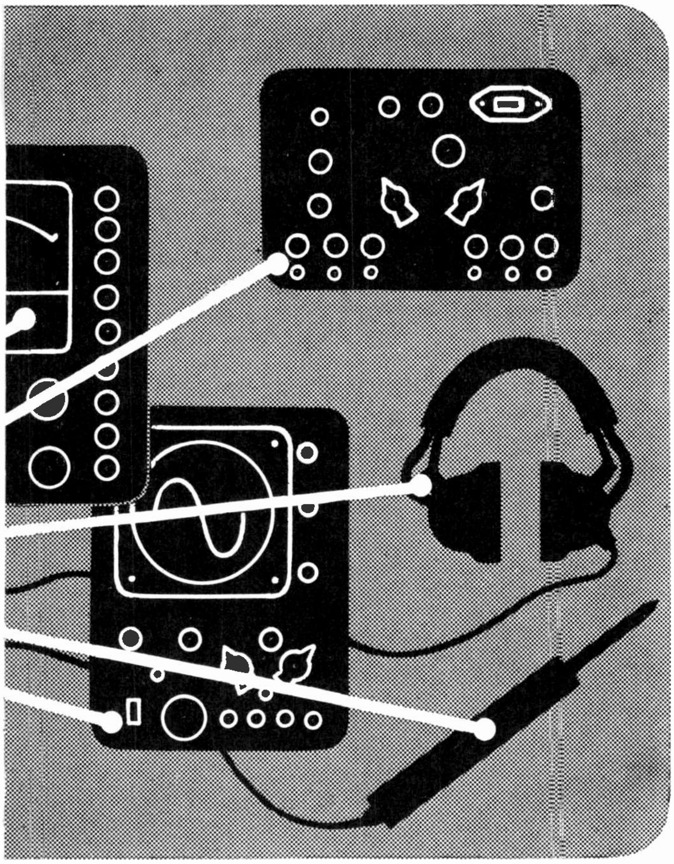
The only disadvantage of an i.c. operational amplifier over a conventional preamplifier with selected transistors is its larger self-generated noise level. This noise produces a random broadening of the timebase trace in the absence of a wanted signal. Since no particular frequency is given preference in a normal noise spectrum its display cannot be synchronised and the appearance is that of grass growing on the undeflected timebase trace. (Since the trace is green on most common oscilloscopes the effect is often called "grass".) Even though grass may be very perceptible in a given case in the absence of any wanted signal, it tends to be much reduced subjectively as soon as a definite signal is present. The human eye has a strong capacity for rejecting random patterns such as grass in favour of any constant pattern which may be present. Tests have shown that input waveforms are reasonably clearly observable even when their peak-to-peak amplitude is barely greater than that of the grass, whereas any definite frequency background interference such as mains hum interferes with the proper display of wanted waveforms many times larger. Thus while neither noise nor hum are desirable in a highly sensitive oscilloscope preamplifier it is much more important to avoid hum. The only simple, straightforward way to satisfy this condition is to use a preamplifier with self-contained batteries and a metal case as in the present design.

Random noise (grass) is a function of bandwidth and input impedance as well as circuit type. Bandwidth and input impedance are limitations it is impossible to improve upon even with the very best circuit devices—except by reducing the temperature. This basic noise is due to thermal agitation of electrons. The power generated by this thermal noise, i.e. the *mean square* noise voltage divided by the value in ohms of the effective resistance across which it appears, is equal to $4kT$ Watts per Hz of bandwidth where k is Boltzmann's constant expressed in Watts/°C and T is the absolute temperature. For rough-and-ready assessments of this basic thermal noise it is useful to remember that at room temperature (about 300° Absolute) the peak-peak noise voltage developed across a 1MΩ resistor in a bandwidth of 1MHz is about 0.3mV.

Noise in Practical Devices

This noise level is a physically inevitable minimum regardless of actual circuit device and can be reduced only by lowering the temperature. Very large reductions of temperature are necessary to give a useful improvement because the *mean square* noise voltage is proportional to the absolute temperature. Thus to halve the thermal noise voltage we must quarter the temperature, i.e. go from room temperature to 75° Absolute which is nearly −200°C (liquid air, liquid nitrogen). Hence the drastic cooling methods adopted for the input stages of ground-station satellite communications receivers. Even then, and with the best available circuit devices, the noise level on many full-bandwidth television pictures relayed by satellites is at present barely acceptable.

In simple practical amplifier circuits of the kind featured in this article most of the random noise



is generated by means other than the physically inevitable thermal impedance - bandwidth value. Carbon resistors for example generate noise through random fluctuation of micro-granule contact resistance, especially when d.c. is flowing through them. All multi-electrode active devices such as valves and transistors produce noise due to random fluctuations of current distribution between the electrodes. Balanced input stages using the differential amplifier principle as in i.c. operational amplifiers (this is essential to provide accurate d.c. performance) inherently produce at least two to three times as much noise voltage as a single-ended input stage because the thermal noise components at the two differential inputs IP and $\overline{\text{IP}}$ do not, being random, cancel but add quadratically. There is in addition the current distribution noise between the two sections of the difference amplifier input.

Noise Performance

Since all these noise contributions are of similar character we can express the noise performance of a practical circuit in terms of the number of decibels by which its noise factor is greater than the basic thermal figure for the pure input impedance and bandwidth concerned. With the preamplifier described in this article the theoretical equivalent thermal input noise level would be about 0.2mV in the 1MΩ/350kHz setting but we actually obtain some 2mV. Thus the noise figure of this amplifier is about 20dB. The best circuits with optimum noise matching achieve figures of 4 to 6dB in practice (without supercooling) so that this preamplifier actually generates a noise voltage amplitude some five times greater than the simple practical noise-matched circuit. This is however very acceptable for the intended applications.

Noise Matching

In principle it would be readily possible to reduce the noise figure to well below 20dB with the same operational amplifier because a large part of the actual noise in the 1MΩ/350kHz broadband setting is due to lack of noise matching. The noise factor has to be accepted however due to conflicting demands. Noise matching is obtained when the equivalent noise impedance of the signal source is equal to the actual amplifier input impedance. The best possible signal-to-noise ratio is then obtained with any signal e.m.f. from the signal source and the given amplifier. It is immediately clear from this that a resistive voltage divider at an amplifier input impairs the signal-to-noise ratio because it divides the wanted signal voltage by the impedance step-up factor but the equivalent noise factor is changed only by the square root of the impedance step-up factor. Consequently if a resistive N:1 voltage divider is used at an amplifier input the signal-to-noise ratio with a low-impedance signal source is poorer by a factor $\sqrt{N}$ compared to the value if the same signal is fed straight into the amplifier.

Some form of resistive voltage divider is on the other hand essential at the input of any amplifier intended for general oscilloscope applications in order to satisfy impedance and frequency-compensation demands and —often more important—to protect the amplifier. The test leads or probe will be used to prod about inside television equipment carrying high signal and line voltages even at intentional test points, and any directly-coupled amplifier input would suffer early destruction.

Input Circuit

This discussion of noise considerations puts us in a proper position to understand the actual input circuit used (see Fig. 1). For reasons discussed in Part 2 next month it is feasible to give the operational amplifier an input impedance of 100kΩ as seen at the junction of R4 and C3. Larger values are impracticable yet 100kΩ is insufficient for general oscilloscope work. Hence R2 has been added as the top end of an input divider to provide the standard input impedance of 1MΩ at Sk1. C1 and C2 are used to augment the total input capacitance to 40pF at Sk1 to match the standard 10MΩ/4pF signal probe of the Videoscope MV3. Thus this signal probe (see Fig. 2) may be transferred to the preamplifier input if the higher impedance it offers is required. The preamplifier then cancels the signal voltage loss otherwise produced if the signal probe is connected directly to the Videoscope MV3.

R2 in conjunction with D1 and D2 provide surge and excess voltage input protection. R2 restricts the surge current which can flow through D1 and D2 to a safe value, D1 and D2 restricting the maximum voltage appearing at the operational amplifier input to 1.2V peak-peak under all circumstances —even whilst C3 is charging to large d.c. potentials

TABLE 1: Oscilloscope Preamplifier

Technical Specifications

GAIN SWITCH SETTING (S3)	NOISE TRACE BROADENING WITH VIDEOSCOPE MV3 AT MAX GAIN		DIRECT INPUT				WITH 10:1/10MΩ VIDEOSCOPE MV3 PROBE TO INPUT W	
			INPUT N OUTPUT N	INPUT W OUTPUT N	INPUT N OUTPUT W	INPUT W OUTPUT W	OUTPUT N	OUTPUT W
		3dB BANDWIDTH	20 kHz	30 kHz	40 kHz	250 kHz	30 kHz	250 kHz
		6dB BANDWIDTH	30 kHz	50 kHz	60 kHz	350 kHz	50 kHz	350 kHz
1	INVISIBLE	VOLTAGE GAIN (Prod tip to Videoscope Y-Input)	×20	×2	×10	×1	×0·2	×0·1
		MAX ACCEPTABLE INPUT VOLTAGE	500 mV p-p	5V p-p	500 mV p-p	5V p-p	50V p-p	50V p-p
		INPUT SENSITIVITY with Videoscope MV3 at max gain	5mV/cm	50mV/cm	10mV/cm	100mV/cm	500mV/cm	1V/cm
2	SLIGHT AGITATION (0·1 cm p-p)	VOLTAGE GAIN (Prod tip to Videoscope Y-Input	×100	×10	×50	×5	×1	×0·5
		MAX ACCEPTABLE INPUT VOLTAGE	100mV p-p	1V p-p	100mV p-p	1V p-p	10V p-p	10V p-p
		INPUT SENSITIVITY with Videoscope MV3 at max gain	1mV/cm	10mV/cm	2mV/cm	20mV/cm	100mV/cm	200mV/cm
3	0·2 cm p-p	VOLTAGE GAIN (Prod tip to Videoscope Y-Input)	×200	×20	×100	×10	×2	×1
		MAX ACCEPTABLE INPUT VOLTAGE	50mV p-p	500mV p-p	50mV p-p	500mV p-p	5V p-p	5V p-p
		INPUT SENSITIVITY with Videoscope MV3 at max gain	0·5mV/cm	5mV/cm	1mV/cm	10mV/cm	50mV/cm	100mV/cm
Self-generated hum invisible in all settings		MAX OUTPUT VOLTAGE	10V p-p	10V p-p	5V p-p	5V p-p	10V p-p	5V p-p

THUS ALWAYS SUFFICIENT OUTPUT VOLTAGE FOR FULL SCREEN AMPLITUDE WITH VIDEOSCOPE COARSE GAIN SWITCH "X1" AND ANY SETTING OF FINE GAIN CONTROL (RANGE 0·5V TO 5V FULL SCREEN p-p, 5cm). THUS WHEN USING PREAMPLIFIER
ALWAYS SET VIDEOSCOPE COARSE GAIN SWITCH TO "X1" (NEVER USE "X10" SETTING)
ALWAYS USE FINE GAIN CONTROL ON VIDEOSCOPE

Current Drain 3·6mA per battery (fresh batteries, 9V on load).

Battery Life At least 48 hours non-stop without rest, 60-80 hours intermittent.

Noise Level About five times theoretical thermal agitation voltage for input impedance and bandwidth (see text).

Input N (narrowband) Impedance 100kΩ
Maximum non-destructive AC and/or DC input – 100V p-p for any gain setting.
Maximum blocked DC component in AC mode – ±100V.

Input W (wideband) Impedance 1MΩ in parallel with 40 pF.
Maximum non-destructive AC and/or DC input – 750V p-p.
Maximum blocked DC component in AC mode – ±350V.

Input W (wideband) with VIDEOSCOPE 10:1 PROBE Impedance at probe tip 10MΩ in parallel with 4 pF.
Maximum non-destructive AC and/or DC input – 1kV p-p.
Maximum blocked DC component in AC mode – ±750V.

Output N (narrowband) Impedance 3kΩ in parallel with 2200 pF. Short-circuit tolerated indefinitely without damage.

Output W (wideband) Impedance 1kΩ
Cable length to Videoscope not critical, but should not exceed 2 yards coaxial.
Short-circuit tolerated indefinitely without damage.

Use as AF/RF Signal Tracer Headphones, any impedance low or high, to output N or W.
Test leads (AF) or demodulator probe (modulated RF or IF) to input N or W.
Demodulator probe also usable when oscilloscope connected to output.
Headphones may be connected to one output, oscilloscope to other.

N.B. If using with STROBE-TRIGGER TIMEBASE UNIT connect this preamplifier to the strobe-trigger unit, not between latter and Videoscope.

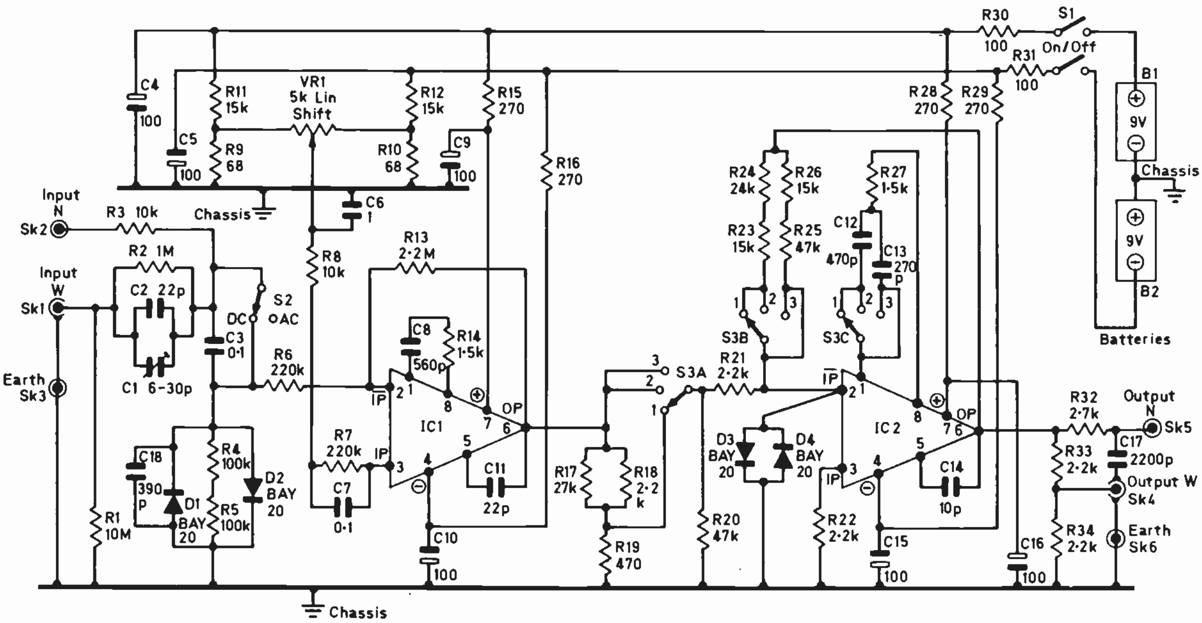


Fig. 1: Circuit diagram of the integrated circuit oscilloscope preamplifier.

in the a.c. setting when the test prod is touched on to a point carrying a d.c. potential much greater than the signal component.

R3 gives direct access to the amplifier since the value of R3 is small compared with 100kΩ and thus negligible in this respect. Nevertheless R3 suffices to maintain surge protection up to ±100V at Sk2 in conjunction with D1 and D2. C18, which is also the bottom-section frequency-compensation capacitor for the broadband network at Sk1, restricts the bandwidth at Sk2 to about 30kHz, i.e. for audio applications. The theoretical thermal noise level at Sk2 is about 30μV and the actual thermal and additional noise level here some 100μV, representing a noise figure of about 10dB which is only 4 to 6dB poorer than special low-noise circuits. This illustrates the improvement in signal-to-noise ratio obtained by restricting the bandwidth and impedance. We thus have two separate inputs Sk1 and Sk2 providing different compromises between noise, bandwidth and impedance.

AC/DC Switch

The entire preamplifier is d.c.-coupled from either input to either output when S2 is closed. In this setting a d.c. component accompanying the a.c. signal is transferred through the amplifier with the same gain factor as the a.c. component, i.e. the bandwidth extends right down to zero frequency and arbitrarily slow changes of the input voltage are amplified correctly. Thus if used in conjunction with any d.c.-coupled oscilloscope this preamplifier maintains full d.c. characteristics right down to the fractional millivolt input voltages involved with the maximum deflection sensitivities it provides. This is the outstanding feature offered by the operational amplifier design. VR1 is the common manual control to cancel d.c. offset or to set it to any desired value. It is normally set so that the d.c. potential at either output socket is exactly zero when the inputs are open-circuit or without impressed signal. If a d.c.-coupled oscilloscope is used VR1 functions as vernier vertical shift control.

Whenever the d.c. and a.c. components are grossly different set S2 to a.c. so that C3 blocks the d.c. component of the input signal. If the d.c. component is much greater than the a.c. component it is not possible to use a d.c.-coupled oscilloscope anyway because the trace would jump off the screen before the deflection sensitivity had been increased sufficiently to display the a.c. component properly. If the d.c. component is much smaller than the a.c. component it is really immaterial whether an a.c.- or d.c.-coupled oscilloscope is used or which setting of S2 is taken.

The Videoscope MV3

The Videoscope MV3 as published (See PRACTICAL TELEVISION, April-July 1969) is a purely a.c.-coupled oscilloscope. As such the undeflected timebase trace position, regardless of where it is placed on the screen with the oscilloscope Y-shift control, represents the absolute d.c. potential, i.e. d.c. component, of any input signal and all other absolute potentials on any displayed waveform are depicted correctly in relation thereto and the selected deflection sensitivity. Thus it is in many respects a more versatile approach to use a separate d.c. meter and an a.c. oscilloscope rather than a straight d.c.-coupled oscilloscope, because the former permits greater latitude in selecting relative ranges. It is merely rather inconvenient to have to keep changing over between the d.c. meter and the oscilloscope test leads. The preamplifier described in this article overcomes this difficulty by using common test leads or signal probe for both functions. The i.c. millivoltmeter described last month can be connected to one output of the preamplifier (giving further increased effective input impedance) and the Video-

★ components list

Semiconductors:

IC1 MC1709CG	D1-D4 Any small silicon
IC2 MC1709CG	signal diode, e.g. BAY20,
(Motorola)	OA200

Resistors:

R1	10M Ω
R2	1M Ω
R3	10k Ω
R4	100k Ω
R5	100k Ω
R6	220k Ω
R7	220k Ω
R8	10k Ω
R9	68 Ω
R10	68 Ω
R11	15k Ω
R12	15k Ω
R13	2·2M Ω
R14	1·5k Ω
R15	270 Ω
R16	270 Ω
R17	27k Ω
R18	2·2k Ω
R19	470 Ω
R20	47k Ω
R21	2·2k Ω
R22	2·2k Ω
R23	15k Ω
R24	24k Ω
R25	47k Ω
R26	15k Ω
R27	1·5k Ω
R28	270 Ω
R29	270 Ω
R30	100 Ω
R31	100 Ω
R32	2·7k Ω
R33	2·2k Ω
R34	2·2k Ω

All ¼W 10%
VR1 5k Ω lin. with knob

Capacitors:

C1	6-30pF ceramic trimmer
C2	22pF 250V ceramic
C3	0·1μF 500V microfoil
C4	100μF 15V electro
C5	100μF 15V electro
C6	1μF 100V microfoil
C7	0·1μF 250V microfoil
C8	560pF 250V ceramic
C9	100μF 15V electro
C10	100μF 15V electro
C11	22pF 250V ceramic
C12	470pF 250V ceramic
C13	270pF 250V ceramic
C14	10pF 250V ceramic
C15	100μF 15V electro
C16	100μF 15V electro
C17	2200pF 250V microfoil
C18	390pF 500V ceramic

Miscellaneous:

B1, B2	Miniature 9V batteries with connectors
S1	D.P.S.T. toggle switch
S2	S.P.S.T. toggle switch
S3	3-pole, 3-way, with knob
Sk1, Sk4	Coaxial sockets
Sk2, Sk5	Wanderplug sockets, red, insulated
Sk3, Sk6	Wanderplug sockets, black, insulated

Metal case, panel approximately 4 × 6 in., about 3 in. deep. Material for printed circuit, bolts, tags, etc.

scope MV3 simultaneously to the other (see Fig. 2(e)). S2 must of course be set to d.c.

Output Voltage Swing

Although its primary purpose is to boost the deflection sensitivity of an oscilloscope, a scope preamplifier should be able to handle large signal voltage swings, especially at the output, without clipping or other forms of distortion. This then makes it unnecessary to repeatedly insert and remove the preamplifier whilst checking through a television receiver or other piece of equipment giving grossly different signal amplitudes at various test points. In other words for optimum convenience in use a scope preamplifier should provide a large range of overlap with the sensitivities and signal swings already obtainable with the given oscilloscope without a preamplifier.

The range of overlap should be such that the full range of any vernier gain control of the oscilloscope can be used without incurring voltage overload before reaching full screen amplitude for any provided coarse gain setting of the preamplifier. The preamplifier described fully satisfies these conditions in relation to the Videoscope MV3 and since the gain and sensitivity characteristics of this oscilloscope are quite typical the preamplifier will be found equally convenient when used in conjunction with most other oscilloscopes.

Since the vernier gain control of the oscilloscope remains fully usable only a coarse gain switch has been provided on the preamplifier. Three positions of this switch S3 were found to suffice for all normal requirements in conjunction with the various combinations of inputs and outputs. Table 1 gives a comprehensive summary of actual performance in all possible arrangements with the Videoscope MV3.

Ratings

The voltage gain figures specified in Table 1 are always the net gains from the input test prod (or prod of the signal probe if used) to the input socket of the oscilloscope. Any attenuation factor of a signal probe is thus included. The maximum acceptable input voltage is the maximum signal amplitude at the prod of the test lead or signal probe which can be handled without distortion right through to the preamplifier output. The maximum output voltage is the corresponding signal amplitude produced at the output of the preamplifier. It is seen that this output swing is independent of the input or gain setting employed, as it must be to satisfy the range overlap discussed above.

The input sensitivity specifications refer to the test lead or signal probe prod and the maximum gain setting of the Videoscope MV3. The range overlap condition permits full utilisation of the 10:1 vernier gain control of the Videoscope MV3 with all gain settings and input/output combinations of the preamplifier so that in each instance the specified input sensitivities can be reduced continuously by a factor of up to ten. The Videoscope MV3 possesses in addition to its 10:1 vernier gain control only a two-position coarse gain switch with the positions ×1 and ×10V/cm. Always use the ×1 setting in conjunction with the preamplifier. The ×10 setting may be used only when the test leads or signal probe are connected directly to the oscilloscope since the preamplifier output swing is insufficient to produce full-screen deflection without voltage overload in this insensitive setting which is provided for scoping very large signal voltages not requiring a preamplifier.

The grass amplitude is about 2mm. peak-peak with the most sensitive available setting of this preamplifier and maximum gain of the Videoscope MV3, giving a deflection sensitivity of 0.5mV/cm. As previously mentioned, the minimum observable signal amplitude is about equal to the grass amplitude so that audio-frequency waveforms down to some 50 microvolts r.m.s. can be resolved with this equipment combination. The inherent hum level is low enough to exploit this sensitivity and the sync circuits —of the Videoscope and especially of the strobe-trigger timebase unit (see PRACTICAL TELEVISION April-July 1970)—are able to lock such small signals even in the presence of noise.

Improved synchronisation is obtained by using the narrowband output Sk5 to feed the *external* sync input of the Videoscope MV3 or of the strobe-trigger

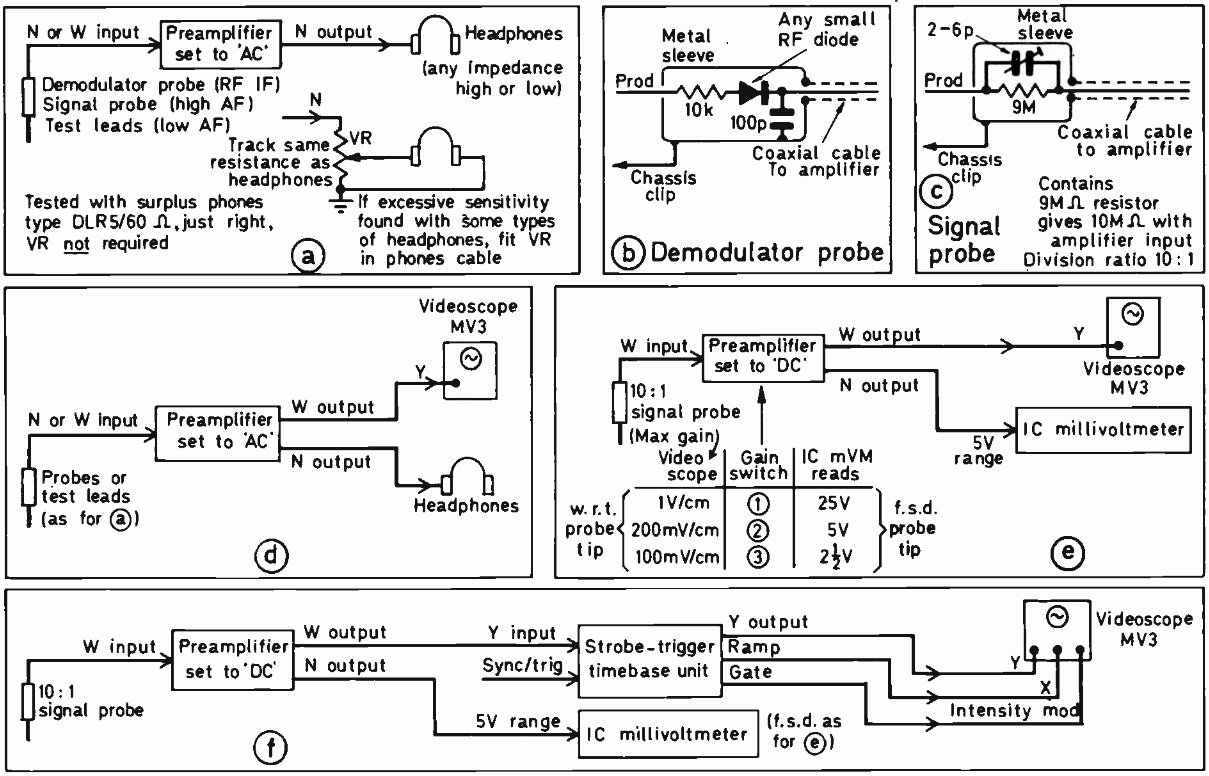


Fig. 2: Typical applications: see text for instructions on use and possible variations.

timebase unit even when taking a broadband Y signal via the wideband output Sk4 of the preamplifier. This avoids an unnecessary noise level in the sync circuits.

Maximum Inputs

The maximum a.c. and d.c. voltages (non-destructive signal levels) are specified below Table 1. These maximum voltages of course produce heavy distortion in the preamplifier but lead to no damage. If only the d.c. component is excessive in this sense switch S2 to a.c. whereupon the distortion vanishes after a few seconds when C3 has charged up to and blocks the high d.c. component. If distortion persists C3 is leaking and must be replaced with a better component. Even very slight leakage in C3 can give trouble in the highest gain settings so the importance of using a very good quality capacitor for C3 cannot be over emphasised.

Coarse Gain Switch S3

The discussion of the partly conflicting requirements between which a satisfactory compromise has to be struck has already revealed a number of essential conditions regarding the form and positioning of the gain control in the preamplifier. The bandwidth problems associated with a continuously-variable gain control have been completely avoided by dispensing with such a gain control. The existing vernier gain control of the oscilloscope remains fully usable and it is merely necessary to switch the preamplifier gain in coarse steps in order to reduce grass when the highest bandwidth-impedance product (input/output combination) is not required, e.g. when displaying audio or the low frequencies involved with simple field and line pulse waveforms in television equipment.

The gain switch cannot be placed at the amplifier input because it would impair the signal-to-noise ratio at low gain settings, thus defeating its purpose. Substantial gain must be provided ahead of the gain switch so that the gain switching is effected at low impedance and at signal levels well above the thermal noise levels generated in the switching network. The ideal place for the gain switch on this consideration alone would be at the amplifier output but this is not possible because it would restrict the maximum undistorted output swing at low gain settings and thus violate the range overlap condition, restricting the usable range of the oscilloscope vernier gain control.

Consequently the preamplifier must possess two stages and the gain switch must be placed between them. Exhaustive tests showed that S3 must provide 10:1 step variation to cater for all practical needs, giving a total gain variation range of 200:1 in conjunction with the attenuation ratios of the available input/output combinations. A factor of 5:1 is provided as a simple resistive voltage divider with S3A between the two amplifier stages and the remaining factor of 2:1 has been provided by switching the negative feedback ratio of the second stage IC2 with S3B at the same time correcting the frequency compensation with S3C. This arrangement was found to give the best noise performance and independence of bandwidth and gain switch setting.

CONCLUDED NEXT MONTH

CONCLUDED NEXT MONTH

showtime '70

THE radio and TV shows this year again took place in London during the traditional period at the end of August and as usual were for the trade only. Next year's shows are to be held at the end of May: the aim is to give the trade more time between the exhibitions and the peak selling period which occurs during the later months of the year.

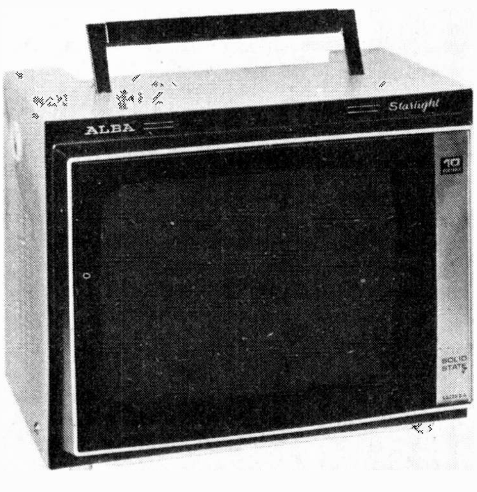
The main features of interest in the television field this year were the large increase in the number of small-screen portable models on the market and the introduction of a number of electronically-tuned (by means of varicap diodes) models—led as noted in *Teletopics* last month by Philips.

Portable Models

The portables are single-standard, transistorised models with tube sizes from 4½ to 14in. and are for 12V battery or a.c. mains operation. Examples are the **Alba** T10 "Starlight", a 10in. portable at £75; the **Toshiba** 11TBB (shown by Hanimex), an 11in. model at £79 10s. 0d.; an 11in. portable, the "Eleven Plus" Model T544, from **Ekco** at £75 18s. 0d.; the **Sharp** 12in. Model SU66H at £79 19s. 0d., and a 9in. version at £72 19s. 0d. expected to be available early next year; the **Standard** 12in. Model TWU65 at £77 4s. 6d.; and the **Teleton** TX12 12in. model at £79. A 13in. portable from Teleton retails at £83 and gives up to 1W audio output.

Several models can in addition be used with an internal battery. Examples are the **Sony** 11in. Model 110UK at £85 15s. 0d. and the **National** 9in. Model TR449G at £89 5s. 0d. The rechargeable battery in this set gives 3½ hours' viewing, takes 10 hours to recharge and is said to have a life of more than 500 hours.

A 9in. model from **Nivico** (Denham & Morley (Overseas) Ltd.) features a dark, concave screen, telescopic rod aerial and phones socket, and has a recommended price of £79 15s. 0d. **Crown** were showing a 14in. model at about £85 with a 0-60 minute timeswitch for turning the set off. The Crown 9in. Model 9TV-305 was shown at £75 15s. 0d., while their 4½in. Model 5TV-204 at £85 15s. 0d. also incorporates a two-band radio. Both these models operate from the mains, dry cells or a 12V car battery. An old brand name that is due to enter the lists shortly with 12 and 14in. mains/battery portable sets is **Elizabethan**, the former at £75 and the latter at £80.



Typical of the new portables—the Alba T10 "Starlight".

Other New Sets

Amongst the colour sets on show this year were the first 26in. models. These included the **Decca** Model CS2611, a consolette at £350 in teak and £355 5s. 0d. in walnut, the **Bush** Model CT197C at £349 19s. 0d and a **Dynatron** consolette at £395. Decca were also showing a 22in. consolette, the CS2211, and a 17in. monochrome transportable, the MS1700, with 17in. squared-screen tube.

New monochrome ranges were shown by the GEC-Sobell and Rank-Bush-Murphy groups. The **Sobell** 1043 and 1044 are 20 and 24in. dual-standard **models** at £85 and £92 respectively. Single-standard versions are the 1047 and 1048 at £74 and £82. The **GEC** models are the 20in. 2082 and 24in. 2083, single-standard sets at £78 and £86 respectively. From **Bush** come the 20in. Model TV191 and 24in. Model TV193. The former is £83 19s. 0d. in the dual-standard version and £74 19s. 0d. in the single-standard version, while the latter is £93 10s. 0d. in the dual-standard version and £84 10s. 0d. in the single-standard version. **Murphy** showed the 20in. Model V2017 ranging in price from £74 19s. 0d. to £85 10s. 0d. depending on whether dual- or single-standard and on the finish—either painted or sapele. BRC showed a number of new introductions fitted with their 1500 chassis. These included the **Ferguson** 3807, 3809 and 3810, **HMV** 2807, **Marconiphone** 4807 and **Ultra** 6807 and 6810.

One fact we noticed repeatedly was the improved linearity of modern receivers—both horizontal and vertical linearity seem much better than a few years ago. How much is due to improvements in picture tubes and how much to circuit design is a matter for conjecture. Perhaps set designers have found that it now costs no more—perhaps less—to obtain a good picture than a "fair" one.

An interesting import from Russia was shown under the **Rigonda** brand name. The Temp 7 is a 23in. monochrome single-standard set at £70 7s. 6d. Although the cabinet design is perhaps a year or two behind current British receivers, the set has a few unusual features. The circuitry is fed via a double-wound mains transformer which gives complete isolation between the mains and the chassis. This means that tape recorders can safely be connected to the set to enable recordings to be made of the sound channel and a tape output socket is fitted as standard. Another unusual feature is a socket for earpiece with a loudspeaker muting switch. Variable bass and treble tone controls and twin loudspeakers are also included.

Push-buttons

Tuning has always been a problem in TV, right from the days of fine-tuning mechanisms in turret tuners. With the advent of transmissions at u.h.f. the problem became much worse while the introduction of colour complicated matters even further (for black-and-white sets too). Most makers soon gave up the idea of continuous tuning on u.h.f. and went over to push-buttons, but the mechanical difficulties in obtaining reset accuracy were quite severe; and drift in the tuned circuits was not always as low as it could have been. The mechanical systems adopted worked well for the most part but considerable pressure was needed to operate the buttons—enough sometimes to result in moving table models a few inches backwards!

An improvement is offered in this respect by the electronic tuning technique—first used in the **Philips** Model 520 (incorrectly quoted as 250 last month in *Teletopics*). With this the tuning buttons merely operate switches which select different bias potentials for the variable capacitance diodes in the tuner unit tuned circuits. The technique is fully described in Part 2 of *Colour Receiver Circuits* elsewhere in this issue. Philips call this type of tuning "Selectronic", and it is also featured in three new **Ekco** models, the 22in. CT109 colour receiver at £303 (fitted with the 691 chassis) and two single-standard monochrome models, the 20in. T540 at £81.12s.0d. and 24in. T541 at £89.18s.0d.

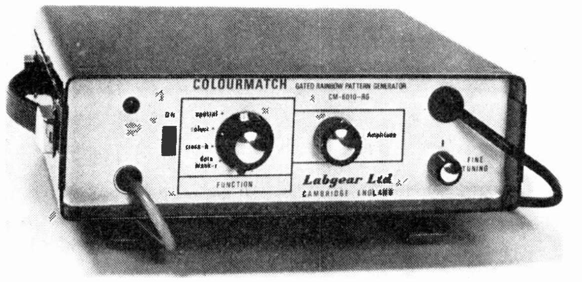
Electronic tuning is also featured in a new **ITT-KB** single-standard colour model, the CK600, which is fitted with a new hybrid chassis, the CVC5.

UHF Distribution

On the distribution side **Labgear** showed a u.h.f. distribution amplifier and a six-way u.h.f. splitter unit. The amplifier—type CM6005/DA—has its own internal mains-operated power supply and eight output sockets. Six of these supply signals at +6dB relative to the input; a seventh socket marked "full output" gives the full amplifier gain and will supply six more outputs via the six-way splitter; the eighth socket marked "auxiliary" is intended to feed a similar amplifier in cascade.

Labgear also showed a new preamplifier covering Bands I, II, III, IV and V—40MHz to 860MHz. This model, the CM6007/SB, is intended for use at the set-end of the downlead and is priced at £7.15s.0d.

One of Teleton's new inexpensive CCTV systems, comprising a 920 camera, standard lens, 9 in. monitor, tripod and cable.



The Labgear CM6010/RG colour pattern generator.

Educational TV

Decca have established a name for themselves in educational TV and showed quite a few new items. A 26in. colour receiver for schools, the CSS2621, was exhibited together with the similar CSS2621/AL which has extra facilities for audio and video line signals. Also unveiled were two off-air colour receiver units, the RU3913 and RU3911, fitted with internal monitor loudspeakers and six video outputs adjustable to 1·0V p-p including sync pulses into 75Ω, and a.f. output of 1mW into 600Ω. Another unit, similar in appearance, gives TV sound coverage only.

Test Equipment

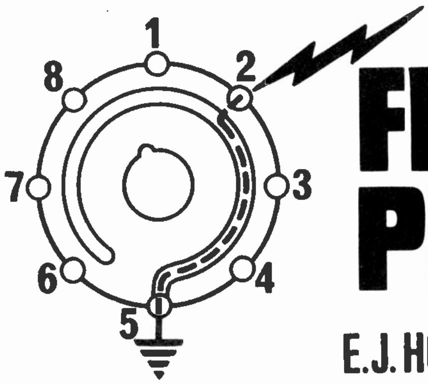
A number of new items of test gear were seen this year. From **Grundig** the FG5 PAL colour generator at £210.8s.0d. provides a number of test signals for colour TV receivers including the standard PAL colour bars. Other test patterns include black-and-white squares in chess-board formation; an electronically produced circle which may be superimposed on a crosshatch pattern if required; horizontal bars; vertical bars; grey scale; and blank red, green, blue, and grey rasters. The FG5 also produces special signals for checking the synchronous detectors and the PAL delay line circuit. The signals are such that adjustments may be performed by analysing the display on the colour c.r.t., although an oscilloscope may also be used of course. A sound carrier may be switched on and off as necessary, and 1kHz modulation is available.

Other new instruments from Grundig include multimeters, millivoltmeters, a distortion-factor analyser, a TV wobbulator, and a frequency counter.

A new colour generator from **Labgear**, the CM6010/RG, is of the gated rainbow type. The price is £75 net trade and the generator produces dots, crosshatch, blank raster, and two colour-patterns, one of which is used to check the PAL delay line circuit and the other to adjust the demodulators. The unit operates on 625 lines with the output pretuned to channel 37 (a non-allocated channel between Bands IV and V).

Rank-Bush-Murphy showed two colour generators, one being a portable type and one a bench model. The generators are of Italian origin and are marketed in this country by Howard Industries, though RBM are licensed to distribute them to RBM dealers. The portable Model EP872 gives red, green and blue rasters, grey scale, crosshatch, and colour bars. There is no provision for sound signals. The r.f. output is nominally 5mV at 540MHz into 75Ω (a 300Ω output is also available). The bench Model EP684R is similar but the output is continuously variable in frequency from 41MHz to 900MHz. The output amplitude is also variable. Sound signals may be added when required and modulated with a 1kHz tone (50kHz deviation). Composite video signals are available from both generators. The prices are £175 for the EP684R and £135 for the EP872. ■

PART 1



FLASHOVER PROTECTION

E.J. HOARE

It is probably well known that all modern picture tubes are prone to the occasional internal flashover. An arc occurs between the final anode and some part of the grid structure, and the e.h.t. energy is discharged direct on to one of the c.r.t. electrodes. It does not need much imagination to foresee the kind of damage that this can do to components in the external circuit—particularly transistors. In a properly designed receiver however no damage occurs and in many cases the average viewer will be quite unaware that anything untoward has happened. The single sharp "crack" and the momentary blacking out of the picture will be masked by the noise and entertainment value of the programme itself.

The fact that present day fully-transistorised colour receivers are largely free from flashover troubles has not come about by chance or some fortuitous set of special circumstances. It is the result of a great deal of care, experience and testing on the part of the setmakers and the manufacturers of cathode-ray tubes. Flashover problems can be very subtle and complicated, and protection has to be built into the receiver as part of the basic design. Unfortunately, as we shall see later, it is impossible to be absolutely sure that the protection is adequate in all cases. A few of the unexplained failures of transistors that occur from time to time are undoubtedly caused by flashover effects. A transistor may fail at the first discharge, or after the cumulative damage caused by several discharges spread perhaps over quite a long period of time. This knowledge may not be very helpful to the unlucky service engineer trying to diagnose a fault, but at least it may be of interest to him to know what is happening.

An important point to emphasise is that any reader of Television who is going to build a receiver incorporating semiconductors must include a number of very important precautions against flashover effects. If he does not he stands the chance of blowing up several transistors or diodes, and this can be highly expensive and frustrating. A line output transistor for example is not a cheap device.

Let us take a look at the subject of flashover problems and see what needs to be done to reduce the risks.

Causes of Flashovers

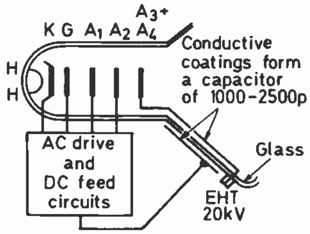
In spite of all the scientific investigations carried out over a period of many years there is still no clearly established theory to explain the mechanism of flashover. At one time it was thought that small particles of dirt or other impurities left behind on the gun structure or on the inside of the tube neck were responsible for initiating an arc. When these foreign bodies were evaporated by successive discharges no more flashovers occurred. This seemed to tie up with the well known fact that flashover is more frequent in new tubes, gradually dying away during the life of the tube.

The generally accepted theory now is that the electrostatic forces around the gun assembly cause small particles of matter to be pulled off the structure. When these hit an electrode they release sufficient energy to initiate an arc discharge. If this theory is correct it seems likely that flashover problems are here to stay, because it is very difficult to see how the effect can be prevented in tubes with high values of e.h.t. on the final anode. The electrostatic forces are considerable.

CRT Flashover Circuit

The key to all the problems of protecting the external circuits and their components lies in having a clear understanding of the paths that the flashover discharge currents may take. It is then possible to foresee the kind of damage that may occur and to devise means of preventing it.

The most important path of all involves the tube electrodes and the circuits which provide drive voltages and d.c. operating potentials. Fig. 1 shows in highly diagrammatic form a normal picture tube arrangement before any flashover occurs: Fig. 2 shows what happens at the instant of flashover. Bear in mind that a typical colour c.r.t. has an e.h.t. smoothing capacitor of about 2,000pF. This



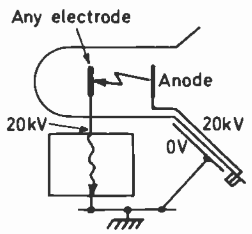


Fig. 1 (left): A highly diagrammatic and simplified representation of a c.r.t. drive and feed circuit with no flashover protection.

Fig. 2 (right): The circuit of Fig. 1 at the instant of flashover between the final anode and one of the electrodes.

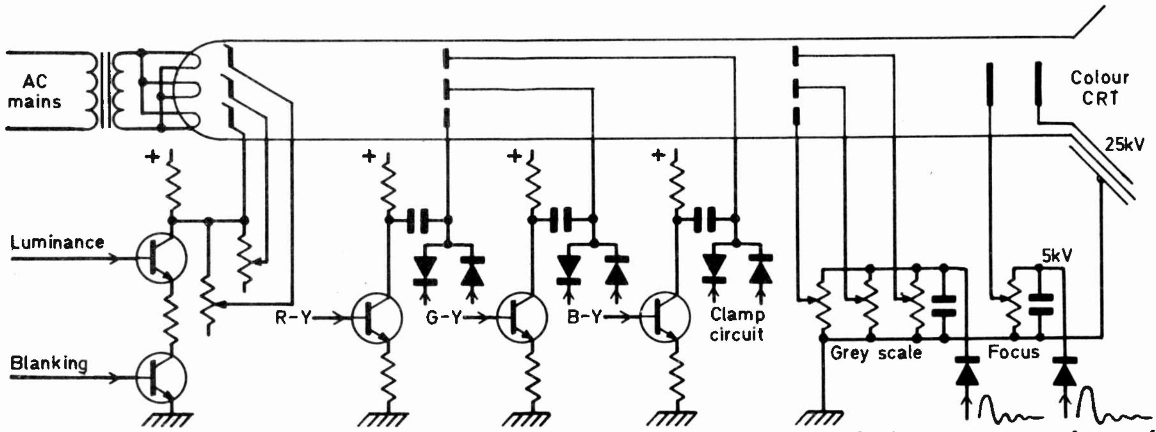


Fig. 3: How much damage would be caused by a flashover to each electrode in turn? Answer, one transformer, four high-voltage power transistors, one low-level transistor, eight diodes (one a 6kV type), six potentiometers and several miscellaneous components!

is not a separate component but consists of the capacitance between the conductive aquadag coatings on the inside and outside of the glass envelope of the tube. This capacitor is charged up to about 25,000V, and the amount of stored energy is very large. Remember also that an electric arc has virtually no resistance.

Damage due to Flashovers

You can now see why it is that 25kV can appear across the external circuit with sufficient energy to do an awful lot of damage. Just to emphasise the point a bit more, Fig. 3 shows an ordinary transistorised luminance plus colour-difference drive circuit for a colour c.r.t. and arrangements for providing the necessary d.c. operating potentials. If you want to frighten yourself, add up how much it would cost to repair the damage if a series of flashovers occurred which placed 25kV on each electrode in turn. None of the semiconductors would survive for a start.

Of course in practice this would never happen. It is true that a flashover can strike any of the electrodes, including the heaters, but in any particular tube only one or two of the electrodes will be afflicted. Furthermore it is only fair to say that most tubes flashover very seldom. It is the odd rogue that for no apparent reason goes on banging away at intervals and tots up quite a high score. Fortunately its record in the flashover stakes bears no relation to its performance in terms of picture quality or life.

Circuit Protection

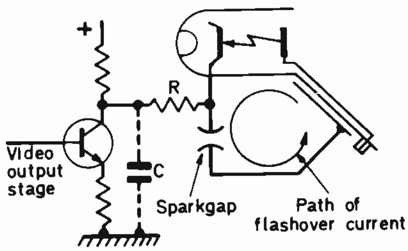
The damage we have just been discussing can usually be prevented quite simply and cheaply by the application of a few techniques which are fundamental to the problem of circuit protection. They are based on the following three principles: (1) Bypass the flashover current so that the smallest possible amount of energy is applied to the external circuits. (2) Add sufficient impedance between the flashover path and the external circuit to prevent the residual energy from damaging any components such as transistors or diodes. (3) Study the earth return paths to make sure that no voltages induced in them are coupled to other sensitive circuits.

Items (1) and (2) are illustrated in Fig. 4. This is the basic circuit technique which should be applied to every c.r.t. electrode in both monochrome and colour receivers if semiconductor devices are present. It is also good practice in circuits where only valves are used, because although they stand up to flashover treatment surprisingly well the associated capacitors are more prone to damage. In Fig. 4 the flashover energy is bypassed via the sparkgap. With all the electrodes except the focus electrode of a colour tube, which operates at about 5kV, this gap will be designed to break down at a d.c. potential of about 2kV. At the instant when the arc occurs a short-circuit path is thus provided in parallel with the external circuit.

The sparkgap on its own however is not enough. There is a very slight delay—of the order of less than 1μsec—after the application of the flashover surge before the sparkgap breaks down. During this very brief interval sufficient energy could be transferred to the external circuit to do some damage. The blocking resistor R prevents this and also helps the build-up across the gap of the voltage that causes it to fire. The output capacitance C of the circuits connected to R combines with R itself to form a low-pass filter. Thus any surge currents which do get past R tend to be bypassed quite effectively by C. If an extra capacitor can be added at this point, so much the better.

Sparkgaps

Now that we have established the right approach to the problems of circuit protection, let us see how to apply it in practice and what other problems arise.



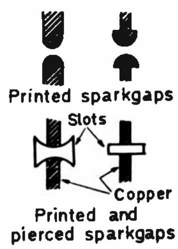


Fig. 4 (left): The basic protection technique which should be applied to each electrode of the c.r.t.

Fig. 5 (right): Sparkgaps can be made very simply in a printed board.

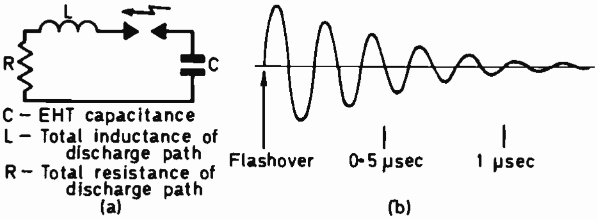


Fig. 6: (a) The equivalent circuit of a flashover path at the instant of discharge. (b) The waveform of the flashover current.

We need to connect sparkgaps with a d.c. breakdown voltage of 2kV to every electrode of the picture tube. The only exception is the focus electrode of a colour c.r.t. where a 7-8kV gap is needed because the electrode normally has a d.c. operating potential of about 5kV.

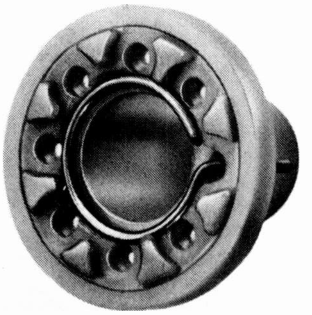
There are a number of different types of commercially produced low-voltage sparkgaps available. One of these is a combined capacitor and sparkgap known as a Cap-Gap. Another one consists of two wires spaced the correct distance apart in a simple plastic ring moulding. There are others. Whatever form the gaps may take the basic requirement is quite straightforward: for a 2kV gap you need an air spacing of about 0·5mm. and for 8kV the spacing should be 6·0mm.

The simplest and cheapest way of making sparkgaps is of course to print them on a copper-clad board. Fig. 5 shows the kind of pattern that can be used. Note that sharp corners must be avoided—particularly at 5kV—because these will cause unreliable operation of the gap due to corona discharges. It is also good practice to make a slot in the board with a width equal to the size of the desired gap, but appreciably longer. This avoids the possibility of the gap being bridged by tracking along the surface or by the usual accumulation of dust.

Although the copper foil on a printed board is quite thin it is capable of standing up to a very large number of discharges without being eroded. These simple sparkgaps therefore work very well, and if you are making your own TV receiver you can quite easily cut the appropriate slots or grooves with a sharp knife.

Ringtrap Tube Bases

In commercially produced monochrome receivers the problem of sparkgap protection has been solved very neatly by the "ringtrap" base. A wire ring is fitted into a groove in the c.r.t. base cap so that it is accurately located about 0.5mm. from each pin. When this ring is connected to earth a sparkgap is formed to each electrode via the c.r.t. pins.



Left: Ringtrap type tube base to provide flashover protection for a monochrome tube. The wire ring forms a sparkgap to each tube pin. (Photograph courtesy of Mullard Ltd.)

Unfortunately this technique is not very appropriate for use in colour receivers because the focus electrode needs a larger sparkgap. A further snag is that there are no unused pins, so it is difficult to bring out a connection from the ring for earthing purposes.

Flashover Currents

Figure 6(a) is a simplified equivalent circuit of a c.r.t. at the instant of flashover. C is the e.h.t. smoothing capacitance, L the total inductance of the discharge path including the earthy connection to the external tube coating, and R the total resistance of this path. The combination of L and C forms a series tuned circuit with a resonant frequency of a few MHz damped by R. When the sparkgap breaks down the discharge current will take the form of a damped oscillation as shown in Fig. 6(b). In a typical case this oscillation dies away in about 1μsec.

The important thing to note about this circuit is the very large current that can flow. In modern picture tubes with e.h.t. capacitances of 1,000-2,000pF charged up to 20-25kV, the peak flashover currents can be in the range 500-1,000A. Yes, 500-1,000A! With currents of this magnitude it does not need much impedance in, say, an apparently innocent earth connection to cause quite a large voltage to appear suddenly: certainly enough to blow up a transistor. In the case of the picture tube earthing however the results can be quite surprising.

Flashover Voltages

Even a straight piece of copper wire being used as an earth connection has some inductance. It is very small, but in the context of flashover problems it is important. The reason is this: the voltage drop along the wire is equal to $L(di/dt)$ where L is the inductance in henries and the term di/dt is the rate of change of current in amperes per second. L is of the order of $\frac{1}{4}\mu$H and di/dt is a bit over 10^{10}A/sec. So if you take the basic protection circuit of Fig. 7(a) and the equivalent circuit of Fig. 7(b), you find that in the case of a colour tube with 25kV on its final anode the voltage drops along the earth lead can be 8kV! If this lead is unnecessarily long, and perhaps coiled up a bit as well, the voltage drop can be considerably higher still.

What happens is that at the instant of flashover the e.h.t. voltage is divided proportionately between the inductance of the path inside the c.r.t. (Lt) and the inductance of the earth connection to the outer

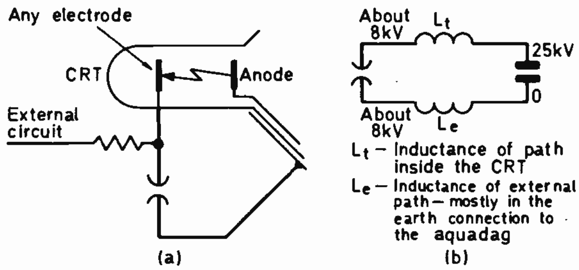


Fig. 7: (a) The basic protection circuit. (b) The equivalent circuit of the flashover path of (a). The e.h.t. voltage is divided between the two inductances.

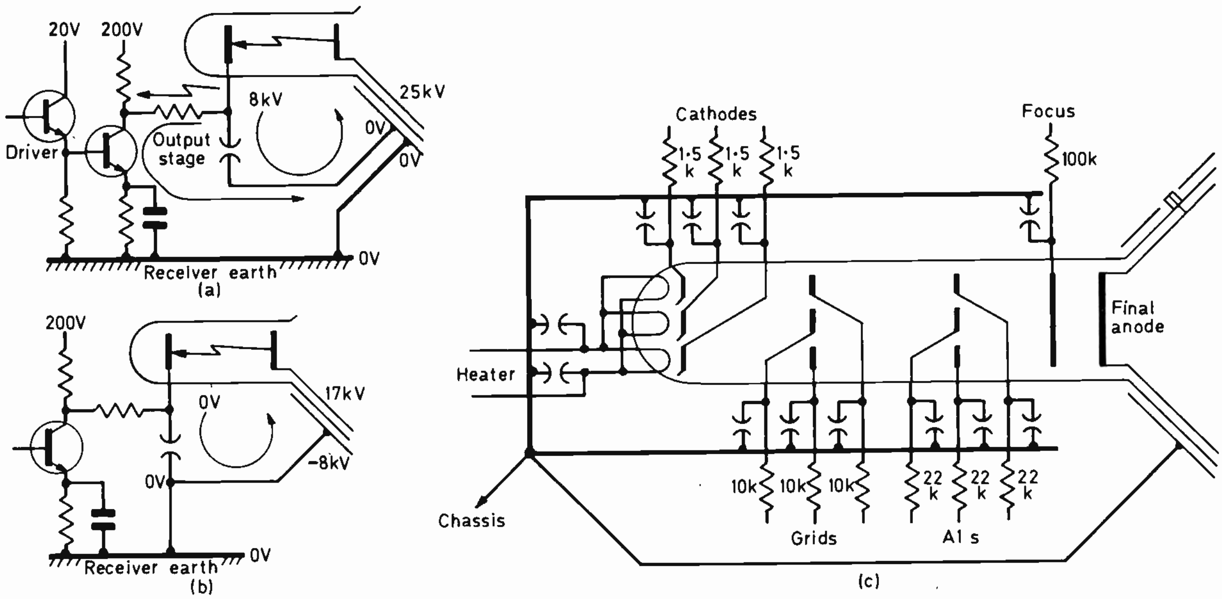


Fig. 8: (a) This shows a video output stage connected to a c.r.t. Normal flashover precautions have been built in but the external tube coating has been connected back to the receiver earth. 8kV is thus applied to the collector circuit with disastrous results. (b) A happier result. The receiver earth is connected to the earthy side of the sparkgap. This point stays at approximately earth potential and the external coating of the tube takes up an instantaneous potential of −8kV. Thus no flashover voltage is applied to the output transistor collector. (c) Complete flashover protection for the external circuits around a colour c.r.t.

aquadag coating (L_e). The voltage drop across the circuit resistance is comparatively small. Now if this earth lead has 8-10kV across it we must obviously give careful thought to the problem of connecting it to the external circuit. Which end of it do we join to chassis?

Earthing the CRT

In the past the aquadag coating on the outside of the tube has usually been connected to the chassis via a coil spring or a flat contact. Let us see what happens if we do the same thing here. The voltages present at the instant of flashover are shown in Fig. 8(a). Imagine connecting 8kV to a video output stage transistor, even if it does have a resistor in between!

The correct method of connection is shown in Fig. 8(b). Once the sparkgap breaks down no high flashover voltages are applied to the external circuit and all is well. But take careful note of the fact that the outer coating of the picture tube has a surge voltage of −8kV, i.e. 8kV below chassis earth. This has some important implications that we will discuss later.

Complete Protection

We have now established the basic technique of sparkgap protection for the circuits connected to the picture tube. This must be applied to each electrode including the heaters. The only remaining problem is how much impedance can be connected in series with each one.

If the impedance is too high we get good circuit protection but the performance may suffer as a result of the voltage drop or the restriction in bandwidth. Conversely if we err the other way the performance is not affected but the protection may be inadequate. The following list is based on Mullard recommendations and should serve as a reliable guide for both monochrome and colour c.r.t.s.

Cathodes	1·5kΩ	For cathode luminance or RGB drive
Grids	10kΩ	
A1	22kΩ	
Focus electrode	0·1MΩ (colour), 22kΩ (monochrome)	

The heaters are usually supplied from a high-impedance source—either a series heater chain or a transformer—so although it is not practicable to add extra series resistance the protection is usually adequate.

Figure 8(c) shows the circuit of a colour c.r.t. with its associated feed components. The series resistors and the sparkgaps should be mounted as closely as possible to the c.r.t. base connections. The lead from the earthy side of the sparkgaps to the outer coating of the tube should be as short as possible, and preferably made from braided copper to give a low-impedance path. It must also be soldered securely so that there is no possibility of it falling off. The resistors have to stand up to a fair old bang when the tube flashes over, so it pays to choose the right type. Generally speaking it will be found that carbon composition resistors are better than carbon film ones for this application. If in doubt use 1W types. Finally, remember that there must be only one earth lead to the chassis, and that this must be connected *directly to the earthy side of the sparkgaps*. Keep it short.

TO BE CONTINUED

TV BOOKS

PRINCIPLES OF TELEVISION RECEPTION, by W. Wharton, C.Eng., F.I.E.E., and D. Howorth, B.Sc.Tech., C.Eng., M.I.E.E., published by Sir Isaac Pitman & Sons Ltd., 296 pages, 40s.

PRINCIPLES OF COLOUR TELEVISION SYSTEMS, by C. R. G. Reed, M.A., C.Eng., M.I.E.E., published by Sir Isaac Pitman & Sons Ltd., 196 pages, 50s.

COLOUR TELEVISION Volume 2, PAL, SECAM and other systems, by P. S. Carnt, B.Sc.(Eng.), A.C.G.I., C.Eng., F.I.E.E., and G. B. Townsend, Ph.D., B.Sc., C.Eng., F.Inst.P., A.K.C., A.M.B.I.M., F.I.E.E., F.R.T.S., F.B.R.S.T.S., published by Iliffe Books Ltd., 276 pages, 75s.

PAL COLOUR TELEVISION, by Boris Townsend, published by the Cambridge University Press in association with the I.E.E., 227 pages, 60s.

A good collection of books here for anyone wanting to delve into the principles rather than the strictly practical aspects of television—though this is not to say that a good grasp of the principles is anything other than very helpful in understanding the practical side. The **Principles of Television Reception** can certainly claim to be comprehensive, giving practical circuitry, both valve and transistor, throughout in addition to a clear explanation of principles taking in both colour and monochrome. At 40s. it represents good value considering the way in which book prices have increased since it was first published, just over three years ago. We have certainly found the book handy, having referred to it on numerous occasions and usually being able to find just what we needed to know. One criticism, perhaps rather carping, is that much of the circuitry shown appears to belong rather more to the realm of good-quality monitors rather than everyday commercial models with their compromises and short-cuts. In particular the colour circuitry seems to bear little relationship to that actually found in commercial receivers.

Colour Television Volume 2 by Carnt and Townsend is of course the complement to their well-known book (Volume 1) published in 1961 which gave a very detailed account of the NTSC colour system. This new book brings us up to date, with PAL, SECAM and a passing glance at other systems. In spite of being Volume 2 it is self-contained, starting with an introductory chapter on the principles of the NTSC system. Practical colour receiver circuitry is illustrated.

Principles of Colour Television Systems sticks, as its title suggests, to a reasonably detailed account of colour television principles, covering NTSC, PAL and SECAM. It puts over the facts clearly and seems to be aimed at students in including test problems where appropriate. There is hardly any circuitry, so that this is a book primarily for those interested in the generation of colour signals, system parameters, encoding and decoding principles and the basic problems of transmitting a colour signal. A criticism of this and the previous book is the inclusion of extensive sections on SECAM: these must be of largely academic interest to UK readers.

PAL Colour Television takes us almost racily through almost every aspect of PAL, from cameras and studio practice to transmission and reception—and a brief potted history. This is a book of rather broader scope than the other two on colour. For example it outlines the design of modern colour television cameras, describes the complex pattern of control and monitoring which the signals undergo in the studio, and discusses the production of colour programmes and the design of videotape recorders in addition to the expected sections on reception. It even rather unexpectedly told us how an Eidophor works.

T.J.

RANK-ARENA

Rank-Bush-Murphy propose to become the majority shareholder in a new company, Rank-Arena, registered in Denmark. The Danish firm making radio, high fidelity equipment and TV sets under the Arena brand name ran into production difficulties following a fire which destroyed their factory last May. Rank will be assisting in rebuilding the factory for the new joint concern. This will give the Rank Organisation a further brand name following their recent introduction of equipment under the Dansette brand name.

DX-TV

—continued from page 59

original type G card followed by the new one, again reverting to the G card—so now we know! I have seen this card on a few occasions and marked my log ?West Germany and it was not until 13/8/70 that I positively identified it. I am glad to say I did at least query it. If only test cards would carry some identification!

Austria: M. J. Dalby of Stroud reports that he has seen this card in vivid technicolour so it is in fact a colour card.

Jordan: This month we publish the Jordanian TV test card. This is not completely impossible for SpE under good conditions. It is on channel E3 from Amman with reasonable power, so we have a hope for 1971. The other Jordanian station on E6 alas need not concern us! We are indebted to Roy Shepperd for this photo and details.

By the time you read this I will, all being well, be on my yearly tour to "them furrin parts". This time to ORTF, TVE and RTP lands then on to Morocco. I hope to see Spanish and Portugese TV as locals—I have not seen much of them this year over here—and I hope to be able to report what Moroccan TV is like.

I had a startling telephone call from A. Thynne of Birmingham on 24/8/70 with a report of his reception of the Austrian test card on channel E5. This is either Vienna Kahlenberg or Pfaender, either of which would be a truly magnificent achievement: our congratulations to him! This opens up new trop prospects. You will recall that R. Bunney and myself had Rigi Switzerland earlier this year on channel E6, so who is going to be the first to get into Italy in Band III?

Modifications to the CONSTRUCTOR'S 625-Line Receiver

KEITH CUMMINS

FOLLOWING the recent series of articles (March-July) on the constructor's 625-line receiver there have been the expected queries from readers. Over a period of time it has been possible to analyse these to see whether they follow a particular pattern or are random and unrelated. Those falling into the second category have of course to be examined individually in order to provide appropriate advice, while problems which recur with different constructors indicate that a common cause should be sought.

Line Timebase Troubles

An analysis of the queries to date indicates that some small troubles have been recurrent in the line timebase, the remainder of the receiver having proved generally trouble-free. In summary the line timebase difficulties reported have been (1) inadequate width, (2) foldover at the left-hand side of the screen, (3) striations (i.e. vertical lines) at the left-hand side of the screen and (4) a sideways jitter at the top of the picture sometimes accompanied by a ticking from the line output transformer.

As mentioned in previous issues it has been found that some line output transformers have their 625- and 405-line output tags reversed so that it is necessary to transfer the connection from tag 3 on the transformer tag panel to the one beneath it (see Fig. 4, April 1970 issue). This however has proved to be an incomplete answer to the line timebase problems in some cases while in others the connections were correct to begin with. If in any doubt as to the correct connection, the one showing the least resistance to the PL36 anode connection is the right one. Make sure that the receiver cannot be accidentally switched on while taking this measurement—both for your sake and that of the Avo!

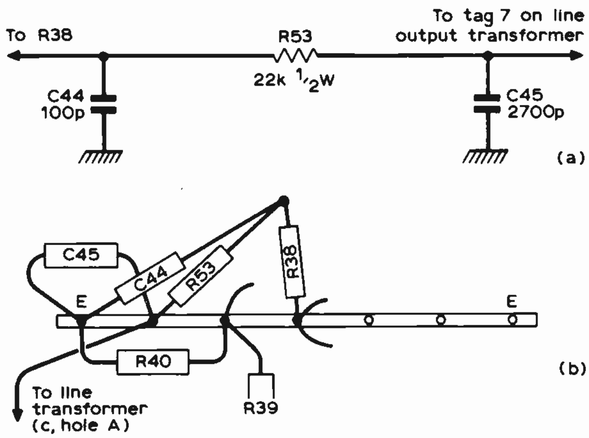


Fig. 1: (a) Line timebase modification. C44 and C45 are 500V ceramic capacitors. (b) Modified tagstrip layout to incorporate the extra components.

Displaced Picture

Tests carried out on the prototype have shown that under certain adverse tolerance conditions it is possible for the optimum line hold control setting to coincide with a picture position displaced too far to the left within the raster. This condition indicates that the video information is commencing prior to the start of the horizontal scan. In order to correct this condition it might seem necessary to advance the phase of the line sync pulses. The same effect however can be achieved by retarding the phase of the reference pulse fed back to the flywheel sync discriminator circuit from tag 7 on the line output transformer, and this approach to the problem is much easier to implement.

Jitter and Striations

The horizontal jitter at the top of the picture was found to be the result of dynamic unbalance in the line a.f.c. discriminator which consequently produced a ripple at 25Hz, the result of the differing field sync waveforms on odd and even fields. The problem is simply resolved by changing the a.c. balance point of the bridge.

Because of the incorrect raster phasing, striations which appear at the extreme left are apparent on the picture instead of being lost in a blank part of the raster. Tuning the transformer however can reduce these striations and a capacitor (C45) has been added for this purpose. When the basic modifications had been carried out it was found possible to increase the line a.f.c. loop time-constant, thus improving the line timebase noise immunity.

Modification Data

The complete modification information is shown in Fig. 1. The network C45, R53 and C44 is interposed between the line output transformer (tag 7) and the a.f.c. discriminator circuit. R53 and C44 form the phase-shifting network to correct the phasing of the raster. C45 tunes the line output transformer to reduce striation, and by reducing the e.h.t. enables less scanning power to be used. Increasing C25 in value to 2,200pF corrects the dynamic unbalance in the a.f.c. discriminator circuit, whilst increasing C26 to 0.022μF improves the noise immunity.

It is recommended that these modifications be carried out in full or not at all. Even where no apparent problem exists it is probably best to carry out the modifications in order to bring the receiver up-to-date in its final form. ■

THAT ELUSIVE IF STRIP

Good news for anyone who may have been put off building the constructors' 625-line receiver by the shortage of the surplus i.f. strips used in the prototype receiver: Manor Supplies have now obtained a large consignment of these i.f. strips. 'Phone 01-794 8751 for quotation and latest delivery situation.

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MURPHY V310A

This set is working perfectly except that when initially switched on the sound comes on first in the normal way but when the line output stage starts working the sound disappears for a couple of seconds, subsequently returning followed by the picture. Is this a fault condition developing?—W. H. Knowles (Leeds).

It is normal for the sound to fade out during the warm up period in this model. This is due to the a.g.c. system becoming locked out until the line timebase gets working properly.

GEC 2029 COLOUR RECEIVER

The picture takes about a minute to appear after switching on and when it comes on there are broad bands of red, blue and yellow. These appear as double lines about ¼in. in width all over the screen and it is about five minutes before they disperse to give a reasonably satisfactory picture—on colour or black-and-white. Once the set is really warmed up the performance is good. Also, the colour control seems to be faulty. When touching it the colour goes.—F. E. Garner (Pudsey).

The warm-up fault appears to be the adjustment of the colour killer and burst phase discriminator circuit. Check the latter first. With colour bars being displayed, remove the aerial lead and replace it again. The colour should lock instantly. If it does not, adjust the subcarrier oscillator frequency control ("SET SC OSC FREQ") very slowly in one direction or the other until the colour does lock. Slow movement is necessary because of the time-constant of the circuit. Repeat removal and replacement of the aerial lead. If necessary adjust the control farther in the same direction and check again. Repeat until the colour locks instantly. If patterning still appears on monochrome or if there is now a general colour haze of noise on the picture, advance the colour killer threshold control slightly. This should be done on colour reception. Turn the control until the colour just disappears, then bring the control back by as small a movement as possible to get colour. Monochrome should then be OK. The two controls are on the decoder board, the "SET SC OSC FREQ" control in the left-hand corner at the back of the set (P302) and the killer threshold control (P304) just beside it to the right.

PHILIPS 19TG122A

There is a double image, side-by-side and overlapping. When the line hold control is moved the images move together and then the picture breaks up. By advancing the brilliance control a picture can be obtained, but with no contrast. Sound is OK.—E. A. Brown (Liverpool).

Replace the ECL80 line oscillator valve and check the associated components. The ECL80 concerned is the one on the bottom of the timebase panel.

BUSH TV115R

The picture was shrinking all the way round and the h.t. was low. The h.t. rectifier was therefore replaced, using a silicon type with the appropriate safety components. The result was a 230V h.t. voltage. The PL36, PY800, PCF80 video amplifier, PL84 field output valve and PL36 screen feed resistor have been replaced. This gave a clear, full-sized picture. After an hour the set was switched over to 625 and the raster, picture and sound disappeared, with a smell of burning I switched off, changed to 405, and switched on again. This time there were two pictures side by side, with very bad linearity. On switching to 625 the raster, picture and sound disappeared again. The tuner push buttons and system changeover switch have been cleaned with switch cleaner.—S. Vantara (Uxbridge).

The h.t. output at the rectifier is low; it should be more like 260V. This fact suggests that the line output stage is drawing too much current. This is likely to be due to insufficient line drive, indicating that the ECC82 line oscillator may be losing emission. Check the valve and that the voltages are 116V at pin 6 and 176V at pin 1.

INVICTA 7301

Three pictures appeared on 405, but adjusting the 405 line hold control corrected matters. Then on switching to 625 three pictures again appeared and only adjusting the 405 line hold control had any effect, and the width was then reduced to two thirds. —E. Butler (London N.1).

The system switch does not appear to be operating correctly. Check this and the hold controls.

TOP RANK TV134U

The original defect was loss of channel 9 sound after 30-40 minutes operation. This loss of sound was preceded for a minute or two by rising and falling volume, picture OK throughout. The tuner and standards contacts have been cleaned and a new PCF806 fitted, with vast improvement on v.h.f. Now Southern ITV sound and vision (never seen or heard before) can be received, but with a weak Southern ITV picture there is good channel 9 sound and with a channel 9 picture only a loud hum. In spite of careful fine tuning no trace of channel 9 sound is obtainable while the channel 9 picture remains on the screen. BBC-1 sound and vision are excellent.—R. E. Baker (Reigate).

Your first action should be to ensure that the PC900 r.f. amplifier valve is up to standard. Then check the 12kΩ resistor which is the oscillator anode load of the PCF806 frequency changer. If this is in order check the 22kΩ screen feed resistor to pin 7 of the PCF806.

ALBA T877

The volume rises at irregular intervals while the background noise increases and a sound similar to a microphone being handled, occasionally increasing to a medium-pitched tone, is heard. The volume control does not decrease the volume of any of these noises.—W. T. Swinchatt (Chessington).

A rather unusual volume control circuit is used in this set, a negative bias voltage from the line output valve grid circuit being fed via the volume control to the grid of the EF80 sound i.f. amplifier. The fault causing the peculiar noises may therefore be in the i.f. or a.f. stages. The first thing to check with this type of fault is that the valves are seating correctly and the pin connections clean. Then check the valves themselves. If these are OK check around this area for a burnt resistor or dry-joint. Check the 0·1μF capacitor which smooths the volume control negative bias line, also C36 (100pF) the i.f. filter capacitor and C39 in the interference limiter circuit.

FERGUSON 3625

ITV on channel 8 can no longer be received, after having been troublesome for quite a while: there is a blank screen and no sound. The BBC channels however are OK, and more distant ITV channels can be received though of course with a poor picture. All aerial leads etc. have been checked.—G. Hicks (Coventry).

The trouble is that the channel 8 coil biscuits are not contacting the leaves on the strip. Clean the biscuit studs and gently prise the contact strip inwards with a screwdriver blade (at each end) to improve the contact.

KB OV30

I have serviced this New Queen model, replacing the e.h.t. rectifier, boost diode and line output valve which was being fed with h.t. through an arc. An R20 e.h.t. rectifier has been fitted. With careful adjustment of the brilliance and contrast controls I can get quite a good picture but the slightest alteration to either control causes the picture to either black out if the controls are turned back or balloon and disappear when turned forward.—A. H. Hicks (Southampton).

The original model was fitted with an R19 e.h.t. rectifier which has a 2·5Ω resistor in series with its heater supply. Check this resistor. If you keep the R20 in, short out the resistor in the heater supply.

SOBELL SC270

The picture keeps rolling on ITV though it is OK on BBC. The sound is good on ITV but bad on BBC and noisy—W. G. Luney (Belfast).

The usual reason for bad sync on one channel but not the other is that the signal strength is poor, perhaps due to an inadequate aerial. Also check that the h.t. voltage to the tuner is about 200V. If low check the two PY82 h.t. rectifiers. The poor sound on BBC is almost certainly due to poor tuner contacts. The tuner can be dismantled and cleaned. At the same time check that there is sufficient pressure on the contacts.

EKCO CT102 COLOUR RECEIVER

There are five broad vertical green stripes across the picture, evenly spaced. The fault is most noticeable on grey-blue backgrounds, but affects all colours.—H. Ellveney (Nottingham).

Check the BC147 or BC107 transistor in position VT28—this is the flyback suppression transistor in the cathode lead of the PL802 luminance output valve on the colour-difference amplifier panel. Also suspect a faulty line linearity choke (L39) which can be shorted as a quick check.

STELLA ST8514U

Only the sound was working when I received this set. A picture was obtained by fitting a new EY51, but faces are elongated and I don't seem to be able to cure this. Also there is a PY33 in the PY32 position.—G. R. Topping (Morecambe).

A PY33 is the correct replacement for the PY32. If the picture is of full width but too long, check the height setting, the cathode bias electrolytic of the front right ECL80, the ECL80 valves and associated components. If width is lacking, check the PL81.

BUSH TV166U

On 405 lines the picture loses contrast when a scene with mainly white background comes on. As this happens line pairing occurs and sometimes the lines overlap intermittently. The vertical field hold becomes more critical and lines with black content tend to be displaced to the right. The PFL200 video amplifier and sync separator has been replaced, and the feed resistor 2R41 to the sync separator grid seems OK. The voltage at the sync separator control grid is rather low at −12·5V however. There is plenty of picture signal.—A. R. Twort (Gillingham).

We suggest you check the 0·1μF sync feed capacitor 2C46 in series with 2R41, and also 2C39 0·22μF which smooths the a.g.c. feed taken from the sync separator grid.

HMV 2644

Sync has been lost on this receiver. When it is switched on all I get is a series of multiple images side-by-side which roll as well. The picture nearly locks for a second or two when the line hold control is adjusted, then breaks up altogether with neither line nor field lock. The EF80 sync separator has been checked and is OK.—J. P. Shelley (Chester-le-Street).

The fault is almost certainly in the sync separator section of the receiver, which is fitted with the Thorn/BRC 980 chassis. Check the 0·1μF coupling capacitor C25 to the grid of the sync separator (pin 2), the screen feed resistor R33 56kΩ and decoupler C23 0·47μF (pin 8) and the anode load resistor R36 68kΩ (pin 7).

BUSH TV105

After switching on and warming up a considerable sissing noise is heard from the speaker along with the sound, while the raster is broken up by line tearing and sometimes finishes up with a very dark screen apart from a vertical 2in. strip which is normal and bright on the extreme right of the picture. Interference in the form of varying symmetrical patterns is also caused on another set. I can see no signs of a short anywhere. The timebase whistle remains steady and is variable with the hold control RV6, and the tube voltages seem to be normal. After about five minutes the trouble quietens down and a picture is obtained though not very good and with little contrast.—F. Hazard (London W5).

Ensure that the external conductive coating of the c.r.t. is well bonded to the chassis. Check the line output stage generally for any signs of discharge. Also check the EY86 base which often becomes decomposed, and the top cap connection.

FERGUSON 406T

Every time the set is switched on the field hold has to be adjusted and afterwards the field jumps and then settles down every few minutes. There is very little contrast control.—C. Smith (Manchester).

First replace the PCL82 field timebase valve. Then check the video amplifier PCL84, the video stage components and the EF80 vision i.f. valves for grid-cathode leakage.

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TELEVISION, NOVEMBER, 1970

TEST CASE

96

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

? *A KB receiver of the WV series was suffering from bad distortion on the f.m. sound of the 625-line standard yet the quality of the sound reproduction was perfectly normal on the 405-line standard. The symptom was also accompanied by buzz on sound changing with picture content (i.e. intercarrier buzz). Since the intercarrier signal is obtained from a tuned circuit following the vision detector it was felt that either this tuned circuit or the intercarrier channel was misaligned, but an alignment check proved that this was not the case.*

The two diodes of the f.m. ratio detector were then carefully checked but each had low forward resistance and very high reverse resistance. The quality of the picture on the 625-line standard was very good, so it was assumed that the alignment of the vision i.f. channel was correct.

What factor was overlooked and what are the possible causes of 625-line sound distortion, assuming that there is no abnormal distortion on the 405-line standard? See next month's "Television" for the solution to this problem and for a further item in the Test Case series.

SOLUTION TO TEST CASE 95

Page 40 (last month)

The video amplifier is a common cause of the symptom described last month when, as in this instance, there is partial d.c. coupling to the tube. It will be recalled, however, that the valve was replaced with only a slight improvement and with diminishing bandwith. A further test would have indicated that the video anode load resistor was overheating and that its value was rising with temperature. As the value of this component not only affects the gain and bandwidth of the video channel but also in this type of circuit the d.c. biasing conditions of the picture tube, the display changed in mean brightness level as well as in definition—the rising value causing a fall in definition.

The trouble was completely solved by replacing the resistor with one of higher wattage rating. It is noteworthy that the valve itself can suffer through excessive screen grid dissipation as a result of too low anode potential caused by the increase in value of the anode load resistor.

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