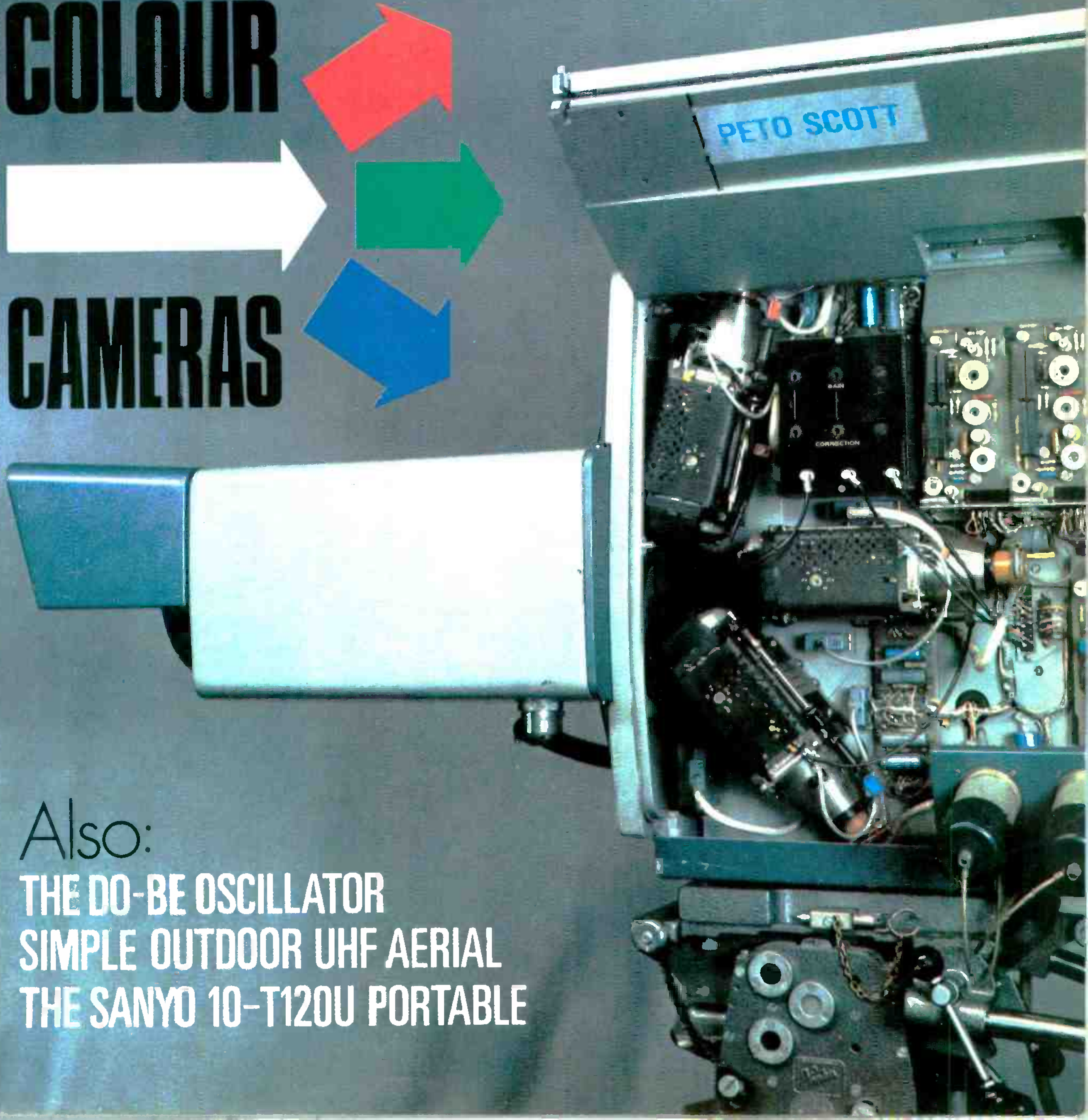
TELEVISION

20p

SERVICING · CONSTRUCTION · COLOUR · DEVELOPMENTS

FEBRUARY 1972

COLOUR CAMERAS



Also:

THE DO-BE OSCILLATOR
SIMPLE OUTDOOR UHF AERIAL
THE SANYO 10-T120U PORTABLE

STEPHENS

**ELECTRONICS,
24 PARTON ROAD,
AYLESBURY, BUCKS.**

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

GUARANTEED VALVES BY THE LEADING MANUFACTURERS BY RETURN SERVICE

1 YEAR'S GUARANTEE ON OWN BRAND, 3 MONTHS' ON OTHERS

AZ31	50p	ECF80/2	47½p	EL803	85p	PCC85	42½p	PY83	50p	UL41	57½p	6AR5	32½p	6EJ7	35p	6SK7	32½p	12BE6	32½p	30PL1	77½p
AZ50	60p	ECF86	55p	EL821	55p	PCC88	70p	PY88	41p	UL84	55p	6AR6	32½p	6EW6	60p	6SL7GT	32½p	12BH7	32½p	30PL13	90p
CBL1	80p	ECH35	67½p	ELL80	75p	PCC89	61p	PY500	£1·00	UM80/4	45p	6AS5	35p	6F1	70p	6SN7GT	30p	12BY7	50p	30PL14	85p
CBL31	85p	ECH42	66p	EM34	80p	PCC189	61p	PZ30	80p	UY41	40p	6AS7G	80p	6F8	40p	6SQ7	40p	12K5	50p	35A3	50p
CY31	35p	ECH81	51p	EM71	62½p	PCF80	51p	QQUO2-6	£2·10	UY85	34p	6AT6	45p	6F6G	25p	6SR7	37½p	12K7GT	35p	35A5	55p
DAF91	41p	ECH83	40p	EM80	40p	PCF82	52½p	QQUO3-10		U25	75p	6AU6	29p	6F11	32½p	6T8	32½p	12Q7G	25p	35B5	65p
DAF96	41p	ECH84	47½p	EM81	42½p	PCF84	47½p		£1·25	U26	75p	6AU6	30p	6F12	22½p	6U4GT	62½p	12SC7	25p	35C5	35p
DF91	45p	ECL80	40p	EM84	37½p	PCF86	61p	QVO3-12	65p	U191	72½p	6BA6	47½p	6F13	35p	6U8	35p	12SG7	35p	35D5	65p
DF96	45p	ECL82	49p	EM87	55p	PCF200/1	81p	R19	65p	U193	41p	6BE6	60p	6F14	60p	6V6GT	32½p	12SH7	25p	35L6GT	47½p
DK91	57½p	ECL83	57½p	EN91	32½p	PCF801	61p	R20	75p	U301	85p	6BH6	42½p	6F15	55p	6X4	25p	12SJ7	25p	35W4	25p
DK96	57½p	ECL86	49p	EY51	40p	PCF802	61p	SU2150A	75p	W729	55p	6BJ6	42½p	6F18	40p	6X5GT	27½p	12SK7	40p	35Z3	55p
DL92	37½p	ECLL800		EY80	45p	PCF805	65p	TT21	£2·40	Z759	£1·22½	6BK7A	50p	6F22	32½p	6X8	55p	12SL7GT	40p	35Z4G	25p
DL94	37½p		£1·50	EY81	40p	PCF806	61p	TT22	£2·50	OA2	32½p	6BL8	35p	6F23	77½p	6Y6G	60p	12SN7GT	40p	35Z5GT	37½p
DL96	46p	EF39	52½p	EY83	55p	PCF808	67½p	U18/20	67½p	OA3	45p	6BN5	42½p	6F24	67½p	7Y4	60p	12SQ7	40p	50A5	65p
DM70	32½p	EF80	40p	EY86	40p	PCH200	70p	U20	67½p	OB2	32½p	6BN6	40p	6F25	75p	9BW6	42½p	12SR7	32½p	50B5	35p
DY86/7	40p	EF83	50p	EY87	42½p	PCL82	51p	U25	75p	OB3	50p	6BQ5	25p	6F26	35p	10C2	50p	1487	80p	50C5	35p
DY802	42½p	EF85	41p	EY88	42½p	PCL83	61p	U26	75p	OC3	35p	6BR7	75p	6F28	70p	10D1	40p	20D1	45p	50L6GT	40p
E55L	£2·75	EF86	66p	EZ35	27½p	PCL84	51p	U31	45p	OD3	32½p	6BR8	95p	6F29	32½p	10D2	40p	20L1	£1·00	83A1	90p
E88CC	40p	EF89	40p	EZ40	45p	PCL85	52½p	U37	£1·50	3Q4	40p	6BW6	82½p	6F30	35p	10F1	90p	20P1	50p	85A2	37½p
E130L	£4·50	EF91	42½p	EZ41	45p	PCL86	51p	U50	30p	3S4	35p	6BW7	69p	6J4	47½p	10F9	50p	20P3	60p	90AU	£2·40
E180F	95p	EF92	50p	EZ80	27½p	PD500	£1·52½	U52	30p	3V4	40p	6BX6	25p	6J5GT	30p	10F18	40p	20P4	£1·00	90C1	60p
EABC80	52½p	EF93	47½p	EZ81	27½p	PFL200	74p	U76	25p	5R4GY	55p	6BZ6	32½p	6J7	42½p	10L1	40p	20P5	£1·00	90CU	£1·25
EAF42	50p	EF94	77½p	EZ90	25p	PL36	64p	U78	25p	5U4G	30p	6C4	30p	6K6GT	50p	10LD11	55p	25C5	45p	807	47½p
EBC33	55p	EF95	62½p	GS10C	£5·00	PL38	90p	U191	75p	5U4GB	37½p	6C5GT	35p	6K7	32½p	10P13	55p	25L6GT	37½p	811A	£1·50
EBC41	47½p	EF183	56p	GY501	80p	PL81	51p	U201	35p	5V4G	40p	6CD6G	£1·40	6K8G	30p	10P14	£1·00	2524G	30p	612A	£3·25
EBC81	32½p	EF184	35p	GZ30	37½p	PL81A	62½p	U281	40p	5Y3GT	30p	6CA4	27½p	6K23	50p	12AB5	50p	25Z6GT	50p	813	£3·75
EBC90	47½p	E280F	£2·10	GZ31	30p	PL82	36p	U282	40p	5Z3	45p	6CA7	52½p	6K25	75p	12AC6	37½p	30A5	40p	866A	70p
EBF80	40p	EF800	£1·00	GZ32	47½p	PL83	51p	U301	57½p	524GT	40p	6CBC	27½p	646GT	45p	12AD6	37½p	30AE3	40p	5642	60p
EBF83	40p	EF804	£1·00	GZ33	80p	PL84	41p	U403	50p	6/30L2	75p	6CD6GA	£1·15	6L7	32½p	12A15	40p	30C15	75p	6080	£1·37½
EBF89	40p	EF811	75p	GZ34	55p	PL500	82½p	U404	37½p	6AB4	32½p	6CG7	45p	6L18	30p	12AQ5	40p	30C17	80p	6146	£1·50
EB91	26p	EL34	52½p	HK90	32½p	PL504	85p	U801	£1·00	6AF4A	47½p	6CH6	55p	6LD20	32½p	12AT6	25p	30C18	75p	6146B	£2·37½
EC53	50p	EL36	47½p	HL92	35p	PL505	£1·45	UABC80	52½p	6AG7	37½p	6CL6	50p	6N7GT	35p	12AU6	75p	30F5	85p	6267	32½p
EC86	60p	EL41	55p	HL94	40p	PL508	£1·00	UBF89	40p	6AH6	50p	6CW4	62½p	6P1	60p	12AV6	30p	30FL1	75p	6360	£1·25
EC88	60p	EL42	57½p	KT66	£1·37½	PL509	£1·54	UBC41	49p	6AJ8	29p	6CY5	40p	6P25	£1·05	12AV7	45p	30FL2	92½p	6939	£2·10
EC90	30p	EL81	50p	KT88	£1·66	PL802	86p	UCC85	46p	6AK5	30p	6CY7	60p	6P28	62½p	12AX7	30p	30FL13	50p	7199	75p
EC92	32½p	EL83	41p	N78	£1·05	PL805	86p	UCH42	69p	6AK6	57½p	6D3	40p	6Q7	37½p	12AY7	67½p	30FL14	77½p	7360	£1·80
EC93	47½p	EL85	42½p	PABC80	40p	PY33	62½p	UCH81	54p	6AL3	42½p	6DC6	67½p	6R7G	35p	12B4A	50p	30L1	45p	7586	£1·25
ECC81	40p	EL86	42½p	PC86/8	51p	PY80	32½p	UCL82	51p	6AL5	16p	6DK6	42½p	6S2	40p	12BA6	32½p	30L15	85p	9002	32½p
ECC82/3	42½p	EL90	32½p	PC95	36p	PY81	41p	UCL83	61p	6AM5	25p	6DQ6B	60p	6S4A	55p	12BA7	32½p	30L17	85p	9003	50p
ECC84/5	42½p	EL91	25p	PC97	41p	PY800	41p	UF41/2	55p	6AM6	22½p	6DS4	75p	6SA7	37½p			30P12	80p		
ECC88	55p	EL95	35p	PCC84	46p	PY801	41p	UF80/5	37½p	6AQ5	32½p	6EA8	55p	6SG7	32½p			30P18	35p		
E88CC	62½p	EL360	£1·15			PY82	35p	UF89	41p	6AQ6	50p	6EH7	32½p	6SJ7	37½p			30P19	75p		

CATHODE RAY TUBES

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

Type		New £	Budget £
MW36-20			£4·50
MW36-21			£4·50
MW43-69Z	CRM171		
	CRM172	£6·60	£4·62½
MW43-80Z	CRM173	£6·60	£4·62½
AW43-80Z	CME1702	£6·60	£4·62½
	CME1703	£6·60	£4·62½
	CME1706	£6·60	£4·62½
	C17AA	£6·60	£4·62½
	C17AF	£6·60	£4·62½
AW43-88	CME1705	£6·60	£4·62½
AW47-90			
AW47-91	A47 14W	£5·95	£4·87
A47 14W	CME1901	£5·95	£4·87
	CME1902	£5·95	£4·87
	CME1903	£5·95	£4·87
	C19AH	£5·95	£4·87
147 13W	CME1906	£10·27½	£8·50
A47-11W	CME1905	£8·86½	£7·00
A47-26W	CME1905	£8·86½	£7·75
A47-26W/R	CME1913R	£9·33½	

Type		New £	Budget £
A50-120W/R	CME2013	£10·85	
AW53-80		£8·93½	£6·25
AW53-88	CME2101	£8·93½	£6·25
AW59-90			
AW59-91	CME2303	£9·58½	£7·20
A59-15W	CME2301		
	CME2302		
	CME2303	£9·58½	£7·20
A59-11W	CME2305		
A59-13W	CME2306	£13·65	£10·97½
A59-16W	CME2306	£13·65	£10·97½
A59-23W	CME2305	£12·60	£10·50
A59-23W/R		£12·60	£10·50
A61-120W/R	CME2413	£13·50	£11·50
A65-11W	CME2501	£16·50	£14·50

COLOUR TUBES

A49-191X	19 inch	£52·50	
A56-120X	22 inch	£57·50	
A63-11X	25 inch	£62·50	

PORTABLE SET TUBES

TSD217		£11·50	
TSD282		£11·50	
A28-14W		£9·16½	Not supplied
CME1601			£7·75
CME1602			£8·00

A discount of 10% is also given for the purchase of 3 or more tubes at any one time. All types of tubes in stock. Carriage and insurance 75p anywhere in Britain.

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, **£4·50**; Push Button, **£5·00**.

SERVICE AIDS

Switch Cleaner, **55p**; Switch Cleaner with Lubricant, **55p**; Freeza **62½p**. P. & p. 7½p per item.

PLUGS

Jack Plugs and Sockets		Co-Axial Plugs	
Standard Plugs	19p	Belling Lee (or similar type)	6½p
Standard Sockets	12½p	Add 2p per doz. p. & p.	

LINE OUTPUT TRANSFORMERS

G.E.C.	BT454	£4·75	G.E.C.	2028	£4·75
G.E.C.	BT456	£4·75	G.E.C.	2041	£4·75
G.E.C.	2010	£4·75	G.E.C.	2000 Series	
G.E.C.	2013	£4·75	Philips	19TG	£4·75
G.E.C.	2014	£4·75	Pye	Mod. 36	£4·75
G.E.C.	2018	£4·75	Pye	Mod. 40	£4·75
G.E.C.	2043	£4·75	Thorn	800–850	£4·75
G.E.C.	2048	£4·75			

STYLII—BRITISH MANUFACTURED

All types in stock.

Single Tip "S"	13p	Double Tip "S"	33p
Single Tip "D"	37p	Double Tip "D"	47p

"S" = Sapphire "D" = Diamond

CARTRIDGES

ACOS	Inc. P.T. each
GP79	£0·63
GP91-18c -1	£1·05
GP91-28c	£1·05
GP91-38c	£1·05
Suitable to replace	
TC8	
GP92	£1·32
GP93-1	£1·24
GP94-1	£1·55
GP94-5	£1·80
GP95	£1·24
GP96	£1·57
ACOS	
104 1-10	£2·09

B.S.R.		Inc. P.T. each
X3M	S/S	£1·50
X3H	S/S	
X5M	S/S	
X5H	S/S	
SX5M	S/S	£2·00
SX5H	S/S	
SX5M	D/S	£2·10
SX5H	D/S	
X4N	D/S	£2·50
GOLDRING		
850		£6·95
G800		£9·35
G800E		£15·00
G800 Super E		£19·50

RONETTE		Inc. P.T. each
105	S/S	90p
106	S/S	99p
DC400	S/S	70p
DC400SC	S/S	70p
105	D/S	£1·11½
106	D/S	£1·11½
DC400	D/S	84p
DC400SC	D/S	84p
SONOTONE		
STA	D/S	£1·35
9TA	D/S	£2·05
9TAHC	D/S	£2·05

EX-RENTAL TV SETS
19 inch B.B.C.2 Sets **£16·50** 23 inch B.B.C.2 sets **£18·50**. Add £5·00 per set for guaranteed working order. Brand new boxed 20 inch K.B. **£55·00**. Carriage £1·00.

SEMICONDUCTORS BRAND NEW MANUFACTURERS MARKINGS NO REMARKED DEVICES

2N388A	63p	SN3704	23p	AF116	25p	BC118	33p	BF115	25p	TIS43	40p
SN697	20p	SN3705	20p	AF117	25p	BC134	58p	BF117	48p		
2N698	25p	SN4061	23p	AF118	60p	BC135	P/A	BF163	35p	**DIODES &**	
SN706	13p	SN4062	23p	AF124	13p	BC136	P/A	BF167	25p	**RECTIFIERS**	
SN706A	13p	SN4286	18p	AF125	20p	BC137	P/A	BF173	33p	1N914	8p
SN930	28p	SN4291	18p	AF126	20p	BC138	P/A	BF178	35p	AA119	10p
SN1132	33p	**RCA**		AF127	18p	BC142	30p	BF179	73p	BA102	23p
SN1303	18p	40253	P/A	AF139	38p	BC143	P/A	BF180	35p	BA115	8p
SN1305	23p	40398	P/A	AF178	45p	BC147	18p	BF181	33p	BA114	13p
SN1306	25p	40458	P/A	AF179	45p	BC148	15p	BF184	25p	BY100	23p
SN1307	25p	AC107	30p	AF180	53p	BC149	18p	BF191	23p	BY126	20p
SN2614	30p	AC117	60p	AF181	43p	BC152	18p	BF195	28p	BY127	23p
SN3826	30p	AC126	20p	AF186	67p	BC158	18p	BF196	43p	BZY88	
SN4905	P/A	AC127	25p	AF239	43p	BC169B	14p	BF197	32p	(Series)	33p
SN4914	P/A	AC128	20p	ASY28	28p	BC169C	15p	BF200	37p	OA5	13p
SN1711	25p	AC176	25p	BA144	P/A	BC171	18p	BF224	30p	OA47	8p
SN2147	73p	AC187	63p	BA145	P/A	BC175	28p	BF225	30p	OA70	8p
SN2160	58p	AC188	38p	BA148	23p	BC183	23p	BF257	47p	OA79	9p
SN2646	58p	ACY17	28p	BA155	P/A	BC184	23p	BFX29	35p	OA71	8p
SN2905	40p	ACY20	25p	BA156	P/A	BC187	29p	BF161	P/A	OA90	8p
SN2926		AD140	40p	BC107	15p	BC213L	27p	BF162	P/A	OA91	8p
Green	14p	AD142	58p	BC108	15p	BCY32	38p	BF163	25p	OA202	10p
Yellow	13p	AD149	58p	BC109	15p	BCY58	23p	BFY19	23p	P/A = price	
Orange	13p	AD161	38p	BC113	28p	BCY70	20p	BFY50	23p	on application	
SN3053	28p	AD162	38p	BC114	38p	BD121	65p	BFY51	23p		
SN3055	75p	AF102	58p	BC115	33p	BD123	83p	BFY52	23p		
SN3392	20p	AF114	25p	BC116	63p	BD124	63p	BSX21	38p		
SN3702	18p	AF115	25p	BC116A	38p	BD131	98p	P346A	25p		

ADD 3p PER ITEM FOR POST & PACKING FOR ORDERS UNDER 24 PIECES

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

BENTLEY ACOUSTIC CORPORATION LTD.

38 CHALCOT ROAD, CHALK FARM, LONDON, N.W.1

THE VALVE SPECIALISTS *Telephone 01-722-9090*

OA2	0·30	6AR6	1·00	6F25	0·54	7H7	0·28	20L1	0·98	85A3	0·40	DF91	0·14
OB2	0·30	6AT6	0·18	6F28	0·60	7R7	0·65	20P1	0·50	90AG	3·38	DF96	0·34
OZ4	0·25	6AU6	0·20	6F32	0·15	7V7	0·25	20P3	0·79	90AV	3·38	DH63	0·27
1A3	0·23	6AV6	0·28	6GH8A	0·50	7Z4	0·50	20P4	0·89	90CG	1·70	DH76	0·28
1A5	0·25	6AW8A	0·54	6GK5	0·50	9BW6	0·50	20P5	1·00	90CV	1·68	DH77	0·18
1A7GT	0·33	6AX4	0·39	6GU7	0·50	9D7	0·78	25A6G	0·29	90C1	0·59	DH81	0·58
1B3GT	0·35	6B8G	0·13	6H6GT	0·15	10C2	0·49	25L6G	0·20	150B2	0·58	DH107	0·90
1D5	0·38	6BA6	0·20	6J5G	0·19	10DE7	0·50	25Y5	0·38	301	1·00	DK32	0·33
1D6	0·48	6BC8	0·50	6J5GT	0·29	10F9	0·45	25Y5G	0·43	302	0·83	DK40	0·55
1FD1	0·33	6BE6	0·21	6J6	0·18	10F18	0·35	25Z4G	0·28	303	0·75	DK91	0·26
1G6	0·30	6BH6	0·43	6J7G	0·24	10LD11	0·53	25Z5	0·40	305	0·83	DK92	0·35
1H5GT	0·33	6BJ6	0·39	6J7GT	0·38	10P13	0·54	25Z6GT	·43	306	0·65	DK96	0·35
1L4	0·13	6BK7A	0·50	6JU8A	0·50	10P14	1·08	30A5	0·44	807	0·59	DL33	0·35
1LD5	0·30	6BQ5	0·22	6K7G	0·10	12A6	0·63	30C1	0·28	1821	0·53	DL92	0·25
1LN5	0·40	6BQ7A	0·38	6K7GT	0·23	12AC6	0·40	30C15	0·60	5702	0·80	DL94	0·32
1N5GT	0·37	6BR7	0·79	6K8G	0·16	12AD6	0·40	30C17	0·77	5763	0·50	DL96	0·35
1R5	0·26	6BR8	0·63	6L1	0·98	12AE6	0·48	30C18	0·60	6060	0·30	DM70	0·30
1S4	0·22	6BS7	1·25	6L6GT	0·39	12AT6	0·23	30F5	0·65	7193	0·53	DM71	0·38
1S5	0·20	6BW6	0·72	6L7	0·38	12AT7	0·16	30FL1	0·60	7475	0·70	DW4/500	
1U4	0·29	6BW7	0·54	6L18	0·44	12AU6	0·21	30FL2	0·60	A1834	1·00		0·38
1U5	0·48	6BZ6	0·31	6L19	1·38	12AU7	0·19	30FL12	0·69	A2134	0·98	DY87/6	0·24
2D21	0·35	6C4	0·28	6LD20	0·48	12AV6	0·28	30FL14	0·68	A3042	0·75	DY802	0·35
2GK5	0·50	6C6	0·19	6N7GT	0·40	12AX7	0·22	30L1	0·29	AC044	1·16	E80F	1·20
3A4	0·25	6C9	0·73	6P28	0·59	12AY7	0·68	30L15	0·58	AC2/PEN		E83F	1·20
3B7	0·25	6C17	0·63	6Q7	0·43	12BA6	0·30	30L17	0·67		0·98	E88CC	0·60
3D6	0·19	6CB6A	0·26	6Q7G	0·27	12BE6	0·30	30P4MR	·95	AC6PEN	·38	E92CC	0·40
3Q4	0·38	6CD6G	1·06	6R7	0·55	12BH7	0·27	30P12	0·69	AC2/PEN/		E180F	0·90
3Q5GT	0·35	6CG8A	0·50	6R7G	0·35	12E1	0·85	30P16	0·30	DD	0·98	E182CC	1·00
3S4	0·25	6CH6	0·38	6SA7GT	·35	12J5GT	0·30	30P19/		AC/PEN(7)		E1148	0·53
3V4	0·32	6CL6	0·43	6SA7	0·35	12J7GT	0·33	30P4	0·58		0·98	EA50	0·18
4CB6	0·50	6CL8A	0·50	6SC7GT	0·33	12K5	0·50	30PL1	0·59	AC/TH1	0·50	EA76	0·88
5CG8	0·50	6CM7	0·50	6SG7GT	·33	12K7GT	·34	30PL13	0·75	AC/TP	0·98	EABC80	·30
5R4GY	0·53	6CU5	0·30	6SH7	0·53	12Q7GT	0·28	30PL14	0·65	AL60	0·78	EAC91	0·38
5V4G	0·34	6CW4	0·63	6SJ7	0·35	12SA7GT	·40	30PL15	0·87	ARP3	0·35	EAF42	0·48
5Y3GT	0·26	6D3	0·38	6SK7GT	·23	12SC7	0·35	35A3	0·48	ATP4	0·12	EB34	0·20
5Z3	0·45	6D6	0·15	6SN7GT	·35	12SG7	0·23	35A5	0·75	AZ1	0·40	EB91	0·10
5Z4G	0·34	6DE7	0·50	6SQ7GT	·38	12SH7	0·15	35D5	0·70	AZ31	0·46	EBC41	0·48
6/30L2	0·55	6DT6A	0·50	6U4GT	0·60	12SJ7	0·23	35L6GT	0·42	AZ41	0·53	EBC81	0·29
6A8G	0·33	6E5	0·35	6U7G	0·53	12SK7	0·24	35W4	0·23	B36	0·33	EBC90	0·18
6AC7	0·15	6EW6	0·55	6V6G	0·17	12SQ7GT	·50	35Z3	0·50	CL33	0·90	EBC91	0·28
6AG5	0·25	6F1	0·59	6V6GT	0·30	13D3	0·45	35Z4GT	0·24	CV6	0·53	EBF80	0·30
6AJ5	0·43	6F6	0·63	6X4	0·20	14H7	0·48	35Z5GT	0·30	CY1C	0·53		
6AK5	0·25	6F6G	0·25	6X5GT	0·25	14S7	0·75	50B5	0·35	CY31	0·31		
6AK6	0·30	6F13	0·33	6Y6G	0·55	19AQ5	0·24	50C5	0·32	D63	0·25		
6AM6	0·17	6F14	0·42	6Y7G	0·63	19G6	0·50	50CD6G	2·17	DAC32	0·33		
6AM8A	0·50	6F15	0·65	7B6	0·58	19H1	2·00	50EH5	0·55	DAF91	0·20		
6AN8	0·49	6F18	0·45	7B7	0·32	20D1	0·49	50L6GT	0·45	DAF96	0·33		
6AQ5	0·22	6F23	0·68	7C6	0·30	20D4	1·05	72	0·33	DD4	0·53		
6AR5	0·30	6F24	0·68	7F8	0·88	20F2	0·65	85A2	0·43	DF33	0·37		

EBF83	0·38	EF183	0·26	HL42DD		PCF806	0·57	PZ30	0·48	UU9	0·40
EBF89	0·27	EF184	0·29		0·50	PCF808	0·68	QQV03/10		UU12	0·22
EBL21	0·60	EFP60	0·50	HN309	1·40	PCH200	0·62		1·20	UY1N	0·50
EC54	0·50	EH90	0·36	HVR2	0·53	PCL82	0·32	QS75/20		UY41	0·38
EC86	0·59	EL32	0·18	HVR2A	0·53	PCL83	0·58		0·63	UY85	0·25
EC88	0·59	EL34	0·44	IW3	0·38	PCL84	0·34	QS95/10		U10	0·45
EC92	0·34	EL35	1·00	IW4/350	·38	PCL805/85			0·49	U12/14	0·38
ECC32	1·50	EL37	0·74	IW4/500	·38		0·40	QS150/15		U16	0·75
ECC33	1·50	EL41	0·53	KT2	0·25	PCL86	0·38		0·63	U17	0·35
ECC40	0·60	EL42	0·53	KT8	1·75	PCL88	0·65	QV04/7	0·63	U18/20	0·75
ECC81	0·16	EL81	0·50	KT41	0·98	PCL800	0·75	R10	0·75	U19	1·73
ECC82	0·19	EL83	0·38	KT44	1·00	PCL801	0·59	R11	0·98	U22	0·39
ECC83	0·22	EL84	0·22	KT63	0·25	PEN4DD		R16	1·75	U25	0·64
ECC84	0·28	EL85	0·40	KT66	0·80		1·38	R17	0·88	U26	0·56
ECC85	0·24	EL86	0·38	KT74	0·63	PEN45DD		R18	0·50	U31	0·30
ECC86	0·40	EL91	0·23	KT76	0·63		0·75	R19	0·30	U33	1·50
ECC88	0·35	EL95	0·32	KT81	2·00	PEN46	0·20	R20	0·56	U35	0·83
ECC189	0·48	EL360	0·49	KTW61	0·63	PEN453DD		R52	0·34	U37	1·75
ECC804	0·55	EM80	0·38	KTW62	0·63		0·98	RK34	0·38	U45	0·78
ECC807	1·70	EM81	0·39	KTW63	0·50	PENA4	0·98	SP42	0·75	U47	0·64
ECF80	0·27	EM83	0·75	M8162	0·63	PEN/DD/		SP61	0·33	U49	0·56
ECF82	0·26	EM84	0·31	MHL4	0·75	4020	0·88	TH4B	0·50	U50	0·26
ECF86	0·64	EM85	1·00	N78	2·05	PFL200	0·52	TH233	0·98	U76	0·24
ECF804	2·10	EM87	0·35	N108	1·40	PL33	0·38	TP2620	0·98	U78	0·20
ECH21	0·63	EY51	0·33	N308	0·95	PL36	0·47	UABC80	·30	U107	0·92
ECH42	0·60	EY81	0·35	N339	0·44	PL38	0·90	UAF42	0·49	U191	0·58
ECH81	0·27	EY83	0·54	N359	0·44	PL81	0·44	UBC41	0·45	U251	0·65
ECH83	0·39	EY84	0·50	P61	0·44	PL81A	0·48	UBC81	0·40	U281	0·40
ECH84	0·34	EY87/6	0·30	PABC80	·33	PL82	0·30	UBF80	0·30	U282	0·40
ECL80	0·30	EY88	0·40	PC86	0·47	PL83	0·32	UBF89	0·30	U301	0·40
ECL82	0·30	EY91	0·53	PC88	0·47	PL84	0·30	UBL21	0·55	U403	0·33
ECL83	0·52	EZ35	0·25	PC95	0·53	PL302	0·58	UC92	0·35	U404	0·38
ECL84	0·54	EZ40	0·40	PC97	0·36	PL504/500		UCC84	0·33	U801	0·93
ECL85	0·54	EZ41	0·42	PC900	0·32		0·62	UCC85	0·34	U4020	0·38
ECL86	0·35	EZ80	0·21	PCC84	0·29	PL505	1·30	UCF80	0·33	VP13C	0·35
EE80	0·60	EZ81	0·22	PCC85	0·26	PL508	0·90	UCH21	0·60	VP23	0·40
EF22	0·63	EZ90	0·20	PCC88	0·41	PL509	1·30	UCH42	0·60	VP41	0·38
EF40	0·49	FW4/500		PCC89	0·45	PL802	0·75	UCH81	0·30	VT61A	0·35
EF41	0·58		0·75	PCC189	0·48	PM84	0·34	UCL82	0·33	VU111	0·44
EF42	0·33	FW4/800		PCC805	0·58	PX4	1·16	UCL83	0·48	VU120	0·60
EF54	0·98		0·75	PCC806	0·67	PX25	0·98	UF41	0·50	VU120A	·60
EF73	0·75	GZ30	0·34	PCF80	0·28	PY33/2	0·50	UF42	0·60	VU133	0·35
EF80	0·22	GZ32	0·41	PCF82	0·30	PY80	0·33	UF80	0·35	W76	0·34
EF83	0·48	GZ33	0·70	PCF84	0·40	PY81	0·24	UF85	0·34	W107	0·50
EF85	0·26	GZ34	0·48	PCF86	0·44	PY82	0·24	UF86	0·63	W729	0·60
EF86	0·29	GZ37	0·67	PCF87	0·77	PY83	0·26	UF89	0·27	X41	0·50
EF89	0·23	HABC80	·44	PCF200	0·67	PY88	0·32	UL41	0·54	X63	0·33
EF91	0·17	HL23DD		PCF800	0·60	PY301	0·58	UL84	0·31	XE3	5·00
EF92	0·35		0·40	PCF801	0·29	PY500	0·95	UM80	0·33	XH/1·5	·48
EF97	0·55	HL41DD		PCF802	0·40	PY800	0·33	UR1C	0·53	Z329	0·65
EF98	0·65		0·98	PCF805	0·60	PY801	0·33	UU5	0·38	Z749	0·68

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1S5	·21	DF91	·14	EF89	·24	PCL86	·37
1T4	·14	DF96	·35	EF91	·12	PFL200	·51
3S4	·24	DK91	·25	EF92	·30	PL36	·47
3V4	·37	DK92	·35	EF183	·26	PL81	·43
5Y3GT	·25	DK96	·36	EF184	·28	PL82	·29
6/30L2	·53	DL92	·24	EL33	·54	PL83	·31
6AQ5	·21	DL94	·37	EL84	·22	PL84	·29
6BW7	·50	DL96	·36	EY51	·30	PL500	·61
6F1	·57	DY86	·23	EY86	·28	PL504	·61
6F23	·67	DY87	·23	EZ80	·20	PY81	·23
6F25	·51	DY802	·30	EZ81	·21	PY82	·24
6SN7GT	·28	EABC80	·30	KT61	·54	PY800	·32
25L6GT	·18	EB91	·9	KT66	·75	PY801	·32
30C15	·56	EBC33	·38	N78	·85	R19	·29
30C17	·75	EBF89	·27	PC86	·45	U25	·63
30C18	·59	ECC81	·15	PC88	·45	U26	·55
30F5	·63	ECC82	·18	PC900	·30	U191	·57
30FL1	·59	ECC83	·21	PCC84	·28	U251	·63
30FL14	·67	ECF80	·26	PCC89	·43	U329	·65
30L15	·56	ECF82	·26	PCC189	·47	U801	·78
30L17	·66	ECH35	·27	PCF80	·27	UBF89	·29
30P4	·56	ECH81	·26	PCF86	·43	UCC85	·34
30P19	·56	ECL80	·29	PCF801	·27	UCH81	·30
30PL1	·59	ECL82	·29	PCF802	·38	UCL82	·31
30PL13	·73	ECL86	·34	PCF805	·59	UF89	·28
30PL14	·63	EF39	·36	PCL82	·30	UL84	·29
DAF91	·21	EF80	·22	PCL83	·55	UY85	·24
DAF96	·35	EF85	·26	PCL84	·33	Z77	·18

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TELEVISION

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SERVICING · CONSTRUCTION · COLOUR · DEVELOPMENTS

FEBRUARY 1972

ANOTHER CORNER?

IN this industry the heart sometimes seems to rule the head. For years many people willed that colour television should be started. Events have proved that it was perhaps wise to wait, but of one thing we can be sure—that the phrase "colour TV is just around the corner", optimistically coined a good few years before the actual fruition of the dream, at one time seemed to be about to pass into folk legend. It was at any rate one of the most elusive corners we ever encountered.

Just now we seem to have another corner on our hands—and around this one is lurking the domestic video recorder. This particular piece of equipment has perhaps rather unkindly been called the greatest non-product in the history of home entertainment, and there is some justification for this epithet (no, we did not say epitaph!).

Since those rather crude whirring devices with a frequency response put optimistically at around 1 MHz which were unsuccessfully launched (it seems) back in prehistoric times developments have certainly accelerated and there are some splendid end-products to prove this. If we set aside the controversies about the non-compatibility of the various competing systems—regular readers will know our views on all this anyway—what are we left with?

Basically a good deal of verbiage, revolving around the great "revolution" about to break out on the domestic front. Lovely vistas have been built up of Mr. Man-in-the-Street sitting at home re-running celebrated films, sports events and recordings of his favourite TV programmes. "The biggest thing since television" it has been enthused. Yet what have we in the way of viable products? A number of competing (and of course non-compatible) audio-visual equipments suitable for educational and commercial use, but on the home front nothing much that looks like proving an economic (or even feasible) proposition for the average viewer.

Philips have promised a home videocassette recorder by the end of this year, but the hardware will cost over £300 (at 1971 prices) and the software in the region of £15 for a 60-minute cassette. A company spokesman has envisaged a sale of 2·5 million models by 1980. To us at this point in time this seems to be expecting rather too much.

W. N. STEVENS, *Editor*

THIS MONTH

THE NEXT ISSUE DATED MARCH WILL BE PUBLISHED FEBRUARY 21

TELETOPICS

BEAB TO TEST TV SETS

The British Electrotechnical Approvals Board for Household Equipment (previously the British Electrical Approvals Board) is to start a testing and approvals programme for TV sets, starting with monochrome sets with screen sizes not less than 17in. The scheme will eventually cover all domestic sound and vision equipment. Monochrome TV sets will be tested to the requirements of the revised edition of BS415 and the first sets to gain approval and the right to carry the BEAB mark will be announced next August.

ITA BACKS COMPUTERS

In its latest annual report the ITA says that the application of general-purpose computers to the operation and control of large television transmitter networks is being intensively studied by its engineering staff: the aim is to apply computers to automatic monitoring and the general improvement of information flow within the organisation, though the ITA stresses that it intends to continue visual monitoring—in part because there are aspects of picture quality that are not yet defined closely enough to make them amenable to automatic measuring techniques. Considerable progress is reported in the recovery of weak signals from distant transmitting stations which need to be monitored from a regional centre. Such signals are normally heavily impaired by random noise and co-channel interference. Computer processing of these signals would enable unattended stations to be monitored without the need for additional plant at the remote station. The experimental system assembled in the Authority's laboratories is we understand being field tested to check operator reaction as well as the technical operation of the system.

THE TRADE SCENE

With colour licenses up to 946,361 at the end of September, a jump of 200,000 in three months, the colour set boom looks well established. RBM who two years ago estimated sales of colour sets during 1972 at 600,000 are now predicting sales of twice this figure. They say that if deliveries continue at the present monthly rate total monchrome plus colour set sales will reach 5 million this year. Hitachi have surveyed the market for portable sets in the UK and suggest sales of 250-300,000 this year, twice last year's figure. The survey found that last year one third of the sales of portables were for replacement purposes and two thirds were for use as second sets. To command a sizeable share of the market they say that a set must have a screen size of 12in. or more. Some recent figures from the Department of Trade and Industry throw an interesting sidelight on the boom: apparently retailers are at last beginning to increase their share of the market, with a slight drop in the percentage of total business done by the rental specialists. With this trade boom and announcements by setmakers of component shortages we wonder why BREMA felt it necessary to send a deputation recently to see the Minister of Aerospace—who is responsible for the electronics industry—in an attempt to have quotas on colour set imports from Japan introduced.

Those Pye dealers who were asked recently to vote for or against the maintenance of recommended prices voted overwhelmingly for their retention. 77% of the dealers replied, with 76% of replies in favour of recommended prices and 24% against. Pye say they will therefore be continuing their policy of suggesting recommended prices but will review the position from time to time in the light of changing retail conditions.

BREMA announce that at present 18% of setmakers' output consists of dual-standard sets and that this is expected to fall to 10% by the end of the year. ITT and GEC have already given up producing dual-standard sets but GEC say they could re-enter the market if the position warrants it.

TRANSMITTER NEWS

BBC-1 on u.h.f. is now being transmitted from the **Malvern** (channel 56, aerial group D with vertical polarisation) and **Fenton** (channel 31, aerial group A with vertical polarisation) relay stations. In addition the BBC-Wales service from **Kilvey Hill** (Swansea) is now in operation on channel 33 (aerial group A with vertical polarisation).

IS THAT DECOUPLER REALLY LEAKY?

Rank-Bush-Murphy report that dealers are returning to them as faulty some of the small $0{\cdot}1\mu F$ capacitors used in their single-standard colour chassis as decouplers associated with the intercarrier sound i.c. but that most of them have been found to be OK when tested at their Chiswick laboratory. The capacitors are semiconductor low-voltage ceramic disc types and the basic difference between them and conventional ceramic disc types is the barrier-layer dielectric which gives very small size (capacitances as much as 100 times greater than those obtained with normal disc ceramic capacitors can, for a given size, be achieved). The main electrical difference is that they exhibit a much lower leakage resistance. They are intended therefore primarily as a.f. bypass and coupling capacitors in low-impedance transistor circuits where size is of importance. The leakage resistance falls markedly with increase in applied voltage and is quoted therefore for the capacitor's rated voltage. It is assumed that dealers have returned these capacitors because of the comparatively low resistance readings obtained when measurements have been made using an Avo or similar ohmmeter.

NEW VIDICON FROM MULLARD

A new inexpensive miniature vidicon television camera tube announced by Mullard has a resolution of 550 TV lines—more than adequate for a high-quality picture. This resolution has been achieved by fitting the tube—type 20PE13—with a separate mesh. Electromagnetic focusing and scanning are used. The 20PE13 requires a heater supply of 6·3V at 95mA. When subject to an illumination of 10 lux from a lamp with a colour temperature of 2854K it has a signal current of 150nA. Its dark current is 20nA.

The new vidicon is designed for use in small inexpensive cameras for closed-circuit television systems. Its small size—17·70mm. in diameter and 108mm. long—makes it particularly suitable for use in cameras that have to be hidden, as in the security systems of banks etc. The 20PE13 can be supplied complete with yoke assembly and socket for £26·25 or the individual components can be ordered separately.

DO-IT-YOURSELF AERIAL

Antiference have introduced a TV aerial kit for the do-it-yourself enthusiast. The kit consists of a 10-element array in two sections, mounting arm and bracket, coaxial output box, 6ft. flylead, cable guards, clips, wall plugs and screws. The kit costs £4 and comes complete with assembly instructions. There are group A, B and C/D versions. Antiference Ltd., Aylesbury, Bucks.

THE VIDEO RECORDING FRONT

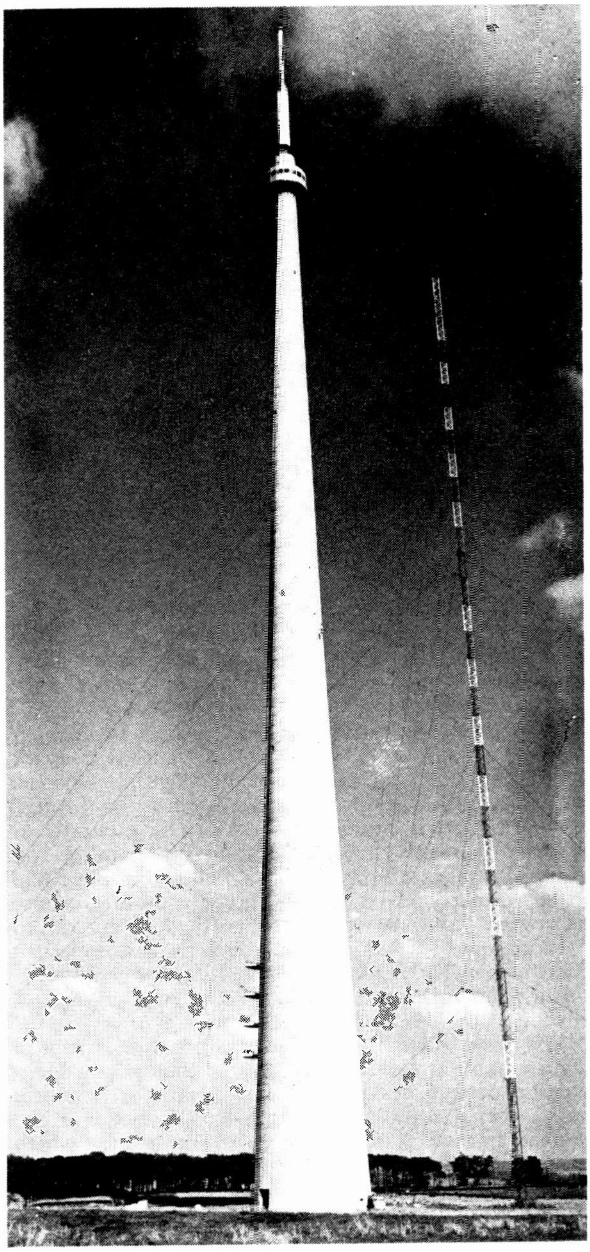
An aggreement between Sony and 3M has been announced. 3M are to manufacture Sony's ¾in. U-Matic videocassette equipment and Sony are to produce 3M's new high-energy magnetic tape which uses a cobalt-energised iron oxide formula giving improved signal-to-noise performance.

Decca announce that they hope to market their Teldec Videodisc players in 1973-4 at about £70 (monochrome) and £150 (colour) before tax.

The introduction of Ampex's Instavideo cartridge videotape recorders/players has been delayed—prototypes were expected to have been on show in London last October. An official announcement says the system "is being held in the US for further development". In common with other systems it is understood that difficulty is being experienced in meeting new rulings from the US FCC.

ITA's CONCRETE TOWER

The ITA is justly proud of its new aerial-support tower at Emley Moor in Yorkshire, being the first self-supporting concrete tower ever to be built for television broadcasting in the UK. Some statistics: the concrete section is 900ft. high and has a base diameter of 80ft. tapering to 20ft. at the top; above this are triangular lattice steel sections carrying the transmitting aerials, covered by glass-reinforced-



plastics—bringing the total height to 1,080ft.; the total weight of the tower and its foundations exceeds 15,000 tons. The tower was built to replace the tubular steel mast which collapsed on March 19th, 1969. Work on the new tower began in the summer of 1969. A unique feature of the construction was the lifting—in a week-long operation—of the entire steel section with the u.h.f. aerials in position (a weight of about 60 tons) up through the centre of the tower.

The new aerials and increased transmission power have resulted in a significant improvement in the pictures received by viewers. The change from the temporary low mast brought almost another 1¼ million viewers within reach of Yorkshire Television's 625-line colour and black-and-white programmes. This improvement in coverage also applies to the BBC-1 and BBC-2 u.h.f. services from Emley Moor which also use aerials on the new tower.

TV TEST REPORT

E. M. BRISTOL

THE EAGLE KHP30 EHT PROBE

AN accurate and easy-to-use means of reading e.h.t. has always been a necessary item of workshop equipment and now that colour receivers are finding their way into the workshop in increasing numbers it is more essential than ever as a colour set's e.h.t. must be adjusted exactly and many fault conditions must be investigated by first of all checking the e.h.t.

The majority of devices hitherto available fall into three main categories. First there are the test probes designed to work in conjunction with a normal meter. These are quite reasonably priced and accurate but are designed for a particular meter sensitivity. Convenience of use is not a strong point as leads must be changed and the meter switched. Also they are fairly bulky. And the meter is tied up when it may be needed for making simultaneous measurements—say of the boost voltage.

A self-contained instrument is more convenient but accurate e.h.t. meters are not cheap, some being around the £20 mark. Although this is not a great sum for a professional workshop it is enough to make the enthusiast think twice.

As a result there has also been a crop of cheaper devices consisting in the main of calibrated spark gaps. Discharge has either been through air between two electrodes and visible to the operator or through a neon lamp via limiting resistors. The accuracy of these instruments depends among other things on atmospheric conditions so that small errors have had to be accepted. Even so they served a useful purpose as general e.h.t. testers in the early days of valved monochrome TV sets. With modern transistor circuits however any sudden violent surge as a result of inducing a deliberate spark discharge can have disastrous effects on the line output transistor.

The Eagle KHP30 is a self-contained e.h.t. meter at a reasonable price. It is no bigger than many high-voltage probes designed to work with an external meter, being only 14in. long and 2in. wide at the thickest part. It is housed in a grey plastic case which is claimed to be strong and impact resistant.

Contact with the e.h.t. source is made by means of an exposed 1¼in. long metal spike. This is followed by a tapered barrel some 5½in. long and ¾in. thick at the widest point. Then comes the spark trap and the body which houses the meter and serves as a handle. The meter is set at a slight angle from the horizontal, enabling it to be read easily from the rear. It is clearly calibrated 0-30kV d.c. in 1kV divisions with a red mark at the 25kV point. The needle is edge-type and coloured red. A zeroing screw is flush-mounted just below the meter scale.

The handle part tapers back and is of half-round section, the outer surface being slightly crinkle-finished to give a non-slip grip. The earth return is by means of a plastic lead permanently wired into the end of the instrument. This is some 3ft. long and terminated by an insulated crocodile-clip.

The Eagle KHP30 high-voltage test probe.

Our first concern was the accuracy of the instrument which is claimed to be within 3%. As no other e.h.t. meter of sufficient accuracy to provide a standard of comparison was to hand a new colour receiver was used to check the meter. First of all the set was carefully set up and its boost voltage adjusted to the maker's figure. Under these conditions the e.h.t. should be exactly 25kV. A measurement was taken with the probe and indeed it read spot on the 25kV mark. A check was then made at the low end of the scale by measuring the boost voltage of another receiver which was adjusted to 800V. This should give a reading on the probe of just below the first 1kV division. It was rather lower than expected although over the halfway point. It is perhaps asking a lot for an accurate reading as low as this—all meters are at their least accurate at the low end of the scale. Even so it wasn't very far out.

Experience with monochrome receivers with a wide range of e.h.t.s over the several months the instrument was on test in the workshop indicated that the readings were consistently spot on over the important part of the scale, from 10 to 25kV.

The Probe in Use

The current taken from the source is low. The meter has a sensitivity of 20kΩ/V and so takes 50μA for a full-scale reading, the load being 600MΩ. There should therefore be no observable voltage drop as a result of the connection of the probe. As a result the probe is very docile in use: approaching and touching the e.h.t. point does not cause a fierce spark or crack. In fact because of this there is a danger of misleading readings: if the probe is inserted under an e.h.t. cap but does not touch the metal connector there will be an e.h.t. discharge to the probe and a reading several kV lower than the full e.h.t. value will be obtained. Because there is no sound or fuss from this small discharge—not even splashes on the picture if one is being received—the operator may be unaware that the probe is not in actual contact with the connector. The rule when probing under the plastic e.h.t. cap should therefore be to push the probe well in until you *feel* that contact has been made. Do not rely just on the fact that a reading has come up on the meter.

How then does the instrument handle in use? In most cases very easily. The probe can be guided home and the meter read all in one action without, as is the case with a probe and separate meter, having to divert attention. The spike slides easily under the e.h.t. flap once the edge has been lifted and is just the right length to make contact with the connector in the centre. The barrel is long enough in most cases to get between the panels and receiver hardware and the c.r.t. flare. Some sets are rather awkward to get at but this would be so with any test instrument.

Altogether then I can enthusiastically recommend this probe as a well designed and worthwhile addition to any TV repair workshop, outside engineer's kit or home experimenter's outfit. It is packed in a solid polystyrene container with contoured well for the instrument and this can be used to house the probe when not in use. The retail price is £10·40 which is subject to the normal trade discounts.

a look at Imported SETS.....

SANYO 10-T120U mains/battery portable

H. K. HILLS

CONTINUING our series in which we take a close look at the circuitry used in imported sets the spotlight this month is turned on the Sanyo 10in. mains/battery portable Model 10-T120U. The same basic chassis is also used in the **Alba** Model T10 Starlight. The set can be operated from 240V a.c. mains—via a double-wound transformer—or a 12V battery, a four-transistor voltage regulator circuit providing a 10·7V stabilised l.t. line on both systems. Other features include a two-stage noise-cancelled sync separator circuit, a gated a.g.c. circuit with delayed line to the tuner and a line output stage in the emitter-follower mode which also provides a 9·5kV e.h.t. supply, a 100V supply for the video output stage and a separate h.t. supply for the tube first anode and focus circuits and the brightness control.

Line Output Stage

We will take a look at the line output stage first since it is involved with so many other sections of the receiver and is representative of the arrangements found in many other small-screen portables. In some ways transistor line timebase circuits are comparable with valve circuits though in other respects they differ widely. As is usually the case a three-transistor circuit is employed, with a blocking oscillator line generator (Q117, 2SC536), driver stage (Q118) which is really a pulse amplifier and output transistor (Q119). The circuitry around the latter two stages is shown in Fig. 1 and it will be seen that both transistors are pnp types with their collectors returned to chassis. The high-amplitude output from the line oscillator alternately drives Q118 from cut-off to saturation so that the output from the driver is the rectangular waveform required for operating the output transistor Q119 as a switch, "on" during the latter part of the forward sweep and "off" during flyback and the first part of the forward sweep. As the output transformer and scan coils present a highly inductive load to the output transistor, switching in a d.c. voltage in this way produces a rising current that closely approximates the required sawtooth rise during the forward scan (with a purely resistive load the current waveform is of course a replica of the applied voltage waveform).

With valve circuits the current from the line output pentode provides beam deflection from about screen centre to the right-hand edge of the screen, current via the boost diode providing the forward scan at the left-hand side of the screen. The transition is of course gradual, with considerable overlap towards the centre, but the total current rate-of-change remains substantially the same throughout the forward scan. In solid-state line output stages a broadly similar action occurs but with the difference that while valves can conduct in one direction only a switched on transistor can conduct in both directions so that when used for line output they can also function—within certain limits—as the reclaim or efficiency rectifier. In practice however a damping diode is always used with transistor line output stages since this greatly reduces the power dissipation of the transistor and linearises the scan.

Deflection Current

Starting with the spot in the centre of a line—when the scan coil current is instantaneously zero—current then flows with a linear rate-of-change through Q119, building a strong magnetic field around the scan coils (L109). The peak current reached at the screen edge is terminated by the arrival of the next pulse to reverse bias Q119, the sudden cessation of current in Q119 inducing a high reverse voltage which charges C613, C621 and C622—the total value of these capacitors determining the flyback duration. The start of the next sweep is produced by the reverse current which flows mainly through the damper diode D10, maintaining a current in the deflection coils which *decreases* with linear rate-of-change until the spot is at the centre of the line when the current direction is reversed as the

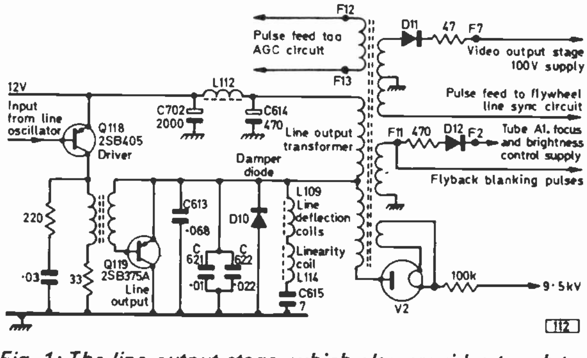


Fig. 1: The line output stage, which also provides two h.t. and three pulse feeds. There is no fixed forward bias to the line output transistor Q119: it is simply driven to saturation by the high-amplitude negative-going pulses transformer coupled from the driver Q118 to its base. The damper diode D10 fulfils a similar function to the efficiency diode used in a valve stage but without providing a boost h.t. supply.

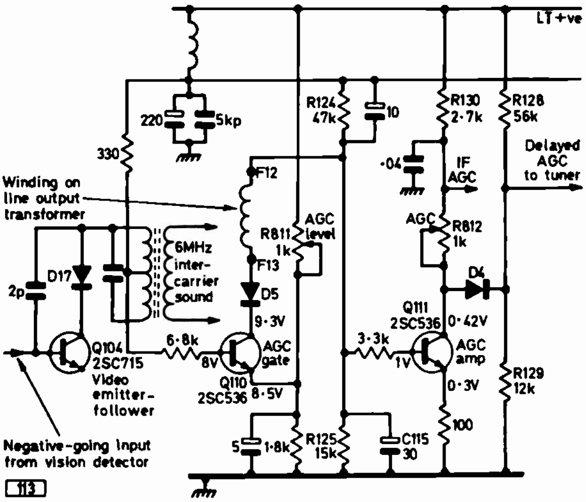


Fig. 2: The gated a.g.c. circuit. The gating transistor Q110 conducts only when positive-going line flyback pulses appear at its collector, its degree of conduction being determined by the amplitude of the tips of the sync pulses in the video signal applied to its base.

output transistor is switched on once more. Width is adjustable by disconnecting C621 and/or C622 from the circuit: this reduces the flyback time and increases the e.h.t.

Transistors cannot of course cope with the high peak voltages that valves are subjected to in line output stages and two methods are employed to prevent the instantaneous flyback voltage rising to too high a value. These are (a) third harmonic tuning of the output transformer—as in valve circuits—and (b) increasing the flyback time since for any given inductor the reverse e.m.f. generated is directly dependent on the rapidity of the current change, i.e. e.m.f. $= -L(di/dt)$.

Supply Filtering

Line linearity is achieved by including L114 and C615 in series with the scan coils. The pi filter C702/L112/C614 in series with the 12V supply to the line output stage prevents line frequency components reaching other stages operated from the same l.t. rail. In valve receivers it is common to find several h.t. rails, each individually *RC* decoupled, but with portables which must operate from a single 12V supply it is essential to have low-resistance filtering to isolate the various circuits—hence the choke and high-value electrolytics and also the r.f. chokes between the feed points on the l.t. rail to the i.f. and other sections of the receiver.

Gated AGC Circuit

The a.g.c. circuit is gated by pulses taken from terminals F12 and F13 on the line output transformer. The complete a.g.c. circuit is shown in Fig. 2 and as the gain-controlled transistors are npn types with their emitters taken to chassis the positive a.g.c. potential applied to their bases must increase with rising signal strength for forward a.g.c. action to take place. The a.g.c. gate Q110 is normally reverse biased since R811 is set for an emitter voltage of 8·5V which is above the 8V at the base—this latter voltage being determined by the voltage at the signal take-off point which is the 6MHz intercarrier sound i.f. transformer connected in the collector lead of the video emitter-follower Q104. The signal polarity at the take-off point is positive-going with the sync pulses the most positive parts of the waveform. The positive-going sync pulses at Q110 base coincide with the positive-going gating pulses from the winding on the line output transformer connected in Q110's collector lead and result in bursts of current through this transistor. As the line pulses are of constant amplitude these bursts of current depend entirely on the amplitude—which is a measure of the true signal strength—of the sync pulses. The a.g.c. amplifier Q111 is forward biased by the potential divider R124/R125 and as the pulses of current through Q110 also flow to this point the mean potential across C115 is lowered and the forward bias to Q111 reduced. Q111's collector current thus falls and its collector voltage increases due to the reduced voltage drop across R130 and R812. The forward bias to the first vision i.f. stage is taken from the junction of these two resistors and the action therefore leads to increased collector current in this stage and reduced gain through forward a.g.c. action.

Delayed AGC Feed

The u.h.f. tuner used in this receiver incorporates a transistor r.f. amplifier and oscillator, a diode mixer and transistor i.f. preamplifier stage to which a.g.c. is applied in the following manner. The forward bias to the i.f. preamplifier is taken from the potential divider R128/R129, the values of these resistors being such that the voltage at their junction is 1·1V on weak signals. As the collector voltage of Q111 is less than this D4 is reverse biased. If the signal strength increases sufficiently however the collector voltage of Q111 will rise above 1·1V and D4 will conduct. The increased current through R129 will then increase the base potential of the i.f. preamplifier stage and forward a.g.c. action will commence. The signal level at which a.g.c. is applied to the i.f. preamplifier can be varied by adjusting R812. This is a factory preset adjustment and should not normally require readjustment: following transistor replacement however it should be adjusted to give a voltage of 0·4-0·5V at the emitter of the first vision i.f. stage (test point TP-B).

Noise-cancelled Sync Separator

The only real disadvantage with negatively modulated transmissions is that random noise pulses are in the same phase as and are comparable to the sync pulses —since both are high-amplitude spikes with fast rise

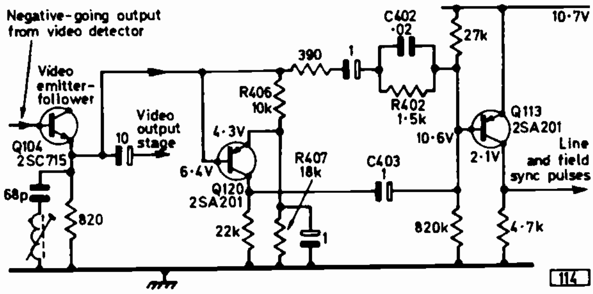


Fig. 3: The noise-gated sync separator circuit. Both transistors are fed with the video signal: Q120 produces cancelling pulses in the presence of high-amplitude noise.

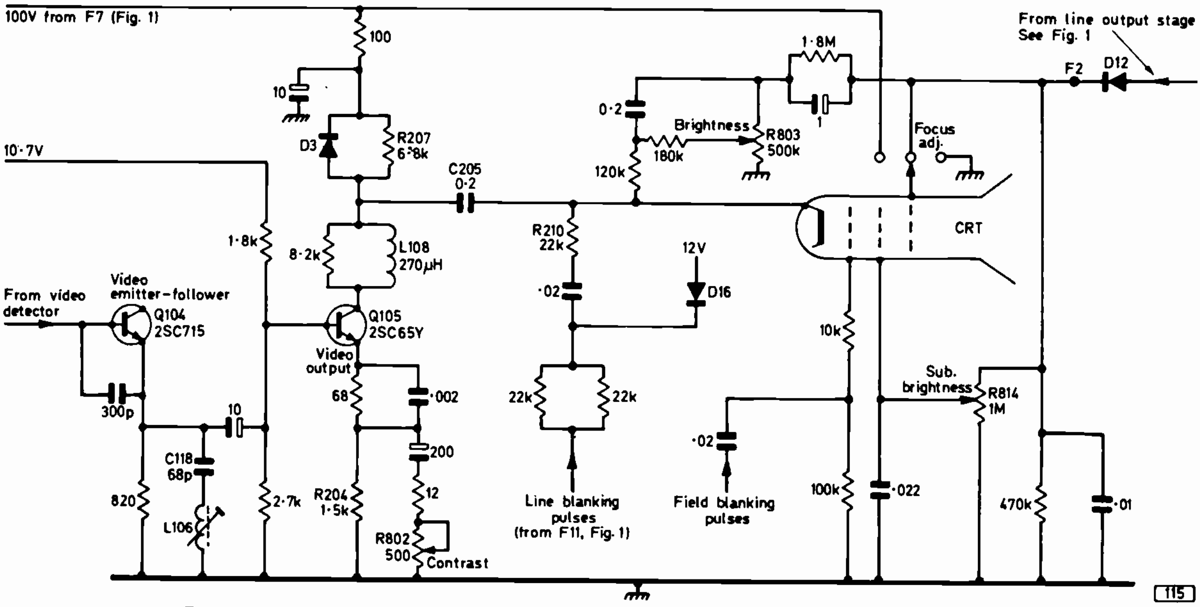


Fig. 4: The video circuitry: the vision signal is a.c. coupled to the cathode of the c.r.t.

times. Particularly in colour receivers and portables—because of the low-gain pull-out aerials generally used with the latter—it is beneficial to use a noise-gated or noise-limited sync separator circuit so that even severe noise pulses do not affect the timebase synchronisation. In this receiver a noise-gated cancelling system is used. The circuit is shown in Fig. 3 and consists of the noise-canceller transistor Q120 and the sync separator Q113. Both transistors are fed from the video emitter-follower Q104 and as this transistor receives a negative-going signal from the vision detector the output at its emitter will be in the same phase. Q120 and Q113 are both pnp types with their collectors taken to chassis. Thus a negative-going drive to their base is required to instigate collector current. Q113 functions in the conventional manner, being cut off during picture information but conducting heavily during the sync pulse periods. Q120 on the other hand is heavily reverse biased as its emitter is fed from the junction of the potential divider R406/R407 which sets its emitter voltage at 4·3V while its base voltage, from Q104 emitter, is 6·4V. The base-emitter junction of Q120 is thus reverse biased by 2·1V so that even though the sync pulses in the composite video feed are of considerable amplitude Q120 normally remains cut off. The circuit values however are such that high-value noise pulses exceeding the pulse tip value make Q120 conduct. The simultaneous increase in Q120's collector voltage from the zero (chassis) value is then applied via C403 to the base of the sync separator. As this pulse is positive-going it cancels the negative-going noise pulse in the video feed to Q113's base and thus gives the noise-cancelling action. In addition to this cancellation of high-amplitude noise pulses attenuation of noise at all levels is effected by the time-constant of the network C402/R402 in the base feed to Q113.

Video Circuitry

No receiver review would be complete without a look at the video circuitry, particularly as in solid-state receivers this differs so much from model to model. The circuit is shown in Fig. 4 and following general practice the output transistor Q105 is driven by an emitter-follower stage Q104 in order to prevent the input capacitance of Q105, magnified by this transistor being in the common-emitter mode, swamping the vision detector load. C118 and L106 form an acceptor wavetrap tuned to 6MHz to remove the intercarrier signal from the video feed. The 100V supply for the collector of Q105 is taken from terminal F7 on the line output transformer assembly but for maximum d.c. stability its base forward bias is taken from the stabilised 10·7V l.t. rail. The video signal is capacitively coupled by C205 to the cathode of the c.r.t., D3 protecting Q105 from flashovers in the tube and L108 providing h.f. boost.

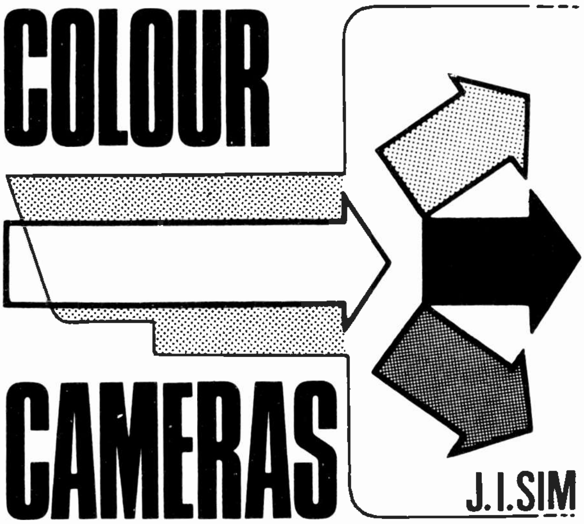
As is normal in small-screen portables contrast control is effected by means of a variable resistor (R802) in the emitter circuit of the video output transistor: this varies the degree of negative feedback developed across the main emitter resistor without affecting the d.c. conditions of the stage. Increasing the resistance of R802 increases the feedback developed and decreases the video gain. Control of brilliance is effected by varying the c.r.t. cathode potential (R803)—raising the voltage decreases the brightness—while a subsidiary brightness control R814 presets the first anode voltage.

Flyback Blanking

Negative-going field flyback pulses are applied to the c.r.t. grid while positive-going line flyback pulses are applied to its cathode via a stand-off resistor (R210) to minimise capacitive loading. Applying the flyback blanking pulses to separate c.r.t. electrodes in this manner prevents the line pulses reaching the field timebase circuit via the pulse feeds and possibly causing line pairing.

All told this Sanyo receiver is a compact, high-gain model with several commendable features. The printed panels and transformers can be easily removed and the construction generally facilitates service work when required.

COLOUR CAMERAS



J. I. SIM

THE heart of any camera is the camera tube. This is especially true of a colour camera in which at least three tubes must be used to obtain the necessary Red (R), Green (G) and Blue (B) information from the scene.

The first generation of colour cameras used 3in. image orthicon camera tubes or a combination of image orthicons and vidicons. Both arrangements have great disadvantages: any camera using more than one image orthicon must be very large and cumbersome—not the thing for moving delicately and artistically around the studio floor. Vidicons could be used but these are not considered suitable for rapidly moving subjects because of "lag" (i.e. retention of an image on the target after the image has moved). The vidicon also has an uneven dark current: that is with no light falling on the tube the current which flows in the tube is not linear over a line or field period. This could be tolerable if each vidicon tube had the same characteristic—but unfortunately they don't.

Both these vidicon defects are tolerable in monochrome television and the tube has an established place in small studios such as those used for regional news. In colour however the lag shows up as a coloured smear on the picture and uneven dark currents between tubes lead to tinted backgrounds.

Because of these defects Philips undertook development of a camera tube especially for colour television. The result, introduced early in the 1960s, was the Plumbicon tube. This uses a lead-based target—as the name suggests—but is otherwise very similar to the vidicon in construction. It works on similar principles as it is also a photoconductive type of tube. The tube's characteristics are somewhat different however in that the Plumbicon has very much less lag than the vidicon and has a dark current which is very even and which is reproducible between tubes. Physically the standard sized Plumbicon is a little longer and a little larger than the 1in. diameter vidicon.

By using the Plumbicon either a three- or four-tube colour camera can be built that is little larger than the 4½in. image orthicon cameras which have been used for many years for monochrome productions.

Three- and Four-Tube Cameras

In the three-tube colour camera each tube produces the signal equivalent to one of the primary colours—red, green and blue. These are the only essentials required because the luminance (Y) signal can be matrixed from these three primaries. There is however some advantage in using a fourth tube in the camera to produce the luminance signal directly.

There are a number of arguments in favour of both systems. To analyse these completely would cover the pages of this issue of TELEVISION, so we will simply put down the more important aspects:

Sensitivity: Under the low and variable light conditions often found in outside broadcast work the three-tube arrangement has the advantage—the available light being shared between fewer tubes. In studio work the differences are insignificant.

Monochrome reproduction: It would be expected that the four-tube camera has the advantage here because the luminance signal is obtained directly. In fact because corrections have to be made to this signal to achieve a compromise between the different values of gamma for a monochrome and a colour c.r.t. the resultant is no better than with the three-tube camera.

Registration (i.e. the convergence of the camera tubes and their scans): The three-tube camera is undoubtedly easier to register and this can usually be done more accurately. In a four-tube camera however the high-frequency information comes from the luminance channel (each of the three chrominance channels being bandwidth restricted to 1MHz). Most of the misregistration errors are therefore less noticeable.

Dimensions and running costs: A three-tube camera contains less items but as the size and weight of a camera are determined more by the lens system and the viewfinder the differences between three- and four-tube cameras are insignificant. On costs whereas there is less equipment to go wrong in the three-tube camera the condition of a four-tube camera can be allowed to deteriorate more before replacements are necessary to give the required performance.

As can be seen the arguments for and against both types of camera are hardly conclusive and the first purchases of camera channels by the broadcasting authorities showed little favouritism for one type or the other. As a compromise between three- and four-tube operation, particularly between sensitivity and convergence (registration) requirements, the major manufacturers have now turned to three-tube formats using red, blue and luminance or white. The sensitivity is then basically that of a three-tube camera but the registration is as tolerant as the four-tube arrangement.

As we must keep this article uncomplicated only the RGB three-tube camera will be looked at. The same principles are used in the four-tube camera and other versions of the three-tube format although there are some specialised differences.

Colour Camera Block Diagram

Figure 1 shows a simplified block diagram of an RGB three-tube colour camera. It is in two basic physical blocks—the camera itself on the studio floor, mounted on a tripod or pedestal, and the camera control unit fitted in the engineering area of the studio. Coupling the two blocks is the camera cable.

The video paths are fairly straightforward and are repeated for each channel—red, green and blue. The very small signal from the individual Plumbicon target (about $0{\cdot}3\mu$A peak signal current) passes to the head amplifier which determines to a great extent the overall signal-to-noise ratio of the camera channel. This

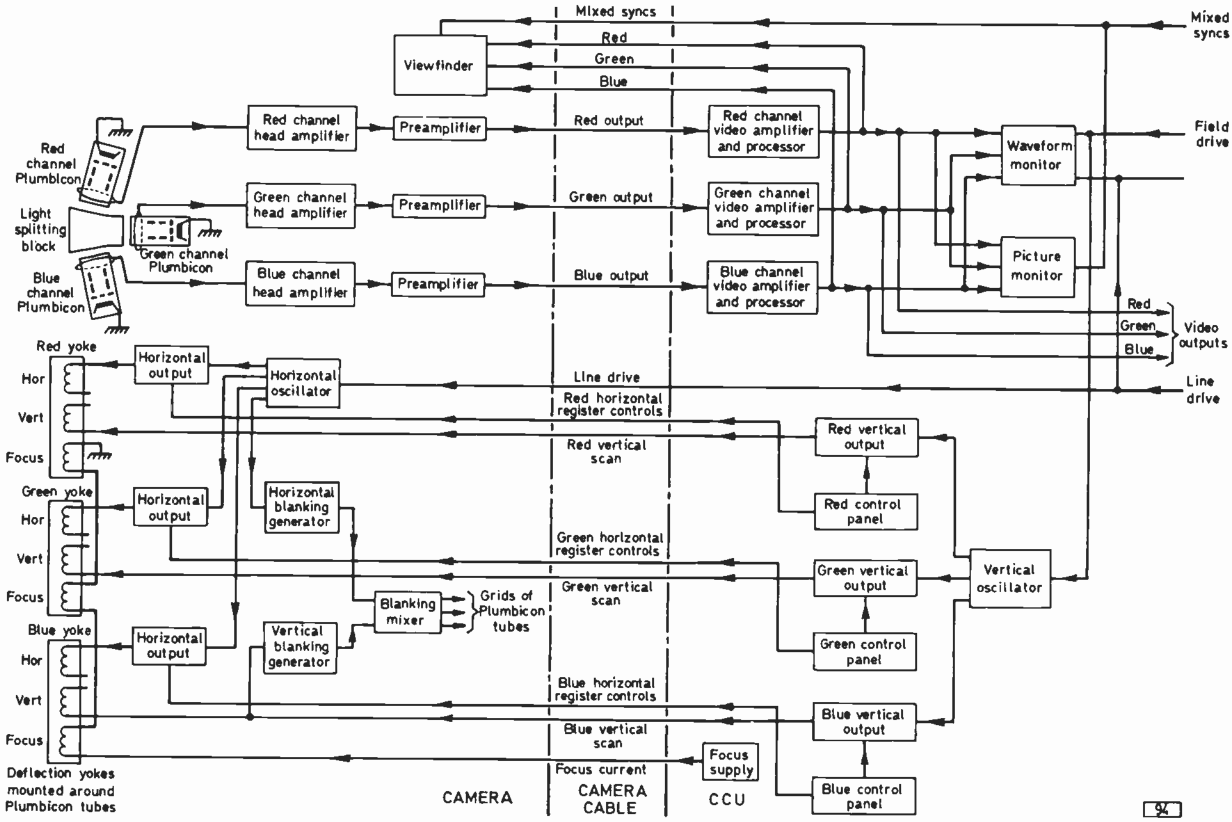


Fig. 1: Block diagram of a three-tube colour camera, with camera control unit.

amplifier output then passes to another amplifier—the preamplifier—to bring each video signal up to a sufficiently high level to be passed through the camera cable without interference. When the video signals reach the camera control unit (c.c.u.) they are further amplified and processed—in fact clamped, clipped, gamma corrected and blanked. The final stages form a distribution amplifier with the outputs being used to feed the picture and waveform monitors, the channel outputs and back up the cable to the viewfinder.

The scanning and scan control circuits of the camera channel are more complex. Basically the vertical scan generation is in the camera control unit and the horizontal scan generation is in the camera. Each deflection yoke on each Plumbicon tube is fed with both vertical and horizontal scan waveforms. Each feed is derived from a separate output stage which is controlled to make possible variation in shift, amplitude and linearity. These functions are controlled from the c.c.u.

Camera in Detail

Figure 2 shows the camera part of a Peto Scott PC60 camera channel. An electrically-controlled servo zoom lens is fitted at the front of the camera (left on picture). The controls for the zoom are brought on to the control arm at the rear. These include four preset zoom angles and an operating handle for general zoom work. Two basic zoom speeds are provided and these are supplemented by the pressure that the operator puts on the control handle.

The camera cable outlets can be seen on the side of the camera body and these can also be seen in Fig. 3. This photograph of the camera with the left-hand side opened up also shows the bulk of the electronic layout. The three tubes are on the left-hand side with the green Plumbicon "firing" horizontally, the red Plumbicon "firing" downwards and the blue Plumbicon "firing" upwards. The small black box they all lie against is the optical splitting unit. Above the green Plumbicon is a screened box containing the three video preamplifiers and to the right are the individual horizontal output assemblies.

Figure 4 shows the green Plumbicon assembly more clearly. The drilled cover has under it the head amplifier. The input to the head amplifier is taken direct from the tube's target—the very short lead on the left—and the output is taken by the thin coaxial lead up to the preamplifier. The tube itself is inserted from the rear into the whole assembly—most of which is

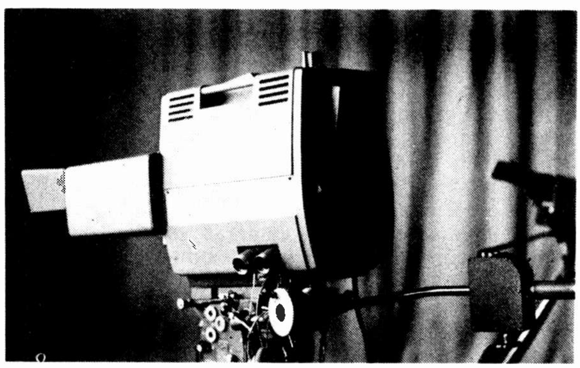


Fig. 2: The Peto Scott PC60 colour camera.

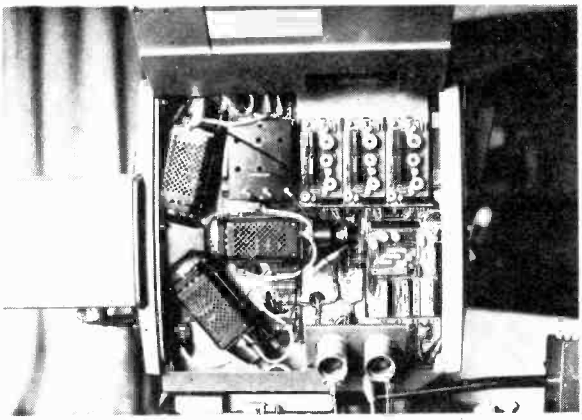


Fig. 3: Peto Scott PC60 colour camera with side opened

the scanning yoke.

At the other end of the camera cable lies the c.c.u. Fig. 5 shows a general view of the unit. From the top are housed a monochrome picture monitor, a waveform monitor, the operational controls and then the alignment controls. A monochrome picture monitor is necessary for alignment of a colour camera channel because of the accuracy of registration required. Such accuracy can only be gained with good resolution of the picture display and this is not obtainable with a colour monitor. The waveform monitor has automatic triggering on line and field. The display itself is in fact three displays—one period of red, one period of green and one period of blue information—laid in a row. The monitor also has its own internal calibration.

A closer view of the operational controls is shown in Fig. 6. The meter indicates the lens angle at any instant unless one of the three "target" buttons below it is pressed. If so that particular target voltage is indicated. The other controls (left to right) are remote servo control of lens iris, video gain control, black level control of all three channels and separate black level control for the red channel. Below these four controls are four push-buttons. The first three are for red, green and blue and switch the inputs to the picture monitor so that any of the channel signals can be displayed separately or in pairs or together. The fourth button inserts an external test signal into the monitor system.

The alignment controls forward of these operational controls are for the individual camera tubes

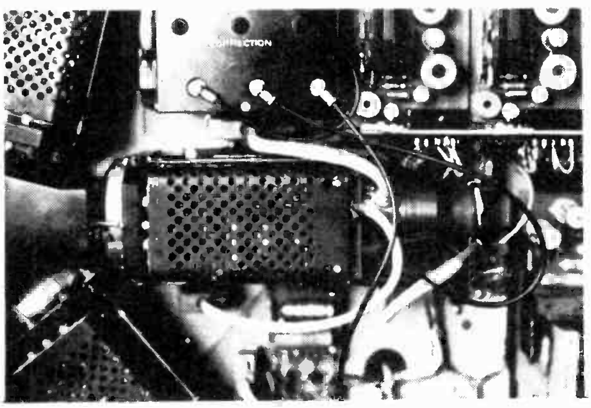


Fig. 4: Close-up view of the green tube assembly in the Peto Scott PC60 colour camera.

Fig. 5: The PC60 camera control unit.

and are the conventional ones of focus, beam, etc., and also the registration ones for shift, amplitude and linearity of the scans. These are not touched after the engineering line-up of the camera.

From our point of view the actual operating procedures are relatively unimportant and the individual circuits used for video processing are either very conventional or highly specialised. Two sections of the camera are however of particular interest.

Light Splitting System

The colour splitting system is probably the simplest and yet the most complex part of any colour camera. To get precise colour fidelity the light passed to each of the three colour tubes must be divided at exactly the same frequencies as the phosphors used in the shadowmask tube at the display end of the system. This science of chromaticity separation is a highly

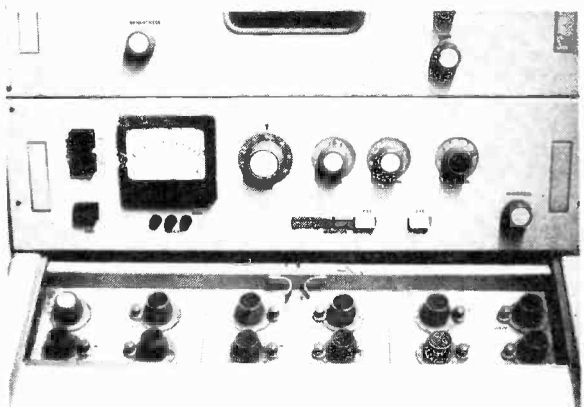


Fig. 6: PC60 operating controls.

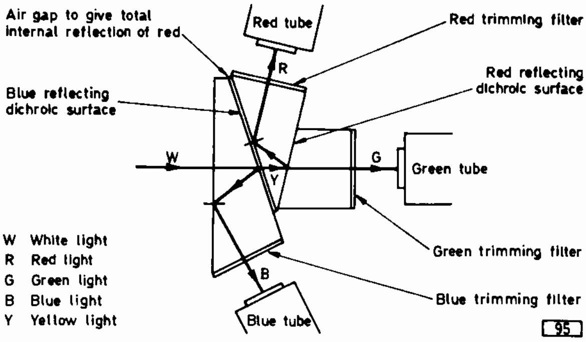


Fig. 7: Colour-splitting prism in the PC60.

specialised one and is yet still somewhat empirical. The system used in the Peto Scott camera is shown in Fig. 7.

The dichroic surfaces reflect only one particular bandwidth of light, allowing through all other bandwidths. An electrical analogy would be the bandstop filter. The colour trimming filters are really bandpass filters—shaping and cutting off the spectrum precisely.

The shorter the path each individual colour of light has to take the better. This reduces light transmission losses and the chances of different time delays at different light frequencies. Additionally each optical path must be the same length.

Head Amplifiers

It can be shown that the signal-to-noise ratio from a Plumbicon tube is large in comparison to many video sources (rather better than 50dB under the correct operating conditions). The output impedance of the tube however is very large and must be correctly matched by the head amplifier if this signal-to-noise ratio is to be preserved. At the same time the head amplifier must provide a reasonable amount of gain, must be stable, must have a bandwidth at least that of the video signal and most important must introduce very little noise.

We have seen in television receivers that good gain with low noise is obtainable from the cascode amplifier configuration. It might be useful to briefly explain this circuit again. Fig. 8(a) shows the simple, single-stage, grounded-cathode amplifier. It has the advantage of high input impedance but the disadvantage that the interelectrode capacitance from anode to grid (*C*ag) becomes a feedback path and at high gain the stage is liable to go into oscillation. This problem can be overcome by the grounded-grid amplifier—Fig. 8(b)—where any feedback signal through *C*ag is earthed by *C*. The gain is the same as with the grounded-cathode stage because the input signal is still applied between grid and cathode. A very big disadvantage however is that the anode current and cathode current are the same. The higher the stage gain the larger *I*a becomes and the lower the input impedance. It can easily fall below 10Ω. This is obviously impossible to match to the high output impedance of the Plumbicon.

The cascode amplifier—Fig. 8(c)—combines the grounded-grid and grounded-cathode stages and combines their advantages. V1 is the grounded-cathode stage and has high input impedance but little gain (to make it stable). Its low output impedance feeds the low input impedance of V2 (the grounded-grid stage).

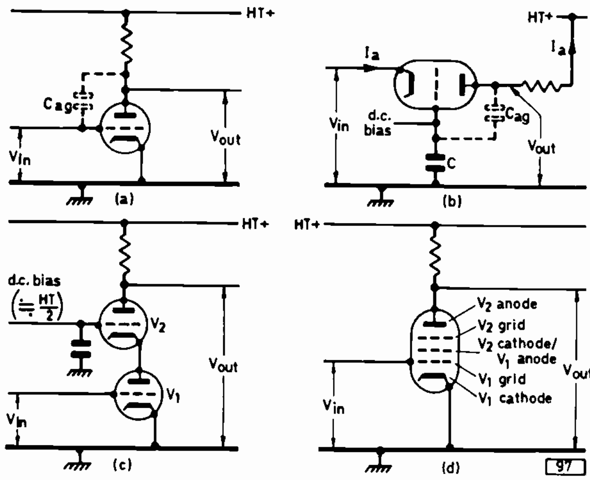


Fig. 8: Derivation of the cascode amplifier circuit.

The gain of this stage can then be made high because it is always matched perfectly at its input. It can be shown that the noise of this type of amplifier circuit is predominantly that of the first active device—in this case V1, a triode—but the gain is that of an equivalent pentode. Fig. 8(d) shows somewhat simply how this comes about.

To apply the cascode amplifier to a Plumbicon tube output sounds devastatingly simple. However the valve (even a triode) is basically a noisy device and it would be better to avoid it in this critical position. If a valve had to be used the choice of type would be very important (i.e. limited to nuvistors or a valve such as the E180F strapped as a triode). What would be better would be to use a semiconductor arrangement, bipolar transistors coming immediately to mind. But these have a low input impedance and although this can be increased it is only possible to do so to a limited extent and only at the cost of gain.

The answer to the problem is to use a field-effect transistor. These have the low noise figure of a semiconductor but the high input impedance of a valve. The f.e.t. need be used only in the lower part of the cascode arrangement as the upper device is only required to provide a low impedance input with high gain. Fig. 9 shows a typical f.e.t. head amplifier for a colour camera. Two f.e.t.s are paralleled so that they match the output capacitance of the Plumbicon tube (12pF). At the same time this arrangement

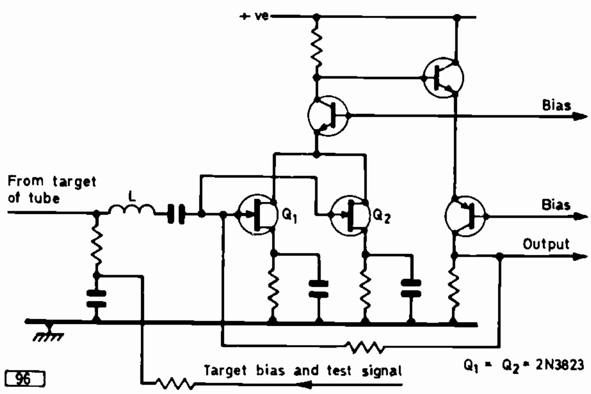


Fig. 9: Hybrid cascode head amplifier for a colour camera channel using f.e.t.s for the input.

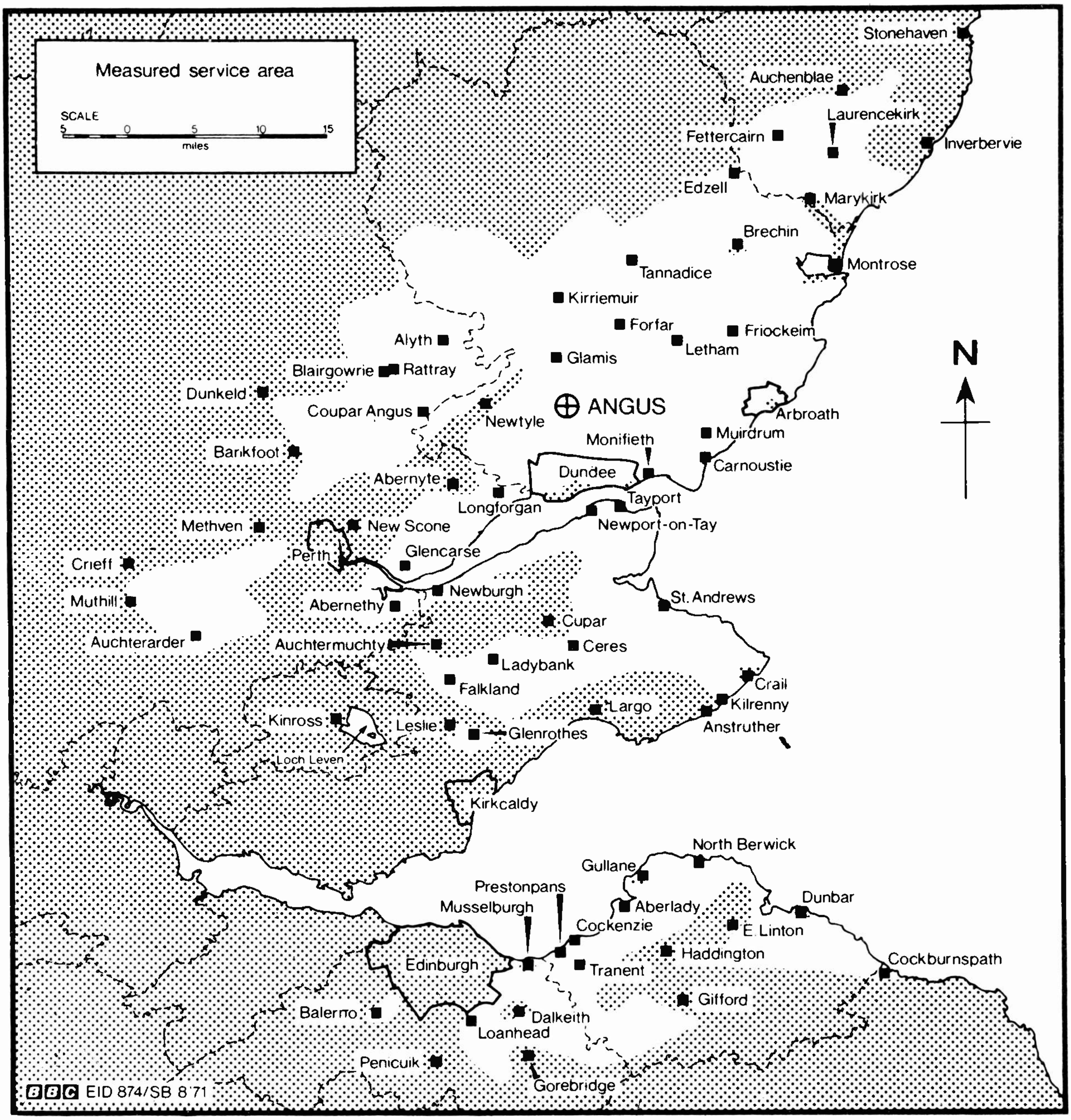
doubles the gm for the signal but the noise, being a random quantity, adds in an r.m.s. manner: this gives an immediate improvement in signal-to-noise ratio of about 3dB. The second part of the cascode circuit consists of a bipolar transistor and the output is impedance matched and isolated by another transistor circuit.

L is known as a Percival peaking coil and by a resonance process gives an improvement in the signal-to-noise ratio at the higher frequencies. This coil has been used for some years in various camera channels. Feedback is applied and the load resistor for the camera tube is in fact the feedback resistor. This greatly reduces the problems of equalisation that would arise by simply paralleling the camera tube load resistor across the input terminals of the amplifier.

We shall be publishing further articles by J. I. Sim on colour broadcasting techniques from time to time.

ANGUS UHF SERVICE AREA

Channels: Fourth 53, BBC-1 57, BBC-2 63, ITV 60
Receiving aerial group C, horizontal polarisation



The approximate service area is indicated by the unshaded parts of the map. Maximum vision e.r.p. is 100 kW. Map courtesy BBC Engineering Information Service.

SERVICING television receivers

L. LAWRY-JOHNS

THE GEC BT302 SERIES—cont.

Incorrect Tube Supplies

If the e.h.t. is OK absence of a raster will indicate incorrect tube base supply. In this case check the heater voltage across pins 1 and 8, remembering that some tubes (7405A etc.) have a 12·6V heater, then check the voltage supply to pins 2, 3 and 7. Pins 2 and 6 are the grid pins and the voltage here should vary with the brilliance control setting from zero to approximately 170V. Pin 3 is the first anode: the voltage here should be over 400V depending on the meter used. If the voltage is not much more than 200V suspect C149 and disconnect it for test. Pin 7 is the cathode which should record very roughly 150V according to the video swing and the condition of the video stage and resistors.

The Display

Having got something on the tube face by getting the line timebase working just what is displayed will be determined by the performance of the vision signal stages and the condition of the tube itself. If the original tube is still fitted it can hardly be expected to provide a bright, crisp picture: a certain amount of softness must therefore be tolerated.

Bright Raster, No Picture

This is a fault which will almost certainly be encountered on some of these sets: the raster will be over bright with no picture signal. V6 will probably be bright red with shame (as you would be if you had a high oscillatory voltage on your grid). The cause is lack of decoupling in the vision i.f. stage. A replacement 0·001μF (C60) capacitor from pin 8 of V5 to chassis will usually put things back to normal and V6 will then stop blushing. It is possible however that V6 will not recover from its ordeal and may have to be replaced. Also check MR1 (GEX35, OA70 or similar) which may have suffered some damage. Always check the two 12kΩ video load resistors.

Normal Raster, No Picture

If this is accompanied by a no sound condition the cause will normally be in the tuner but remember that the i.f. stage V4 is common to both vision and sound and check this. The tuner valves are B319 (PCC84, 30L1, etc.) and LZ329 (PCF80, 30C1 etc.). Either could be at fault to cause a no signals (or weak signals) condition. Apart from the usual poor stud contact—which responds to cleaning—however the tuner does

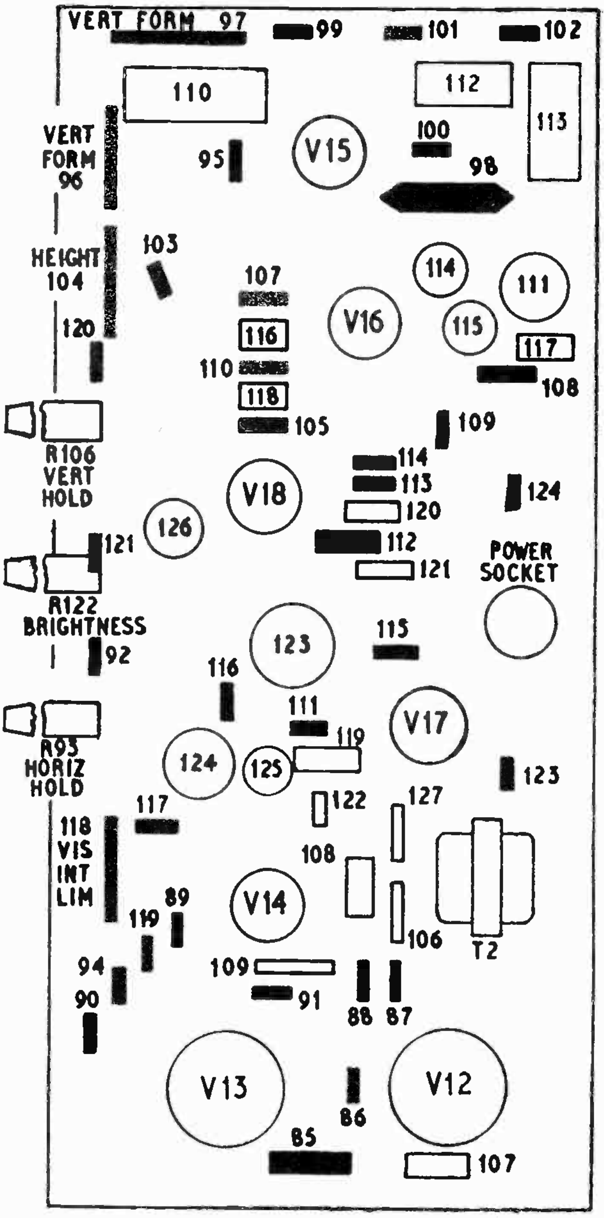


Fig. 4: Layout of the timebase printed panel. Capacitors shown in outline, resistors shown in solid black.

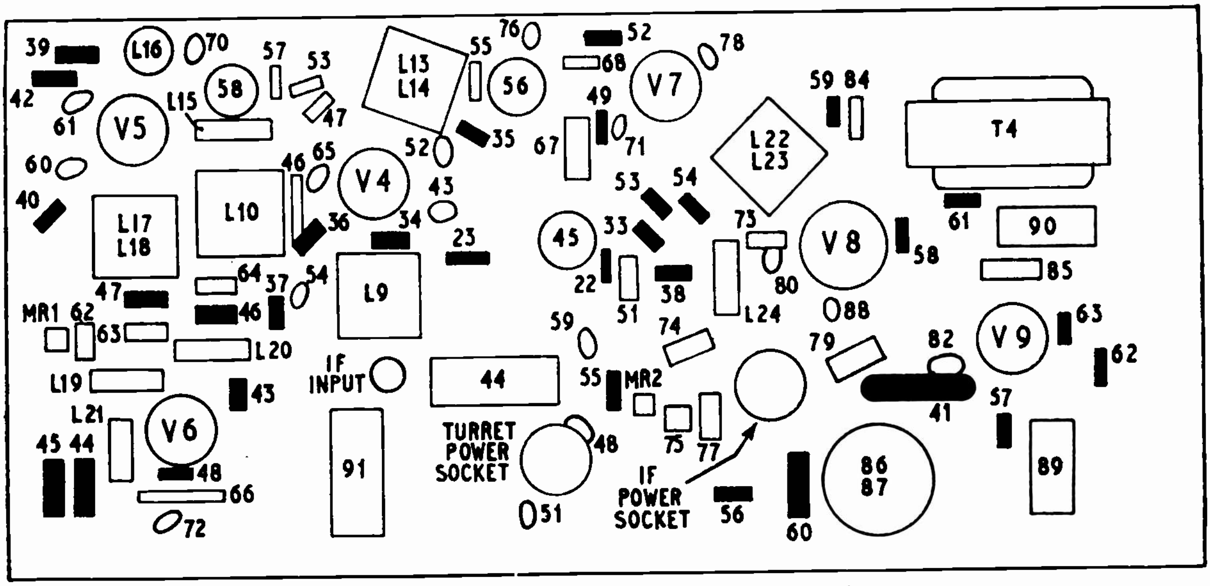


Fig. 5: Layout of the receiver section printed panel.

not give much trouble. Remember that the valve positions are the reverse of normal, V1 being at the front.

Picture Normal, No Sound

Whilst this could be due to a large number of factors it seems to have been our lot to find that usually the DH77 (6AT6, EBC90) has stopped functioning. If one of these is not to hand an EF91 (Z77) can be fitted for test purposes. This will produce some sort of weak sound at least to prove that the DH77 was in fact at fault.

Check V7, V9, MR2, R59 and the h.t. feed resistors R41 and R60 if necessary. And, er, by the way—make sure the speaker leads have been plugged in . . .

Sound Interference

A loud rustling noise varying in intensity often denotes a breakdown of the insulation between the pins of one of the two power plugs on the left side panel. Moving the plugs will often indicate which is at fault and therefore which is to be replaced (or the h.t. connection removed and made in some other way).

Sound-on-Vision

This is a very common complaint on these receivers. Normally it is due to the beehive type trimmers C58 (or C56) having been disturbed. C58 is the sound rejector trimmer and it is necessary for this and C56 to be finely set at 38·15MHz. A signal generator is not necessary if a constant tuning note can be received whilst the trimmers are set for minimum vision disturbance.

It is sometimes the case however that the trimmers cannot clear the sound-on-vision. This indicates that some form of undesired coupling is taking place. First ensure by turning the volume to minimum that this is not caused by vibration (a microphonic vision circuit valve will respond to sound waves in the cabinet or to vibration). Then check decouplers such as C45 (0·1μF a.g.c.) and C59 (h.t.). Valves V4 and V5 could be faulty. It is also possible that one of the fixed capacitors across the trimmers has become faulty, but this is less likely.

Picture Shape and Size

Having a picture on the screen is one thing, having the right sort of picture is another. It is very common for the height of the picture to contract. Whilst this can be due to a number of factors it is the height control itself which in these receivers is most often at fault, developing one or more dud spots on its track. The only remedy is replacement: cleaning and attempting to repair the contact is rarely successful and is not worthwhile. To a lesser extent the same remarks apply to the linearity controls.

If these are not defective check the condition of the N379 valve (PL84 or 30P18), its bias electrolytic C111 and resistor R98.

The B729 (6-30L2) is occasionally at fault, mainly when the trouble is inability to lock or failure to open up the scan at all (because the valve is oscillating at the wrong frequency or not at all). The value of R105 is critical as far as the hold is concerned. Capacitors C110, C112 and C113 must be checked for leakage in the event of non-linearity.

Variation of Line Hold

The most persistent offender is V14, again a Z329. It is essential that a stable valve is used in this position and the first replacement tried may not be suitable. If the valve is not at fault check R90 and the values of R92, R93, R94 and R125 (if used).

Picture Shading

If the left side of the picture is brighter than the right check C149 which decouples the supply to pin 3 of the tube base: it could be open-circuit. If the top is lighter (or darker) than the bottom check the D77 (EB91) valve which could have heater-cathode leakage. V6 can produce the same effect but doesn't seem to so often.

LONG-DISTANCE TELEVISION

ROGER BUNNEY

NOVEMBER was a rather quiet month though conditions were about average for the time of year. The main highlight during the month consisted of improved Tropospherics over the period 2nd-3rd November, with various ORTF (France) transmitters on both v.h.f. and u.h.f. and —unusually here—the BRT (Belgium) E8 and E10 transmitters. Reports from other enthusiasts indicate that the improved conditions were widespread with various West German and other v.h.f./u.h.f. transmissions at similar distances. Unfortunately the Leonids Meteor Shower during the middle of the month did not give the expected increase in Meteor Scatter/Shower signals, only a slight improvement being noted. Possibly I was unlucky and missed the critical moment: did anyone else see anything? My log for the period is as follows:

2/11/71	CT (Czechoslovakia) R1 (MS); BRT E2,8,10 plus various ORTF (France) v.h.f./u.h.f. trops.
3/11/71	NOS (Holland) E4 (trops); ORF (Austria) E2a,*E5;* CT R1; via MS.
4/11/71	WG (West Germany) E9 (trops).
5/11/71	TVP (Poland) R1 (Sp.E).
6/11/71	BRT E2.
8/11/71	NOS E4; WG E4 (MS).
9/11/71	CT R1.
10/11/71	NOS E4 (trops).
11/11/71	DFF (East Germany) E4 (MS).
12/11/71	Switzerland E2 (MS); BRT E2.
13/11/71	NRK (Norway) E3 (Sp.E).
16/11/71	CT R1; NOS E4. An increase in MS was noted during the evening from the Leonids MS.
17/11/71	CT R1; WG E2 (MS).
18/11/71	BRT E2.
19/11/71	Switzerland E3 (MS).
20/11/71	ORF E2a; RAI (Italy) IB; both MS.
22/11/71	WG E4; DFF E4.
23/11/71	CT R1.
25/11/71	CT R1, NOS E4.

The opening of the new Belgian transmitter at Schoten on ch.E62 was just in time for the improvement in Tropospherics. This is located near Antwerp and we understand it is now operating with 200kW e.r.p. and that an electronic test card is in use. Our contact states that he has not seen this one in use before and we are awaiting further news and possibly a photograph. Whilst on the subject of test cards, the same contact advises that the West German Deutche Bundespost transmitters which carry the ZDF (2nd programme) are now using a test card with the identification "ZDF" within the centre of the electronically generated test card. Also, apparently, the HR (Hessischer Rundfunk) network in Germany is carrying a 15 minute news programme in English each Wednesday at 0645 (GMT).

We have had a report from our Dutch friend Peter van der Kramer saying that the Swiss test card has been noted carrying an identification "G". At present we do not know the reason for this new identification but are investigating. For the record the usual identifications on the Swiss card are as follows: Q experimental transmission; B Bellerive—studio for the German service; U Uetliberg—the main transmitter covering Zurich; D La Dole—the main transmitter covering the French speaking area of Switzerland; Z Studio Zurich. The identification is carried at the upper right-hand side of the test card. We understand that there is a possibility of a change in the normal Swiss test card but the card in its usual form is still being used at the time of writing.

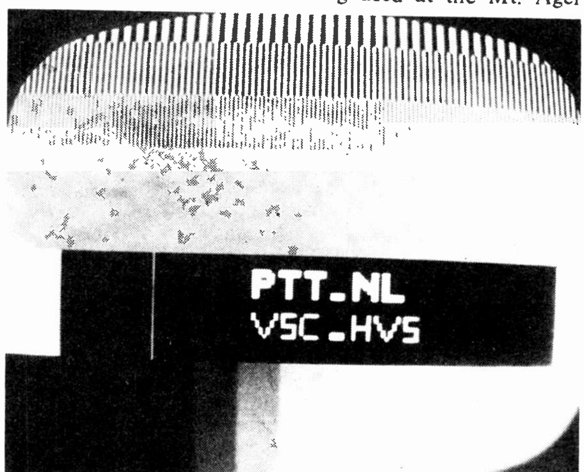
News Items

Belgium: At present this country transmits using System C—that is positive-going vision modulation with a.m. sound. There appears to be a long-term plan for a change from this system to System B (negative-going vision and f.m. sound) as this is used extensively in Western Europe. The Band III transmitters at Wavre on chs.E8 and E10 will apparently be the first to change and this will allow for colour transmission. It would follow that the other Belgian transmitters on v.h.f. will eventually change to System B.

Holland: Our Dutch friends tell us that the Philips organisation is once again operating its own TV transmitter. The transmissions are on ch.E60 using an omnidirectional aerial, the transmitter power being 2kW. The Philips plant is at Eindhoven, south of the town of Waalre.

Monte-Carlo: We have recently reported on the activities of Tele Monte-Carlo with tentative television transmissions into the Northern Italy area. A second conflicting report has now come in—originating initially from a resident in Monaco—advising that only a low power (2kW e.r.p.) ch.E35 transmitter is being used at the Mt. Agel

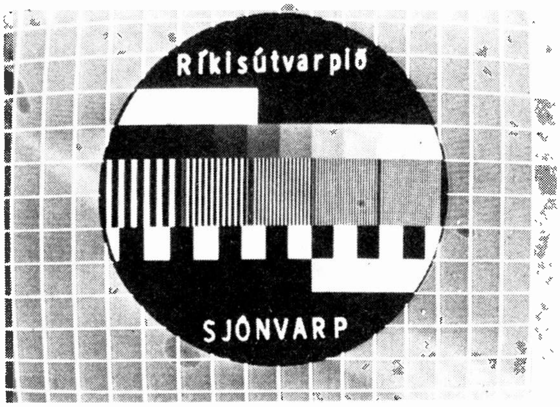
Main national news caption, Dziennik Telewizyjny, Warsaw, Poland. Courtesy OIRT Prague.

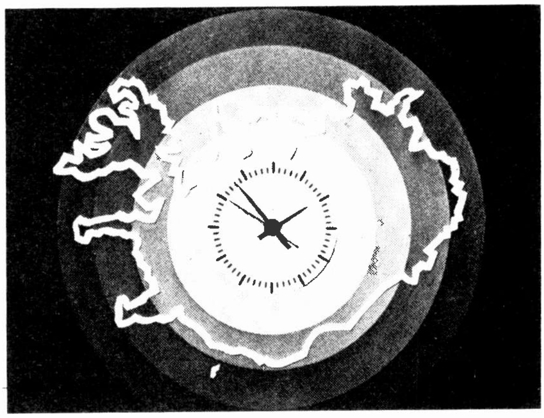


EBU test pattern in use with NOS Holland.

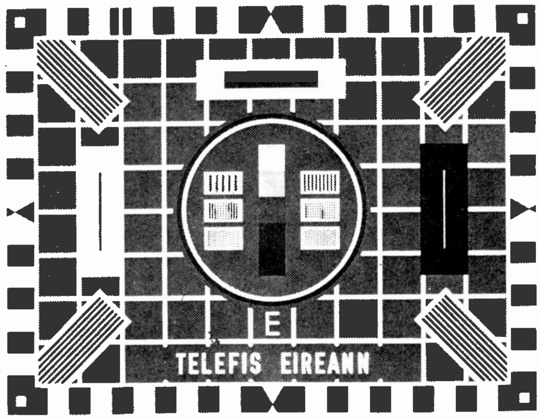
DATA PANEL 7—2nd series

ICELAND, EIRE





Above: Iceland Rikisutvarpid Sjonvarp Test Card and Clock.



The above are official photographs issued by the broadcasting authorities. However, Iceland has been noted to use this card with or without the grid and rarely with the identification as shown here.

Right: Test Card used by Eire—Radio Telefís Eireann.

Our thanks to the broadcasting authorities of both countries for their kind assistance in supplying information.

v.h.f. transmitting site. This is all very curious, especially in view of the very detailed first report. To try to get clarification we have written to our Italian contact at Bergamo to find out the true situation there.

ORTF-3

We have important news about the proposed new French network which will be known as ORTF-3. This network will commence operations towards the end of 1972 and will initially cover the Northern and Eastern parts of France. The network will expand rapidly to give near national coverage by the end of 1976. We understand that the first transmitters will be located at Paris, Lille and Strasbourg using 50kW units, the Lille transmitter having an e.r.p. of 1000kW. The Lille transmitter—actually Lille-Bouvigny—will operate on either ch.E24 or E27. I would make a guess and suggest that ch.E24 will be used by Lille as in the early days of Lille on ch.E27 interference problems were caused with NOS Lopik—also on ch.E27—resulting in Lille changing channel to ch.E21. The programme material will be "of a national rather than a regional theme", and production facilities are to be encouraged outside Paris, the first main centres being at Lille and Marseilles. Programme transmission will be in colour—SECAM.

From Our Correspondents . . .

A new name in our correspondence column is Geoffrey Chapman of Blandford, Dorset who has obviously been very active during the summer months. He has written detailing the Sp.E openings logged at his home. Of particular interest is his reception of the West German transmitter at Goettelborner Hoehe on ch.E2: this is a most difficult transmitter to receive, being vertically polarised, at a very short distance for Sp.E propagation and some 40 or so miles more distant than Luxembourg. The improved Tropospheric conditions during October were also noted at Blandford: one signal that gave a consistent strength through until nightfall was RTE-Dublin on the 7th October. Actually we are featuring this month the RTE test card in the Data Panel series.

Letters arrive from Eire from time to time and there seem to be a number of enthusiasts in that area. J. Bradley has received a number of signals during the summer and from his sketches we confirm reception of Switzerland and Poland. Mr. Bradley lives in the Dublin area and apart from a low-power ch.B3 transmitter the whole of Band I seems to be clear, certainly an unusual feature for most of us!

I. C. White of Farnborough, Hants, has written telling us of conditions there during October and of the stations received on his GEC portable and Baird colour receiver. The Dutch u.h.f. stations were particularly good in colour at high signal levels, and West Germany also. Mr. White was surprised to note that the Belgian u.h.f. network uses negative-going vision: in fact Belgium uses the same as West Germany and Holland for u.h.f. transmissions with positive-going vision for the v.h.f. transmissions only. The new EBU test pattern of NOS was also noted, carrying the long identification, and we are pleased to feature this photograph also with the column this month—thanks to our old friend P. D. van der Kramer.

From time to time letters arrive from overseas readers with the sender's address on the envelope only: as the envelope is often discarded and the letter then passed to

—continued on page 181

PART 5 **K. T. WILSON**

MOTOROLA TV ICs—2

DEMODULATION is one operation in a TV receiver that is particularly suited to integration. We saw in Part 1 the basic differential amplifier circuit—widely used in i.c.s—operating as an f.m. detector in an intercarrier sound i.c.: the circuit functioned as a quadrature detector for the f.m. input signal. The same basic circuit can however be used in other ways to provide demodulation, depending on the inputs applied to it. This month we are going to take a look at two Motorola detector i.c.s, the MC1330P which acts as a synchronous detector for the vision and sound signals and the MC1327P which acts as a chroma signal demodulator, RGB matrix and PAL switch. In both these i.c.s differential amplifier circuits are used as double balanced demodulators.

Video Synchronous Demodulator

The Motorola MC1330P low-level video detector is used in the new Decca 12in. mains/battery portable Model MS1210 and in the BRC 8000 single-standard colour chassis. Fig. 1 shows the i.c. in block diagram form together with the external circuitry as used in the BRC 8000 chassis. The input from the final i.f. stage is fed to an integrated emitter-follower at pin 7. This emitter-follower provides two drives, one to a limiter amplifier section and the other to the synchronous detector section. As is by now well known a synchronous detector requires two inputs, the signal to be demodulated and a reference signal to provide the switching action. In this case the 39·5MHz i.f. carrier is used as the reference signal. The limiter section removes the modulation and feeds the carrier to the external tuned circuit L108/C126. The 39·5MHz sinewave is then clipped and applied to the synchronous detector section. The detected output is fed to a video preamplifier section which provides across its external load resistors R126 and R232 the 6MHz intercarrier sound feed at pin 5 and the video signal at pin 4. L109/C129 remove the 6MHz signal from the feed to the luminance and chrominance sections of the receiver.

The use of this i.c. makes possible a number of basic changes in TV receiver design. First, detection is carried out at a much lower level (about 50mV) than is possible using a single diode detector. In addition

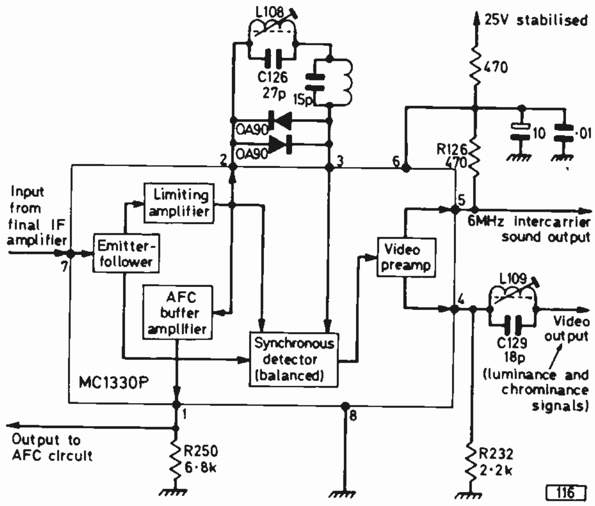


Fig. 1: Block diagram of the MC1330P low-level video synchronous demodulator i.c. together with the external circuitry as used in the BRC 8000 chassis. The carrier applied to the external 39·5MHz tuned circuit L108/C126 is used as the reference signal which gates the internal balanced synchronous detector. The latter provides full-wave rectification of the signal, giving an output consisting of half sinewave pulses of amplitude proportional to the modulation.

to providing more linear detection this means that less i.f. gain is required—making up the gain at v.f. is a simple matter. The advantages of this include less need for sound trapping, less critical tuning and more stable i.f. performance.

AFC Output

The i.c. also provides an output (a 350mV clipped carrier) across the external load resistor R250 to drive an a.f.c. circuit. In the BRC 8000 chassis the a.f.c. circuit consists of a limiter/amplifier stage, discriminator and d.c. amplifier.

Internal Circuit

The internal circuit of the MC1330P is shown in Fig. 2. The input emitter-follower is Q4. This drives the differential amplifier pair Q5/Q13 which forms part of the synchronous detector circuit and Q16 which with Q17 forms part of the limiter/amplifier section. The external 39·5MHz tuned circuit is connected between the collectors of Q16 and Q17 between which the clipper diodes D1 and D2 are also connected. As a result anti-phase squarewaves appear at the bases of Q8 and Q9 which act as emitter-followers driving Q7 and Q11, and Q10 and Q6, respectively. The double balanced synchronous detector consists of Q6, Q7 and Q5 on one side and Q10, Q11 and Q13 on the other side. The output is developed across the base-emitter junction of Q20 which is connected in the collector circuit of Q7 and acts as an emitter-follower to drive the video amplifier section Q23, Q24 and Q25. As we have seen external loads are connected to Q25 —at its emitter and collector—providing the main output at pin 4 and an auxiliary output if required at pin 5. The carrier signal for the a.f.c. system is taken from the collector load of Q17 and passed via the buffer amplifier Q21, Q22 to pin 1. A d.c. supply of

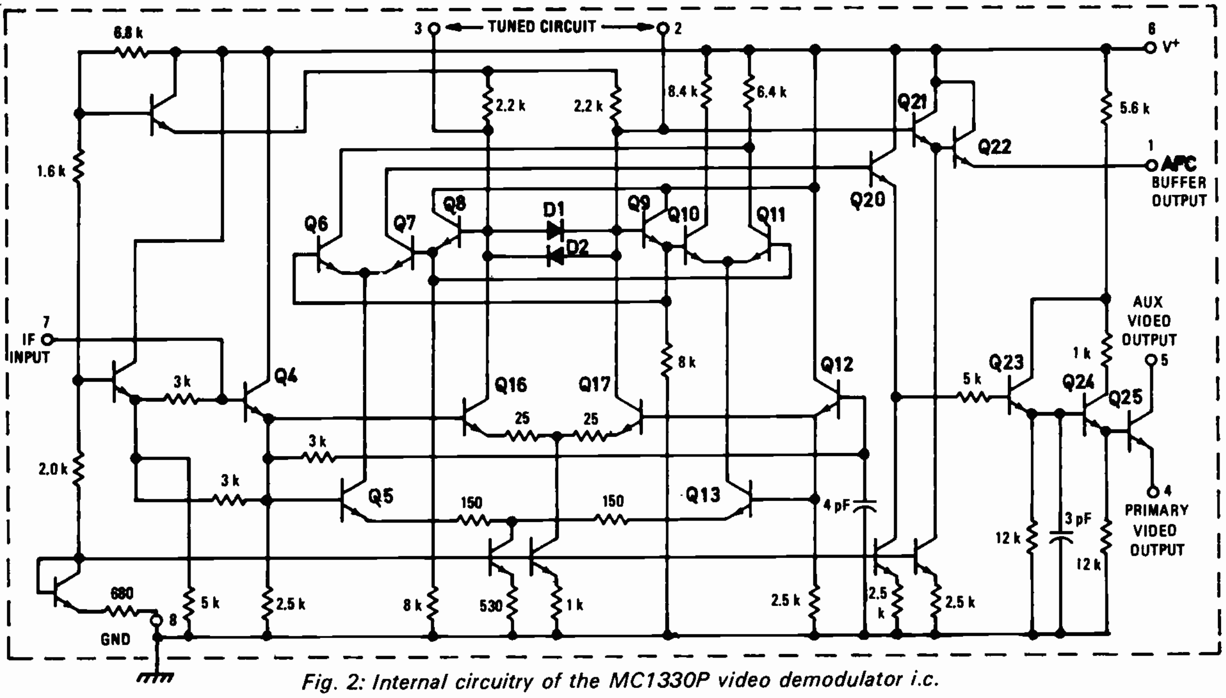


Fig. 2: Internal circuitry of the MC1330P video demodulator i.c.

about 20V stabilised is fed in at pin 6 while pin 8 provides the common earthing point.

Chrominance Demodulator

For chrominance signal demodulation, RGB matrixing and PAL V switching a Motorola type MC1327P i.c. is used in the BRC 8000 colour chassis. Fig. 3 shows a block diagram of the i.c. and the surrounding circuitry. The V and U signals, separated in the PAL matrix circuit part of which is shown, are fed in at pins 9 and 8 respectively to separate double-balanced chroma synchronous detector circuits which are of the same basic pattern as used in the MC1330P. The U and V reference carriers are fed in at pins 13 and 12 respectively, C178 and R191 giving a 90° shift to the U reference carrier to obtain the correct quadrature conditions. The PAL V switch is built in and is driven by a waveform derived from the ident signal. This is fed in at pin 11. The luminance signal is fed in at pin 3 and line and field blanking pulses at pin 6: blanked RGB outputs are then obtained from emitter-followers behind pins 2, 1 and 4 respectively. A 5V peak-to-peak output signal is obtained with an input of 0·3V p-p and the i.c. incorporates a regulated power supply.

Acknowledgements are due to Motorola Semiconductors Ltd., Decca Radio and Television and the British Radio Corporation for their help with this and the previous part in the series.

TO BE CONTINUED

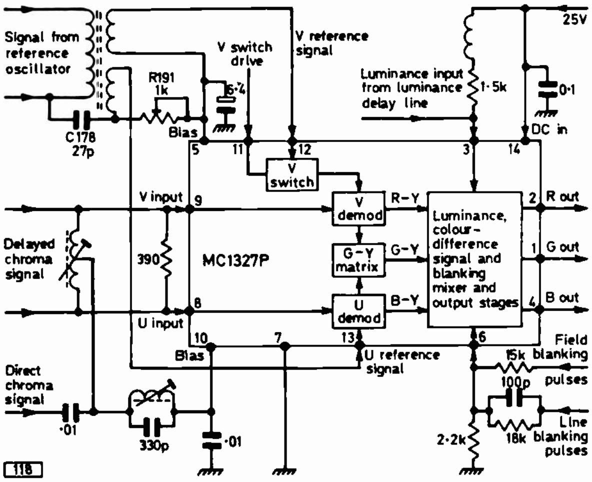


Fig. 3: Block diagram of the MC1327P chrominance signal synchronous demodulator, PAL V switch and matrixing i.c. which provides blanked RGB outputs. External circuitry as used in the BRC 8000 chassis.

FOR THE SERVICE ENGINEER

Meteronic (114-116 Shipbourne Road, Tonbridge, Kent) have introduced a fully portable lightweight oscilloscope, Model 113, featuring d.c.-8MHz bandwidth, 100mV/cm.-50V/cm. vertical sensitivity, 100nsec/cm.-150msec/cm. sweep speed range and a single control to cover all signal locking requirements. Power supply 7-9V d.c., size 8×6×4in., weight 3lb, price £93. Optional accessories are the MSB111 rechargeable Ni-Cd battery pack at £18, and the MSB112 mains/battery charger pack at £19.

To assist aerial riggers in siting and orientating u.h.f. aerials Labgear have introduced a new lightweight (5lb.) battery-powered u.h.f. signal-strength meter, Model CM6016/SM. The meter reads from 30μV to 3mV in four switched ranges to an accuracy of $\pm$6dB and detects the peak amplitude of the signal to which it is tuned. Withdrawal of the aerial feeder plug automatically switches the instrument off and a circuit is incorporated to differentiate visually between the sound and vision carriers. The recommended trade price is £40.

THE DO-BE OSCILLATOR

N. BANTON

THE changeover to the 625-line u.h.f. standard brought many problems to the amateur TV constructor but his infinite patience and not a little ingenuity resulted in a spate of converted receivers many of which were never intended to operate in this way. We well remember the time of an even greater conversion epic, when the Ministry of Supply unloaded its surplus v.h.f. gear in the late forties and for many of us opened the door to a new hobby and a wider technology. It was in those days that the family egghead, so called because of his preoccupation with junky old wireless sets, came into his own in producing for all to see a moving—albeit green—picture on the end of his thirty bob VCR97.

Timebase Conversions

The point to be made here however is that some of the types of problems encountered then are now causing trouble with u.h.f. conversions—namely finding reliable timebases and in particular line generators. Much depends of course on the type of set being converted, but even sets designed by the manufacturers for conversion can suffer from jittery locking when this is undertaken. The Thorn 850 convertible chassis for example can be critical in this way even with the flywheel sync circuit used in the conversion kit. Blocking oscillators are a firm favourite and can generally be easily modified for u.h.f. operation, but here again the triode types can be jumpy: pentodes are better but are much less frequently encountered. Many early models are suitable for trying out as conversions but are not equipped with facilities to enable flywheel sync control to be used, e.g. they may not have a winding on the line output transformer from which a suitable reference pulse for a flywheel circuit can be obtained. This is not to say that flywheel sync cannot be added in some way but if this is attempted will the locking be good enough without further modifications to the timebases? Let us not forget that amateur interest apart the other reason for doing the conversion is to save money.

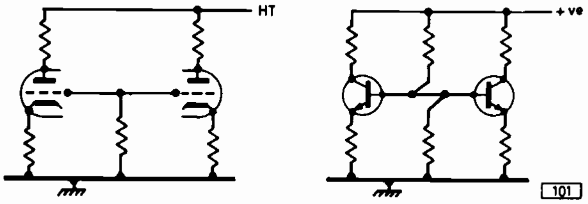


Fig. 1: Basic do-be (double beam) configurations, left valve circuit and right transistor circuit.

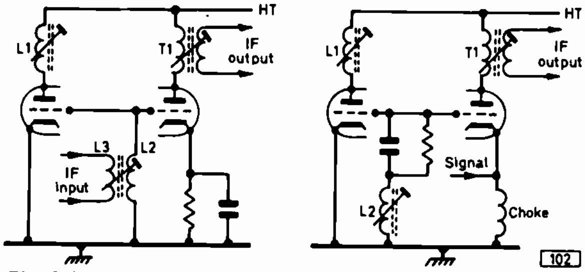


Fig. 2 (left): The do-be circuit used as an i.f. amplifier. The circuit is slightly regenerative but does not appear to sharpen the tuning or narrow the bandwidth.

Fig. 3 (right): The do-be circuit as a tuner, with the left-hand triode as local oscillator (L1 and L2 coupled to give the required feedback) and the right-hand triode acting as mixer to give an output at i.f.

Basic Do-Be Circuit

Can we then find a timebase generator that is sensitive enough to lock on to a mediocre strength sync pulse? After all if the display is good enough to watch the sync pulses should be reasonably strong. The answer I have found is the do-be, i.e. double-beam, oscillator. The basic circuit is shown in Fig. 1 and consists of two amplifying devices strapped together gridwise or basewise as the case may be. This simple circuit can be useful in a number of ways with the same basic configuration but different components. For example in Fig. 2 it is an i.f. amplifier: no gimmick, it is working at present in a u.h.f. set. The circuit is slightly regenerative but does not appear to sharpen the tuning or narrow the bandwidth. In Fig. 3 the circuit is a tuner. It could be a quadrature detector and so on but the version we are interested in is shown in Fig. 4 because here it is a timebase oscillator: uncomplicated, simple and with excellent stability.

Do-Be Timebase Generator

In this circuit V1a operates as a blocking oscillator with the l.f. transformer L1, L2 and the timing circuit C1, R2, R3 and R4. V1b acts with R1 and C2 as a linear sawtooth generator. On switch-on both valves conduct. The anode coil L1 produces a voltage across the grid coil L2 and this drives both grids and consequently the two valves hard on. V1b anode voltage falls rapidly, discharging C2 to give the flyback portion of the waveform. V1a anode voltage is of course also falling. As the valves approach saturation grid current flows producing a negative charge on C1 which cuts the valves off. C1 then commences to discharge via R2-R4 while C2 charges via R1 to give the forward scan portion of the waveform. When C1 has discharged sufficiently for the grids to reach the cut-on point the action is repeated.

V1a anode is not cluttered with components to interfere with its easy action and L1 is very sensitive to even a modest negative-going sync pulse. The circuit has given excellent results without flywheel sync but this can of course be added by following the usual practice with blocking oscillator circuits. The

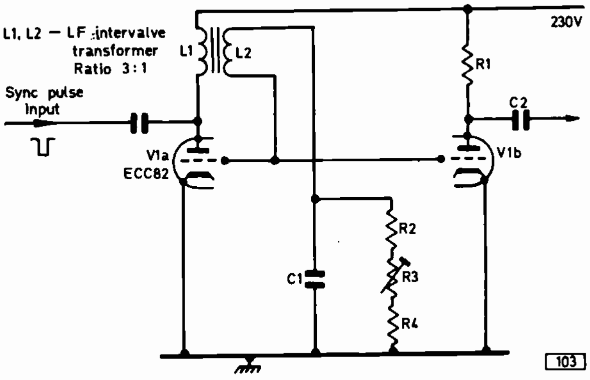


Fig. 4: The do-be circuit as a timebase generator, with V1a connected as a blocking oscillator and V1b acting as a discharge valve. When V1b conducts C2 discharges to chassis, giving the flyback portion of the timebase waveform. R3 provides hold control.

variable resistor in the grid leak network—giving hold control—can be altered in value to suit individual choice providing the fixed resistors are altered in proportion: some constructors no doubt prefer finer control. A noisy variable resistor will obviously give trouble in this position. Blanking pulses can be taken from V1b anode.

Practical Circuits

Figures 5 and 6 show respectively the line and field timebases—using do-be oscillators—in my conversion of the GEC Model BT2747. The timebase output stages and the power supply arrangements are in fact the only original circuits left on the chassis!

The do-be timebase generator is well worth a trial by anyone suffering with jittery locking and where the set initially uses a separate oscillator valve it should not be too difficult to instal this circuit. Where a blocking oscillator transformer is present on the set being converted this can be used for the do-be circuit: otherwise a 3:1 ratio l.f. transformer is suitable. Separate decoupling of the h.t. supply to the do-be oscillator has not been found to be necessary though I always use separate choke/capacitor smoothing to the timebase panel and i.f. amplifiers.

Thorn 850 Conversion

In a recent conversion of the Thorn 850 convertible chassis I found it worthwhile converting the field generator to a do-be circuit. This chassis is well worth spending a little time on: it's the one where you hang the u.h.f. conversion panel on the top rail rear. When all three programmes became available locally on u.h.f. I decided to chuck out the v.h.f. panel and do a complete u.h.f. modification: it would at least mean that I could close the back of the set again! It is not a difficult modification and the end product is a good u.h.f. set. I found the timebases to be a bit touchy but after experimenting with one or two sync separator circuits I got the line hold to settle down. The field hold continued to be jumpy even though all components likely to affect matters were replaced. So I decided to change to a do-be oscillator.

The modification consists mainly of substituting a transformer for the multivibrator components originally used—the existing valves are used in the conversion as are R145-R147 and Z3 in V13a anode

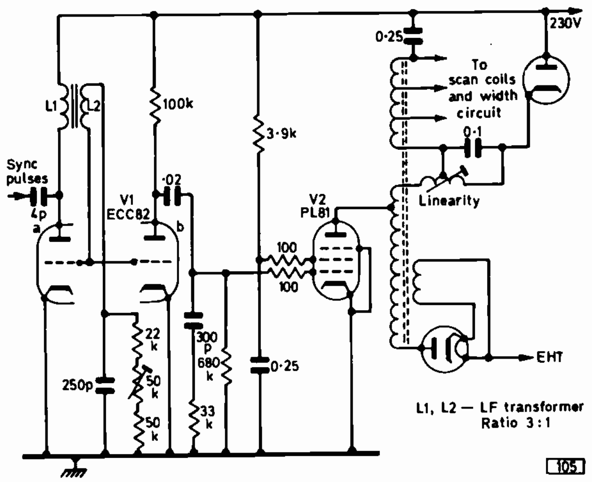


Fig. 5: GEC Model BT2747 line timebase conversion with do-be generator stage.

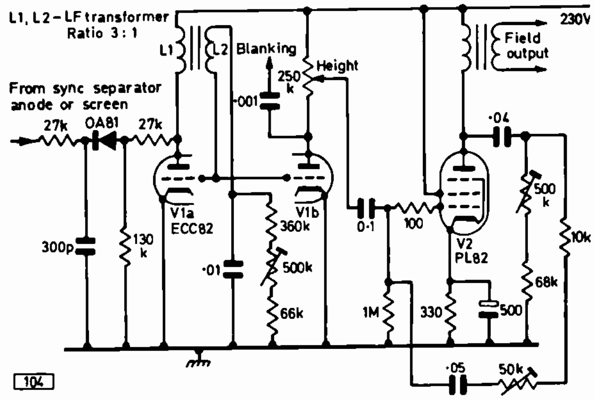


Fig. 6: GEC Model BT2747 field timebase conversion with do-be generator stage.

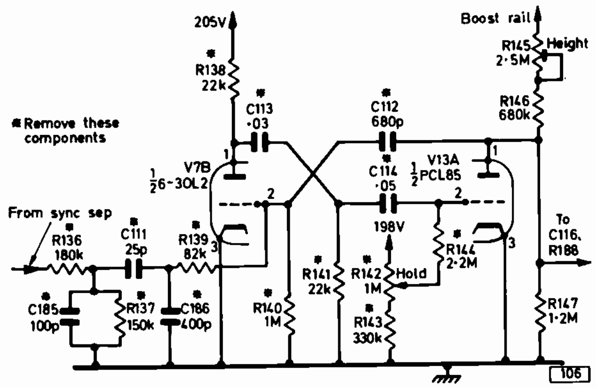


Fig. 7: Original field generator (multivibrator) stage used in the Thorn 850 convertible chassis, showing the components to be removed for the suggested conversion.

circuit. The field output stage V13b is not altered. Fig. 7 shows the components that have to be removed and Fig. 8 the completed modification. To make room for the 3:1 ratio blocking oscillator transformer I removed the smoothing capacitor block from the left-hand side of the chassis (looking from the rear). Room for the capacitors was found on the top rail using a spring-type clamp. The do-be oscillator grid leak resistors can be altered to suit the user—a 500kΩ

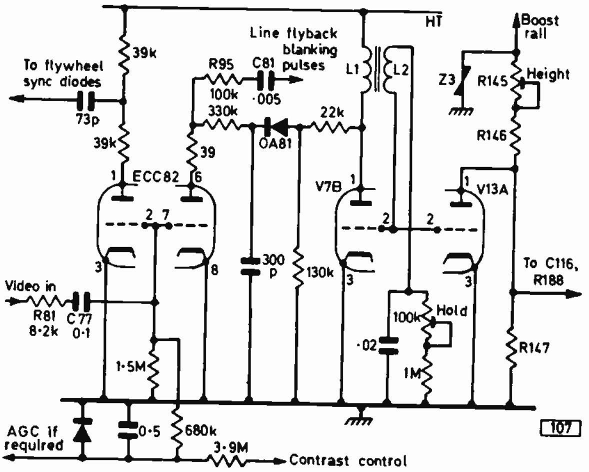
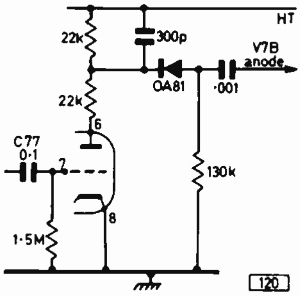


Fig. 8: Thorn 850 field timebase modification using a do-be generator stage.

Fig. 9: The field sync separator circuit shown in Fig. 8 locks the generator well with the set correctly tuned but is of a rather experimental nature. A more conventional arrangement that has been used successfully to lock do-be field generator circuits is shown here.

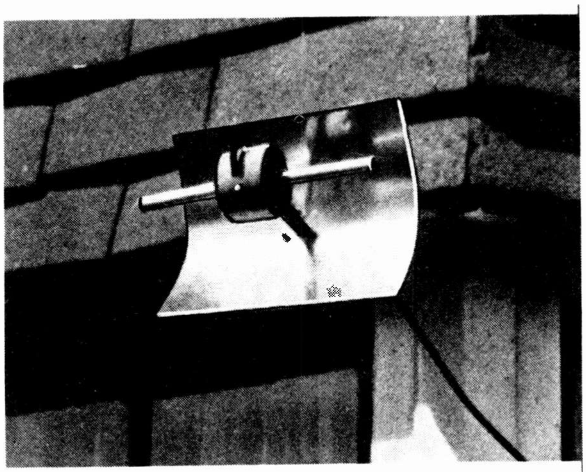


variable plus 680kΩ fixed resistor for example may be used—providing you obtain centre locking as near as possible. These oscillators are easy to set up and play around with—at least at these frequencies. The output is far more than adequate and the linearity excellent. If the original presets in the Thorn 850 chassis are still in circuit a replacement will be required for the field hold control (R142) since the original 1MΩ variable resistor is too big for use with this circuit. The modification is an easy one and although some constructors may think that the sync separator arrangement is a bit odd my excuse—if one is needed—is that it works! Those wishing to use an alternative however could try the field sync separator circuit shown in Fig. 9 which I have used with other do-be oscillator conversions. I mounted the ECC82 sync separator by the way in place of the 200μF electrolytic (C380) on the Thorn conversion panel. The set is working at present without a.g.c. and gives very good results: I intend however to build in an a.g.c. circuit suited to u.h.f. use in due course. Those wishing to retain the mean-level circuit in such a conversion can do so in the manner shown in Fig. 8. Changing the line oscillator to a do-be circuit doesn't seem worthwhile: the existing circuit is a blocking oscillator anyway and works well with the flywheel circuit on the conversion panel. The line hold control is sharp but does not slip.

This then is the do-be timebase oscillator. Perhaps it is not used commercially because it requires two triodes and a transformer whilst most commercial circuits use either two valves (multivibrator) or one valve and a transformer (blocking oscillator on its own). But do try it, in the place of those commercial Christmas trees! ■

SIMPLE OUTDOOR UHF AERIAL

K.E.G. Pitt B.Sc.



THE aerial described in this article does not fall readily into any of the commonly used types but instead is a mixture of several. It started life as a corner reflector but as this type of aerial is rather too bulky for outside use the reflector size was reduced to half wavelength square (from one wavelength by two). A single dipole is mounted about $\frac{1}{8}\lambda$ in front of the reflector. As shown in the photograph the aluminium reflector sheet may be bent to a roughly parabolic shape—a marginal increase in gain is found if this is done. The aerial does not have high gain but nevertheless gives quite good results in fairly strong signal areas. Its main advantage is that it is very short and may be mounted quite unobtrusively just inside or outside a window. The group C version shown measures only 4½in. from the front of the insulator to the back of the reflector. It will thus fit easily behind the curtains where it will pick up almost as much signal as when it is mounted outside.

The cross bar and dipole halves are cut from ⅜in. aluminium tubing while the reflector and its mounting bracket are sheet aluminium—the prototype used 18 s.w.g. sheet but the gauge used can be chosen with regard to availability and the strength needed to combat the weather if mounted outside. The aerial mounting bracket to the wall is similar in design to those used for the aerials described in the August 1971 issue. The block holding the dipole is made of wood: details are shown in Fig. 1. The aerial dimensions are listed in Table 1.

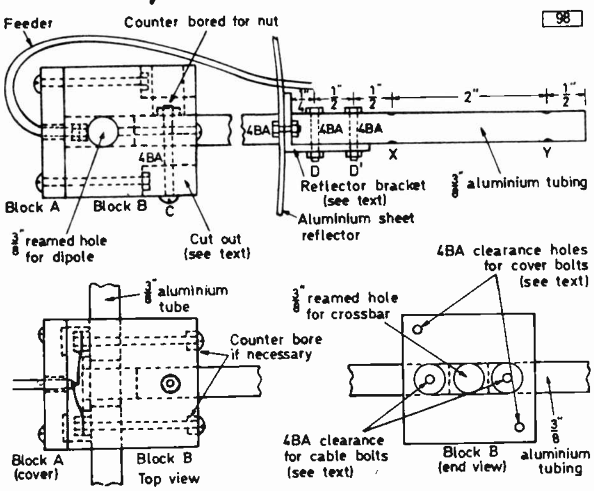


Fig. 1 Constructional details.

Table 1: Aerial Dimensions

Group	Spacing (in.)	Dipole length (in.)	Reflector sides (in.)
A	5·1″	2 × 5·3″	11·5″ × 11·5″
B	4·1″	2 × 4·3″	9·0″ × 9·0″
C/D	3⅜″	2 × 3·5″	7·5″ × 7·5″

The reflector consists of a sheet of aluminium one half wavelength square and the cross bar passes through a tight fitting hole at its centre. The cross bar is clamped to the reflector by means of a bracket of similar material. In the prototype the bracket is 1½ by 2in. and is bent into two halves at right angles, each 1½ by 1in. A tight clearance hole for the cross bar is made in the bracket so that it is tangential to the bend. The cross bar is then inserted through the holes in the reflector and bracket as shown in Fig. 1 and two 4BA clearance holes made, one either side of the cross bar. Two holes—D and D′—are drilled as shown for 4BA bolts to secure the cross bar to the bracket. Holes X and Y are 2BA for attachment of the aerial assembly to a 12 s.w.g. aluminium mounting bracket which should be Rawlplugged to the wall or window sill.

Dipole Assembly

One of the difficulties in making weather-proof outside aerials is to construct a block which both supports the active elements and also protects them from corrosion. For this model two wood blocks are used and these should preferably be of one of the hard woods. As shown in Fig. 1 block A acts as a front cover for the actual mounting block (B). It is 1½in. square by ¼in. deep. At its centre a tight clearance hole is drilled for the cable. Block B is a 1½in. cube. A pair of 4BA clearance holes are drilled at diagonally opposite corners through both blocks as shown in Fig. 1 to hold the cover on. After completion of the aerial two blind holes are drilled in block A to cater for the proud ends of the cable fixing bolts and their nuts. This will enable the two blocks to fit closely—the basis of the weather seal.

Block B has a ⅜in. reamed hole at its centre as

—continued on page 181

A CLOSER LOOK AT PAL

PART 3

E. J. HOARE

PAL DECODING ERRORS

No colour television receiver is immune to errors of hue and saturation caused by distortion of the signal or by imperfections in the design or alignment of the decoder and i.f. channel. Now although PAL is a very robust system there are bound to be imperfections in the chrominance content of the picture and it is instructive to see how these can occur. We are going to interpret the title of this article a bit loosely and include any cause of chrominance distortion affecting the signal whether it arises in the decoder circuits or elsewhere: this will enable us to discuss some of the interesting side issues which tend to get overlooked.

A good starting point in our discussion of chrominance distortion is the subject of Hanover bars or blinds. The presence or absence of blinds on a picture has more significance than is often appreciated, and an understanding of the processes involved is almost by definition an understanding of decoding itself.

Hanover Bars or Venetian Blinds

Anyone who begins to study the mysteries of PAL colour television techniques is almost immediately introduced to this phenomenon. It has an intriguing sounding name and is easy to identify on the screen of a receiver. It consists of pairs of horizontal lines on coloured areas of the picture and the degree of visibility depends upon the amount of colour present. Even a student can spot the effect quite easily and he retires happy in the knowledge that he has learnt something useful! Unfortunately the real significance and value of blinds and the mechanism by which they occur is seldom explained to him.

The fact of the matter is that blinds are a wonderful built-in test of decoder design and alignment, and are characteristic only of the PAL system. In NTSC the decoder alignment is very critical and difficult to assess: in PAL the alignment is not very critical and is easy to assess. If you inspect a well saturated colour picture on a PAL receiver and see no blinds at all you know immediately and without any further testing that most aspects of the decoder alignment are correct or at least sufficiently so for practical purposes—by this we mean that the subcarrier (PAL) delay line matrixing and the synchronous demodulation processes are O.K. Conversely if blinds are present to an appreciable extent you can be certain that the alignment is not very good and needs checking. Furthermore if the blinds are clearly visible you can sometimes deduce what the errors actually are. There must be very few pieces of electronic equipment where this built-in checking facility is inherent in the system!

What are Blinds?

Blinds are caused by differences in luminance, hue or saturation between consecutive lines of a field. Due to the use of interlaced scanning this appears as differences between consecutive *pairs* of lines on a picture and gives rise to a rather coarse structure. Furthermore because of the four-field sequence of V axis switching with respect to the line scanning the eye strobes the blinds and they appear to be moving steadily up the screen of the c.r.t.

Differences in chrominance information between consecutive lines can be caused by misalignment of the decoder or by differential phase distortion either in the decoder itself or more commonly in the incoming signal. The effects are often aggravated by the breakdown of the constant luminance principle—but we will discuss this separately because it tends to get a bit complicated. Another cause of blinds is poor design of the decoder whereby crosstalk occurs between the two colour-difference signals. If R−Y gets into the B−Y channel or vice versa blinds will occur unless the demodulation phases are highly accurate.

Decoding an Undistorted PAL Signal

If we take a magenta hue the chrominance subcarrier and burst phases on alternate lines are as shown in Fig. 1. Fig. 2 is basically the same diagram but this time we have described the magenta hue in terms of the U and V colour-difference components which when modulated together give the chrominance subcarrier shown in Fig. 1 (and dotted in Fig. 2). You will notice that in all PAL phase diagrams a mirror image of V about the U axis is obtained on alternate lines.

In decoders incorporating a delay line there are two separate processes that have to be carried out in order to obtain the detected +or −U and V signals. With suitable adjustments of gain (de-weighting) in each channel these then become B−Y=2·03U and R−Y =1·14V. The two processes are delay line matrixing and synchronous demodulation.

The purpose of the delay line is to store up information so that the chrominance subcarrier from one line of the picture can be mixed with the subcarrier from the line before to give completely separate U and V carriers. This not only makes the process of synchronous demodulation more accurate and less critical but also enables electronic averaging to cancel out certain errors.

Figure 3 shows the U and V components of our magenta hue on four successive lines. Now if we take the U and V subcarriers from lines 2 and 3 and add them we get 2×U as shown in Fig. 4(a) because the V carriers cancel. Similarly if we subtract one carrier from the other the U carriers cancel and we get 2×V

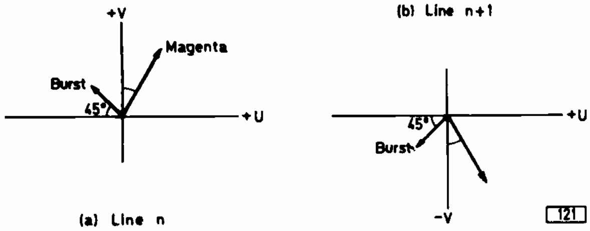


Fig. 1: The phase of the chrominance subcarrier on alternate lines corresponding to a magenta hue.

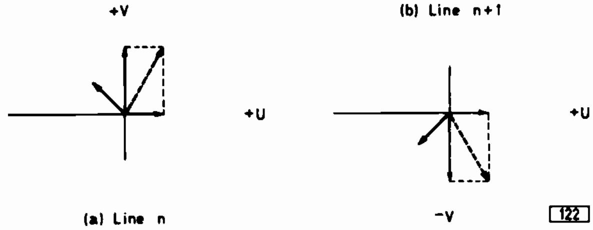


Fig. 2: The phase and amplitude of the V and U signal components that form the resultant chrominance subcarrier shown in Fig. 1 (and also in broken line above).

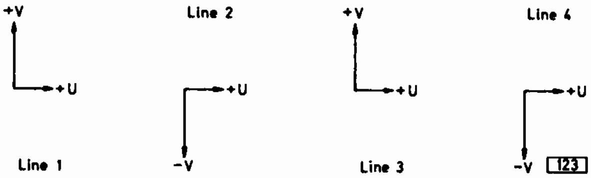


Fig. 3: The U and V components for four consecutive lines of a magenta hue (burst omitted).

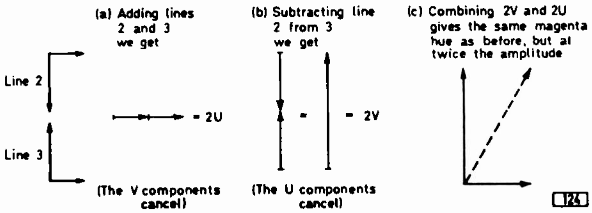


Fig. 4: The delay line matrixing process. Under correct conditions the U and V components of the signal are separated without distortion.

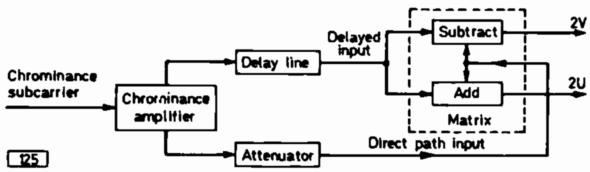


Fig. 5: Block diagram of the PAL delay line and its add and subtract matrix network.

—see Fig. 4(b). If we take lines 3 and 4 instead of 2 and 3 we get precisely the same answer and since consecutive outputs are identical there can be no blinds. We are assuming for the purpose of our example that the same chrominance information is being transmitted on all four lines. In practice this is substantially true and the principle breaks down only over the small picture areas where one hue changes to another and the transition is abrupt.

The delay line matrixing operation takes place in a circuit shown in block diagram form in Fig. 5. The U and V carriers obtained from the add and subtract

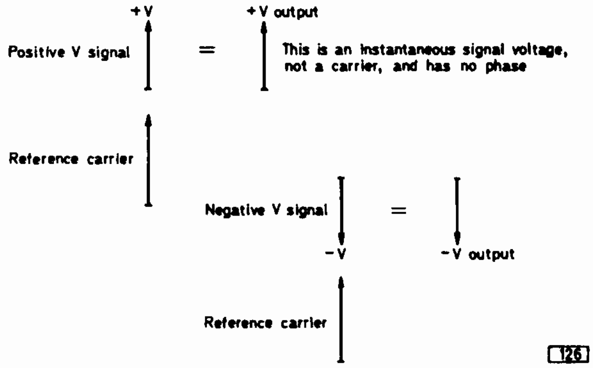


Fig. 6: Synchronous detection measures not only the amplitude of the U and V subcarriers but also their polarity, i.e. whether positive or negative at the instant when the demodulator is switched on by the reference carrier.

networks are then demodulated by two separate synchronous detectors. The U detector is also fed with a locally generated reference carrier in the same phase as the +U axis while the V detector is fed with a reference carrier switched 180° from line to line in the same phase as the V axis (alternatively the V signal itself may be switched 180° from line to line before being fed to the V detector).

Correct and Incorrect Demodulation

Thus if all is well with both reception and decoding a reference carrier exactly in step with the wanted U or V carrier is used at the demodulators as a switch so that the demodulators measure (a) the instantaneous amplitude of the U or V carrier and (b) its polarity (positive or negative). See Fig. 6.

It is important to note that if all is well no U signal appears in the V channel and vice versa. Clearly the detected V output should not contain any U signal. If the delay line matrixing is correctly carried out but the reference carrier applied to the V detector is in the wrong phase the detected V signal will be too small but at least will contain no U component.

A different situation arises if the matrixing is inaccurate: the U and V channel signals are then not completely separated and the U and V detectors can give outputs comprising a mixture of both.

Reference Carrier Phase Errors

We have just seen that if decoding is correctly carried out there is no difference in the information from line to line—assuming the input signal remains the same—so no blinds will be present on the picture. Now let us see what happens when the phase of the reference carriers applied to the demodulators is incorrect. We will assume an error in the quadrature conditions: i.e. one axis correctly demodulated and the other not.

Incorrect Quadrature Conditions

Let us take the same magenta hue as before and assume that the delay line matrixing is perfect. Thus the V channel contains only a pure V subcarrier and the U channel only a pure U subcarrier. Fig. 7(a) shows our V subcarrier in its correct phase and a reference carrier from the local reference oscillator with a very definite phase error (β) of about 20°. These two

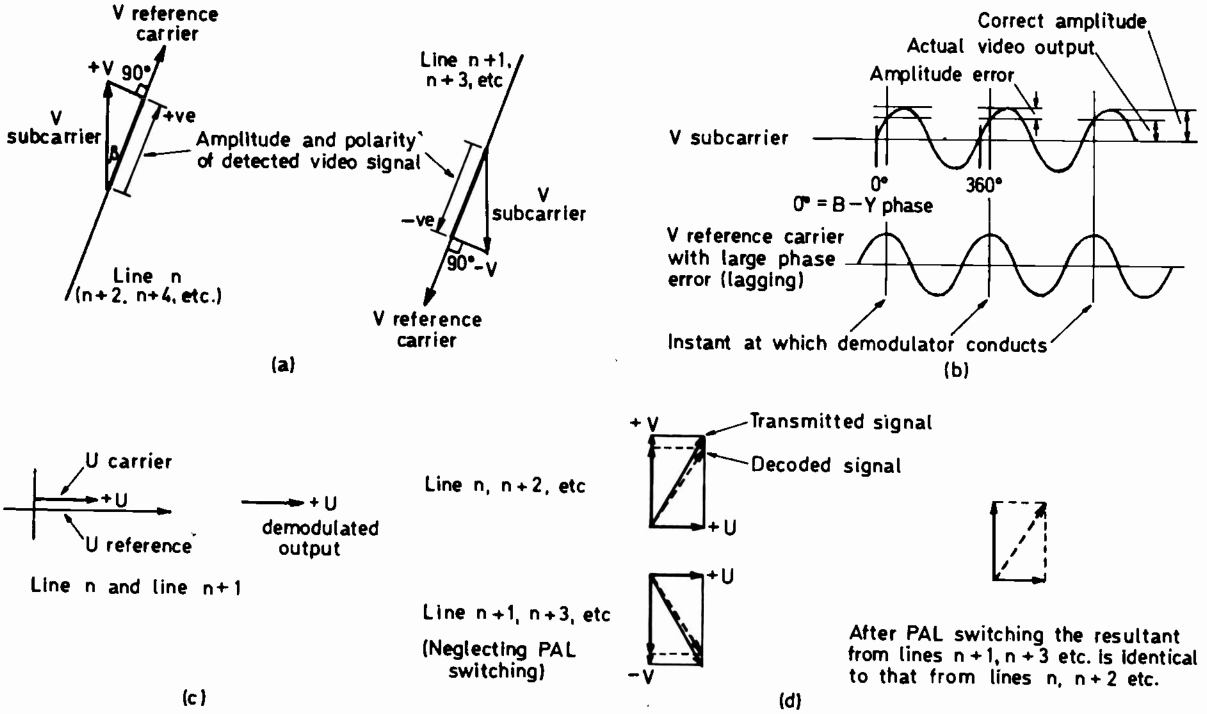


Fig. 7: (a) Vector diagram showing incorrect demodulation due to a shift in the V reference carrier phase. The amplitude of the demodulated signal = V cos β. The amplitude error = 1 — V cos β (β = the phase error of the reference carrier). (b) The same process as in (a) but drawn with sinewave carriers instead of vectors: how much more tedious to draw! (c) Accurate demodulation of the U signal because the phase of the U reference carrier is correct. (d) The resultant obtained from an incorrect V output and a correct U output from the demodulators is a hue error together with reduced saturation. The errors are identical on every line and thus no blinds are present on the display.

carriers are applied to the V synchronous demodulator and the outputs on every line will be pure V—since the V channel contains nothing else—but at a reduced amplitude. The amplitude will be the same on every line.

A different phase diagram showing exactly the same process is drawn in Fig. 7(b) only here we have abandoned vectors and used sinewave carriers instead. You will see that at the instant when the reference carrier is at its positive peak and the demodulator diodes open to measure the amplitude and polarity of the V signal carrier this is at less than its peak value. Thus the demodulator output is incorrect, i.e. too small. Now suppose that the U demodulator reference phase is correct: Fig. 7(c) shows that the correct U output is obtained.

What then is the overall result? If we add together the slightly small V signal and the correct U signal the resultant is rotated away from its original position and its length is reduced as shown in Fig. 7(d). This means that the transmitted hue and saturation have been changed in the decoding process. The magenta hue has become slightly too blue and the saturation has been reduced. Furthermore due to the incomplete application of the constant luminance principle—inherent in all present-day colour broadcast systems—any hue error is accompanied by a change in luminance because the chrominance signal carries some luminance information. Thus the saturation suffers a further error.

The effect of the hue and saturation errors on the picture is fairly small for the sort of demodulator phase errors that occur in practical circumstances. A saturation error can easily be corrected by adjusting the saturation (colour) control. The hue error cannot of course be corrected at all in a delay line PAL receiver. Usually it will pass unnoticed except on subtle hues such as skin tones and these are commonly affected much more by errors of grey-scale tracking than by errors of demodulation.

So far we have discussed the case of a quadrature error, assuming that the static phase of the reference oscillator a.p.c. loop is correct and thus (in our example) that the U reference carrier is correctly phased on the U axis. The V reference carrier was rotated off the V axis so that the two reference carriers were not 90° apart: i.e. not in quadrature. Now let us consider the situation when the two reference carriers are in quadrature but the reference oscillator a.p.c. loop has a phase error which causes both reference carriers to be rotated equally away from their respective axes.

Reference Oscillator Phase Error

It is common practice to feed the output of the reference oscillator direct to one demodulator and via a 90° phase-shift network to the other demodulator. The V reference carrier (or V chrominance subcarrier) is switched 180° on alternate lines. The two reference carriers may be in perfect quadrature relationship (a phase difference of 90°) but if there is a phase error in the output of the reference oscillator this error will be applied equally to both demodulators.

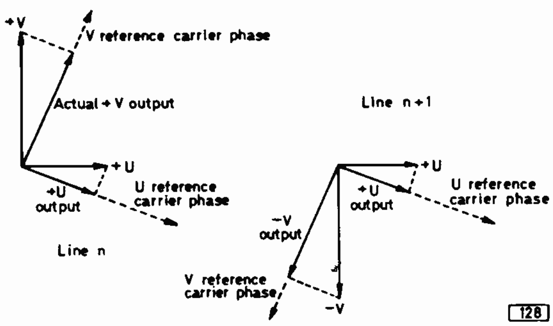


Fig. 8: With equal phase errors on both the U and V axes the U and V signals are reduced by the same proportion on all lines.

Figure 8 shows the same V and U components as before and the effects of a demodulation phase error of the same amount on each axis. It will be seen that both the V and U outputs are reduced in proportion. When these outputs are combined we get a resultant at the same angle as before, and therefore the same hue, but of reduced length. So we have the correct hue but at a reduced saturation. Note that the outputs on alternate lines are completely symmetrical and of equal amplitude and so there are no blinds present on the picture.

Causes of Blinds

Our quest for the causes of blinds has so far not been very productive but we have at least established the effects of demodulation phase errors on an accurate PAL chrominance signal. It is clear that the asymmetrical effects of a quadrature phase error are more important than those resulting from, say, a static phase error in the a.p.c. loop. You can always adjust the saturation control, but you can never adjust the hue—at least not with PAL.

If you think about it you will see that an accurate PAL chrominance signal applied to the demodulator can never result in the asymmetrical differences in output from line to line that are the cause of blinds. For blinds to occur there has to be a spurious switched component somewhere that gets demodulated differently on alternate lines. If for example there is a switched (i.e. 180° phase alternated) V component in the U channel then the U demodulated output will vary from line to line in the kind of way that we are looking for. The errors need only be quite small because the eye is very sensitive to changes in brightness or saturation, although less so to changes of hue.

More generally any kind of crosstalk that causes an unwanted V signal to appear in the U channel or U to appear in the V channel means that the delay line separation process has been partly nullified and some of the advantages of delay line PAL have been lost. Crosstalk between the U and V channels can occur in a number of ways but the most obvious one is the case where the delay line matrixing has been inaccurately adjusted.

Matrix Adjustments

There are two operations that have to be carried out in setting up the delay line matrixing. In the first place the amplitudes of the delayed and undelayed signals must be precisely equal. This is usually achieved by means of a potentiometer in the undelayed signal path. A typical delay line causes an attenuation of about 15dB in the delayed signal and this must be matched by an equal degree of attenuation in the undelayed path (or appropriate gain must be introduced in the delayed signal path). We then get the amplitude relationships illustrated earlier in Fig. 4.

The other adjustment concerns the phase of the delayed and undelayed chrominance signals. Clearly the delay time must be equal to one line scanning period if electronic averaging is to be carried out between a picture element on one line and the similar element on the line immediately preceding it. Now although we need very accurate timing in the delay line in order to get nearly perfect registration of these two picture elements the vital factor is not the registration but the phase of the delayed and undelayed carriers. The phase difference between them must be kept to within about $\pm 3°$ if complete separation of the U and V components of the chrominance subcarrier is to be achieved. This is equivalent to a delay time accuracy of about ± 2nS (1nS$=1/1{,}000\mu$S$=10^{-9}$ seconds). You can check this on the basis that there are 283·5 cycles of the subcarrier in one line period of 64μS.

Effect of Amplitude Differences between the Direct and Delayed Signals

If we take the matrix circuit shown diagrammatically in Fig. 5 and make the amplitudes of the delayed and undelayed paths unequal what is the result? Fig. 9(a) shows the U and V components of the chrominance subcarrier for three consecutive lines of the picture. These are the inputs to the delay line matrix. Now if we make the direct signal which bypasses the delay line too large we get the signal components of Fig 9(b) in the matrix (mixing circuit) on lines 2 and 3. These U and V components are added at (c) to give the U output and subtracted at (d) to give V. Note again that the direct path signal is too large. Also we are subtracting the delayed signal from the direct one.

The results at (c) and (d) are not at all good. The U signal has incorrect amplitude—it is too large—and worse still it contains a switched V component. The V signal is also too large and it contains an unswitched but unwanted U component.

If we combine these U and V components in order

Summary of Decoding Errors

Perfect signal and matrixing

- Static phase error causes desaturation
- Quadrature phase error causes change of hue

Perfect signal, faulty matrixing

- Matrix amplitude error with correct demodulation causes saturation errors
- Matrix amplitude error plus incorrect demodulation causes hue and saturation errors which produce blinds
- Matrix phase error with correct demodulation causes hue errors and blinds
- Matrix phase error plus incorrect demodulation causes hue and saturation errors and blinds

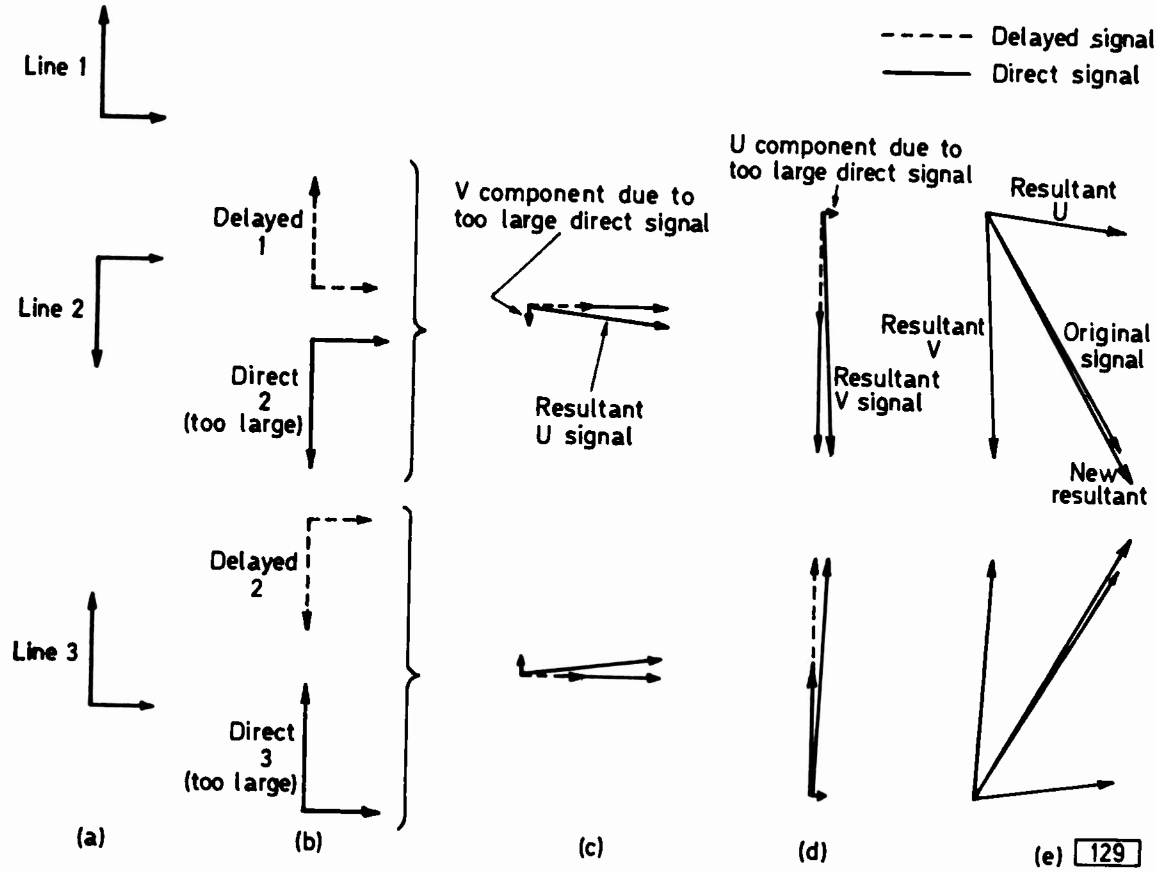


Fig. 9: The errors caused when the direct path signal to the matrix is too large (the direct and delayed signals should be equal). (a) Transmitted signal. (b) Delayed and direct signals applied to the matrix. (c) Adding to give the U output from the matrix. (d) Subtracting to give the V output from the matrix. (e) When the separated U and V signals are recombined the resultant obtained is not identical to the original signal.

to see what has happened to the original signal we get the resultant chrominance subcarrier shown in (e). This by itself however does not show clearly the evil effects which will accrue when it is demodulated even with minor errors of reference carrier phasing. Before going into this aspect of the matter let us see what happens when the delay line timing is wrong.

Incorrect Delay Time

It is difficult to manufacture a delay line to the very tight timing tolerances that are required and in any case differences of circuit impedance matching will cause slight variations of delay time. It is therefore normal practice to connect an adjustable coil across the input end of the line to introduce a reactive element which will produce a phase change of a few degrees in the subcarrier. This is used to cancel out as accurately as possible any small timing error in the line. Misadjustment of this phase correction causes a phase difference between the direct and delayed chrominance signals in the matrix and hence incomplete separation of U and V components.

We can see how this happens in Fig. 10. Diagram (a) shows the chrominance signal for three lines of the picture, as before. In (b) the U and V components are drawn for lines 2 and 3 at the input of the matrix circuit. The delayed signal in each case has a phase error of β. The result of adding these direct and delayed path signals and hence the output to the U channel is shown at (c) while (d) shows the results of subtracting the two signals to obtain the V channel signal.

You will see immediately that things have gone wrong again, only more so. The signal being fed into the U channel changes in amplitude from line to line, has an unswitched V component and the vector is rotated away from its axis. Anything more conducive to causing blinds and decoding errors in general would be hard to devise, but it is matched by the signal fed to the V channel. This also varies in amplitude from line to line, has a constant U component and is rotated off its axis.

If the signal in either the U or V channel has a different amplitude from line to line it is clear that even with perfect demodulation the output will vary and blinds are the inevitable result. If demodulation phase errors are present as well it is only to be expected that the phase errors in the U or V signal and the spurious signal components will add to the general confusion and produce further spurious components in the output.

Effect of Matrix Errors when Demodulation is Correct

If we take the effects of amplitude errors in the matrix, which were illustrated in the vector diagrams

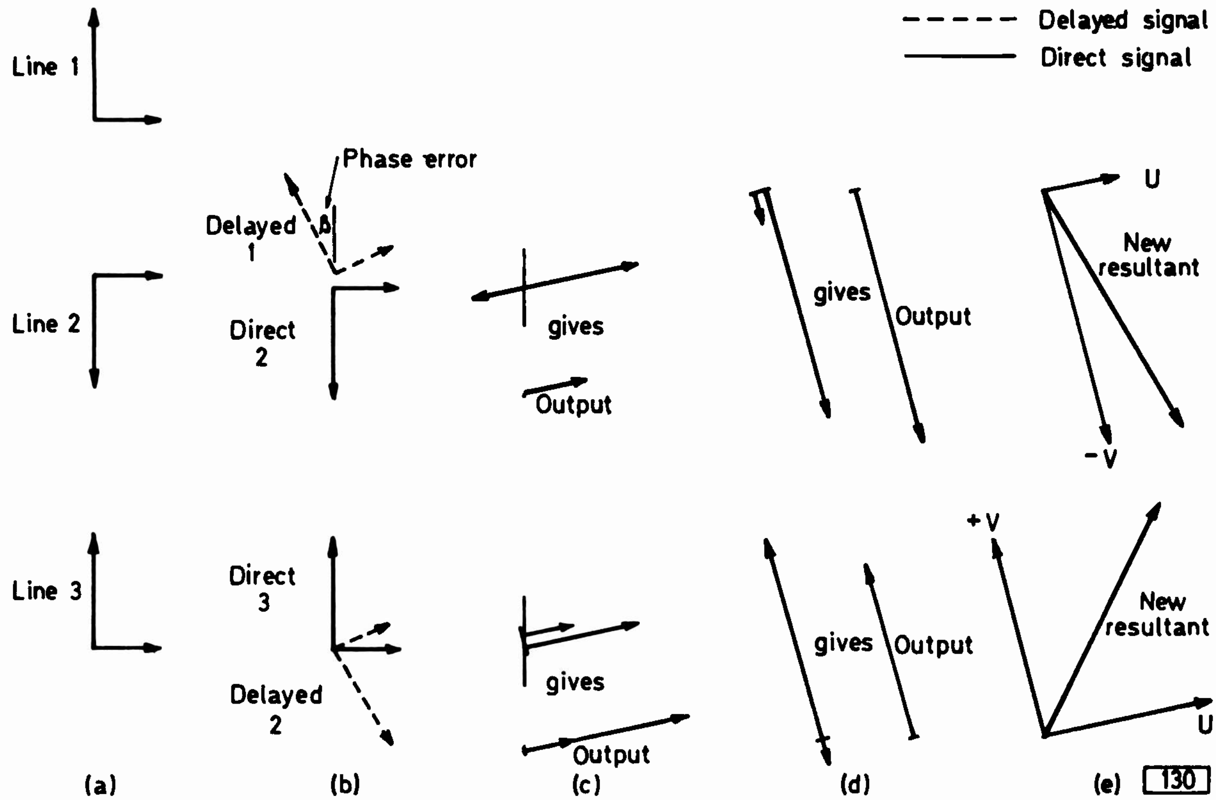


Fig. 10: The errors caused by a phase error in the path of the delayed signal to the matrix. (a) Transmitted signal. (b) Delayed and direct signals fed to the matrix. (c) Adding to give the matrix U output. (d) Subtracting to give the matrix V signal output. (e) The U and V signals vary in amplitude from line to line.

Note that the resultants shown in Figs. 9 (e) and 10 (e) will not be obtained with correct demodulation—only in the special case of demodulation along the axes of each individual U and V component.

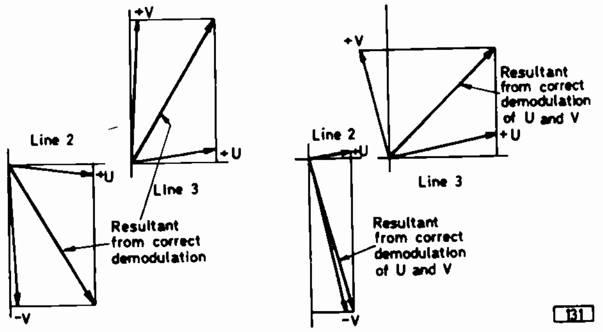


Fig. 11 (left): Correct demodulation of the U and V components shown in Fig. 9 (e) produces a resultant of incorrect amplitude but correct hue. There is no difference from line to line and thus no blinds.

Fig. 12 (right): The gross hue error on alternate lines caused by incorrect phase adjustment of the delay line. This causes hue blinds even with perfect demodulation.

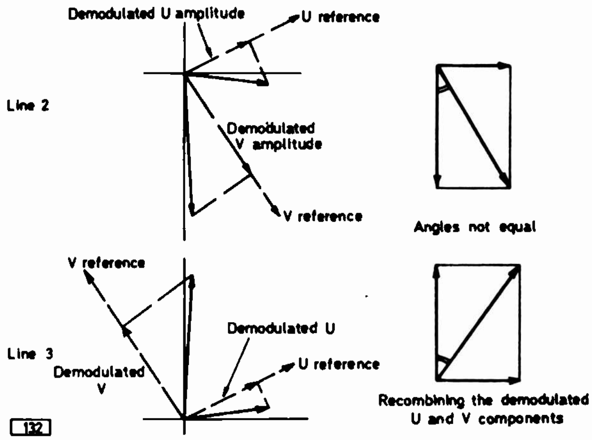


Fig. 13: Incorrect matrix amplitude adjustment and incorrect reference signal phases at the demodulators produce hue errors from line to line and thus blinds.

in Fig. 9(c) and (d), and demodulate the U and V outputs correctly we get the state of affairs shown in Fig. 11. In each case the demodulated outputs are too large—because the U and V signals coming from the matrix are too large—but they are in the same proportion and so no hue error is caused. No blinds are present because there is no difference from line to line.

The effect of matrix phase errors is shown in Fig. 12. As we commented earlier the outputs from both the U and V channels differ from line to line even with perfect demodulation and so blinds are inevitable. But take careful note: the resultant of the U and V components shows a marked hue error from line to line. Thus the amplitude errors of the individual U and V components appear on the picture as "hue blinds" rather than "saturation blinds". You will probably have to look at the line structure of the picture quite closely to see the difference, but the

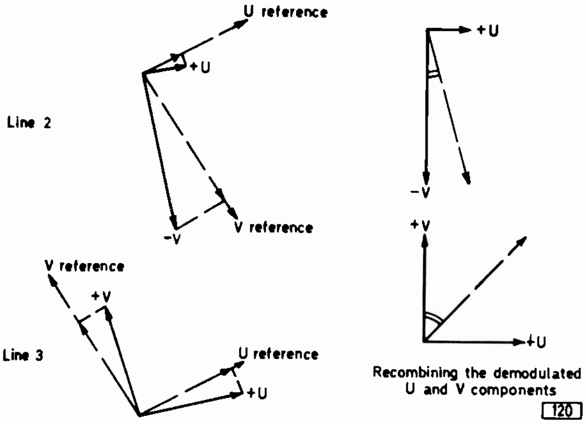


Fig. 14: The combination of a matrix phase error and demodulation phase errors causes gross hue errors and differences in saturation from line to line. The resulting blinds would be totally unacceptable.

diagnosis may come in useful when assessing decoding errors.

Matrix Errors + Faulty Demodulation

We do not wish to test your patience to breaking point with yet more vector diagrams, but it seems a pity not to complete our survey now that we have come so far together. You can always turn to the summary chart (p. 175) but here briefly are the results.

The effect of combined quadrature and static phase errors on the outputs of a matrix with inputs of unequal amplitudes is illustrated in Fig. 13. Unless the phase errors are equal to both demodulators there will be amplitude and hue errors in the resultant of the outputs. So we get blinds on the picture caused by both saturation and hue errors.

The equivalent case arising from a phase error in the matrix is shown in Fig. 14. The results are similar to those of Fig. 13 but the errors are enhanced by the amplitude errors from line to line which are present in the output from the matrix.

Conclusions this Month

Perhaps now it is timely to apologise for inflicting so many diagrams upon you. Unfortunately it is not practicable to describe PAL decoding problems in any other way and since this is a much neglected subject it seemed well worthwhile doing the job properly. Even so there are still a number of issues that we have not yet covered.

Just to summarise matters, here are the main conclusions from our survey:

(1) A static phase error in the a.p.c. loop swings both the U and V reference phases equally and causes equal desaturation to both demodulated outputs. It is not particularly harmful.

(2) A quadrature error causes a change of hue.

(3) An amplitude error in the matrix causes a saturation error with correct demodulation but hue and saturation blinds with even small swings of the phases of the reference carriers.

(4) A phase error in the matrix causes hue blinds with correct demodulation and both hue and saturation blinds with incorrect demodulation.

A more general conclusion is that the matrix must always be adjusted with the greatest care. If you have not yet the right equipment or experience it is probably better to leave well alone.

A further point is that any crosstalk between the U and V channels will cause blinds unless demodulation is very accurate and sometimes even if it is. Crosstalk is a design problem and can be caused by: coupling in the earth paths of the U and V channels; chrominance subcarrier in the luminance channel getting into the decoder; phase changes of the U or V signal, or reference carriers, due to base input capacitance of transistor stages; and in a number of other ways.

Now go and look at your nearest colour receiver and see if you can spot any blinds!

INCREASING THE X SENSITIVITY OF THE HEATHKIT OS1 'SCOPE

by K. J. Young

WHEN it is desired to display lissajous figures or to plot curves using the Heathkit OS1 oscilloscope the coarse speed switch (see Fig. 1) is placed in position 1 —rendering the X oscillator V4 inoperative—and the appropriate sinusoidal signals are fed to the X- and Y-amplifier inputs. As can be seen the X-amplifier input is taken to V4 anode and an input of about 6V r.m.s. with maximum X-gain setting is necessary. This problem can be overcome by modifying the circuit so that V4 acts as an X amplifier: the modification is shown in Fig. 1 and apart from the external a.f. transformer which is necessary for isolation and to preserve the correct phase relationship of the signals costs about 25p.

Position 1 on the left-hand capacitor switchbank shown in Fig. 1 must be permanently earthed. A socket in which the contact *closes* when the plug is withdrawn, for example a 3.5mm. phone socket, is connected between position 1 of the right-hand capacitor switchbank and chassis. The X signals are fed via the external transformer to a plug suitable for this socket. With the coarse speed switch in position 1 therefore V4 acts as an amplifier instead of being unused. This gives adequate sensitivity for all normal measurements and displays, e.g. curve tracing or bridge displays. The hole for the socket should be carefully drilled above the fine speed control, clear of other components. ■

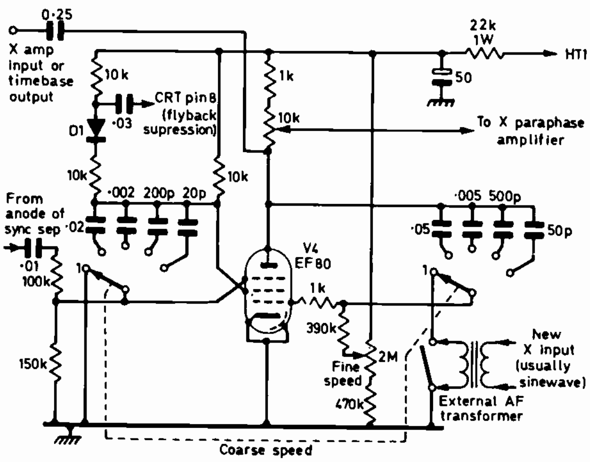


Fig. 1: Circuit details of the modification.

SERVICE NOTEBOOK

G. R. WILDING

VHF Tuner Troubles

There was no v.h.f. sound or vision on an Ekco Model TC437, only a brilliant, completely noise-free raster. U.H.F. was not obtainable locally, but on switching to 625 background hiss came from the speaker and grain appeared on the raster, clearly indicating either a v.h.f. tuner fault or defective power switching from one tuner to the other. There was normal h.t. present on the v.h.f. tuner's power input tag but we noticed that there was a cold, slightly discoloured resistor on top of the push-button unit. This had h.t. at one end but not the other. Reference to the service manual showed this resistor to be R13, 12kΩ, used to supply h.t. to the PCF801 triode on v.h.f. A resistance test showed that there was no short from the valve end to chassis and on replacing R13 we obtained normal reception, clearing up in minutes what at first sight seemed to be a lengthy job.

Common Faults

This emphasises the point made by the service department of a leading British manufacturer, that up to 90% of the faults found in v.h.f. tuners returned to them for service were of a basically simple nature that could very quickly be put right. Most complaints with v.h.f. tuners are due to defective contacts, strained valveholders or resistor burn-ups and in most instances careful visual inspection will reveal the trouble. Burnt out resistors are usually caused by interelectrode shorts in valves, to transposed r.f. amplifiers and mixers or to a breakdown in decoupling or lead-through capacitors.

Low Gain

Low gain is rather more difficult to pin down and though—apart of course from the valves—usually the result of an open-circuit or dry-jointed decoupler the practice of temporarily soldering a replacement across them seldom gives conclusive results. Quite often you may find that soldering a replacement appears to improve the gain but when you remove the suspect and wire the new one in its place in similar short-lead fashion the increase in gain has disappeared: in such cases the replacement's long leads were probably introducing slight positive feedback and/or mistuning the stage. The best and usually the quickest way in the end—after probing has failed to reveal a dry-joint—is to adopt the manufacturer's method and replace all suspect decouplers en bloc.

If printed circuit coaxial input sockets are used however check for a crack between the socket and the soldering points to which the aerial isolating capacitors are connected—this was a common fault with Pye/Ekco sets of a few years ago. Also check these capacitors by temporarily shorting them out with a screwdriver blade.

Although not part of the tuner make sure that the preset sensitivity or "delay" control circuitry is operative and applying a.g.c. to the r.f. amplifier only on high signal inputs. With valved tuners it is always safe to momentarily short-circuit the a.g.c. supply tag on the tuner to the earthed frame. On low inputs this action should produce negligible or zero gain increase but at high inputs it should produce a marked increase.

Also make sure that the right type valves are fitted—sometimes you may find a high-gain 30L15 in place of the earlier PCC84, used either mistakenly or in a misguided effort to increase the front-end sensitivity—and ensure that the coaxial output lead from the tuner to the i.f. strip is well connected at both ends.

If you find that touching the outer metal braid of the coaxial downlead or the shell of the coaxial plug increases contrast—these points are not directly earthed to the signal—there is either a soldering disconnection or the braid isolating capacitor is open-circuit. When contrast drastically falls following a local thunderstorm first take a look at these capacitors: on several occasions I have found one or other split open due to heavy instantaneous aerial voltages.

Cramped Raster Base

A raster that becomes cramped at the base a short while after switch-on is almost always caused by a defective field output pentode and/or reduced value cathode resistor. If the cramping remains fairly constant the odds are that the high-value electrolytic shunting the cathode resistor has lost most of its capacitance. On occasion however other faults can cause this base contraction and two quite different examples came our way recently.

The first was in an old convertible Pye model and after replacing the PCL85 and checking that the two series-connected cathode resistors totalled the correct 446Ω or very close to it we found that cathode voltage rose from its correct value of 18·5V at switch-on to almost 24V after about a quarter of an hour. The only likely cause for the underlying increase in cathode current was a leak to the pentode grid from the triode anode via the 0·01μF coupling capacitor and on replacing this component the cathode voltage stayed correct and the raster cramping ceased. Although these grid feed capacitors often come under suspicion in practice they seldom fail and we can recall only two or three other instances where they have been at fault.

The other example was a set fitted with the Thorn 950 chassis. This time the raster size and linearity were normal at switch-on but after about 20 minutes use the base contracted and there was also a slight reduction from the top. After checking the usual probabilities and as the resistors in the circuit had no discolouration (usually a reliable sign that they have not changed value) we disconnected the height-stabilising v.d.r. in the anode circuit of the PCL85

SERVICE ACTION: DISTORTED SOUND

(1) V.H.F./U.H.F. implying an a.f. fault.

Grating tone, probably worse at low volume levels: This is caused by the speaker coil rubbing against the magnet. Check speaker centring by light pressure on cone when distortion will increase or decrease as coil placement in gap is varied. The only real cure is replacement. With any speaker it should be possible to freely move the cone in and out without any suggestion of rubbing.

Nasal tone: This suggests an overbiased valve, particularly if it gets progressively worse as set temperature increases. Replace triode-pentode a.f. valve—usually a PCL82, PCL83 or PCL86—which will almost certainly be excessively hot due to grid current. Also check cathode-bias resistor for value reduction (common) or short-circuit bypass electrolytic (rarer).

A reduced-value pentode-cathode resistor will by underbiasing the valve cause excessive anode/screen current to further reduce the resistor's value in a cumulative manner and result in premature valve failure. Carbon type resistors tend to reduce in value on sustained overload currents.

If contacting the pentode control grid with a meter on its high-voltage range markedly reduces distortion check the feed capacitor from triode anode for leak. Surest method is to remove valve, short valveholder heater sockets and test for possible slight positive voltage at control grid socket. Occasionally leakage may only be apparent when set is warm. Replace capacitor if there is the slightest suspicion of its insulation not being perfect.

Also check that grid resistor is not high-resistance.

Excessively nasal, constant distortion: This is caused by an open-circuit cathode resistor, resulting in the shunting electrolytic breaking down and providing a comparatively high-resistance connection to chassis and thus grossly overbiasing the valve.

Thin reedy tone: Short-circuit turns on primary of sound output transformer (rare).

Strident, high pitched tone: Open-circuit tone control or negative feedback component.

Shrill reproduction, tending towards instability: Open-circuit decoupler or r.f. bypass capacitor. Unearthed output transformer core or secondary winding. Unearthed screened leads.

High hum level: Poor heater-cathode insulation in a valve. Open-circuit or reduced-value h.t. electrolytic smoothing capacitor. Replacement h.t. feed resistor not of sufficient value.

Hum level varies with field hold setting: Pickup from field timebase circuit to (usually) triode grid circuit. Impaired h.t. rail smoothing. Unearthed screened leads of volume control casing. Misplaced triode grid wiring or use of excessively large grid capacitor. An earthed metal-cased type will invariably cure this trouble.

(2) V.H.F. only.

Changed value resistors reverse-biasing the noise limiter diode.

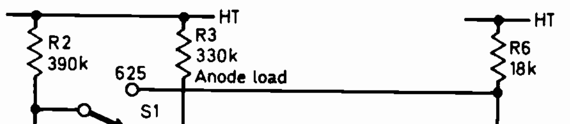
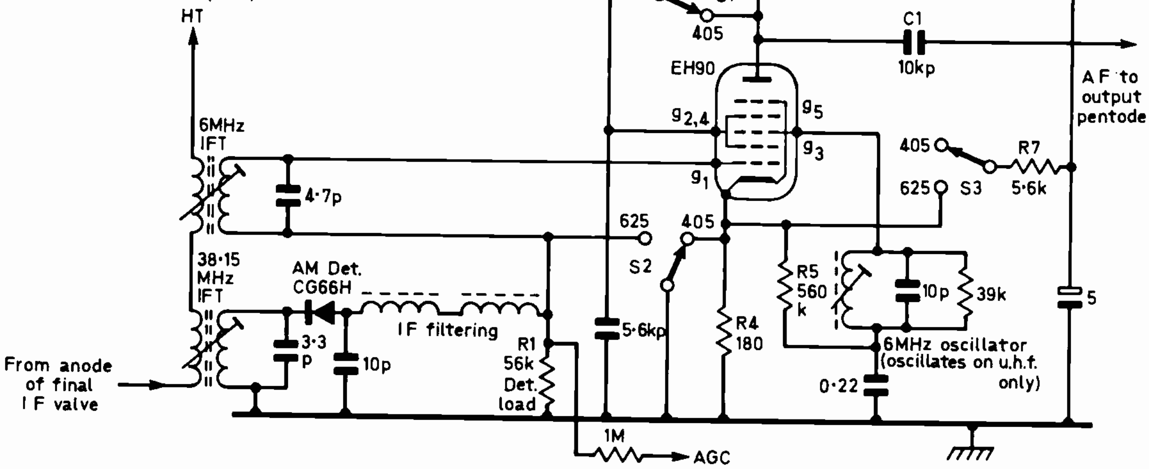
(3) U.H.F. only.

Defective diodes, malajusted a.m. balance control or drift in 6MHz i.f. transformer. These transformers can safely be readjusted on signal since input is constantly on frequency.

Incorrect working voltages with EH90 type of discriminator.

Note on EH90 circuits

These valves operate as heptode discriminators on u.h.f., the anode current being determined by the "locked-in" phase difference between the applied signal and the locally-generated 6MHz oscillation. See typical circuit below.

Typical EH90 circuit (Pye-Ekco). On v.h.f. the EH90 acts as a triode a.f. amplifier to the input signal across R1. On u.h.f. the EH90 acts as a high-output f.m. discriminator, S2 shorting the a.m. input and introducing cathode bias while S1 changes the valve to heptode operation and S3 powers the 6MHz oscillator via R5. Due to space-charge coupling within the valve the 6MHz tuned circuit begins to oscillate and this constant-phase signal plus the f.m. input control the anode current, i.e. the signal developed across R3 is determined by the phase difference between the a.f. signal impressed on the 6MHz carrier and the local 6MHz signal.

triode. The height immediately became excessive, as was to be expected, but on reducing it with the height control to just fill the screen we found that there was no subsequent variation. The field hold was not up to standard but as we didn't have the exact replacement to hand we fitted a 2MΩ resistor in place of the v.d.r. This seemed to restore normal locking and was left till the replacement arrived.

Very Dark Picture

A very dark picture on a receiver fitted with the STC-ITT VC51 chassis proved to be due to a brightness circuit fault: fully advancing the brilliance control on no-signal failed to produce the customary blank raster.

Unless you are sure that the video pentode is a.c. coupled to the tube the first move must be to replace this valve, for if it is d.c. coupled a significant reduction in its anode current due to excessive bias, reduced screen voltage or any other reason will increase its anode voltage and thereby that of the c.r.t. cathode to overbias the c.r.t. As the PCL84 video pentode is a.c. coupled in this chassis however, we immediately checked the c.r.t. voltages, for with this fault the cathode voltage must be too high or grid voltage too low. The former was 140V, a normal figure, but even with the brilliance control fully advanced the grid voltage indicated on our meter remained under 75V whereas it should reach about 130V. As the d.c. supply to the c.r.t. grid is via a 68kΩ resistor in series with another of 18kΩ from the slider of the brilliance control however, individual meter readings could vary considerably.

On next checking the voltage at the h.t. tag on the brilliance control we found little more than 75V though as this 500kΩ potentiometer is returned to chassis via a 47kΩ resistor and one pole of the on/off switch and is fed from the 230V h.t. rail via a 330kΩ resistor simple proportion indicated that there should be something in the region of 130/140V present depending on component tolerances. As anticipated, the 330kΩ resistor turned out to be markedly high-resistance and after replacing it full brilliance could be obtained with the control well back from maximum.

It gives better reception than mistletoe!

SIMPLE OUTDOOR UHF AERIAL

—continued from page 171

shown in Fig. 1 to take the cross bar. In order to secure the cross bar rigidly hole C is drilled with the bar in place and then counter bored in the wood on one side only to enable the nut to bear directly on the aluminium. Cut out sections ½ by ¼in. are shown dotted at the back of the block: these were made to enable the two cover screws to be 1½in. types—if longer screws are used these cut outs will not be needed.

The dipole elements are slid into ⅜in. holes—also reamed—as shown. This hole will run into the cross-bar hole but this is unimportant provided neither of the dipole halves touches the boom. When the dipole halves are in place holes are drilled for the cable bolts. These holes are drilled from the front, through the tubing. The back of the block can be counter bored for the screw head, to give just enough thread to take two nuts, two washers and the cable. The front is also counter bored so that the inner nut locks the tube firmly in place in its hole. Surplus wood between the bolts is cleared to enable the bared cable to lie flush when the cover block A is attached.

The prototype model shown in the accompanying photograph used a round-section dipole block.

Finish

All nuts and bolts should be rust proofed and blocks A and B should each be given a coat of varnish or emulsion paint before assembly. After mounting the reflector on the cross bar the dipole block B is attached to it. The cable is threaded through block A and attached to its bolts. A liberal coat of Bostik White Seal is applied over the inner face of the two blocks and the cover then screwed on.

Remove the surplus White Seal. White Seal should also be put around the cable entry and over all exposed nuts and bolts to reduce further the risk of corrosion. ■

LONG-DISTANCE TELEVISION

—continued from page 165

me I am sometimes unable to reply. Such readers should ensure, therefore, that their address is on the letter itself! Two recent letters have been from a reader in the Lebanon requesting advice and from Leslie Hetesi of Hungary who apparently has been very active, with reception from most countries in Europe including BBC-1 and Jordan ch.E3 via Sp.E.

Sunspot Predictions

Predictions, courtesy of the Swiss Solar Observatory: November 50. December 48. January 47. February 45. March 43. April 42.

DX-TV Pamphlet

The DX-TV pamphlet proved extremely popular, so much so that we quickly disposed of two printings. In view of the growing interest in this hobby I decided to rewrite the information in a somewhat larger and more detailed form with information on World-Wide television transmissions. This project is coming along well and I expect to be able to announce its completion shortly. In the meantime I must apologise to all those who wrote in for the original pamphlet and were disappointed.

COLOUR RECEIVER CIRCUITS

CHROMINANCE SIGNAL DEMODULATION

GORDON J. KING

THE previous instalment took us up to the output of the PAL decoder and matrix circuit (adder/subtractor system). We discovered that as a result of the electronic averaging of the direct and delayed lines of chroma signal, and the fact that the V chroma signal is alternated in phase line by line, phase insensitive U chroma signal is obtained from the adder part of the matrix and V chroma signal from the subtractor part. The next requirement therefore is to demodulate these separate chroma signals in order to produce the original R−Y and B−Y colour-difference signals.

We must bear in mind of course that although effectively of video frequency, i.e. within the video spectrum, the signals emanating from the PAL matrix are sidebands of the original colour-difference signals based on the subcarrier frequency of 4·43MHz. The original modulation was of amplitude so it follows that a simple amplitude detector would yield the original R−Y and B−Y information. Things however are not quite as easy as this because before demodulation can be accomplished the missing subcarrier must be reinserted. The 4·43MHz signal provided by the receiver for this purpose is commonly called the *reference signal* and the source the *reference generator*. Fig. 1 shows in block schematic form the general arrangement.

Each PAL matrix output requires its own detector. Thus we find one detector accepting the V chroma signal and delivering the demodulated R−Y signal and the other accepting the U chroma signal and delivering the demodulated B−Y signal. It will also be recalled that PAL weighting factors were applied to the R−Y and B−Y signals at the V and U modulators at the transmitter. This means that the detectors or associated circuits must introduce deweighting so that the true values of the R−Y and B−Y signals are ultimately obtained. The detectors are variously referred to as the V and U detectors, the chroma detectors, the R−Y and B−Y detectors or the red and blue detectors. I prefer calling them simply the V and U detectors after the names of the chroma signals applied to them.

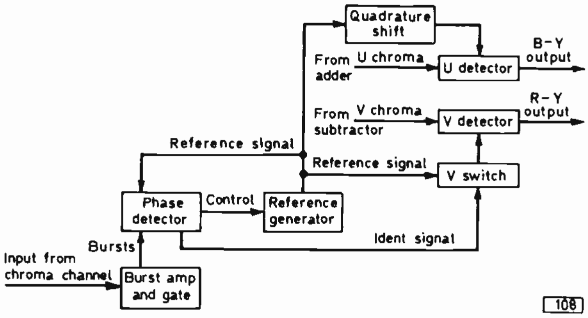


Fig. 1: Block diagram of the chrominance detectors and the reference signal arrangements required for synchronous demodulation.

One part of each detector receives the appropriate chroma signal and another part the reference signal. For accurate demodulation it is absolutely essential for the reference signal to match accurately the frequency and phase of the original subcarrier, and to make this possible the bursts transmitted on the back porches of the line sync pulses are derived from the transmitter's subcarrier generator. They are used at the receiver either to produce the reference signal or to synchronise the frequency and phase of the reference signal produced by the reference generator.

Because the V and U chroma signal subcarriers at the transmitter are in phase quadrature—as required for quadrature modulation—the equivalent reference signals applied to the V and U detectors in the receiver must also be in phase quadrature: that is a phase difference must exist between them of 90 degrees. As at the transmitter, a single source usually provides both reference signals and the quadrature shift is provided by a phase-shift network in one of the reference signal feeds to the detectors.

Demodulation of the U chroma signal is reasonably straightforward because the signal is "phase-constant" line by line. Because the phase of the V chroma signal changes line by line however the V detector must in some way be switched in synchronism with these alternations so that the R−Y output is also "phase-constant". This can be achieved by alternating the phase of either the reference signal *or* the chroma signal applied to the V detector line by line. Both schemes are found in practice.

The actual switching of the selected signal is not all that difficult but mild complications arise since the alternations must be synchronised with those at the transmitter. Clearly if the V detector is switched to operate in the +V phase when the actual signal phase is −V then the colour display is going to be seriously in error. The required synchronising information is provided by the swings of the bursts which it will be recalled are phased at 135 degrees (relative to the +U axis) when the V phase is positive and at 225 degrees when the V phase is negative. Thus the bursts swing ±45 degrees (90 degrees overall) relative to the −U chroma axis. The method of swinging equally either side of the −U chroma axis means that the *average* phase is in fact along the −U axis which is another requirement.

At the receiver the swinging bursts are effectively "detected" and give rise to a quasi-squarewave output of half-line frequency. After processing this signal is used to synchronise the V detector switching. The frequency is approximately 7·8kHz and the term *ripple* or *ident* signal is commonly used to describe it. In many receivers it is—as earlier instalments have shown—the ident signal which operates the colour killer and also sometimes the chroma trap in the luminance channel.

The block diagram (Fig. 1) summaries all this and the only sections not mentioned so far in this article are the burst amplifier/gate and the phase detector. The first picks up signal from the chroma channel via a 4·43MHz tuned circuit, the gate being arranged to open only during the periods of the bursts (the back porches of the line sync pulses). Thus the gate is switched by suitably processed line flyback or sync pulses. The gate blocks the chroma signal proper and the bursts that it passes are amplified and fed to the phase detector which also receives sample reference signal. It is the job of the phase detector to compare the reference signal with the bursts and when the parameters of frequency and phase fail to coincide to produce a control potential to correct the reference signal so that it matches the bursts in these respects.

The bursts from the amplifier/gate are also commonly rectified and used as a potential to automatically increase or decrease the gain of the chroma channel should the amplitude of the chroma signal decrease or increase for any reason. This of course is the automatic chroma control (a.c.c.) function which is desirable for maintaining the saturation level constant under various conditions of operation.

The various sections of Fig. 1 comprise a whole system and although from now on we shall be investigating each section separately in terms of the types of circuits used we should nevertheless keep the overall system in mind. Last month we concluded with the PAL decoder/matrix circuit so it is appropriate this month to go on to the V and U detector circuits.

The vast majority of colour receivers of recent design use four semiconductor diodes in each detector circuit (called a diode bridge circuit) but it is possible to employ two diodes or in fact a thermionic valve or transistor while in the latest sets integrated circuits are being increasingly used. For the time being however let us get to grips with the diode bridge circuit.

The basic diode bridge circuit shown in Fig. 2 is found in most PAL-D receivers. Two are used, one for the V chroma signal and the other for the U chroma signal. To make the V detector suitable for the alternating $\pm$V chroma signal the phase of the reference signal fed in via T1 is generally alternated line by line by means of switching diodes (not shown) in the reference signal coupling circuit. For the moment though we will assume that the input is the U chroma signal or if you like the V chroma signal minus its phase alternations.

It is simplest to think of chroma detectors of this kind as being switched on by the reference signal during part of one half-cycle of each complete reference signal cycle. The reference signal is applied across points A and B on the diode bridge and since

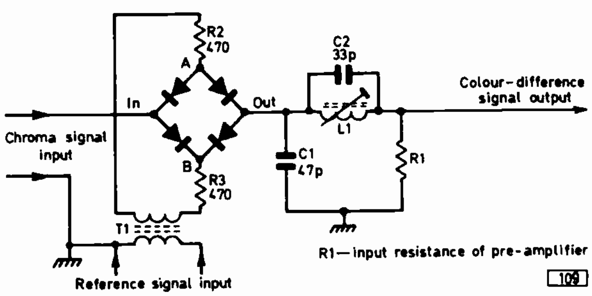
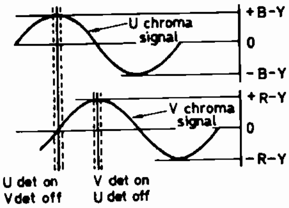


Fig. 2: The diode bridge synchronous detector circuit shown here is widely used in colour receivers.



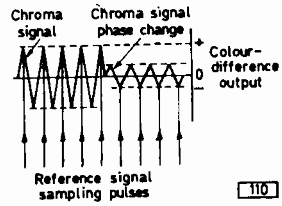


Fig. 3 (left): The signal sampling periods of the two chroma signal synchronous demodulators. The amplitude and polarity of the colour-difference signal output from the detectors is determined by the amplitude and phase of the chroma signal at the instant of sampling.

Fig. 4 (right): How the colour-difference signal output changes with the amplitude and phase of the chroma signal.

it is a sinewave it follows that on the half-cycle which makes point A positive with respect to point B all four diodes switch on thereby providing signal continuity between the points on the bridge marked in and out. At the same time of course the chroma signal is present at point *in* so the effective chroma signal voltage appears at point *out* where it passes through filter L1/C2 to the appropriate colour-difference preamplifier. On the subsequent half-cycle of reference signal point A swings negative with respect to B and the four diodes switch off thus disconnecting the path from in to out.

As this action continues the charge which develops on C1 results in the diodes switching on only during the peaks of the appropriate half-cycle of reference signal. This is because the time-constant of C1, R1 (the latter component being the detector load) is adjusted to suit the frequency of the reference signal. The time-constant of C1 and R1 is in fact in the order of 0·23μS. In some circuits R1 consists of the input resistance of the appropriate colour-difference preamplifier. L1 and C2 form a filter which removes the unwanted chroma components, leaving only the colour-difference signal for application to the preamplifier. Resistors R2 and R3 in series with the reference signal source serve as "hold offs" to avoid reference generator damping and high peak currents in the diodes due to the reference signal.

Chroma Detector Action

The action of a chroma detector can be described in various ways but the two main points to keep in mind are (1) that the amplitude of the chroma signal determines the magnitude of the colour-difference signal and (2) that the instantaneous phase of the chroma signal determines the polarity of the colour-difference signal. This is of course merely the reciprocal of the modulation operation.

The detector is designed so that the chroma signal is sampled for a short period of time during each reference signal cycle. Indeed the reference signal can as we have seen be regarded as a switching signal for the detector. The switching of the two chroma detectors in phase quadrature (remember that there is a 90° phase difference between the reference signals fed to the two detectors) is illustrated diagrammatically in Fig. 3. It will be seen that when the U detector is switched on by the reference signal to sample the amplitude and phase of the U chroma signal the V chroma signal should be passing through zero. Conversely when the V detector is switched on by its reference signal the U chroma signal should be at zero.

There can never be a really instantaneous sample because the diodes are bound to remain conductive for a finite part of the positive half-cycle of the reference signal. The sampling period ("dwell angle") differs between circuits but is not usually a significant portion of the switching half-cycle.

In Fig. 3 the U and V chroma signals are shown being sampled when their phases are positive-going. Thus the outputs will be +B−Y and +R−Y respectively. Owing to the nature of the colouring information the U chroma signal phase at the instant of sampling could be negative, in which case the appropriate detector output would be −B−Y of magnitude governed by the amplitude of the modulation. The same of course applies to the V chroma signal.

Figure 4 attempts to illustrate the action when a chroma signal alters from one phase and amplitude to another. The amplitude change is obvious. To emphasise the phase change the chroma sinewaves are shown as expanded triangular waves. It will be seen that when the positive peaks of the larger amplitude sinewaves to the left are sampled a colour-difference output of positive polarity is obtained while after the signal phase change the lower amplitude negative peaks to the right appear at the sampling times and give a colour-difference output of negative polarity and smaller magnitude. For accurate operation it is essential for the reference signal to remain constant in frequency and phase.

That is all there is to it really! Some texts illustrate the effect differently and different writers have their own pet ways of explaining the action. Many people have difficulty in understanding why the chroma signal consists of 4·43MHz sinewaves since the subcarrier is suppressed at the transmitter. The sinewaves of course represent the components of the sidebands and it is the modulation information which results in the amplitude and phase changes. The former controls the saturation and the latter the hue.

From all this it can be seen that the exact timing of the reference signal is of the utmost importance: timing in this context means phasing, and in a PAL-D receiver incorrect phasing can affect both the saturation and hue of a display. It can also result in crosstalk between the V and U signals at the detector outputs and encourage Hanover bar interference.

Before leaving the general theory of detector operation it should be understood that the amplitude and phase of a chroma signal can change more often and over more intermediate values than implied in Fig. 4. In this diagram the phase and amplitude of the chroma signal are shown remaining constant for a number of sampling reference signal cycles then changing to another stable value. This is what would happen for example during a transmission of the colour bars: in fact the change in amplitude and phase in Fig. 4 is representative of what happens from one colour bar to the next with the U chroma signal.

Complete Decoding System

To conclude this month Fig. 5 shows the complete system including the PAL delay line and matrix which were fully examined last month. Excluding this therefore we have the V detector D1 and the U detector D2, both diode bridge arrangements, which receive the appropriate signals from the PAL matrix. Each detector also receives a reference signal from the crystal-controlled reference generator.

The reference signal to the U detector passes first

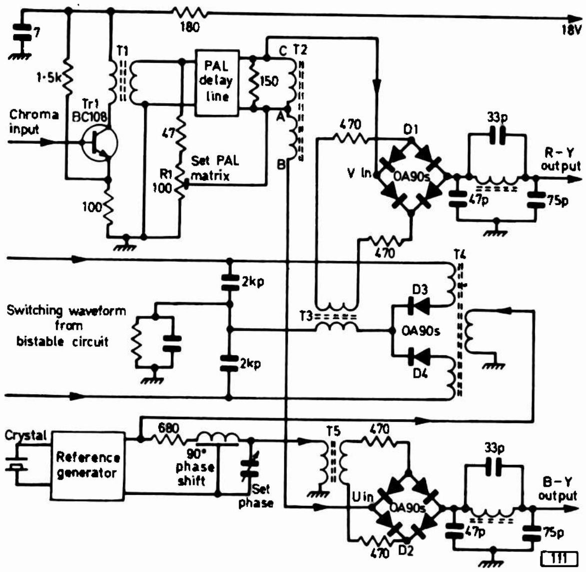


Fig. 5: The complete decoding system: PAL delay line, adder and subtractor (T2), synchronous detectors (D1 and D2), reference signal generator, PAL V switch (T4 with D3 and D4) and 90° phase shift network.

through the 90-degree phase shifter (to provide the correct timing for quadrature demodulation) and thence to the coupling transformer T5.

PAL V Switch

The reference signal to the V detector passes through a more complicated circuit which includes the switch for alternating the phase of the reference signal line by line to counter the PAL ±V chroma signal alternations. The reference signal goes first to T4 and thence via T3 to the detector D1. There are two secondary windings on T4 and to get from either one of these to T3 primary the signal has to pass through diode D3 or D4.

These diodes constitute the V switch and are themselves switched on and off alternately line by line by the squarewave outputs from a bistable circuit (not shown) which will be investigated in a subsequent instalment. The two secondary windings on T4 provide outputs in opposite phase, thus providing the actual phase inversion of the reference signal. In action D3 is on when D4 is off and vice versa. Thus when D3 is on the reference signal passes to T3 primary from the top secondary of T4 and when D3 switches off and D4 switches on the reference signal arrives at T3 primary in opposite phase from the bottom secondary of T4 via D4. Clearly then the phase of the reference signal applied to the V detector D1 swings over 180 degrees each time the diode switch D3/D4 is operated; and since the switch operates line by line, line by line phase alternations occur.

This is where we must leave off this month. The general plan of the scheme should now be clear and in this respect it would be a good idea to keep Fig. 1 handy or better still in mind! We should by now be fairly clear how the chroma detectors work—how they sample the amplitude and phase of the chroma modulation and yield colour-difference signal outputs of varying magnitude and polarity. With these very important factors resolved we can progress next month towards the various other circuits.

YOUR PROBLEMS SOLVED

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FERGUSON 3800

This 20in. receiver is fitted with the BRC 1500 chassis. The height control is right at one end of its track. The PCL805 field timebase valve has been replaced and the voltages in the stage checked but they all seem to be OK. There is still a 1¼in. band at the bottom of the picture.—F. George (Bradford).

If the picture is compressed at the bottom check the field output stage bias decoupler C79. The value of this is 160μF but a 250μF 25V one will do. If the overall height is lacking check R123 (330kΩ) and C89 (1μF) which decouple the boost feed to the oscillator section and R93 (330kΩ) in series with the height control.

EKCO T422

There is no raster and the PL36 glows cherry red. The picture went suddenly without any previous deterioration. The PL36 and PY800 have been tested and found to be OK.—P. Redmond (Norfolk).

It seems that the line oscillator valve V14, PCL84, is faulty. Check this and the coupling capacitors C90 47pF (150pF in some chassis) and C87 0·01μF.

GEC BT302

When the valves have warmed up there is a vertical band of light about 1in. wide accompanied by a very faint picture which fills the left-hand side of the screen. After a few moments the line whistle alters and the narrow strip expands to fill the whole screen area, growing very dim and then disappearing. If the PY81 top cap is removed the original fault condition reappears. All the line timebase valves have been replaced. The PL81 screen voltage appears to be rather high and the boost voltage low.—B. Gray (Basildon).

The defective component is the boost reservoir capacitor. This is C152, 0·1μF, on the left side just above the line output section. Use a replacement rated at 1kV.

PYE 169 CHASSIS

When a dark scene is being received there is vertical, alternately dark and light shading in the form of 2in. wide bars. The same effect is present on all programmes and aerial adjustment has made no improvement. The bars go right across the screen but the one nearest the left is slightly stronger than the others.—R. Knight (Harrogate).

The problem seems to be trouble with the flyback suppression circuit and we suggest you check C82 1kpF, C35 22kpF and R92 120kΩ.

KB KV005

After about 20 minutes the sound becomes very distorted and stays this way until the set is switched off and allowed to cool.—T. Blake (London W3).

Replace the PCL86 audio output valve and check that its bias resistor R123 120Ω (pin 7) is the correct value. If necessary check the value of the 10MΩ resistor R115 which loads the noise limiter diode.

FERGUSON 3660

After switching on, the sound on one of these models (BRC 1400 chassis) periodically reduces, sometimes to nothing. The operation of a switch on another electrical appliance, e.g. fire, fridge or a light, will sometimes produce this fault and at other times bring the sound back to normal for a while. The fault is less troublesome when the set has been in operation for an hour or two and only affects v.h.f.—R. Didcomb (Leicester).

This is not an easy type of fault to pinpoint. However it is almost certainly due to a faulty capacitor and is likely to be one across one of the 405 sound i.f. coils. The suspects are C56 75pF, C65 22pF and C71 22pF.

PYE 11U

When first switched on the picture is normal. After five minutes or so however the picture becomes over contrasted and negative with loss of sync. The set is operating on u.h.f. If the preset contrast control is turned down the fault is cured for a minute or two but then recurs. This process can be repeated until you end up with a picture with little or no contrast in order to get a stable picture.—P. Dewhurst (Denbigh).

Replace the video/sync/a.g.c. valve PCL84 (V9) and then check the resistors in the video circuit—R26 5·6kΩ the screen feed, R30 150Ω the cathode bias and R27 330Ω the grid stopper.

GEC 2048

On viewing the screen from the front the left-hand side of the picture is lighter than the right-hand side. The components associated with the tube grid circuit —C241, C233, C234, R245, R248, R244 and R249 have all been replaced without success. By altering component values the condition can be made worse but not better, i.e. the left-hand side of the picture can be made lighter still.—A. Chater (Chippenham).

The trouble is most likely to be due to faulty tube first anode or grid circuitry and as you have checked the latter we suggest you check the decoupling of the first anode supply—R243 680kΩ, C231 22kpF and R311 22kΩ. If this does not solve the problem check the earthing of the tube coating. Then try removing the video signal, leaving a blank raster, to see whether the fault persists. If it is not now present check the smoothing of the l.t. supply to the transistor stages (derived from the line output transformer) as if the decoupling here is faulty the signal will be modulated at line frequency.

PYE 59

The sound is OK but the picture is dark when the brightness is set half way and also narrow with a 2in. margin at both sides. When the brightness control is turned up the picture widens to fill the screen but then disappears leaving a blank, dark screen. On turning the brightness down again the picture comes back as before. The height is OK. The line timebase valves and output transformer have been replaced without improving matters.—T. Hope (Daventry).

We suspect low h.t. and also suggest you check the main reservoir capacitor C66. Alternatively the drive to the line output valve may be incorrect. Also check the boost reservoir capacitor which is C118 (0·047μF).

BUSH TV103

On increasing the brightness or contrast control settings the picture goes negative. All valves have been checked and found to be up to standard. The picture tube voltages have been checked and the first and focus electrode readings seem a little low.—A. Creveny (Hull).

You will probably find that the focus control has changed value: change it or put a 1MΩ resistor in series with it. This will brighten the picture to some extent but the tube is no doubt wearing and in need of replacement.

LONG-DISTANCE ITV

We have installed here at Portslade, Sussex, a channel 9 aerial in order to try to receive London ITV, using a GEC model 2019. We get a fair picture but the fine tuner has to be adjusted so much in order to receive the sound that the picture is nearly lost. Is there any way of tuning in the sound better without losing picture quality? The local-distance link is set at distant.—L. Jarvis (Portslade).

Assuming that the aerial is an efficient one capable of long-distance reception we can only recommend a mast-head amplifier to boost the signals before they are applied to the set. Other than this the i.f.s could be peaked to narrow the bandwidth (increasing the overall gain) but this may impair the definition achieved with local transmissions.

HMV 2703

This colour set is fitted with the BRC 3000 chassis. The fault is no colour. Also after two-three hours the line hold control has to be adjusted to one end of its range, a black band then appearing on the left-hand side.—J. Trafford (Newport).

It is possible that both these faults are caused by the same component. However, first check the chrominance fault. Check that the fine tuning is correct. If it is connect an 82kΩ resistor from the junction of C323, C324 across the ident amplifier 7·8kHz coil to chassis. This will switch on the PAL switching transistor VT307 and over-ride the colour killer action. If you obtain a good colour picture by doing this the fault lies in the colour killer circuit: check the associated components especially the diodes W305 and W322. If on the other hand you obtain Venetian blinds it is most likely that the fault is in the 7·8kHz ident circuit or the PAL switch W309-W310. The switching diodes can easily be checked but the ident circuit is not so easy: if this is working however an audible whistle will be heard from the loudspeaker if a 470kΩ resistor is connected from the junction of C323, C324 to the slider of the volume control. If this cannot be heard check the ident circuit. If on over-riding the colour killer there is no colour at all check the reference oscillator VT304 and the chrominance stages VT110, VT309 and VT310. Turning now to the line oscillator fault, check the electrolytics C506 and C511 in the line oscillator stage. Check also the flywheel sync diodes W501 and W502. Also the resistors R502, R524 and R505 in the line hold control circuit as these may be high-resistance. Finally C520, 7500pF, in the circuit which supplies the burst gating pulses can cause no colour which will return if the line hold is unlocked.

GEC 2018

Sound and vision disappeared on 625 lines. The tuner unit was removed for examination but no obvious fault was found. On refitting the tuner unit all three u.h.f. channels came back to life. After about four hours however the ITV signal went off. BBC-1 was tuned in and lasted a few more hours before that too went off. The same thing happened with BBC-2.—G. Dossett (Oxford).

The trouble you describe is quite common on this series of models and is caused by the mixer-oscillator transistor failing to oscillate. The transistor—Tr2, AF186—can be replaced or alternatively the problem can be overcome by raising the 12V supply to 13V by shunting the upper resistor R32 (10kΩ wire-wound) of the potential divider which supplies the u.h.f. tuner with a resistor of some 47kΩ—check with a voltmeter.

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TELEVISION FEBRUARY 1972

TEST CASE

110

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 Philips Model G24T300 came in with the complaint of height varying spasmodically. The outside engineer had already performed the usual on-site tests, including changing the PCL85 and EF80 valves used in the field timebase, checking the field timebase panel interconnections and examining the obvious timebase components, but to no avail.*

The back was removed in the workshop and the receiver operated normally when switched on and failed to show the symptom even after an hour's operation. It was then set up on the test bench with the back held in position at one fixing point, the display being checked from time to time by the apprentice. After thirty minutes or so the symptom appeared, starting with field judder and developing fairly quickly to intermittent height variation, ending up with the height reducing to about 2in.

The apprentice was asked to observe the picture while the bench engineer quickly removed the back and performed an exploratory test armed with only a screwdriver. To the amazement of the apprentice the symptom disappeared and although there was slight vertical overscan the picture was perfect. What component was most likely to be responsible for the symptom and what could have been the exploratory test made by the engineer to prove the possibility? See next month's TELEVISION *for the solution and for another item in the Test Case series.*

SOLUTION TO TEST CASE 109

Page 138 (*last month*)

After testing almost every component in the line timebase, including the line output transformer, the technician in desperation decided to extract the scanning coils for detailed examination. This was where the trouble was discovered.

The line linearity control in this model consists of a copper foil loop cemented to the inside of a paper sleeve operating inside the scanning coils round the tube neck. Linearity is adjusted by moving the sleeve. If the sleeve and hence the loop is incorrectly adjusted the line scan as well as the linearity is affected due to the loop acting something like a shorting turn. The loop in the set in question had departed from the sleeve and had become stuck to the tube neck in the "shorting turn" position!

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EF80	39p	PCL82	48p	U26	91p	30F5	91p
EF85	41p	PCL83(S)	60p	U37	75p	30FL1 & 2	62p
EF183/4	54p	PCL84	57p	U191	86p	30L15	91p
EH90	51p	PCL805/85	54p	U193	47p	30L17	86p
EY51	60p	PCL86	63p	U251	91p	30P12	90p
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Large bulb Imported PCF80 30p! Philips PCL805/85 54p!

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EF85	12½p	PCF80	7½p	PY33	22½p
EF183	12½p	PCC89	12½p	U191	17½p
EF184	12½p	PCL85	22½p	6F23	17½p
EY86	17½p	PCL82	17½p	30PL1	22½p
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ECC82	30p	PCF801	50p	PL84	55p	6CD6G	90p	30P19	70p
ECL80	40p	PCF802	50p	PL500/4	65p	6F23	75p	30PL13	75p
EF80	27p	PCF805	50p	PY81	35p	6F28	48p	30PL14	75p
EF183	37p	PCF808	60p	PY800	35p	20L1	85p	etc., etc.	
EF184	37p	PCL82	37p	PY801	35p	20P4	90p		
EH90	45p	PCL83(s)	50p	U25	65p	30C15	70p		
EY51	50p	PCL84	37p	U26	60p	30FL1 & 2	75p		
EY86/7	37p	PCL85	45p	U191	65p	30L15	75p		

NOTE
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AERIALS

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2N2369	15p	2N3404	32p	2S322	50p
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2N2412	50p	2N3415	20p	2S324	£1·20
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DIODES & RECTIFIERS

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AA120	8p	BYZ10	35p	OA47	7p
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BY101	12p	BYZ16	35p	OA85	7p
BY105	15p	BYZ17	35p	OA90	6p
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BI-PAK Order No.	Similar Types to: Description	Price and qty. prices 1-24 £p	25-99 £p	100 up £p
BP00 = 7400	Quad. 2-input NAND gate	0·15	0·14	0·12
BP01 = 7401	Quad. 2-input positive NAND gate (with open collector output)	0·15	0·14	0·12
BP02 = 7402	Quad. 2-input positive NOR gates	0·15	0·14	0·12
BP03 = 7403	Quad. 2-input positive NAND gates (with open collector output)	0·15	0·14	0·12
BP04 = 7404	Hex Inverters	0·15	0·14	0·12
BP05 = 7405	Hex Inverter (with open-collector output)	0·15	0·14	0·12
BP10 = 7410	Triple 3-input positive NAND gates	0·15	0·14	0·12
BP13 = 7413	Dual 4-input Schmitt trigger	0·29	0·26	0·24
BP20 = 7420	Dual 4-input positive NAND gates	0·15	0·14	0·12
BP30 = 7430	8-input positive NAND gates	0·15	0·14	0·12
BP40 = 7440	Dual 4-input positive NAND buffers	0·15	0·14	0·12
BP41 = 7441	BCD to decimal nixie driver	0·67	0·64	0·58
BP42 = 7442	BCD to decimal decoder (4-10 lines, 1 of 10)	0·67	0·64	0·58
BP46 = 7446	BCD-to-seven-segment decoder driver	2·00	1·75	1·50
BP47 = 7447	BCD-to-seven segment decoder drivers (15V outputs)	0·97	0·94	0·88
BP48 = 7448	BCD-to-seven-segment decoder driver	0·97	0·94	0·88
BP50 = 7450	Expandable dual 2-input and-or-invert	0·15	0·14	0·12
BP51 = 7451	Dual 2-wide 2-input NAND-or-invert gates	0·15	0·14	0·12
BP53 = 7453	Quad. 2-input expandable NAND-or-invert	0·15	0·14	0·12
BP54 = 7454	4-wide 2-input NAND-or-invert gates	0·15	0·14	0·12
BP60 = 7460	Dual 4-input expander	0·15	0·14	0·12
BP70 = 7470	Single-phase J-K flip-flop	0·29	0·26	0·24
BP72 = 7472	Master-slave J-K flip-flop	0·29	0·26	0·24
BP73 = 7473	Dual master slave J-K flip-flop	0·37	0·35	0·32
BP74 = 7474	Dual D type flip-flop	0·37	0·35	0·32
BP75 = 7475	Quad. latch	0·47	0·45	0·42
BP76 = 7476	Dual J-K with pre-set and clear	0·43	0·40	0·38
BP80 = 7480	Gated full adders	0·67	0·64	0·58
BP81 = 7481	16-bit read-write memory	0·97	0·94	0·88
BP82 = 7482	2-bit binary full adders	0·97	0·94	0·88
BP83 = 7483	Quad. full adder	1·10	1·05	0·95
BP86 = 7486	Quad. 2-input exclusive Nor gates	0·32	0·30	0·28
BP90 = 7490	BCD decade counter	0·67	0·64	0·58
BP91 = 7491	8-bit shift registers	0·87	0·84	0·78
BP92 = 7492	Divide-by-twelve counters	0·67	0·64	0·58
BP93 = 7493	4-bit binary counters	0·67	0·64	0·58
BP94 = 7494	Dual entry 4-bit shift register	0·77	0·74	0·68
BP95 = 7495	4-bit up-down shift register	0·77	0·74	0·68
BP96 = 7496	5-bit parallel in parallel out shift-register	0·77	0·74	0·68
BP100 = 74100	8-bit bistable latches	1·75	1·65	1·55
BP104 = 74104	Single J-K flip-flop equiv. 9000 series	0·97	0·94	0·88
BP105 = 74150	Single J-K flip-flop equiv. 9001	0·97	0·94	0·88
BP107 = 74107	Dual master slave flip-flop	0·40	0·38	0·36
BP110 = 74110	Gates master-slave flip-flop	0·55	0·53	0·50
BP111 = 74111	Dual data lock-out flip-flop	1·25	1·15	1·00
BP118 = 74118	Hex set-reset latches	1·00	0·95	0·90
BP119 = 74119	Hex set-reset latches. 24-pin	1·35	1·25	1·10
BP121 = 74121	Monostable multivibrators	0·67	0·64	0·58
BP141 = 74141	BCD-to-decimal decoder/driver	0·67	0·64	0·58
BP145 = 74145	BCD-to-decimal decoder/driver. O/C	1·50	1·40	1·30
BP150 = 74150	16-bit data selector	1·80	1·70	1·60
BP151 = 74151	8-bit data selectors (with strobe)	1·00	0·95	0·90
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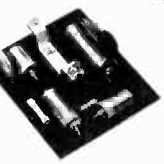

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