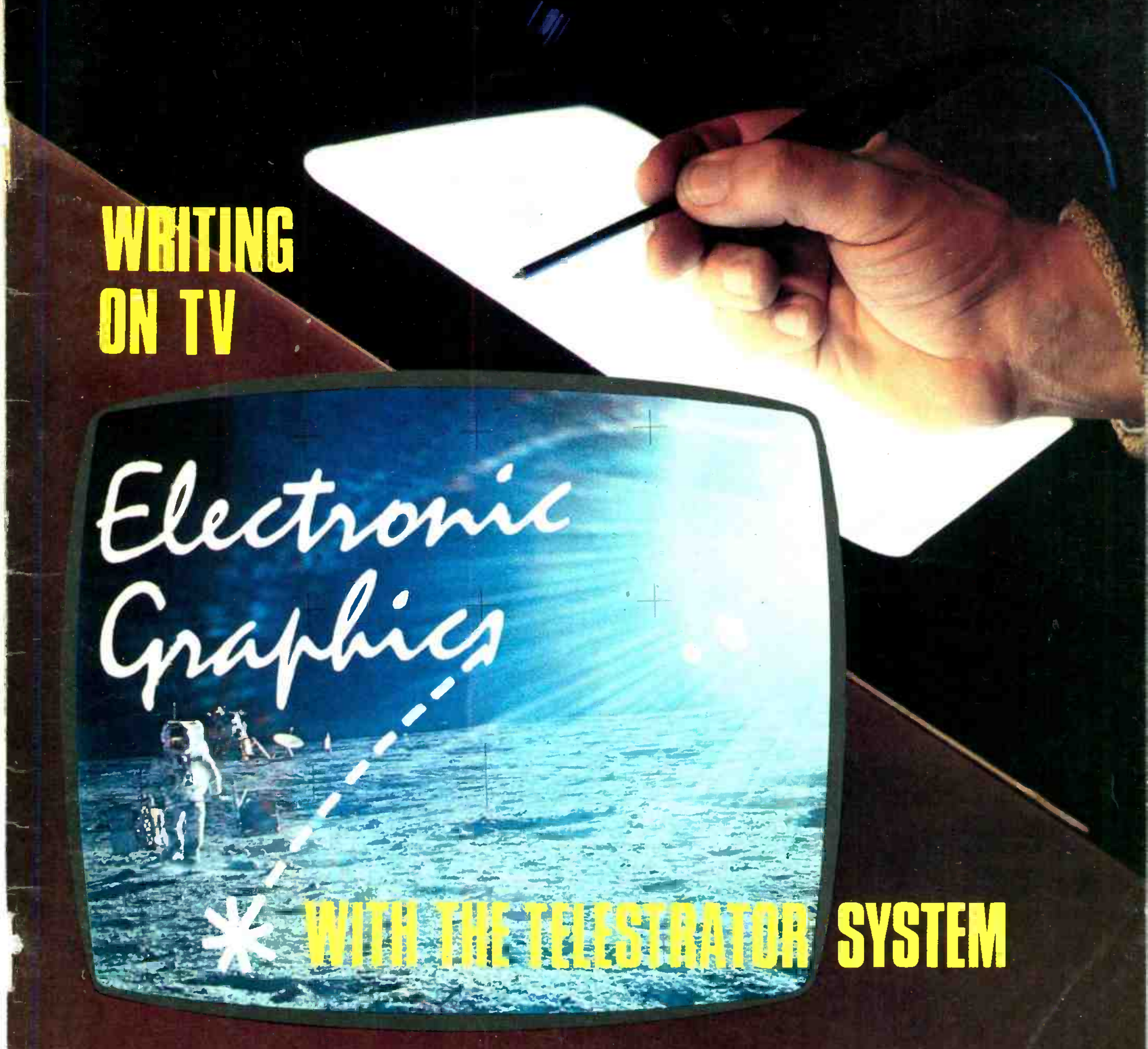
TELEVISION

SERVICING · CONSTRUCTION · COLOUR · DEVELOPMENTS

20p

JANUARY 1972

WRITING ON TV



WITH THE TELESTRATOR SYSTEM

ALSO:
TIME-SAVING REPAIR HINTS
FAST-ACTING VISION AGC
SERVICING THE GEC BT302 SERIES

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	£1·25	U25	75p	6AU6	29p	6F11	32½p	6T8	32½p	12Q7G	25p	35B5	65p
DAF96	41p	ECH84	47½p	EM81	42½p	PCF84	47½p	QVO3-12	65p	U26	75p	6AU6	30p	6F12	22½p	6U4GT	62½p	12SC7	25p	35C5	35p
DF91	45p	ECL80	40p	EM84	37½p	PCF86	61p	R19	65p	U191	72½p	6BA6	47½p	6F13	35p	6U8	35p	12SG7	35p	35D5	65p
DF96	45p	ECL82	49p	EM87	55p	PCF200/1	81p	R20	75p	U193	41p	6BE6	60p	6F14	60p	6V6GT	32½p	12SH7	25p	35L6GT	47½p
DK91	57½p	ECL83	57½p	EN91	32½p	PCF801	61p	SU2150A	75p	U301	85p	6BH6	42½p	6F15	55p	6X4	25p	12SJ7	25p	35W4	25p
DK96	57½p	ECL86	49p	EY51	40p	PCF802	61p	TT21	£2·40	W729	55p	6BJ6	42½p	6F18	40p	6X5GT	27½p	12SK7	40p	35Z3	55p
DL92	37½p	ECLL800	£1·50	EY80	45p	PCF805	65p	TT22	£2·50	Z759	£1·22½	6BK7A	50p	6F22	32½p	6X8	55p	12SL7GT	40p	35Z4G	25p
DL94	37½p	EF39	52½p	EY81	40p	PCF806	61p	U18/20	67½p	OA2	32½p	6BL8	35p	6F23	77½p	6Y6G	60p	12SN7GT	40p	35Z5GT	37½p
DL96	46p	EF80	40p	EY83	55p	PCF808	67½p	U20	67½p	OA3	45p	6BN5	42½p	6F24	67½p	7Y4	60p	12SQ7	40p	50A5	65p
DM70	32½p	EF83	50p	EY86	40p	PCH200	70p	U25	75p	OB2	32½p	6BN6	40p	6F25	75p	9BW6	42½p	12SR7	32½p	50B5	35p
DY86/7	40p	EF85	41p	EY87	42½p	PCL82	51p	U26	75p	OB3	50p	6BQ5	25p	6F26	35p	10C2	50p	14S7	80p	50C5	35p
DY802	42½p	EF86	66p	EY88	42½p	PCL83	61p	U31	45p	OC3	35p	6BR7	75p	6F28	70p	10D1	40p	20D1	45p	50L6GT	40p
E55L	£2·75	EF89	40p	EZ35	27½p	PCL84	51p	U37	£1·50	OD3	32½p	6BR8	95p	6F29	32½p	10D2	40p	20L1	£1·00	83A1	90p
E88CC	40p	EF91	42½p	EZ40	45p	PCL85	52½p	U50	30p	3Q4	40p	6BW6	82½p	6F30	35p	10F1	90p	20P1	50p	85A2	37½p
E130L	£4·50	EF92	50p	EZ41	45p	PCL86	51p	U52	30p	3S4	35p	6BW7	69p	6J4	47½p	10F9	50p	20P3	60p	90AU	£2·40
E180F	95p	EF93	47½p	EZ80	27½p	PD500	£1·52½	U76	25p	3V4	40p	6BX6	25p	6J5GT	30p	10F18	40p	20P4	£1·00	90C1	60p
EABC80	52½p	EF94	77½p	EZ81	27½p	PFL200	74p	U78	25p	5R4GY	55p	6BZ6	32½p	6J7	42½p	10L1	40p	20P5	£1·00	90CU	£1·25
EAF42	50p	EF95	62½p	EZ90	25p	PL36	64p	U191	75p	5U4G	30p	6C4	30p	6K6GT	50p	10LD11	55p	25C5	45p	807	47½p
EBC33	55p	EF183	56p	GS10C	£5·00	PL38	90p	U201	35p	5U4GB	37½p	6C5GT	35p	6K7	32½p	10P13	55p	25L6GT	37½p	811A	£1·50
EBC41	47½p	EF184	35p	GY501	80p	PL81	51p	U281	40p	5V4G	40p	6CD6G	£1·40	6K8G	30p	10P14	£1·00	2524G	30p	612A	£3·25
EBC81	32½p	E280F	£2·10	GZ30	37½p	PL81A	62½p	U282	40p	5Y3GT	30p	6CA4	27½p	6K23	50p	12AB5	50p	25Z6GT	50p	813	£3·75
EBC90	47½p	EF800	£1·00	GZ31	30p	PL82	36p	U301	57½p	5Z3	45p	6CA7	52½p	6K25	75p	12AC6	37½p	30A5	40p	866A	70p
EBF80	40p	EF804	£1·00	GZ32	47½p	PL83	51p	U403	50p	524GT	40p	6CBC	27½p	646GT	45p	12AD6	37½p	30AE3	40p	5642	60p
EBF83	40p	EF811	75p	GZ33	80p	PL84	41p	U404	37½p	6/30L2	75p	6CD6GA	£1·15	6L7	32½p	12A15	40p	30C15	75p	6080	£1·37½
EBF89	40p	EL34	52½p	GZ34	55p	PL500	82½p	U801	£1·00	6AB4	32½p	6CG7	45p	6L18	30p	12AQ5	40p	30C17	80p	6146	£1·50
EB91	26p	EL36	47½p	HK90	32½p	PL504	85p	UABC80	52½p	6AF4A	47½p	6CH6	55p	6LD20	32½p	12AT6	25p	30C18	75p	6146B	£2·37½
EC53	50p	EL41	55p	HL92	35p	PL505	£1·45	UBF89	40p	6AG7	37½p	6CL6	50p	6N7GT	35p	12AU6	75p	30F5	85p	6267	32½p
EC86	60p	EL42	57½p	HL94	40p	PL508	£1·00	UBC41	49p	6AH6	50p	6CW4	62½p	6P1	60p	12AV6	30p	30FL1	75p	6360	£1·25
EC88	60p	EL81	50p	KT66	£1·37½	PL509	£1·54	UCC85	46p	6AJ8	29p	6CY5	40p	6P25	£1·05	12AV7	45p	30FL2	92½p	6939	£2·10
EC90	30p	EL83	41p	KT88	£1·66	PL802	86p	UCH42	69p	6AK5	30p	6CY7	60p	6P28	62½p	12AX7	30p	30FL13	50p	7199	75p
EC92	32½p	EL85	42½p	N78	£1·05	PL805	86p	UCH81	54p	6AK6	57½p	6D3	40p	6Q7	37½p	12AY7	67½p	30FL14	77½p	7360	£1·80
EC93	47½p	EL86	42½p	PABC80	40p	PY33	62½p	UCL82	51p	6AL3	42½p	6DC6	67½p	6R7G	35p	12B4A	50p	30L1	45p	7586	£1·25
ECC81	40p	EL90	32½p	PC86/8	51p	PY80	32½p	UCL83	61p	6AL5	16p	6DK6	42½p	6S2	40p	12BA6	32½p	30L15	85p	9002	32½p
ECC82/3	42½p	EL91	25p	PC95	36p	PY81	41p	UF41/2	55p	6AM5	25p	6DQ6B	60p	6S4A	55p	12BA7	32½p	30L17	85p	9003	50p
ECC84/5	42½p	EL95	35p	PC97	41p	PY800	41p	UF80/5	37½p	6AM6	22½p	6DS4	75p	6SA7	37½p			30P12	80p		
ECC88	55p	EL360	£1·15	PCC84	46p	PY801	41p	UF89	41p	6AQ5	32½p	6EA8	55p	6SG7	32½p			30P18	35p		
E88CC	62½p					PY82	35p			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
GP91-1Sc -1	£1·05
GP91-2Sc	£1·05
GP91-3Sc	£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		

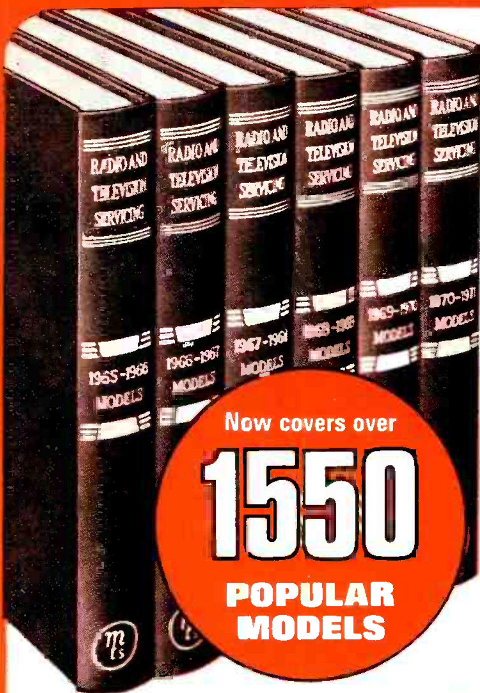
ADD 3p PER ITEM FOR POST & PACKING FOR ORDERS UNDER 24 PIECES

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

save time—make money with

RADIO & TV SERVICING

6 Volume Technical Repair Library



Full repair data on

1965-71 MODELS

Now, more than ever before, RADIO & TV SERVICING gives more value for money. Every Servicing Engineer realises the value of having repair and servicing data at his fingertips—it means more speedy servicing and as a result more profits—and information on earlier models that come in for repair is now unavailable through any other channel. Radio & TV Servicing will give you just this—it is the most comprehensive library of servicing data available.

TELEVISIONS · STEREOGRAMS RADIOS · TAPE RECORDERS · CAR RADIOS · RECORD PLAYERS

Here in 6 handy-sized volumes you have comprehensive technical information for servicing over 1,500 of the popular 1965-71 models of Television (including Colour TV) Stereograms, Radios, Tape Recorders, Car Radios and Record Players. The section on Colour TV alone makes this 3,596 page library a sure money spinner for years to come. See for yourself. Examine RADIO & TV SERVICING on *10 days free trial* and prove for yourself how valuable and indispensable this money-making library is.

COLOUR TV

Radio & TV Servicing has kept pace with the growth of Colour TV. In 450 fact-filled pages you will find—installation instructions. New term explanations. Purity adjustments. Colour balance. Static convergence. Circuit diagram notes, etc. You have over 594 circuits, component layout diagrams, block diagrams, printed panel diagrams, waveforms, photos and tables. In fact all the information needed for efficient and speedy repairs.

3,596 PAGES, 4,200 CIRCUITS, PRINTED PANEL DIAGRAMS, COMPONENT LAYOUT DIAGRAMS AND WAVEFORM GRAPHS

Yours to examine at leisure on

10 DAYS FREE TRIAL

TELEVISION

SERVICING·CONSTRUCTION·COLOUR·DEVELOPMENTS

VOL 22 No 3
ISSUE 255

JANUARY 1972

ALL PALS TOGETHER

Four months ago in this column we noted the encouraging trade figures for colour television receiver deliveries. At the risk of boring readers with more figures it is nevertheless felt that the latest statistics released by BREMA justify another minor bout of number-dropping.

In the third quarter of 1971 deliveries of colour receivers to the UK market reached 272,000 compared with 121,000 in the same period for the previous year and *more* than the deliveries to the trade for the first six months of 1971! Deliveries in September alone amounted to 113,000, a rise of 28% over August (88,000). No doubt a partial explanation of the accelerated scale of deliveries is given by the recent easing of HP and credit restrictions (and this is confirmed by the rise of 12% over the period for monochrome receivers—reversing the previous dropping trend) but even so these latest figures must be very encouraging to manufacturers and the retail trade. The only fly in the ointment so far as UK set makers are concerned must be the rate at which imports of both monochrome and colour receivers is increasing.

For the service engineer the prospect is one of increasing involvement with faulty colour receivers: what might previously have been a trickle may soon turn into an avalanche! Some engineers have taken the time and trouble to become thoroughly familiar with the new techniques and circuitry. Others have—dare we say it?—blundered on hoping that their mastery of monochrome receivers will see them through. But we are now fast approaching the point of no return: those who do not soon get to know what really makes colour tick will be left behind.

TELEVISION has played its part with regular articles covering the technical colour scene. We intend to keep this up and our new series "A Closer Look at PAL" is we think particularly timely. Those concerned with the servicing of colour receivers will do well to follow these articles carefully as their purpose is to give a deeper understanding of the problems of colour television.

W. N. STEVENS, *Editor*

The Editor and Staff of
TELEVISION
wish readers a Merry Christmas
and a Happy New Year

THIS MONTH

THE NEXT ISSUE DATED FEBRUARY WILL BE PUBLISHED JANUARY 17

Cover: The colour photograph of the Moon walk shown on our cover this month was kindly supplied by the US Embassy, London.

TELETOPICS

THE FOURTH TV CHANNEL

A pretty determined effort is being made by the ITA at present to secure under its wing the fourth u.h.f. service. The campaign for ITV-2 is being led by the ITA's director-general Brian Young. Already the ITA has completed investigations into the problems of setting up a second ITV channel and has spent six months working out the costs involved. The ITA has been in consultation with the programme companies, executives, programme makers and unions and has received a warm welcome for its hopes from RTRA president Tony Jackson. It is submitting a blueprint for ITV-2 to Christopher Chataway, Minister of Posts and Telecommunications.

The government's reaction to all this is believed to be on the cool side at present. The reason for the ITA's determination to press the issue at this time is its wish to start a second channel before 1976 when both the ITV Act and the BBC Charter expire. If the ITA can get permission soon to set up a second channel it considers that this could be in operation by 1974, giving a clear couple of years to see how the service works out before the whole future of broadcasting comes up for review in 1976. It is understood however that the Minister would prefer to shelve any plans until a full inquiry is held to draw up recommendations for broadcasting after 1976.

There are likely to be powerful lobbies at work backing the idea of ITV-2—those of us who recall their success in 1954 will not underestimate their determination and skill. Do we really want to see however just another channel competing for the widest audience—and it's difficult to see what other role a second commercial service could in the end fashion for itself. If we are to have a fourth channel this could be an opportunity for a truly independent one—independent of both the broadcasting establishment and commercial interests. The ITA has at least brought the matter into the open: it's time for broadcasting's "great debate" to start.

S-BAND CONVERTER

Research workers at Stamford University California have developed a simple 2·62GHz (S band) receiver with a 7ft. dish aerial for receiving satellite TV transmissions: it is claimed that the receivers could sell at £80 in 1,000 unit quantities. The receiver is a fixed-tuned single-channel set with few adjustments, designed for quantity production. Signals at 2·62GHz are fed from the dish aerial to a Schottky-barrier mixer diode to which a 2·5GHz local oscillator signal is also fed. After i.f. amplification, detection and remodulation a signal in the 50-88MHz range is produced for feeding direct to the aerial input socket of a conventional TV set. As mentioned in our November issue this part of S band has been allocated for satellite TV use in developing and sparsely populated regions.

TRANSMITTER NEWS

The BBC-1 u.h.f. service from **Stockland Hill,** Devon, is now in operation on channel 33 with horizontal polarisation. Receiving aerial group A. The ITA's **Darwen** relay station is now in operation on channel 47 with vertical polarisation—receiving aerial group B.

EMI-Varian in conjunction with a Hungarian firm have demonstrated the use of a single klystron as the sound and vision power output stage of a transmitter.

UHF DIPLEXERS

As the ITA's u.h.f. services extend across the country a growing number of people in favourable locations can receive alternative ITV programmes on u.h.f. One problem is to combine the signals from different group aerials. To meet this need a range of u.h.f. diplexers has been introduced by S. A. Collard Ltd. (Wetherby Road, Osmaston Park Industrial Estate, Derby). The A/1048 and A/1049 units are designed to combine u.h.f. signals of varying groups and incorporate provision for powering a masthead amplifier on one input—the A/1048 is for combining groups A or B with CD and the A/1049 for combining groups B or CD with group A. The insertion loss of these two units is approximately 3dB and the price 0·60p. There is also a two-way inductive splitter, type A/1050, at 0·45p designed to split the signals for distribution to two outputs and incorporating a d.c. through pass on one outlet, and also combining units without the d.c. through pass provision.

SET NOTES

Is the end of TV set recommended prices in sight? Pye/Ekco at any rate are making an effort to assess the situation by sending questionnaires to their dealers to find out whether they would prefer to see recommended prices dropped. The move has come as a result of delegates to the RTRA Midlands regional conference strongly urging setmakers to abolish suggested selling prices which many felt bore little relationship to the trading conditions they experienced.

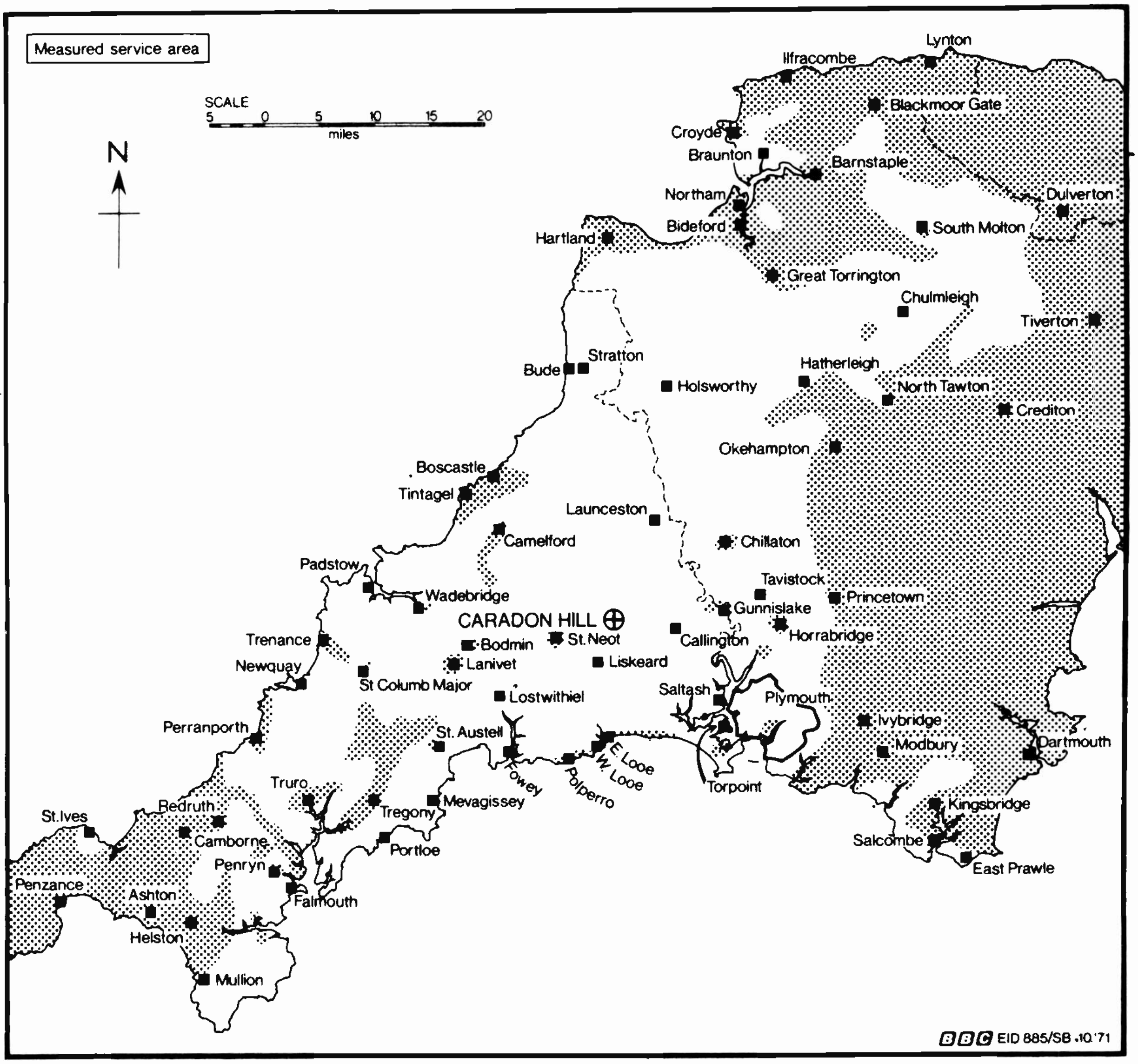
A new 14in. portable receiver, Model 14TV-45, has been added to the **Crown** range. It can be operated from 240V a.c. mains or a 12V battery, comes complete with loop aerial and features tape recorder and earphone sockets and slider brightness, contrast and volume controls. The suggested retail price with loop aerial and earphone is £85 and the weight 24·2lb.

Over the last two years BRC have produced nearly half a million of their 3000 single-standard colour chassis. Two new versions have now been introduced. The 3000 series Mk II chassis is an improved version; a variation of this, the 3500, has been devised to meet the different performance requirements when a 26in. 4:3 aspect ratio tube is fitted. All modules used in the new chassis are interchangeable with the earlier 3000 chassis with the exception of the convergence board used in the 3500. The latter, designated 00V6-277, incorporates pincushion correction, a width control and improved convergence circuits. The flatter face of the 26in. tube has necessitated pincushion correction but BRC are sticking to their blue gun down configuration with this chassis to give optimum raster shape when looking slightly downwards at the screen.

ITT Semiconductors have introduced a new video output transistor, type BF137, which supersedes their BF117. The BF137 is encapsulated in a TO-39 can, has a V_{ceo} of 160V and power dissipation of 680mW.

MAZDA PAL RECEIVER SERVICING BOOK

Thorn Radio Valves and Tubes Ltd. in conjunction with W. Foulsham and Co. Ltd. have just published "The Mazda Book of PAL Receiver Servicing". The 288-page book features extensive use of colour throughout and is priced at £3·50. We have had a look at an advanced copy and have been favourably impressed—a full review will be appearing later. The book deals in a very practical manner with what goes on in a PAL colour receiver and what can go wrong: those wishing to get started with colour servicing should take a look at a copy at the earliest opportunity.



The measured service area of the **Caradon Hill** *u.h.f. transmitter is indicated by the unshaded area of the above map. Channels: BBC-1 22, ITA 25, BBC-2 28, fourth 32. Maximum vision e.r.p. 500kW. Polarisation horizontal. Receiving aerial group A. Map courtesy the BBC Engineering Information Service.*

LETTERS

PLAYING AT TELEVISION?

YOUR editorial in the November issue posed a number of questions of considerable interest and importance to current television engineering. But in doing so, I would suggest that it was less than fair to the broadcast and transmission engineers who in recent years have developed insertion test signal and other automatic monitoring techniques—not for their own amusement but because of the very real advantages, both economic and operational, for the system; and so, ultimately, for the viewers.

The editorial is factually wrong in suggesting that insertion test signals were developed "mainly to satisfy Trade demands". They were developed primarily to enable the broadcasters and the Post Office to monitor the technical performance of the transmission system. It is true that these signals can also be of assistance to the Trade, and indeed this should be encouraged, though in practice at present relatively little use is being made of the signals by the Trade.

The real value of these signals is to the viewer, since already they play a significant role in maintaining the high standards of British television. While it is always easy to suggest that broadcast engineers are in danger of losing sight—in their enthusiasm for technical quality—of the programme function, there is little evidence of this happening. Certainly our own efforts are aimed at extending the u.h.f. colour service as rapidly as possible throughout the country, but doing so in such a way as to ensure reasonably consistent technical standards in all parts of the country. Would you have it otherwise?

It may not be generally appreciated that although all ITA u.h.f. transmitters are unattended—and it would be virtually impossible to contemplate a network having over 500 manned stations—all transmitted programmes are "eyeball" monitored at each of 14 colour control centres located at manned v.h.f. stations. The technical quality of each programme is assessed and logged by experienced engineering staff—and this forms an important element in the overall control of technical quality of Independent Television exercised by the ITA.

It is thus hardly fair to claim that engineers are "doing a great deal less programme monitoring". Indeed over the past two years the ITA has established this nationwide network of colour monitoring centres which are we believe far superior to the earlier system. In these control centres, ambient light is controlled for level and colour temperature, viewing distance is standardised, acoustic conditions have been carefully controlled, the sound and picture monitoring equipment is of the highest professional standard and the monitors are set up using accurately calibrated devices designed for this purpose.

Similarly, technical standards within the studios of the ITV programme companies are defined by an ITA Code of Practice which ensures that technical equipment of the highest standard is used. It is, I would suggest, this type of attention to technical quality—and the corresponding though rather different measures taken by the BBC—which has gained British colour television so many words of praise from overseas visitors more used to seeing colour in their own countries. This does not mean we claim that all our programmes are technically excellent—if they were there would be little need for such a complex control system. But what it does mean is that we have accurate records of technical performance, based on human monitoring, allowing us to deal quickly and effectively with significant impairments. Hardly a matter of showing "a reduced sense of urgency in correcting faults"!

Certainly modern u.h.f. colour calls for more sophisticated engineering: we are studying methods of monitoring using mini-computers and techniques designed to allow an accurate assessment of performance of a distant transmitter even when its direct off-air signals are almost buried in co-channel interference. And while various forms of automated monitoring are being developed by broadcasters, the ITA still places great value on the eyes of an experienced engineer looking at a monitor screen. What we aim to do is to exploit all techniques which can optimise the performance of a large regionally-orientated u.h.f. transmitter network in order to provide viewers in their homes with as good and as consistent a colour picture as the system allows.

In any large network there will always be the possibility of transmitter breakdowns and impairments beyond those for which the in-built redundancy of the equipment allows. The answer to this problem is a question of developing the use of regionally-based mobile maintenance teams. I would stress that a u.h.f. colour network based on fully-manned stations would in practice have limited colour television in this country to major centres of population. I suggest that far from "playing at television", the broadcast engineers in this country are creating a highly professional system for the benefit of the viewers.—**Pat Hawker** *(ITA Engineering Information Service).*

We acknowledge the concern of the ITA for the quality of its transmissions. What we were primarily concerned about was the possibility of a relaxed sense of urgency with the changing scene in TV transmission—from the v.h.f. service to the rather different engineering conditions of the u.h.f. service. Clearly however the ITA is well aware of the problems and determined not to overlook them. As we recall it the vertical interval test signals were first introduced by the BBC who suggested they were for the trade—and were agreed in talks with BREMA.—*Editor.*

LINE OUTPUT STAGE CHECKS

While agreeing with K. B. Whapples that speed is important in servicing TV sets I feel however it should be pointed out that to unplug the deflection coils is asking to have an expensive c.r.t. replacement. The correct procedure is to unplug the e.h.t. cap first—otherwise if the line timebase does come to life it will burn the screen before the set could possibly be switched off.—**E. A. Lynn** *(Portsmouth).*

BACK NUMBERS

With reference to the closing of the Back Numbers Department I have copies going back to September 1965 for disposal—also many obsolete valves which are often usable in old peoples' receivers. Enquiries with a stamped, addressed envelope will be welcome. —**R. Jackson** (37 *Gibraltar Avenue, Halifax, Yorkshire*).

FAST-ACTING VISION AGC

Keith Cummins

THE speed at which an a.g.c. system can operate to stabilise a television picture is something which is not, it seems, often considered: the main concern of designers seems to be that the average picture should be kept stable. Over the years several different approaches to providing a.g.c. for television receivers have emerged and it is interesting to retrace our steps to see how the designers' approach to a.g.c. systems has evolved.

In the early days of single-channel sets no form of a.g.c. was employed on the vision side. The sound section usually had the familiar arrangement of a negative bias derived from the detector diode and applied to an h.f. or i.f. stage. Such a scheme could not be used for vision a.g.c. however as the video signal at the detector is not constant but varies with picture content, and because positive modulation is employed in the 405-line system it was not easy to derive a stable a.g.c. bias. This is illustrated in Fig. 1 (a) and (b) which shows peak white (a) and black (b) signals as they appear at the output of the detector of a receiver used with positive modulation. Point A indicates the "back porch" of the line sync pulse: this is the only part of the signal—apart from the much shorter "front porch"—that remains constant under all picture conditions (the sync pulse itself equals nil carrier).

In the early 'fifties the Pye "Automatic Picture Control" TV set was introduced: it was the first commercial receiver employing vision a.g.c. The system used a gating stage which connected an a.g.c. measuring diode to the video signal during the line sync back porch period only. Thus a constant a.g.c. bias independent of video variations was developed. Signal fluctuation could be the only cause of a change in back porch level and the a.g.c. system responded by adjusting the vision i.f. amplification accordingly.

The system was originally employed on single-channel receivers but soon after this ITV came on the scene and it was then immediately apparent that a.g.c. would not be simply a luxury for fringe-area receivers but would have to be an essential feature of all receivers capable of receiving more than one programme with differing signal levels: manufacturers realised that viewers would not be prepared to keep adjusting contrast controls when changing channels and a.g.c. was thus accepted as a necessity.

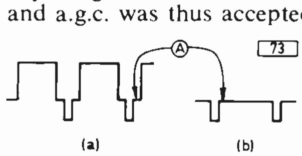


Fig. 1: With positive modulation the sync back porch —A—is the only reference level in the video signal.

The early Pye system was excellent, for it maintained a stable black level in the displayed picture. A second important feature which we can recognise in retrospect was the fact that as a signal sample was taken once every line changes in signal level could be measured quickly and control applied accordingly. The system could cope therefore with quite rapid fluctuations of signal caused by aircraft flutter.

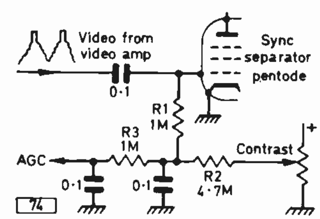
After this excellent start in the technique of vision a.g.c. the cold draught of commercial interests started to be felt and "mean-level" a.g.c. made its debut. While the gated a.g.c. system was technically sound it was also expensive, involving additional stages and special components such as pulse transformers. Manufacturers decided that a more economical system should be found.

Mean-level a.g.c. was subsequently adopted in most sets. It makes use of the negative voltage developed at the grid of the sync separator stage as the a.g.c. potential. As Fig. 2 shows, the system is very simple. The negative bias from the sync separator grid circuit is fed via the grid resistor R1 to the network R2 and R3. The negative bias is cancelled to a degree by the positive feed via R2 from the contrast control—this sets the working point of the system. The resultant bias is fed via R3 to the grid circuits of the controlled stages. The system works well in accommodating widely varying signal levels since the loop gain is high—the video amplifier is included in the a.g.c. loop. The system fails only in its inability to retain the black level of the picture. This is inevitable as the negative bias used as the control potential is a measure of the whole video signal amplitude, not just the black level. As the picture content changes so does the a.g.c. bias with the result that dark scenes are too bright and bright scenes too dark. It was found however that viewers seemed to accept this situation quite happily, and the great majority of 405-line only sets ended up with mean-level a.g.c. Pye for economic reasons had to abandon their gated system and adopted mean-level a.g.c.: a classic case of "If you can't beat 'em, join 'em"!

In all fairness however it should be pointed out that the gated system suffered from one disadvantage, namely that it could not cope with some severe ghosting situations. If a negative ghost happened to cancel the back porch of the line sync pulse, the a.g.c. failed to operate. Mean-level a.g.c. is not of course affected in this way.

So it was that mean-level a.g.c. became virtually universal. The system however is much slower acting than gated a.g.c. as the whole video signal contains a large 50Hz component (field repetition) which does not appear at the output of a gated system. As a result the filtering on the a.g.c. line with a mean-level system must have a much longer time-constant. This slows the a.g.c. action considerably and some manufacturers lengthened the time-constant even further to minimise changes in level during commercial breaks, etc.

Fig. 2: Typical mean-level vision a.g.c. circuit. The negative potential developed at the grid of the sync separator is used as the a.g.c. source.



The mean-level system is therefore inevitably susceptible to aircraft flutter. Some designers realising that most of the d.c. level was lost as a result of the use of mean-level a.g.c. abandoned it completely by the use of a.c. coupling without d.c. restoration in the video stage and tube circuits. The time-constants in this part of the circuit were kept short in order to attenuate the low-frequency flutter component of the signal.

With the advent of 625-line transmissions with negative modulation the possibility of improved a.g.c. arose but could not unfortunately be implemented in the early years of u.h.f. broadcasting since dual-standard receivers were then essential. Mean-level a.g.c. remained dominant and it was certainly the simplest system capable of coping with both systems of vision modulation.

It was found however that mean-level a.g.c. had certain disadvantages for u.h.f. working. The worst of these was the host of problems resulting from the use of mean-level a.g.c. and intercarrier f.m. sound together. Because of the variation of video levels and sync amplitude the intercarrier sound could be affected by sync pulse punch-through and peak-white captions, both of which gave rise to an objectionable buzz on sound. Often these problems arose in the field and manufacturers modifications had to be carried out. Another difficulty arose from the fact that flutter on u.h.f. can be much worse than on v.h.f.; here again the deficiency of mean-level a.g.c. became apparent. The advent of three-channel u.h.f. broadcasting with single-standard sets however enabled efficient economic a.g.c. to be introduced.

A fundamental difference between the old 405-line system and the 625-line system lies in the vision modulation sense. The negative modulation employed with 625-line transmissions results in the output from the video detector being reversed. The sync pulses therefore represent 100% modulation instead of zero, while the black level is set at 77%. This is illustrated in Fig. 3. As a result of this the tips of the sync pulses provide a measure of signal strength whatever the content of the picture. A circuit which measures the amplitude of the sync pulse tips can therefore be used to form the basis of a black-level stable a.g.c. system.

In its simplest form the circuit shown in Fig. 4 will suffice. The video signal as shown is applied to diode D1 which conducts and charges C1 to the peak level of the sync pulses—provided the time-constant of C1, R1 is long by comparison with the sync pulse repetition rate. Thus this peak rectifier circuit can provide an output suitable for a.g.c. purposes: usually however the circuit is somewhat more complex since comparison and control of contrast are involved.

The circuit shown in Fig. 5 is the original sync-tip a.g.c. circuit employed in the Constructor's 625-line Receiver (Practical Television March-July 1970, see alternatively page 471, August 1971 Television). A pnp buffer transistor Tr1 acts as an emitter-follower

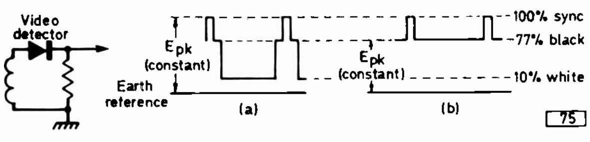
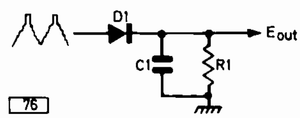


Fig. 3: Showing how measurement of the sync tip amplitude can produce a stable a.g.c. reference level independent of picture content. (a) Peak white line. (b) Black line.

Fig. 4: Simplest possible peak detector circuit.



coupling the positive-going detector output to the peak measurer Tr2. This npn transistor conducts to an extent dependent upon the sync tip amplitude, charging C20 to this level. C20 and R31 perform the same function as C1 and R1 in Fig. 4, i.e. the potential developed across them is used for a.g.c. The circuit was described in further detail in the June 1970 issue of Practical Television (page 407).

It will be seen that the time-constant of C20 and R31 is very long indeed, since C20 is 10μF. It is quite long enough to slow down the action of the a.g.c. system considerably—something which we have seen to be undesirable. The reader will ask of course why this long time-constant was employed. The answer is to reduce the effects of interference pulses which will be positive-going but mainly of short duration. A short time-constant network would be very susceptible to such pulses since the energy stored in the capacitor would be low and the interference level potentially high. Interference pulses could therefore have a disturbing effect on the a.g.c. action, causing the gain of the receiver to be reduced. The effect of this would be a fluctuating picture with black interference spots. By having a long time-constant measuring circuit the effects of interference are minimised: the stored energy is much higher and the interference pulses can be regarded literally as "drops in the ocean", having little effect on the stability of the a.g.c. voltage.

It can be seen then why a long time-constant circuit was chosen and speeding up the a.g.c. action can apparently only take place at the expense of noise immunity. There is however a solution to this problem. We need to measure only the sync tip amplitude, so if our measuring circuit is connected only when a sync pulse is present the noise immunity will be greatly improved. The improvement can be reckoned as at least 10 times since interference during the active line period cannot gain access to the measuring circuit.

The result we require can be achieved by gating the a.g.c. circuit on during the sync pulse period only. Obviously we do not wish to disturb our peak measuring circuit, so the gating action must take place between the detector and the a.g.c. measuring circuit.

Let us consider how to gate the circuit shown in Fig. 5. If the positive supply to the top end of R30 is interrupted the circuit cannot operate: it follows however that it will operate provided this supply is available when the sync pulse which we wish to peak rectify is present. Here then lies the solution to our

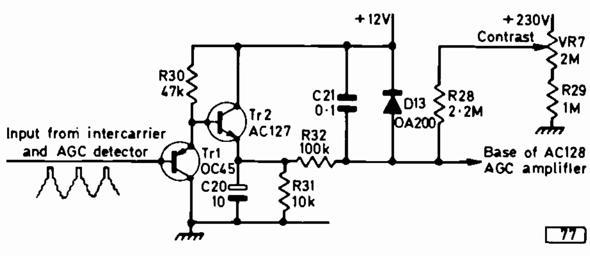


Fig. 5: The original sync tip a.g.c. circuit used in the Constructors' 625-line Receiver.

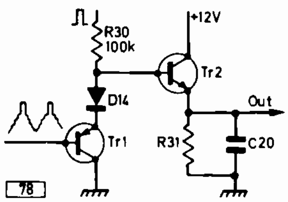


Fig. 6: The basic modification to the circuit shown in Fig. 5 to provide gating. The gating pulse, derived from the line output stage, is applied to Tr1 emitter, gating it on during the line sync pulse period.

problem of obtaining rapid a.g.c. action and good noise immunity: to have a short time-constant measuring circuit which is connected only during the sync period.

Figure 6 shows the basic modification necessary to enable line-pulse gating to be employed. The top end of R30 is normally at earth potential except for the period of the line sync pulse. During this period a gating pulse from the line timebase is applied. The lower end of R30 then moves positively to the point where D14 conducts, the voltage at this point being in turn determined by the emitter potential of the buffer stage Tr1. The base of Tr2 is thus connected to a potential which is the measure of the sync pulse amplitude and C20 is accordingly charged to this level by the current through Tr2. It will be observed that as the impedance of the emitter-follower Tr1 and diode D14 are much lower at the point of conduction than the resistance of R30, variation of the gating pulse amplitude will have negligible effect on the operation of the a.g.c. system. This is important since variation of picture width could otherwise affect the contrast level!

The complete circuit of the fast-acting a.g.c. system evolved for the Constructor's 625-line Receiver is shown in Fig. 7. In order to obtain a positive-going gating pulse from the line output transformer the earth connection to tag 6 of the transformer is disconnected and the end of the flywheel sync feedback winding is taken to R67 and C46 (Fig. 7) instead. A positive-going round-topped pulse of 20-25V amplitude is developed across these components and applied to the top end of R30. Unlike the early gated a.g.c. systems for 405-line use the pulse does not have to be delayed so as to coincide with the back porch. Instead it simply has to embrace the sync pulse with sufficient latitude either side to allow for phase errors in the setting up of the line hold control.

When the circuit was being tested it was found that

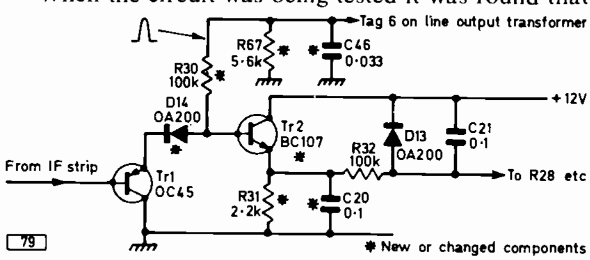
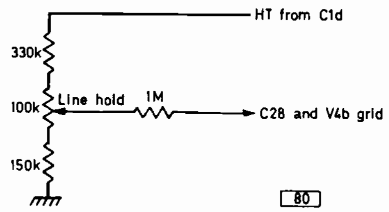


Fig. 7: The fast-acting gated sync tip circuit evolved for use in the Constructors' 625-line Receiver.

★ components list

Components added:		Components changed:	
D14	OA200	Tr2	BC107
R67	5·6kΩ ½W	R30	100kΩ
C46	0·033μF 100V	R31	2·2kΩ
		C20	0·1μF



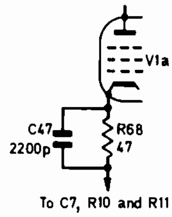


Fig. 8 (left): Line hold circuit modification.
Fig. 9 (right): Video circuit modification.

a problem arose while the receiver was warming up. On switch-on the transistor circuits operate immediately at maximum gain before the gating pulse is available from the valve circuits. This resulted in an unstable feedback condition building up, including the a.g.c. and line a.f.c. loops, since the gating was random until the line became synchronised. The problem was solved by modifying the line hold control circuit as shown in Fig. 8. Feeding V4b grid circuit from a positive supply via a higher grid resistor prevents the oscillator from slipping modes and the feedback no longer occurs.

Returning to Fig. 7, the components shown asterisked are those which comprise the modification. Note that Tr2 has been changed to a silicon BC107 type: this change was needed because of excessive base-to-collector leakage with the AC127. It will be found that the a.g.c. action using the new circuit is not only faster but also more precise. This is a result of the gating action and a very stable picture results. This applies particularly during tuning when spurious peaks occur outside the gating time.

It was mentioned earlier that the a.g.c. action could not start until the line timebase got under way. This has no detrimental effect on the video stage in the Constructor's 625-line Receiver since the signal is a.c. coupled (apart from being negative-going). Early 405-line receivers needed a protection circuit for the d.c. coupled video stage which would otherwise have been driven excessively positive at the grid.

In the event of the sound section warming up ahead of the line circuits it is likely that sound will be heard accompanied by a buzz until the a.g.c. takes effect.

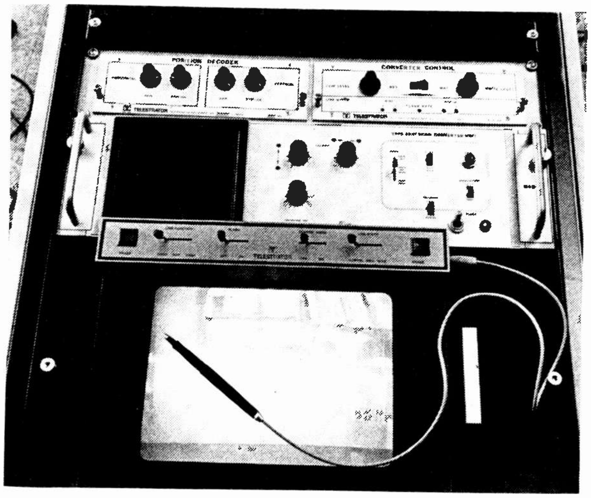
If the receiver is being modified to employ the fast-acting a.g.c. system a small but useful modification can be carried out in the video stage which further improves its performance. Fig. 9 shows the detail. An additional compensating network is added in series with the cathode of V1a. This enhances the high-definition parts of the picture. The modification results in the anode voltage of V1a becoming higher so that the cathode load resistor of the d.c.-coupled cathode-follower V1b needs to be increased. This can be conveniently achieved by disconnecting R9 from the cathode of V1b and reconnecting it to the junction of R12 and C8. Besides increasing the cathode load this attenuates the drive to the sync separator but as plenty of drive is available this is permissible.

A final note concerning the receiver: if the line timebase only just scans the picture with the width control fully advanced it is possible to increase the line drive by increasing the value of R47 (330kΩ). If the value of this resistor is increased too much however the centre of the picture will cramp. A 1MΩ potentiometer can be substituted for R47, adjusted to the optimum point, the resistance then measured and the appropriate fixed resistor fitted in place. ■

Electronic Graphics

* the TELESTRATOR system

J. I. SIM



View looking down at the operating surface and the component sections of the Telestrator type TIM-400. The scan converter and converter controls can be remotely mounted if required.

THE Telestrator is a means of producing writing or drawings on any television picture electronically. The operator "writes" with an electronic stylus on a transparent surface mounted above a picture monitor. As the stylus is moved the picture on which the graphic is being put displays the result. The operator can therefore see instantly how he is progressing. Controls located near the monitor and stylus enable the markings to be made wide or narrow, dotted, dashed or solid, chain or rings etc., and if required the markings can be flashed on and off to draw greater attention to them.

You have almost certainly seen this unit in operation: it has been in use on a number of current affairs programmes—most notably during coverage of the US moon shots—and has even been used to take the place of the spoken word on *Disco—2*.

Position Indication

The method of translating a mechanical movement into an electronic form suitable for use as a television signal is the heart of any equipment of this type. The transparent surface that is "written" on, or to be more accurate run across by the stylus, must be position-sensitive so that with the stylus touching any point an indication is given of the position of that point on the television raster. There are a number of ways in which this can be achieved and in fact alternative methods can be used with Telestrator. There are also methods which are less suitable for television signal derivation. We will describe first, however, the principal method used in the Telestrator system as the others employ a fairly similar means of operation.

The "writing surface" consists of a glass overlay on the monitor being used. This glass overlay has a special semiconductive coating which is deposited on the glass at a high temperature. The semiconductive coating has a finite resistance across its surface but is thin enough not to affect the optical transmission properties of the glass.

An audio oscillator (Fig. 1) and following chopper are used to generate a low-distortion 10kHz squarewave of 12V peak-to-peak, i.e. 6V positive and negative about the zero voltage axis. Metal contact strips are connected to each of the four sides of the treated glass overlay. Two outputs from the audio oscillator are fed to two of these strips through diodes (we will consider just one diode in each circuit feed—in practice an array of many diodes is connected along each of the four edges). Thus a 6V positive-going squarewave is connected to the top plate and a 6V negative-going squarewave to the left-hand plate. The opposite sides of the overlay are connected through further diodes and equal resistances (*R*) to chassis. As the opposite polarity squarewave voltages on the top and left sides of the overlay are derived from the same source they are of course out-of-phase—i.e. whilst a pulse of voltage is present on the top plate there is zero voltage on the left-hand plate and vice versa.

The overlay surface has a finite resistance and its semiconductor nature provides this resistance top to bottom for a positive voltage and left to right for a negative voltage. In any other direction no current flows: for example no current can flow from the top-plate to the right-hand side because of the blocking diode on the earthy side. While the positive pulse is present on the top plate there will therefore be a

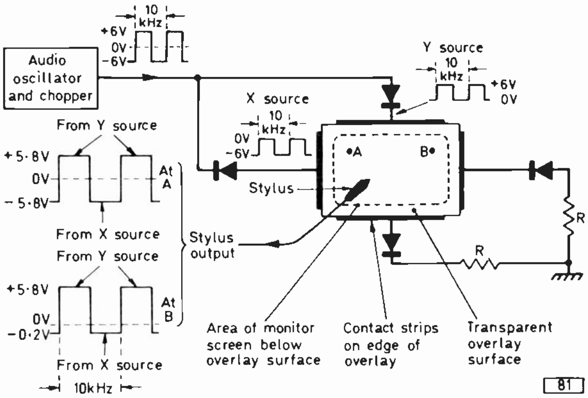


Fig. 1: Telestrator position detector.

voltage gradient from top to bottom, i.e. the full 6V will be present at the top and a lower voltage at the bottom; and when the negative pulse is present on the left-hand plate there will be a similar voltage gradient from left to right.

Stylus Output

The electronic stylus is simply a metal probe in the handy shape of a pen which is used to make contact with the conductive layer. At any point on the surface there will be two voltage components: a proportion of the vertical (Y) voltage pulse on one half cycle and a proportion of the horizontal (X) voltage pulse on the other half-cycle. At point A for example there would be little change in the voltage pulse in either the X or the Y directions, giving at the stylus output the fairly symmetrical squarewave indicated. At point B however the X voltage level is rather less so that the output is asymmetrical about the zero voltage line. Any point on the surface of the overlay can therefore be expressed as an X voltage pulse and a Y voltage pulse, negative and positive respectively, and as there can be no exact duplication of the waveform produced at the stylus output every point on the surface has its own waveform coding.

If the stylus is not touching the overlay there is obviously zero voltage output. To make absolutely sure that this same no voltage condition does not exist anywhere on the overlay the resistors *R* are included in the earth feeds: this means that there will always be some small voltage on the right-hand and bottom plates.

Using the Position Coding

The output pulse voltage varying about the zero voltage axis has to be used to produce a video voltage pulse at the correct line and field point to correspond with the point on the overlay touched by the stylus. Each cycle of the 10kHz squarewave present on the stylus has first to be separated into its X and Y components (Fig. 2). This is simply achieved by using diodes once more (the waveforms in Fig. 2 correspond more or less with position B on the overlay shown in Fig. 1).

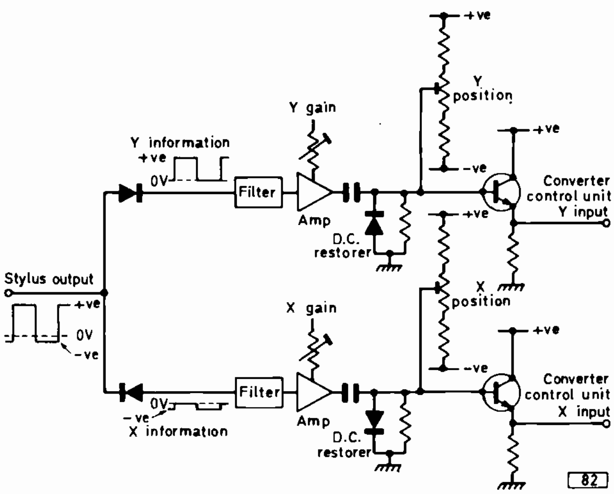


Fig. 2: Position decoder—basic processing of the X and Y position signals.

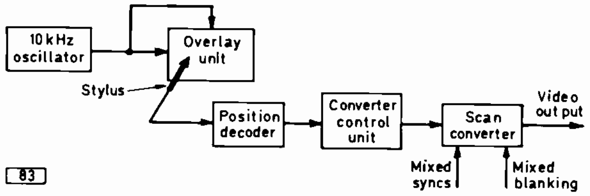


Fig. 3: Simplified block diagram of the Telestrator system.

The separated components are filtered to remove the noise that is inevitably present. After separation of the X and Y components it is still necessary to preserve the d.c. zero level: the amplifiers fed by the filters are a.c. coupled for simplicity and stability of gain but their outputs are d.c. restored. The gain of the amplifiers can be controlled independently and after d.c. restoration preset d.c. voltages are added to the signals from bleeder chains. These two sets of controls give variation of the X and Y gain and X and Y position to allow setting up to be accurate so that the display Telestrator signal will appear exactly below the point at which the information is "written" by the stylus. This is a form of tracking.

Converter Control Unit

The control signals are then passed through an emitter-follower in each leg to the *converter control unit*. The decoded signals pass directly out of this unit when the output is to be a continuous line. Alternatively the signals can be used in the unit to lock a free-running multivibrator to get a dashed line output or to trigger a one-shot multivibrator to produce a dotted line output. If a circular output is required the converter control unit provides a sinewave signal at its Y output and a cosine wave at its X output. These two signals are derived from a quadrature oscillator so that they are always locked together. The level of all these output signals is directly proportional to the input signal obtained from the stylus on the overlay.

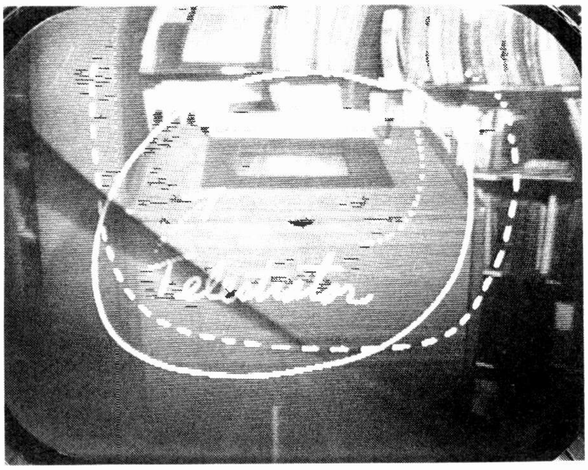
Scan Converter

The *scan converter* is driven from the converter control unit (Fig. 3); it is a slightly modified Tektronix unit using a storage-tube oscilloscope as the electrostatic retaining and conversion unit. The unit is also driven by mixed syncs and mixed blanking signals in order to lock its output to the television standard in use. When the erasure button on the main console is depressed the stored signals are immediately removed from the storage tube, thus removing them from the output.

The width of the line is controlled by adjusting the intensity of the storage-tube trace. Flashing is effected by alternate switching between the scan converter output and no output—the switching takes place during field blanking so as not to upset the picture information (vertical interval switching).

Graphic Effects

The various combinations of circle/dot/dash/solid lines and line widths give over 50 possible graphic effects. Different effects can be drawn on the same picture by changing the function switches as required. Erasure however is always complete erasure. The



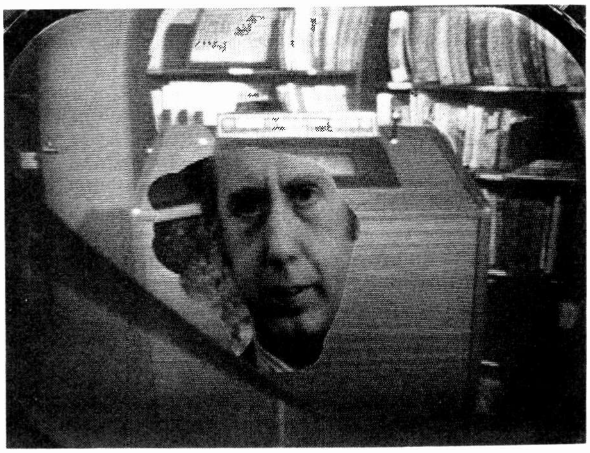
Some of the patterns possible with the Telestrator—solid, dotted and dashed lines—photographed on the face of a monitor. The background shows a podium Telestrator type TIC-100.

video output from the scan converter can also be controlled from white down to black level to suit the video background into which it is being injected.

The Telestrator in the Studio

It would be quite practical simply to use the Telestrator output as an input to the studio vision mixer to add to the required video source. This however is not flexible enough in productions of any complexity. Instead (Fig. 4) it is more usual to employ a separate video matrix to drive equipment, the video source to be treated being selected in this matrix. Then instead of using a mixer at the injection point a *keyer* is used.

A keyer differs from a mixer in that instead of the vision signals simply being added together the keying signal in a keyer is inserted into the main channel, actually *replacing* the main chain video signal at the points where it occurs. In this way the injected signal can be anything from black to peak white and if the signal is fed through a colour synthesizer unit and coder the markings can be in any colour. One output from the keyer is fed to the monitor below the overlay



Photograph of monitor face showing an insert key of a second video source. Note the arbitrary shape that can be wiped in, in this case with a medium-strength continuous line.

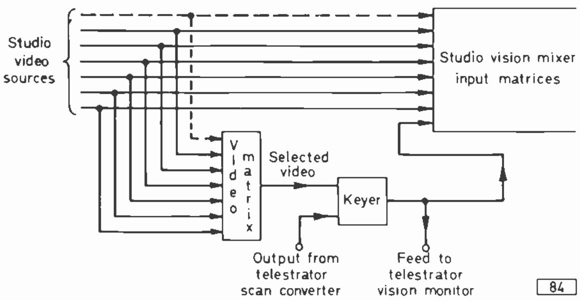


Fig. 4: How the Telestrator output is used with the studio system.

surface so that the operator can immediately see the results of his work; the other output is taken to the studio's main mixer for use as a video source.

With this arrangement whichever video source is selected in the matrix can be treated with the Telestrator output and if required the operator can set up his graphics before going on transmission.

Other Types of Overlay

Although the semiconductor overlay coating is the one most widely used in Telestrator equipment there are occasions when a rather smaller screen surface is required—for example for outside broadcast use. In such applications there can also be excessive light reflection from the overlay surface because of the high ambient light level.

For such use a second type of overlay in the form of a flexible black stainless steel mesh of 300 line/in. fineness is available—this mesh can be stretched or curved over any shape of monitor faceplate.

The wire mesh has considerably less resistance across it than the semiconductor layer and its action is limited by the forward impedance of the diodes driving it (the forward resistance of each diode is a few ohms while the wire mesh resistance is only milliohms). To overcome this problem a system using a series of step-down transformers is included in the voltage feeds to the overlay. The diode resistance is then unimportant.

In computer technology one of the most popular interfacing devices is the light pen. This however requires a certain amount of developed skill for efficient use and there are problems when it is used with high ambient light levels—the monitor has then to be operated with the whites set at a high level of brightness and with virtually no contrast down to black.

Other X/Y read-out devices have similar groups of advantages and disadvantages. Certainly the semiconductor overlay with a simple contact stylus is very simple to use.

Conclusion

The Telestrator can be an extremely useful tool in television production. For example the ability to mark particular points of interest on the pictures received back from the moon at the beginning of last August was invaluable to the viewer. But one of its most important uses will probably be in education where the ability to use a normal sort of surface for scan writing without a camera over your shoulder has great possibilities. ■

Workshop HINTS

by VIVIAN CAPEL

TIME is money to the professional engineer, so short-cuts and quick methods of fault diagnosis and repair are continually necessary in order to get through the day's quota of work and to keep labour charges at a reasonable level. We have often described such methods on this page and will continue to pass on time-saving tips: great care however must be taken not to go to the other extreme and to employ practices which could affect the performance or reliability of the equipment under repair.

Such bad workmanship is unfortunately often encountered in sets that have been repaired elsewhere, and enquiry frequently reveals that the repairs have not been carried out by a local handyman—in which case the results are only what one would expect—but by established dealers or repair agents. It is of course true that sometimes an ancient set that should have been scrapped years ago and is not really economical to service is given to an engineer to repair. The owner's circumstances however are in such cases often such that the engineer feels that some attempt to get the set going, even if only for a short while, is justified. In this type of case any safe method of restoring a viewable picture with a minimum cost must be adopted.

MAKING RELIABLE REPAIRS: SAVE TIME BUT DON'T BODGE!

Such cases however are the exception rather than the rule, and many of the sets that have been bodged are quite recent models in otherwise good condition. Makers on the other hand do not always help by having special components readily available so that often the only alternative to a long wait for parts—of perhaps months—is to use the nearest available component and to adapt the circuit to suit. A succeeding engineer may consider this a bodge when he encounters it, yet it probably took more time to carry out than fitting the proper part! What then constitutes a justifiable departure from normal service practice? We would say anything that saves time without degrading performance or reducing reliability, or any method which gets things going under special circumstances such as economic non-viability or non-availability of components. Even in the latter type of case the physical safety angle must be considered and anything which would constitute a danger to the user cannot be permitted. To illustrate this argument we will consider this time some of the things that although often encountered should not be done.

Faulty Electrolytics

A common component to replace is the electrolytic capacitor which is often in the same can as one or more others. Either the complete can must be replaced, thus throwing out good components, or an additional unit must be fitted to take the place of the defective one. To do the latter means finding or making some method of support for the new capacitor, and tags to connect it to. A quick solution is simply to connect a wire-ended tubular component across the original one, using its tags both to physically support and to connect the new parts. Although time saving this is a bad practice. In addition to loss of capacitance, the usual reason for replacement, there may be an abnormally high leakage current or poor power factor. These will remain in the circuit in parallel with the new capacitor. Furthermore the old capacitor may subsequently develop a more serious leak or even a short-circuit due to the continued voltage across it. Even if neither of these conditions occurred it is common for faulty capacitors to exude their contents over the surrounding area, which is highly undesirable to say the least.

Although less common it is also possible for a faulty capacitor section to develop a leak to one of the other sections, thus bypassing the smoothing resistor or choke in the case of reservoir and smoothing capacitors or coupling circuits together in the case of decoupling or cathode bypass capacitors. This type of fault can be quite baffling when encountered and leaving a faulty capacitor section in circuit can well lead to it.

If either the reservoir or smoothing section of a multiple electrolytic goes open-circuit the best solution is to discard the unit and fit a new one. The time spent trying to find room to mount an extra can and then the drilling and clip-mounting processes soon overcome in labour costs any saving in the cost of components.

With the majority of TV receivers only a limited range of multiples is needed for replacement purposes. The exact value is not too important: $60+120\mu$F and $100+200\mu$F will replace most values, each of these being required in 250 and 350V working voltage ratings. The voltage rating of the capacitor is again not very important as both common values are used in similar circuits with similar voltages across them. The 250V unit is slimmer than its 350V counterpart however so the mounting clips are of different size. Using a different voltage type will therefore mean changing the clip and drilling different fixing holes.

Occasionally a set is found where the reservoir and smoothing capacitors have been replaced and the reservoir is connected using the inner section while the outer is used as the smoother. Care must be taken to avoid this error because the lower ripple current rating of the inner section will put it under severe stress if it is used as a reservoir. The usual colour coding of red for the outer (reservoir) and yellow for the inner (smoother) must be observed.

Replacing Metal Rectifiers

Some older sets that come into the workshop with the symptoms of low h.t. are found to contain air-cooled selenium rectifiers that have gone high-resistance. The common practice now is to replace these with silicon rectifiers and extra surge-limiting resistors. These need to be supported and connected however and quite often the tags of the old rectifier offer a convenient anchoring point. As with the capacitors this means that the old part is still in circuit. While in many—perhaps most—cases no harm will result from this, selenium rectifiers have however a nasty habit of leaking to the frame which of course is earthed to the chassis thus producing an h.t. short along with a very pungent odour. This possibility will always exist if the old rectifier is left in circuit and as the rectifier is faulty anyway it is best to remove it. This clears the decks and makes room for the replacement parts.

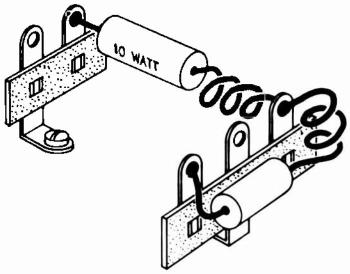
One of the fixing holes of the old rectifier can be used to mount a tagstrip to hold the silicon rectifier and surge limiter resistor. This resistor carries both the reservoir ripple current and the h.t. current so it gets very hot. Adequate power rating is essential if premature failure is to be avoided. Although low in resistance value, a 10W rating is recommended. Heat from the resistor should be kept away from the rectifier as much as possible so they should be kept physically apart. In particular the rectifier should not be mounted over the resistor so that convection air currents flow around it.

The wire ends should be kept long so as to give the maximum distance of wire between the two components and thus minimise the heat conducted along the wire. To facilitate this it is better to use two short tagstrips mounted separately as shown in Fig. 1 as this gives better spacing. The wires between resistor and rectifier are left long but are either coiled or formed into a zig-zag pattern so that the surplus will not constitute a hazard. This will also aid heat dissipation. The opposite wires from each component can be short in order to provide a rigid mounting for the part and to conduct heat away. Coiling can be quickly and easily done by using the shaft of a screwdriver as long as the blade does not widen out and so make it difficult to withdraw. This arrangement, although taking more time than simply mounting on the tags of the old rectifier, is far less likely to give trouble in the future.

Wire-ended Components

Leaving the rectifier and surge resistor with long leads is done to provide heat isolation. There are other occasions when the leads on wire-ended components should not be cut short. Transistor replacements is one. Mounting the transistor right close to the printed board by pulling the wires hard through the holes in the print means that when soldering takes place heat will very likely damage the component because of the meagre heat isolation of the short wires. Even if the transistor is unaffected it will most likely be destroyed if it is necessary to remove it at a later date, perhaps for a substitution test. There is no need to go to the other extreme and leave the full amount of wire on the transistor. Generally about half an inch of wire is sufficient and this also enables measurements from the wires at the component side of the board to be taken in future tests, an operation which is difficult when the transistor is pulled close to the board with little of the wire accessible.

In the majority of cases, however, wire-ended components should be mounted close to the printed board or tagstrip and the wires cut as necessary. Very often



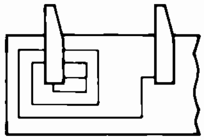


Fig. 1 (left): A replacement silicon rectifier and surge limiter resistor mounted well spaced apart using two tagstrips. The adjacent wire ends have been left long and coiled to minimise heat conduction and maximise heat dissipation.

Fig. 2 (right): Part of a Philips printed-circuit tuner coil. Contact is made with vertical terminal posts: these must be cleaned individually with a toothbrush.

parts that have been replaced in a receiver stand out like a sore thumb—literally—because no attempt has been made to mount them in position or to cut the wire ends. This is very slip-shod work because so little extra time is involved in cutting the leads and mounting the component safely on the board. The result is not only untidy and unprofessional looking: the component can easily be displaced to one side or pressed down on to others on the board when refitting the panel or reconnecting flying leads so that there is a real risk of short-circuits.

Open-circuit Mains Switches

Quite a common fault is failure of the mains switch. Frequently one of the paxolin supports for one of the contacts breaks and this results in one pole but not the other going open-circuit. It is a great temptation to effect a quick repair by shorting out the affected pole. The switch thus operates just as well and there is no effect on performance or reliability. This violates the qualification as to safety however: the possibility of the chassis being live with the set switched off constitutes a danger to the user. It may be that the mains lead is fitted with a three-pin plug and the shorted switch pole is in the neutral lead. This would appear to make the practice safe. There is no guarantee however that the set will not at some later date be moved to another room, or change hands, and a two-pin plug be fitted. It could also happen that the owner might remove the plug for some reason and refit it incorrectly. Thus there is always a possibility of danger and a new switch should always be fitted in such cases even if it means a new double control as well. If a replacement is not immediately available it would be safer to short out both poles and instruct the owner to switch off at the mains socket while the new part is being obtained.

Tuner Cleaning

Cleaning the v.h.f. tuner is a frequent and sometimes time-consuming job. Noisy contacts give rise to varying signal strength, picture break-up, noise on sound and sometimes complete disappearance of both sound and picture. There are occasions when a proper cleaning job cannot be undertaken, for example where the cost must be kept down and time is short but access to the tuner is only possible after a lot of dismantling. Often if the contacts are not too bad they can be temporarily cleaned by rapidly rotating the tuner knob. The owner can then be advised that cleaning properly may be needed in the near future.

If hand cleaning of the contacts is undertaken however it should be done properly. All too often tuners are encountered that have been cleaned by smearing silicone grease over the stud coil biscuit contacts yet the contacts remain discoloured beneath the layer of grease. Even if these have been cleaned off before applying a lubricant it is frequently discovered that the leaf phosphor-bronze contacts have not been touched and that they are heavily tarnished. Although quick and possibly effective at the time such "cleaning" can only result in the reappearance of the trouble later.

The leaf contacts can be reached by taking several biscuits out if the full number are present, but if as is usual only two or three coils are in place—corresponding to the local stations—then access can be had by just turning the rotor around so that they are out of the way. Cleaning can then be done by wiping the contacts with a rag damped with methylated spirit, taking care not to bend or distort them. A thin smear of grease or liquid lubricant can then be applied. The same thing applies to the coil biscuit contacts.

A particularly awkward one to clean is the printed-circuit Philips type of coil where contact is made at the side of the terminal rather than across the top. Here each terminal must be cleaned individually instead of several at a time as with the stud type. The best way to do this is to use an old toothbrush dipped in the meths: scrub around each post in turn. It is a long job but there is no short-cut here. Among the easiest tuners to clean on the other hand are the rotary Fireball type where the coil disc can be removed by unscrewing a single nut and all contacts then cleaned with one or two wipes.

EHT Cap Cleaning

A similar case where time is saved at the expense of reliability is in cleaning the e.h.t. connector to the tube. Brushing sometimes originates around this point with the usual symptoms on the screen. Often an attempt to cure the trouble is made by liberally daubing the surrounding area with silicone grease. As this material is a good insulator it is thought that it will prevent further discharge. Invariably however the trouble is due to conductive deposits building up around the e.h.t. cavity along with the inevitable dust. Putting a coating of grease over these deposits has no effect as leakage will still take place between the connector through the deposits to the aquadag. Some temporary improvement may possibly result merely because the deposits are disturbed, but it is certain that the trouble will start again.

It takes little extra time to clean these deposits off. A rag and meths will do the trick but be careful not to extend the area of cleaning too far as on some tubes meths removes the aquadag. Clean out with meths to where the aquadag starts; clean further with a dry cloth. It will then be found that no grease application is needed at all.

These then are some examples of trying to cut corners and save time at the expense of performance, reliability or safety. While time is valuable and can legitimately be saved in many ways in the workshop it should never be at the expense of a good job.

LONG-DISTANCE TELEVISION

ROGER BUNNEY

UNDOUBTEDLY the main talking point amongst TV-DX enthusiasts this month has been the excellent tropospheric conditions that have twice presented themselves during October. From reports coming in it seems that these conditions were noted over much of the country, although they were possibly somewhat better in the South of England. The two main spells of activity were the periods October 2-8th and October 22-24th. Of the many letters that have arrived two were of particular interest. Hugh Cocks (Mayfield, Sussex) received the DFF (East Germany) ch.E10 transmitter at Dresden at some 760 miles and even more impressive the ch.R8 Katowice transmitter of TVP (Poland) at some 900 miles, initially on the RETMA card and then on the EBU pattern—the signals were very weak. Both these receptions were on October 7th during the early morning period. Another friend—David Griffin of Norwich—has sent in some exciting news telling of reception of Switzerland via u.h.f., on chs.E22 and E31. This is in fact the first time the Swiss u.h.f. network has been received in the UK. David also noted various Band III transmissions from DFF, West Germany and ORF (Austria) over the period October 7-8th; quite an impressive record.

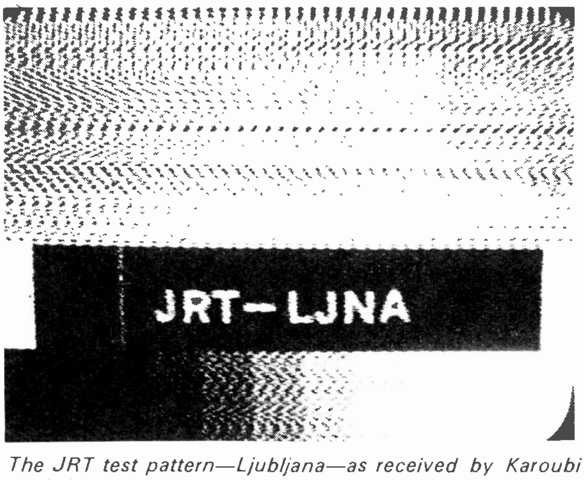
My own log for the period reflects the improved tropospheric conditions and also the unfortunate effects of a valley location!

1/10/71 BRT (Belgium) E2; NOS (Holland) E4 -both trops.
2/10/71 DFF (East Germany) E4; BRT E2; NOS E4; plus good trops on v.h.f./u.h.f. into Northern France.
3/10/71 Switzerland E2 (Sp.E); BRT E2.
6/10/71 ORTF (France) 21 x 2, 22, 25, 27, 29, 33, 43, 45, 56; BRT E10, 11; NOS E4; RTE (Eire) B7, H; Newhaven, Sussex ch.B6 (a new one for me!).
7/10/71 ORTF 21 x 2, 25, 29, 33, 43; Luxembourg E7; BRT E2, 3, 8, 10, 11; NOS E4; WG (West Germany) E9, 11, 21, 24, 27; Channel Islands B9.
8/10/71 WG E6, 8, 9 x 2, 10, 11, 21, 22, 24, 25, 26, 29, 31; DFF E5, 6; (WG ch.E9 a new one—Waldenburg).
9/10/71 CT (Czechoslovakia) R1; NRK (Norway) E4 —both via Sp.E.
11/10/71 DFF E4—via MS.
12/10/71 DFF E4 (MS); SR (Sweden) E2 (Sp.E).
13/10/71 SR E2, 4; RAI Italy IB—both Sp.E.
15/10/71 NOS E4—trops.
16/10/71 DFF E4 (MS); BRT E2 (trops).
17/10/71 SR E2, 4 (MS).
20/10/71 WG E4 (MS); SR E4 (MS).
22/10/71 ORTF v.h.f./u.h.f. down into central France; WG E8, 9; BRT E2, 8, 10, 11; RTE B7, H; Luxembourg E7.
23/10/71 WG E6, 9, 10, 11, 31; BRT E2, 8, 10, 11; NOS E4, 6; Luxembourg E7.
24/10/71 NOS E4; various ORTF v.h.f./u.h.f. trops.
26/10/71 TVP (Poland) R1 (MS).
28/10/71 CT R1 (MS).
29/10/71 TVP R1 (MS).
30/10/71 CT R1; NRK E3, 4—both MS.

A sporadic E opening was noted by Maurice Opie (Ringwood) on 24/10/71 at Midday. Signals were of long duration and favoured Eastern Europe, reaching up to ch.R3. Towards the end of the month increasing Meteor Shower activity was noted throughout Band I, giving prolonged bursts of signal at fair strengths. The tropospheric opening of October 22nd was of particular note as RTTY (Teletype) signals were noted at various frequencies in Band III during the afternoon period. Earlier on that day the Philips electronic pattern type PM5540 was noted on ch.B8 and was eventually tracked down to Presely, West Wales. All things considered then October was an extremely active month and some of the tropospherics noted were the best for some years—especially Luxembourg, which was received in many parts using their new 625-line standard.

News Items

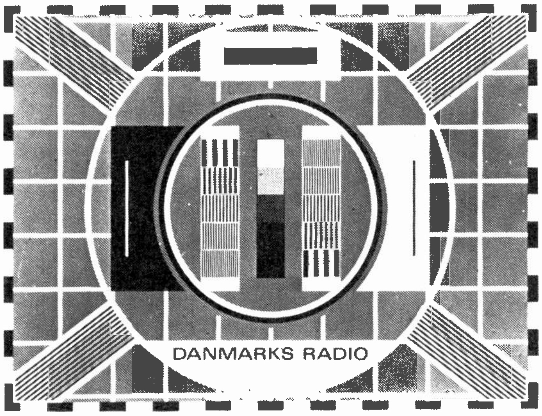
Belgium: We understand that the following u.h.f. transmitters are expected to commence operation shortly. Anderlues (near Mons) ch.61 horizontal, ?e.r.p., RTB network — approximately Christmas 1971; Egem (near Bruges) ch.43 horizontal 1000kW, BRT network, December 1971; Ougree (near Liege) ch.42 horizontal 1000kW, RTB network, October 1972; Schoten (near Antwerp) ch.62 horizontal, ?e.r.p., BRT network, November 1972.
Spain/Canary Islands: The EBU has advised that the Intelsat-IV satellite is now relaying news programmes and sporting items from the Spanish mainland to the Canary Islands for transmission over the Izana ch.E3

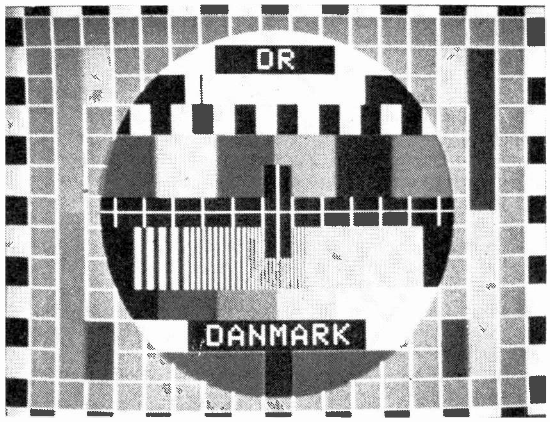


The JRT test pattern—Ljubljana—as received by Karoubi Abdelkader in Algeria.

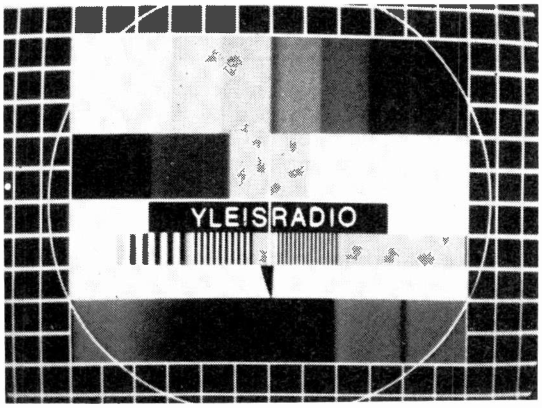
The Intervision news caption—CCCP Moscow.

DATA PANEL 6-2nd series





Denmark. Two main Test Cards are used by Danmarks Radio, Test Card G as shown above left and the Philips PM5544. The latter has two versions, one with identification as shown above right and the other not identified but carrying a single vertical white line in the lower black rectangle, or, the left-hand side one tenth of the way in.



Finland OY Yleisradio. Two test cards are used, the electronic one above including the circle for the TVI network and omitting it for the TV2 network, and also recently on TV2 Test Card G with the identification "Yleisradio TV2".

Colour Test Card used by Sweden—Sveriges Radio.

Photographs this month courtesy of Danmarks Radio, Seppo J. Pirhonen Finland, Sveriges Radio and Keith Hamer and Garry Smith of Derby.

outlet. We understand that certain programmes will be transmitted simultaneously in both areas. Consequently great care should be taken in obtaining a positive identification of the Canary Island transmitter.

Norway: NRK should begin colour transmission in January 1972 although starting with mainly material via the Eurovision Network. Already they are using the colour type test card.

Monte-Carlo: We have mentioned in past columns the possible commencement of a u.h.f. service by Tele Monte-Carlo towards Italy. At present an experimental service is being conducted on ch.E35 with test card and announcements from 1500-2100 CET. The aim is to find out the coverage possible on the Plain of Lombardy. The transmitter is situated at Col de Tende on the French/Italian border some 25 km from Monte-Carlo.

New Transmitters

Finland: Sippola ch.49 horizontal 600kW e.r.p. (TV2 network). The following have increased their e.r.p.: Helsinki ch.E6 horizontal 180kW (TV1 network) and ch.E8 horizontal 60kW (TV2 network).

Sweden: Arvidsjaur ch.E21 horizontal 1000kW (approximately 50 miles SW of Boden); Taasjoe ch.E37 horizontal 1000kW (approximately 100 miles W of Vannas).

Predicted smoothed sunspot counts for the next six months, courtesy Swiss Federal Observatory Zurich: October 54, November 52, December 50, January 48, February 47, March 45.

Tropospheric Propagation

Many will have experienced the improved tropospheric conditions over the past few weeks, resulting in the reception of various transmitters at v.h.f. and u.h.f. with relatively stable signal levels—quite unlike those noted during the summer months with sporadic E propagation. Tropospheric propagation is dependent directly on weather conditions within the part of the atmosphere adjacent to the Earth's surface and extending up to about 10,000 feet. When weather conditions become very settled, as with a slow-moving high-pressure system (anticyclone), we can look forward to an improvement in reception. Often during the late summer and autumn months such a weather system becomes virtually stationary over

Western Europe producing fine, cloudless days and cold nights. As evening comes the surface temperature falls more rapidly than that of the upper air producing a temperature inversion which results in enhanced tropospherics. Fog can also form, especially in coastal areas, and the result of the two produces stable reception from the evening until the following morning when the fog is dispersed by the heat of the sun. Reception tends to favour a path parallel to the prevailing isobar pattern (an isobar is a line joining points of equal air pressure).

During such enhanced tropospheric conditions another effect—ducting—can occur. An upper air duct conveys a signal from a distant transmitter to the receiving site, often bypassing intermediate transmitters and generally being limited to one particular direction and distance. Reception of Band III, IV and V transmitters seems to be more favoured by this means than Band I. Distances covered can be anything up to 1,000 miles in Band III and higher. Signals propagated by this mode tend to be stable and slow fading.

From Our Correspondents

Paul Gardiner (Aldershot) has recently been to Greece and on his return sent us information on his observations over there. The EIPT TV Company in Athens told him that at present all the transmitters in operation are in Band III. There are over a dozen transmitters in operation, some of high power. In the Athens area he saw "massive structures"—aerials of 23 elements for Band III ch.E11 and others—vertically polarised—for the E5 transmitter. Paul was able to photograph various test cards off the screen and we hope to feature these in a forthcoming Data Panel.

Karoubi Abdelkader (Algiers) has sent us a long letter. He has constructed a three-standard television receiver which by all accounts is working very well. Tropospheric results include TVE (Spain), RAI, ORTF, TMC (Tele Monte-Carlo), RTM (Morocco) and the results from Sporadic E cover most of Europe. He uses a 75 foot rotatable mast with a 74-element u.h.f. array and a 12-element Band III array. Various Band I arrays are fixed lower down. Karoubi forwarded with his letter a number of photographs of his reception and we are showing this month an unusual JRT (Yugoslavia) test pattern which he received this summer. This shows the EBU pattern, but with an abbreviated Ljubljana identification, on ch.E3.

Ian Beckett (Buckingham) has been extremely busy during the recent tropospheric conditions and his letters detailing the various stations received at his Buckingham home resemble a transmitter list issued by the EBU! During the month, Ian received 16 *new* West German stations, five new ORTF, three new NOS and three new UK transmitters, *all* on u.h.f. Our congratulations on this excellent work! Of particular interest was reception of two West German transmitters at present unlisted. These are Unter-Brechung on ch.E29 and E35. NOS were noted using the EBU pattern with a new identification: PTT-NL VSCHVS.

BOOKS

COLOUR TELEVISION THEORY
by G. H. Hutson,
Published by McGraw-Hill,
Shoppenhangers Road, Maidenhead, Berks.
Price £3·85, 326 pages 7¼in. x 9¾in.

This substantial and handsomely produced book tells you pretty well all you could wish to know about colour television. The theory is all there, as the title implies, and is clearly presented with plenty of helpful illustrations. What really makes the book so far as we are concerned, however, is that there's plenty of practice as well. Of the 17 chapters, 12 concentrate on what goes on in a colour receiver with numerous circuit examples taken from production chassis. Thus the receiver sections are based squarely on the chassis the service engineer will encounter in his day-to-day work.

We have found the book most helpful in clearing up a number of obscure points about which we were uncertain and have no doubt that it will be on and off our reference book shelf—in amongst the service manuals—on many occasions in the future. It it up-to-date, covering for example the Sony Trinitron tube, primary-colour drive circuits as used in recent single-standard colour chassis and the passive subcarrier regenerator circuit used in the latest Rank-Bush-Murphy chassis. It mentions i.c.s, now being widely used in colour chassis, only briefly but then there's not much you can do about an i.c. anyway.

We warmly recommend this book to any reader wanting to get to grips with colour television painlessly and to understand the operation of colour receiver circuits. For the sake of overseas readers we should perhaps add that the book is based on PAL colour television techniques: there is a little about NTSC, only a paragraph or two on SECAM.—*J.A.R.*

Principles of Television Reception by W. Wharton and D. Howorth, published by Pitman Publishing, 39 Parker Street, London WC2B 5PB, is now available in a paperback edition at £1·40. This 296-page book is a good, clearly written text on television reception, both monochrome and colour, with plenty of receiver circuitry.

A second edition of **Television Engineering, Principles and Practice,** Vol. 2, Video-Frequency Amplification by S. W. Amos, D. C. Birkinshaw and K. H. Green, has been published by Iliffe Books (88 Kingsway, London WC2B 6AB) at £3·50. The volume is part of a well-established work and describes the fundamental principles of video-frequency amplifiers, examining the factors which limit their performance at the extreme ends of the passband. A wide variety of circuits is described with particular attention paid to the use of negative feedback. A section deals with the special problems of camera head amplifiers. The text tends to be rather mathematical. An all too short chapter has been added on transistor video amplifiers.

A third edition of **Television Servicing Handbook** by Gordon J. King has been published by Newnes-Butterworth (88 Kingsway, London, WC2B 6AB) at £3·80. Gordon J. King of course needs no introduction to readers of TELEVISION to which he has regularly contributed for many years. This is a down-to-earth work on TV sets, what goes wrong with them and quick methods of fault diagnosis. That said, however, one must point out that there is some quite antiquated material left in this third edition. When for instance did you last encounter a set with a triode (6L18!) field output valve, or one using a transitron or gas-filled thyraton timebase generator? Then some of the a.g.c. circuits described relate to the earliest days of a.g.c. in TV sets—the mid-fifties. All this tends to be reflected in the trouble-tracing approach: for example there is no mention of that very common cause of lack of width in sets produced over the last six/seven years, change of value in a high-value resistor in the width stabilising circuit.—*J.T.*

SERVICING television receivers

L. LAWRY-JOHNS

THE GEC BT302 SERIES

A reader recently asked us if we had ever dealt with this series and if so in which issues. Our immediate reaction was that of course we had. Upon checking however we found that we had in fact missed this very popular oldie out. We now hasten to repair the omission. With a little give and take here and there these notes will be found to cover quite a large number of models in the "300" range. They were mainly bow-fronted models, usually with 17in. tubes. Some of later date, however, were fitted with 21, 19 or 23in. tubes while there were also plus v.h.f./f.m. radio, push-button tuner versions and other variations. They all conform mainly to a basic design and exhibit similar fault patterns.

The construction is of box type with a vertical panel on either side. The disadvantage of this is that the print is hidden so that a quick check on the valve bases to locate an open-circuit heater on the left-side panel is not on. It is very common for one of the valves on this panel to develop an open-circuit heater and once it is established that the fault is in fact on the left side panel it is just as well to take out the valves in turn to check the continuity of pins 4 and 5 (except the DH77 of course).

Faults to be Expected

We will assume that one of these receivers has been brought in to be thoroughly overhauled. In the first place the set may not be worth the cost of the repair and this fact should be ascertained at the earliest stage possible.

When first connected to the mains there may be no results at all. Check the 1·5A mains fuse using a neon or a meter. If in order check at the right side dropper. It may well be found that although the mains is at all the dropper pegs it may not be at the voltage adjustment plugs and sockets on the right edge. The reason for this is that the dropper pegs are sunk into a printed panel which connects over to the voltage selector. It is common for a peg to be burned away from the copper print. If this is the case scrape the peg clean and connect a lead from it across to the correct socket. An open-circuit dropper section may be similarly connected, i.e. mounted on a chassis member and connected with leads to the appropriate pegs or sockets.

If all heater sections are in order but no valves light up it is fairly certain that there is an open-circuit valve heater somewhere along the line. The thermistor R75 at the top of the voltage panel is rarely at fault. Whilst it is impossible to pinpoint any one valve which may be at fault it is usually one of the h.f. pentodes—type Z329. As these are used in all sections of the receiver stating this may not be of much help. Follow the heater chain through with a neon if you can or check each valve individually if you prefer to do this. Note that the heater run from the thermistor is through the right side panel after feeding the N308 and U339, then over to the left side to feed three valves and then on to the tuner, back to the left side to the other three valves and then finally to the tube.

The HT Supply

Assuming that the valve heaters are all glowing except the U47, check the a.c. mains through R80, R81 and R82 to the h.t. rectifier and then along to the h.t. fuse for a d.c. reading.

These sets do not normally suffer from h.t. shorts. What does happen is that the h.t. rectifier sparks between the plates and blows the main fuses (or damages a dropper section). As these sets are now quite old it is likely that the original rectifier has been replaced, if for no other reason because of low h.t. (small picture, poor focus). The rectifier fitted may therefore not be of the original finned type or may not be fitted in the original position (front of chassis).

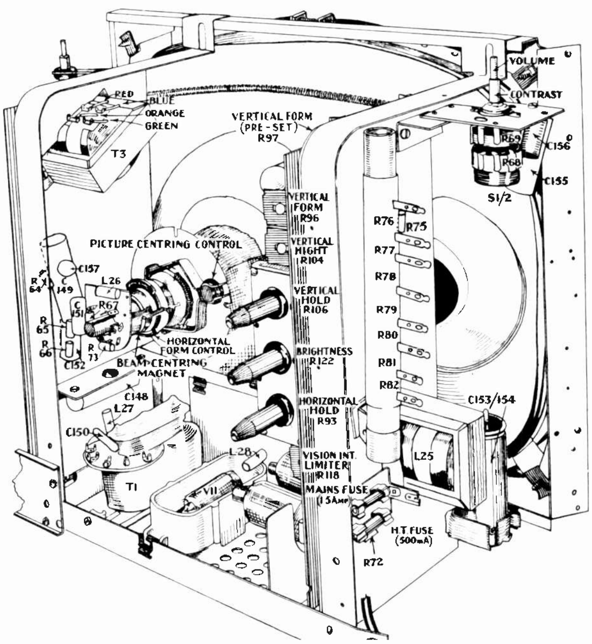
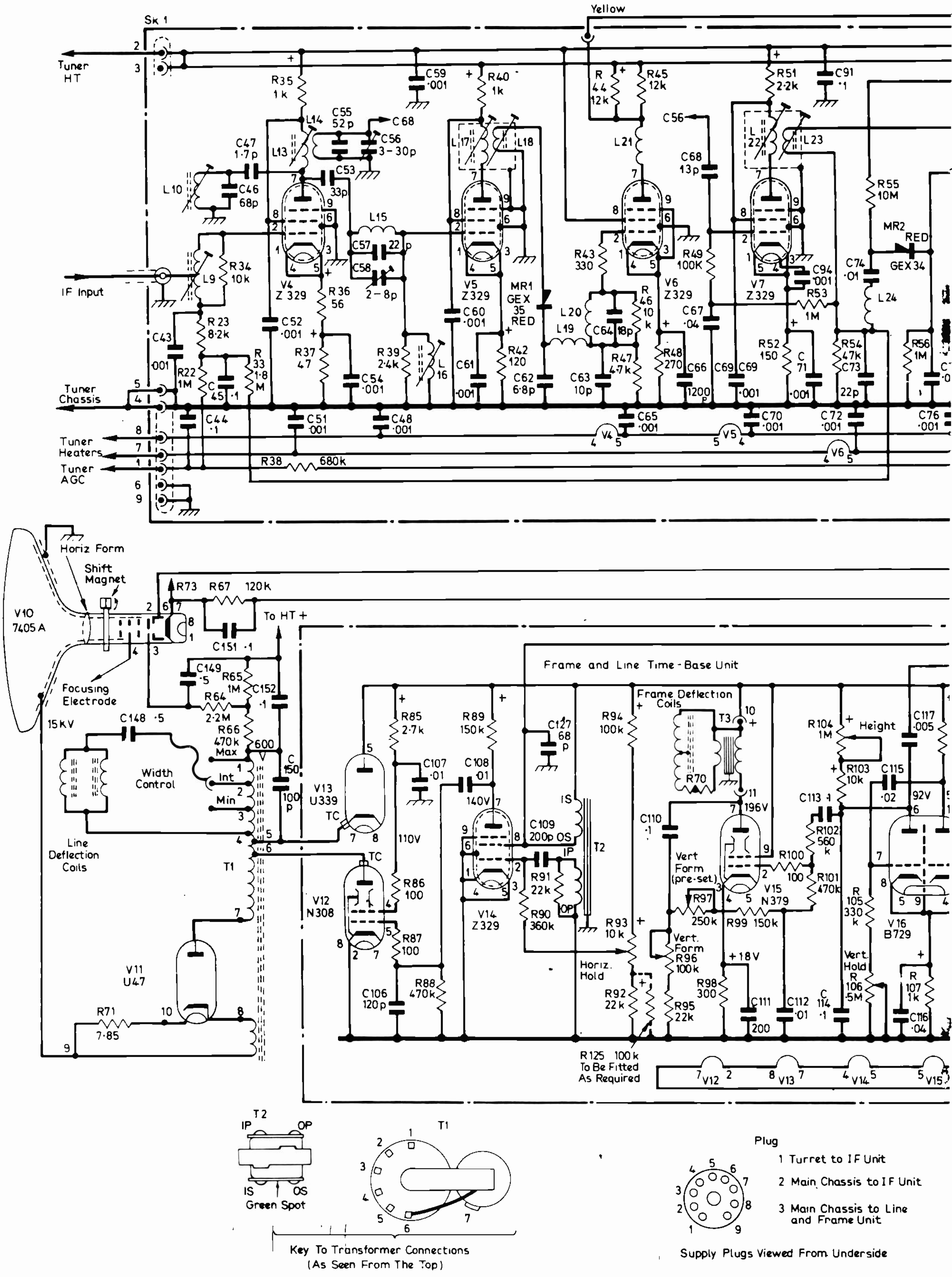


Fig. 1: Rear chassis view. The positions of the tuner and main controls vary from model to model.


Yellow
Sk 1
Tuner HT
IF Input
Tuner Chassis
Tuner Heaters
Tuner AGC
Horiz Form
Shift Magnet
V10 7405 A
Focusing Electrode
15KV
Width Control
Line Deflection Coils
To HT +
Frame and Line Time-Base Unit
Frame Deflection Coils
Height
Vert Form (pre-set)
Vert. Form
Horiz. Hold
Vert. Hold
R125 100k To Be Fitted As Required
Green Spot
Key To Transformer Connections (As Seen From The Top)
Plug
1 Turret to IF Unit
2 Main Chassis to IF Unit
3 Main Chassis to Line and Frame Unit
Supply Plugs Viewed From Underside

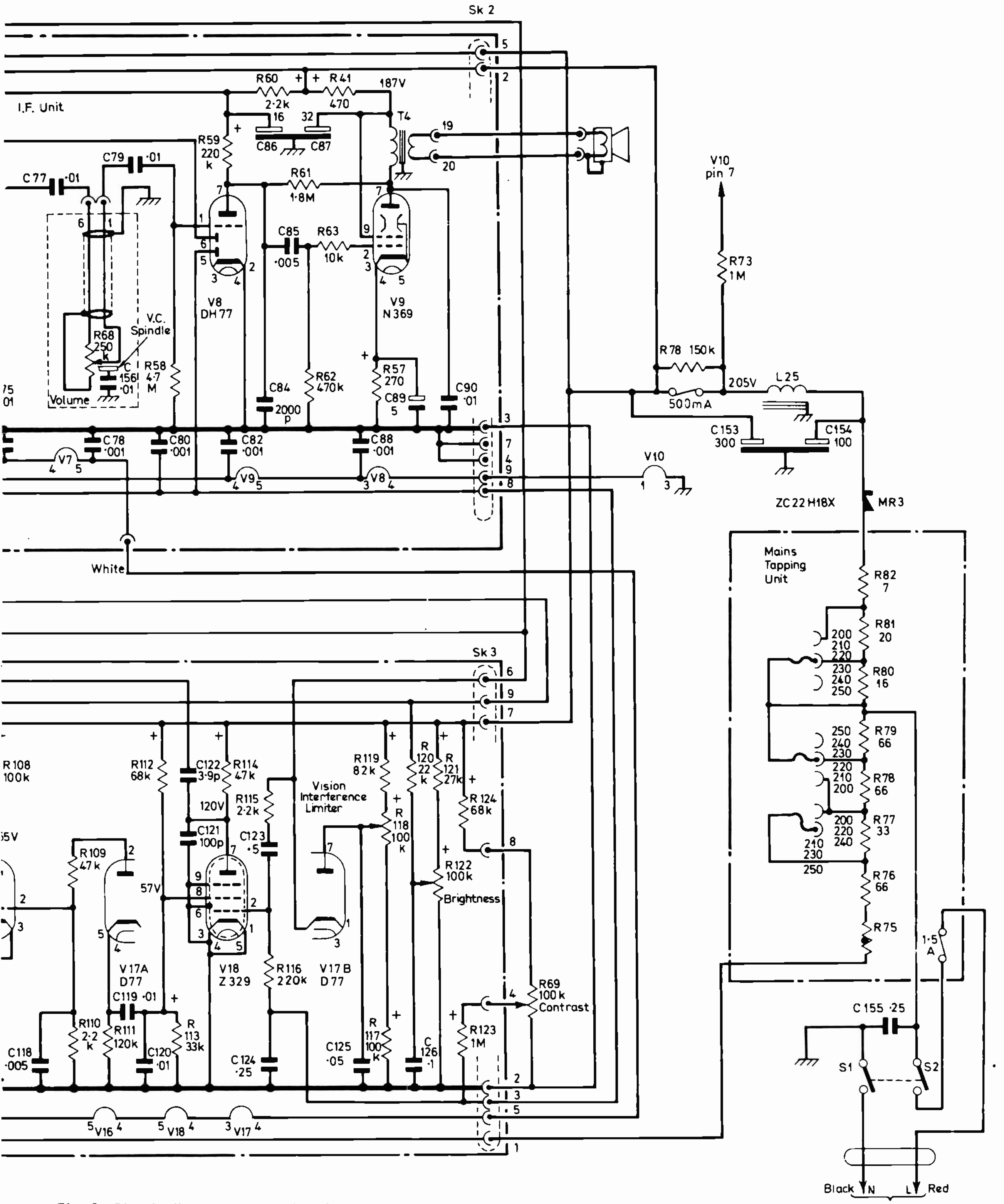


Fig. 2: Circuit diagram, GEC Models BT302 and BT304. The basic circuit with minor modifications was used in a number of other models. Fringe versions incorporate an additional common i.f. stage.

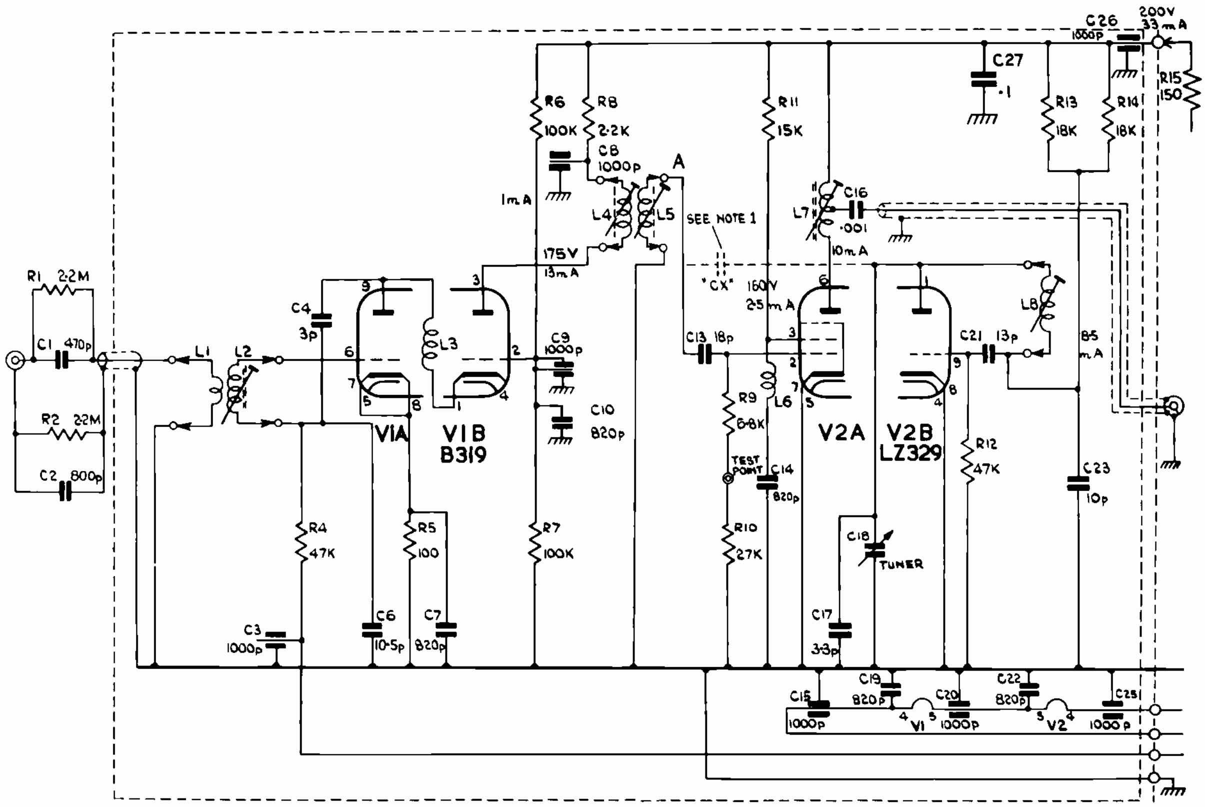


Fig. 3: Circuit of the turret tuner. Note 1: Capacitor CX consists of stray capacitance supplemented on Band III by a loop around L8 connected to point A.

We have just said that these sets do not normally suffer from h.t. shorts: this may not be the case, however, if a silicon rectifier has been fitted or if one or more of the dropper sections have been shorted out by means of the voltage adjustment plugs. Capacitors of the electrolytic or paper type may not like the resultant higher voltage and may make their objection known by shorting. The tags of the main electrolytics are presented in an obvious position on the right side and can easily be disconnected for a cold resistance test. This arrangement incidentally eases fitting a new rectifier if the old one is low since a silicon type can be wired in series with a 15Ω wire wound resistor from the socket of R81/R82 to the 100μF section of the electrolytic (C154).

No Picture

Assuming that the valves are now all lighting (again except the U47) and that the h.t. is now somewhere near right there may well be no sign of life on the screen and for that matter no sound either. The two fault conditions may not be connected and we will assume they are not.

If there is no or very little line timebase whistle it is likely that one of two capacitors has shorted. The first is the boost reservoir capacitor C152 (0·1μF). It is situated on the left side of the centre section above the line output transformer. If removal of the top cap of the U339 produces some e.h.t. this capacitor is almost certainly shorted. A replacement should be rated at 750V or over.

The other capacitor is C150. This is a tubular ceramic of 100pF value positioned on top of the transformer. One end may be discoloured or it may be hot. Disconnecting one end will bring things to life if it is in fact shorted. A replacement should be rated at 6kV or more.

If the line timebase whistle is still not good disconnect the single wire end of the U47. This valve may be shorted inside (although this usually results in a more obvious manifestation—pretty colours and flashing lights, etc.).

If the line timebase whistle is quite normal but the heater of the U47 is not glowing it may well be that the heater of this valve is open-circuit. A U25 is equivalent to the U47 for replacement purposes.

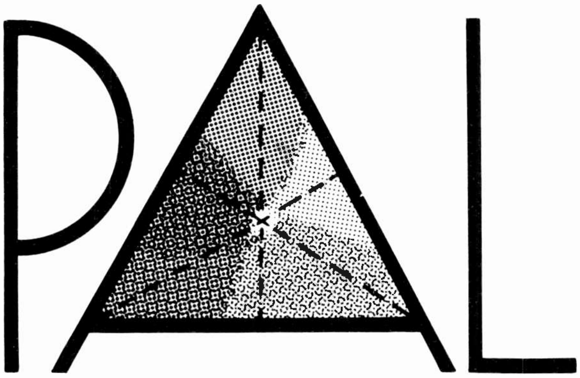
Whilst one is delving into the e.h.t. compartment it may well be found that the insulation of the U47 container is breaking down with brushing and corona discharge providing an interesting display. The obvious remedy is to replace the container. If this is not possible remove the bottom screws and lift the container off the chassis: then put some thick polythene underneath it, cut away that which has to be cut away and insulate the rest as much as possible, if necessary with e.h.t. sealer (e.h.t. Seela or quick start or something of like ilk).

Check the condition of R71 which may be decomposed, and ensure that all soldering has nicely rounded blobs (no sharp edges or wire ends).

If the N308 (near equivalent 30P4, PL36, etc.) and U339 (U191) are in good order and the line oscillator Z329 (30F5, EF80 is near) is driving properly there is no reason why the e.h.t. should not be about right.

CONTINUED NEXT MONTH

A CLOSER LOOK AT PAL



PART 2

E.J.HOARE

INTRODUCING PAL VECTORS

LAST month we commented on the inherent robustness of the PAL system. By this we meant the ability of a PAL receiver to display accurate colour pictures even when the incoming signal is distorted or the receiver itself is poorly aligned or has some minor defect in the chrominance circuitry. Signal distortions tend to occur in studio links, long landlines, microwave links, or as a result of multipath effects in airborne transmissions causing phase changes or echoes. In the receiver a badly shaped i.f. or chrominance passband will cause poor chrominance transient response on the picture while errors in decoder alignment will show up as ventian blinds, desaturation or even as hue distortion (wrong colour) in a bad case.

PAL is really very good at resisting the effects of these distortions and clearly this is a vitally important attribute. It is probably the most important single reason for colour TV being such a success. It is therefore rather surprising to find that most textbooks fail to explain—except in a very cursory sort of way—what happens to a distorted PAL signal and what effect a misaligned decoder has on an undistorted signal. Or even how to align a decoder at all. In sorting out these chrominance processes one inevitably gains a much deeper insight into the principles on which the colour TV system is based. Also it soon becomes clear where the critical areas of circuitry lie and where extra care is needed when carrying out alignment or fault-finding.

At this point we come to a slight snag. Most electronic processes can be described fairly adequately in words, but not PAL decoding. It needs either fairly advanced mathematics or else vector diagrams. Now vectors are not everyone's speciality! Even strong men have been known to blanche at the mention of them and this is a pity. It is true that certain types of vector diagrams can be highly complicated, but the ones used in PAL decoding are not. They are just a simple way of drawing sinewaves without the tedious business of drawing lots of curves. In fact if you will accept that they are not really at all difficult you will find them quite easy! We will shortly be reminding you what vectors are all about, before looking at the decoding processes. First of all however let us summarise briefly the form of the PAL chrominance signal.

Colour Television Fundamentals

Almost any colour occurring in nature can be reproduced by mixing the appropriate proportions of red, green and blue light. The human eye cannot distinguish between the original colour and the new synthesised one. This is the basis of all colour television systems. We therefore have to transmit information proportional to the red, green and blue content of the scene being televised.

The signal is encoded into two parts—luminance (black-and-white or brightness) and chrominance (colour). The luminance or Y signal is obtained by mixing the three primary colours in the proportions 0·3 red+0·59 green+0·11 blue. These proportions have been found by experiment to represent very closely how the eye sees colours in terms of brightness as distinct from hue. When this Y signal is transmitted in the usual way as modulation on a vision carrier a perfectly normal black-and-white picture can be obtained on either a black-and-white or a colour receiver.

Colour-difference Signals

The chrominance signal has to transmit the *extra* information which when added to the luminance signal turns the black-and-white picture into a full colour one. The chrominance signal therefore represents the *difference* between the complete colour information and the black-and-white (luminance) information alone. A colour receiver produces a normal luminance signal and in addition needs the colouring information R – Y, G – Y and B – Y. These are known as the *colour-difference signals* because when they are added to the luminance signal we get (R – Y) + Y=R; (G – Y) + Y=G; and (B – Y) + Y=B. R, G and B are of course what the camera saw and when fed to a three-gun c.r.t. will produce a full colour picture.

Carrier Phase and Amplitude

The rules of simple algebra tell us that since Y is produced from R, G and B we only need to transmit two of the colour-difference signals in addition to Y. R – Y and B – Y are transmitted, and the receiver adds these in the correct proportions to give G – Y. In fact G – Y = –0·51 (R – Y) –0·19 (B – Y). R – Y and B – Y are transmitted as a combined chrominance signal by means of quadrature modulation. Two carriers of exactly the same frequency (approximately 4·43MHz) but differing in phase by a constant 90°, i.e. a quarter of a cycle, are separately amplitude modulated with the R – Y and B – Y colour-difference video information and are then added together to give a single sinewave carrier which is the resultant of the two individual carriers. Any change in the *relative* amplitudes of the two carriers, caused by a change of hue, results in a *phase* change of the combined carrier. An amplitude change of *both* carriers in the same proportion, caused by a change of saturation, results in a change of *amplitude* of the combined carrier, the phase staying the same in this case.

The decoding circuits in the receiver have to be able to detect both the phase and amplitude changes of this combined carrier in order to obtain the hue and saturation information as separate quantities. The study of decoding processes therefore depends upon understanding what is happening in various circuits in terms of the phase and amplitude of what are, to all intents and purposes, carriers of constant frequency.

The PAL Signal

The R−Y subcarrier is reversed in phase by 180° from line to line as part of the PAL switching process in order to make it possible to cancel out certain types of phase error. The subcarrier itself is suppressed in order to avoid overloading the transmitter and also causing an unacceptable beat pattern on the picture. Thus a pilot sinewave has to be transmitted as a short "burst" on the back porch of the line sync pulse so that the correct subcarrier phase and frequency can be regenerated in the receiver. This burst is switched ±45° from line to line in strict sympathy with the switching of the R−Y subcarrier. The switching of burst and R−Y subcarriers adds extra phase considerations to the basic processes of decoding. The simplest way of considering these decoding processes is by means of vector diagrams, so let us now remind ourselves what vectors are all about.

Simple Vectors

Most of us are fairly used to reading maps when driving in strange country—perhaps when on holiday. If the scale of the map is four miles to the inch and our destination is shown on the map five inches away from our present position we know we still have five times four equals twenty miles to go. Now suppose that someone directs us to his favourite pub by explaining that it is in a small village eight miles away in a due Easterly direction. There is no problem is there? We find where we are on the map and then draw a line two inches long, representing eight miles, towards the right-hand side of the map, i.e. due East. We can mark the end of the line with an arrow head and this shows our destination. All this is very simple and straightforward: we have not even had to provide a diagram to illustrate the procedure. And yet we have in effect drawn a vector: we have vectored on to our destination. Painless isn't it?

So we can see straight away that a vector is a straight line whose length represents one quantity and whose direction represents another quantity. In our map reading example the length represented distance in miles and the direction of the vector represented the direction on the map by compass bearing. Instead of saying due East we could just as easily have described it as 90° from North. Suppose then that we are travelling by a cross-country route and want to keep track of where we were going. We could keep a simple log of distance travelled and compass bearing and then plot the result on a map to see where we are. Fig. 1 shows the beginning of the process. We travelled 4 miles East then 7 miles North-East and then 10 miles South-East, i.e. 90°, 45° and 135° compass bearing from due North. The mileage has been converted into inches at 4 miles = 1 inch. We now plot these three parts of the course on a piece of paper and find that we land up at C. By drawing to scale or by trigonometry we find that C has a bearing of 97½° and is 16·5 miles away from our starting point at O. We can draw a line OC to make the matter clear.

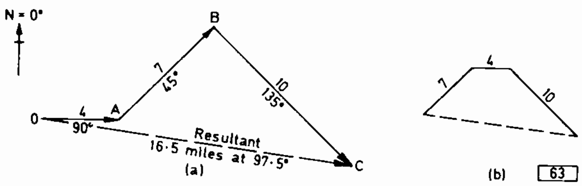


Fig. 1: Simple map reading (a) drawn in the form of a vector diagram. Note that precisely the same answer will be obtained if the vectors are drawn in a different order, as shown for example at (b).

The line OC is also a vector, and is obtained simply by adding together the three individual vectors OA, AB and BC paying due regard to their direction as well as their length. From the diagram we can see that we could have got to our destination C by travelling along the line OC instead of following the dog-leg course via A and B in three stages. The two courses are equivalent. The whole process is quite straightforward and you probably feel quite confident of being able to trace out any kind of zig-zag course. You simply add all the individual components together, find the resultant and then plot on a map to find the destination.

Electronic Vectors

In electronic work we are interested in voltage or current rather than miles and degrees of phase instead of degrees of compass. We can draw a line as shown in Fig. 2 with say one inch equal to 10V. If the line is one and a half inches long we have represented — using the same scale—a voltage of 15V. And the phase indicated is 45°. Note that instead of measuring degrees from North, so to speak, in electronics we measure them from East: East equals 0 degrees. This is just a

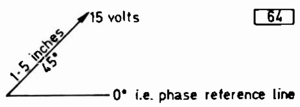


Fig. 2: Electronic vectors are nearly always drawn with their reference phase as shown here. Scale 1 in. = 1V (not shown to scale here). The vectors can be added together in the same way as in Fig. 1.

convenient starting point and has no other significance. Also we measure degrees the other way—anticlockwise instead of clockwise. A line of this kind drawn on a piece of paper then does not cause any particular difficulty. Its length represents volts (or current, as required) and its direction represents degrees of phase. It is rather helpful to get the following distinction clear. You probably readily understand the line as such in terms of volts and phase angle. The reason why many people do not feel happy using these lines as electronic vectors is because they do not understand phase angles properly. Don't blame the vectors: have a go at phase angles instead!

The Importance of Phase

Electronics is based on the use of sinewaves and pulses, although d.c. is used to provide the power and the steady-state conditions. Without sinewaves there would be no radio or television in the form that we

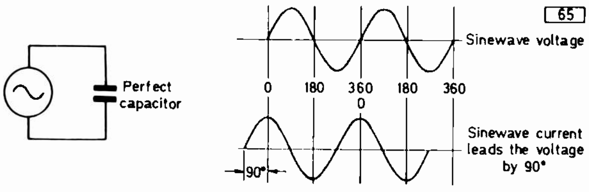
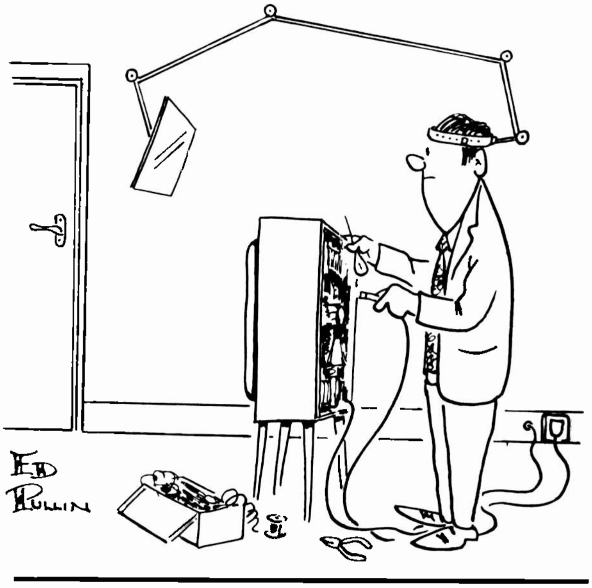


Fig. 3: A sinewave voltage applied to a perfect capacitor causes a current which leads the voltage by 90°.



know them; no tuned circuits giving gain and selectivity; no signal carriers; no synchronous demodulators. A long list could be made out and it is worth remembering that every pulse whatever its shape can be analysed in terms of a fundamental sinewave and its harmonics each of which have a particular amplitude. Thus in electronics we are constantly having to consider the *phase* of one sinewave relative to another. If you apply a sinewave voltage across a capacitor for example you get a sinewave current flowing, but the peaks of the current waveform do not occur at the same time as the peaks of the voltage. One waveform is displaced in time relative to the other: there is a phase difference as shown in Fig. 3.

The reason for this phase difference is of course that if you apply a voltage to a perfect, discharged capacitor the capacitor appears as a short-circuit. Thus a relatively large current flows but there is no voltage developed across the capacitor at the instant of switching on. The flow of current into the capacitor begins to charge it up and the voltage across it gradually builds up too. This voltage acts in opposition to the applied voltage and so the current is reduced. Thus as the charge builds up so does the voltage, but the current falls. See Fig. 3 again.

This situation occurs with nearly every electronic circuit so we need some means of describing current and voltage waveforms and the phase differences between them. It can be done mathematically in various ways but it is often useful to illustrate what is happening by visual means, i.e. a diagram, and here we come to vectors again.

The starting point of Fig. 3 is the sinewave voltage applied across the capacitor. We can represent it in Fig. 4(a) by an arrow whose length is proportional to the voltage. Since this voltage is our starting point we draw it in the direction three o'clock. Now the current through the capacitor leads the voltage by a quarter of a cycle, i.e. by 90°. In other words any point on the current waveform occurs a quarter of a cycle *before* the corresponding point on the voltage waveform. So we can draw a line—whose length is proportional to the amplitude of the current—in the direction of 12 o'clock. By placing the line anticlockwise from the voltage vector it is understood that the current waveform is leading (arriving before) the voltage waveform.

So here we have a vector diagram. It tells us at a glance the amplitudes of the voltage and current and the difference in phase between them. We can draw the same kind of diagram for an inductance. In this case however the current lags *behind* the applied voltage by a quarter of a cycle (90°) so the vector diagram is as shown in Fig. 4(b). The current vector is 90° clockwise from the voltage vector, so it is understood to be lagging in phase, i.e. arriving later.

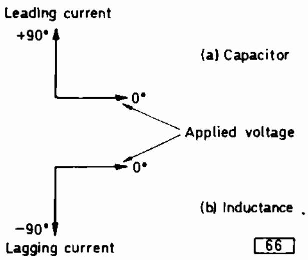


Fig. 4(a): Vector diagram equivalent to Fig. 3: it's much easier to draw! (b) Conditions when a sinewave voltage is applied to an inductor instead of a capacitor.

Vectors Rotate

So far we have drawn our vectors as though they represented stationary or constant quantities. In fact of course they represent sinewaves which are changing in amplitude all the time as they sweep through their zero, maximum and minimum values. What we have drawn so far are lines indicating the *peak amplitudes* of the sinewaves and the phase difference between them. For many purposes this simplification is adequate but to be mathematically correct, and to cater for certain other situations, we should take our explanation a stage further.

Electronic vectors are assumed to be rotating because sinewaves are changing all the time. Fig. 5 is a pictorial representation of why this is so. An a.c. alternator is shown at (a); (b) shows a number of positions of the rotor during the course of one cycle; and (c) the resulting sinewave with its instantaneous amplitude values. Fig. 5 (b) is a vector diagram showing the phase of the sinewave with respect to zero at different instants in time (but the arrows are not drawn to scale and their length in this case has no significance). The vectors can therefore be regarded as rotating. If we consider an electronic oscillation instead of the output of an alternator the situation is

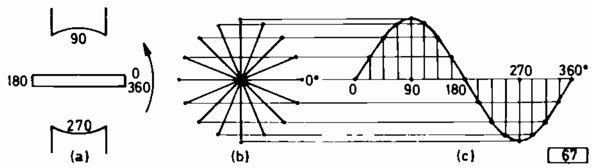


Fig. 5: Electronic vectors are assumed to be rotating anticlockwise. We stop them at a given instant in time in order to compare their amplitudes and phases.

precisely the same: how the sinewave is generated makes no difference. If now we take two sinewaves of exactly the same frequency but with the first one leading the second by a phase difference of 90° we can draw another crop of vectors. Each vector of the two sets will be displaced by an angle of 90° anticlockwise —because the first sinewave started earlier so to speak. If we then inspect both sinewaves at an appropriate instant in time we get the vector diagram shown in Fig. 4 (a) which we have already discussed.

You may feel like saying that whether vectors rotate or not really makes very little difference: you are quite happy to keep them stationary! However when we come to consider single- and double-sideband operation you will see the point. The upper and lower sidebands consist of sinewaves in antiphase. They are rotating in opposite directions and the phase difference between them is therefore not constant — it changes all the time. In this case it is essential to consider the vectors as rotating also and to stop them whenever we want to inspect the phase difference between them.

PAL Subcarrier Phases

Before considering diagrams of PAL signals it is important to be quite clear about what is being transmitted. There are in fact two separate carrier waveforms and both change from line to line in sympathy with the PAL switching sequence even when the same hue is being transmitted. They are of course the chrominance subcarrier and the burst. For the present we will assume that both are of constant frequency, although the phase changes. Later we can consider the implications of the bandwidth necessary in order to transmit changes of information.

Nearly every hue transmitted in an ordinary picture consists of a mixture of R−Y and B−Y colour-difference information and these components may be either positive or negative. The phase difference between the two original subcarriers is always 90°. Now if you take any two sinewaves of the same frequency—whatever their phase difference—and add them together you get a third sinewave of identical frequency which is the resultant (or sum) of the other two. This is how we get the combined subcarrier which contains R−Y and B−Y information. Thus the transmitted chrominance subcarrier can always be regarded in terms of the quadrature (90° apart) R−Y and B−Y components that it contains.

In the vector diagrams we considered earlier the reference line representing zero degrees of phase was set at 3 o'clock and leading phase differences were assumed to be anticlockwise. In chrominance phase diagrams the +(B−Y) component of the signal is always used as the reference. Thus if any +(B−Y) information is being transmitted a vector can be drawn at 3 o'clock with a length to represent its amplitude. Until further notice however we will ignore amplitudes and concentrate on the phase differences. Fig. 6(a) shows the positive B−Y vector drawn in its reference position.

In the PAL system the B−Y component of the signal is transmitted without line by line phase alternation but the R−Y component is inverted from line to line. Let us take a line—which we will call n—in which the R−Y component leads the B−Y component by 90°: we can draw this at 12 o'clock as shown in Fig. 6(a). The ten cycles of reference burst

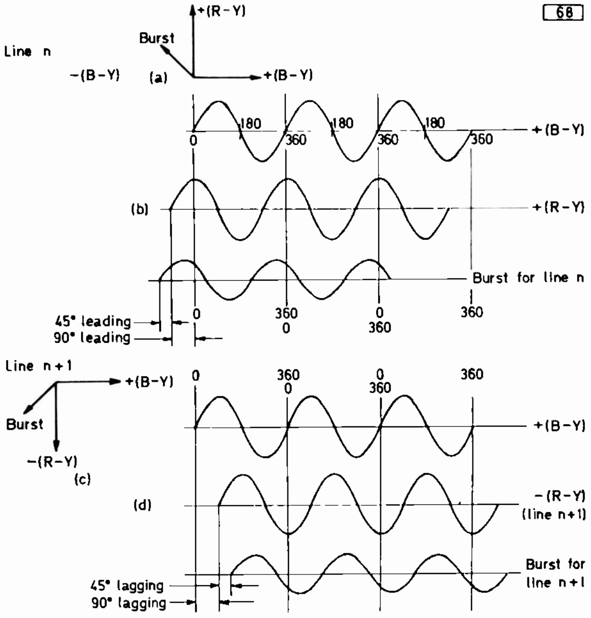


Fig. 6: PAL subcarrier phases shown in both sinewave and vector form.

must also be switched in phase from line to line—so that the receiver decoder will know whether the R−Y component is so to speak upside down—i.e. phase alternated—or not. The phase of the burst signal is ±45° with reference to −(B−Y), swinging positively and negatively in sympathy with the phase of the R−Y component. Thus we can draw a line on Fig. 6(a) to show the relationship of the burst phase to that of the B−Y and +(R−Y)—remembering that R−Y is positive on line n—components of the chrominance subcarrier. Just to show the link between sinewaves and vector diagrams Fig. 6(b) is the direct sinewave equivalent of Fig. 6(a).

On the next line, i.e. line n+1, the R−Y component is inverted which is equivalent to a phase change of 180°. In sympathy with this, and to tell the decoder that inversion has been carried out, the burst phase is changed by 90° to −45° about the −(B−Y) axis. Thus the phase diagram of Fig. 6(a) is replaced by Fig. 6(c) and the equivalent trains of sinewaves are drawn in Fig. 6(d). The next line, line n+2, is a replica of line n so we return to the conditions shown in Fig. 6(a) and (b) again, and so on.

Colour Phase Diagrams

So far we have confined our diagrams to the phases of the subcarrier components themselves without any reference to the actual colours—or hues—being transmitted. If however a magenta hue is being transmitted the chrominance subcarrier will have a phase as shown in Fig. 7(a) during line n and Fig. 7(b) during line n+1 when the R−Y component is inverted. Fig. 8(a) and (b) show how this magenta hue signal phase is derived from separate R−Y and B−Y components of the appropriate relative amplitudes. These two components are drawn as true vectors since their amplitudes are just as important as their angles if the correct resultants shown in Figs. 7(a) and (b) are to be obtained in order to give the magenta hue.

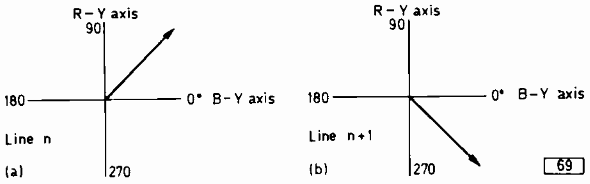


Fig. 7: The phase angle of the chrominance subcarrier on two successive lines for a magenta hue.

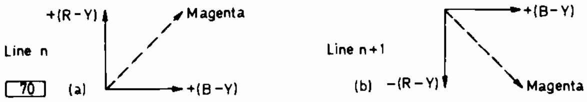


Fig. 8: Showing how individual R — Y and B — Y components combine to give the magenta hue.

Fig. 9: Negative colour-difference components are just as important as positive ones. Compare the phase angles and R — Y and B — Y components of green with those of the complementary hue (magenta) shown in Fig. 8.

Figure 9(a) and (b) shows the same kinds of vector diagram as in Fig. 8 but this time for a green hue. This illustrates that −(R − Y) and −(B − Y) signal components are just as important as positive colour-difference signals in reproducing the whole spectrum of colours that occur in nature.

Thus every hue can be represented by a particular phase of the chrominance subcarrier and in the PAL system the phase of the signal alternates from line to line as the (R−Y) component is switched. Fig. 10 shows the approximate phase angles and amplitudes of the chrominance subcarrier for the three primary colours and their complementaries (yellow, cyan and magenta). Note however that we have changed from ± (R−Y) and ± (B−Y) to ± V and ± U. (Blue rhymes with U!) V = 0·877 (R − Y) and U = 0·493 (B−Y): 0·877 and 0·493 are the "weighting" factors by which the R − Y and B − Y signals are reduced before transmission in order to avoid overloading the transmitter. The reason for our changing horses in midstream is that while U and V are the normal way of referring to R − Y and B − Y (after weighting) nevertheless R−Y and B−Y are more easily understood terms with which to start off our discussion of phase diagrams.

It is quite often stated—quite correctly—that the *phase* of the chrominance subcarrier represents (or describes) the *hue* of the colour while the *amplitude* of the subcarrier represents the *saturation* (strength) of the colour. It is not always easy to make this point clear in words but reference to the diagrams shown in

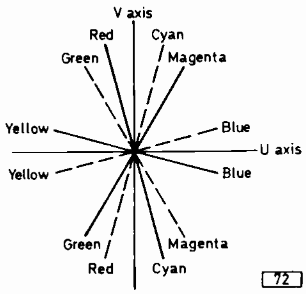


Fig. 10: A true vector diagram showing the phase angles and amplitudes of the chrominance subcarrier on successive lines for the primary and complementary colours.

Figs. 8 and 10 should settle the matter. If the vector corresponding to a magenta or green hue is increased in length it simply means that the amplitude of the chrominance subcarrier has increased: there is no change of phase and thus no change of hue and the receiver simply displays more colour, i.e. a more saturated picture. If on the other hand the vector remains the same length but is rotated in either direction we get a change of hue (and a minor change of saturation). This is because the ratio of R − Y to B − Y has changed and so the three guns of the shadowmask c.r.t. are excited (or driven) differently one to another.

The Subcarrier Phase is Not Constant!

Up to now we have assumed that the frequency of the chrominance subcarrier is constant and that it is derived from two quadrature carriers of the same constant frequency. Now this is simply not true. It is a useful simplification when considering all sorts of coding and decoding aspects of the colour system but its limitations should be born in mind.

Suppose that the same hue is being transmitted on every line of every field: i.e. that a coloured blank raster is being displayed by a set. No chrominance subcarrier is present during the field blanking intervals and the subcarrier will therefore have 50Hz sideband components: in other words there is a change of information (in this case to no subcarrier at all) 50 times every second. By the same token there is a change of information every line when the subcarrier falls to zero during the line blanking interval. Hence there are 15,625Hz components as well. Furthermore as the V signal is switched every line and repeats every two lines we get 7,812Hz components.

From this it is clear that a subcarrier at 4·43361875MHz carries no picture information at all, and this explains why it can be suppressed at the transmitter without any ill effects. In fact suppressing the subcarrier saves transmitter power and reduces the amount of dot patterning visible on the picture. The subcarrier is only reinserted in the decoder to make demodulation possible: it does not add any picture information as such.

The U and V subcarrier components which we happily draw on our vector diagrams are not 4·43361875MHz carriers at all. The vectors are convenient representations of the sum of the sideband components which carry the signal energy. As long as we are considering large picture areas of the same hue this is a justifiable simplification, since the same sidebands are then present in more or less equal degree in both the U and V signals and can be represented by carriers of constant frequency. When we come to a point where the hue changes however the distribution of sideband energy between U and V changes. Our vector diagram then breaks down—at least in part.

Another way of saying this is to point out that PAL vector diagrams showing for example the electronic averaging process do not illustrate the true state of affairs at chrominance picture transitions. In some cases they give approximately the right answer, but they do not state the whole case. We shall have more to say about this in a later article in the series describing some of the PAL signal distortions.

CONTINUED NEXT MONTH

COLOUR RECEIVER CIRCUITS

THE CHROMINANCE (PAL) DELAY LINE CIRCUIT

GORDON J. KING

In the previous two articles we have studied the chrominance channel circuits including the various controls. This month the plan is to investigate the circuits at the chrominance channel termination — those associated with the PAL delay line (see Fig. 7, October 1971).

Apart from one or two non-PAL receivers of Oriental origin all contemporary British-made receivers are of the PAL delay line variety, which means that circuitry is included to average out phase errors so that the display always assumes the correct hue. Non-PAL receivers are not like this and since with these the hue is not effectively "locked" to the scene being televised phase distortion in the system can cause the colours in a picture to deviate from those in the original scene. Such receivers embody a hue control which allows the viewer to adjust the colours over a small range and hence to correct any errors manually.

There is a type of receiver which although designed to operate from a PAL signal does not include the electronic averaging circuitry. This is sometimes called a PAL-simple (or PAL-S) receiver because without the averaging circuitry the decoding department is less complex than that in a PAL receiver with a delay line (PAL-D). With PAL-S receivers there is a small degree of built-in hue correction but this is essentially subjective: when there is a phase error the viewer's eyes integrate the incorrect colour of a picture element on one line and the complimentary colour error on the next line so that the correct colour is perceived. The degree of correction possible with this approach is however small, and if the phase error is large horizontal bars—called Hanover bars—appear on the picture. PAL-D receivers can handle much greater phase errors without any disconcerting effects, the most dramatic effect under correct conditions of adjustment being mild loss of saturation!

PAL Delay Line

A block diagram showing the stages concerned with the electronic delay line averaging process is given in Fig. 1. Here the chroma channel termination, sometimes called the PAL delay line driver stage, feeds the chroma signal three ways: to the PAL delay line, and to an adder network and a subtractor network (these comprise the "PAL matrix" mentioned in previous articles). The signal which passes through the delay line is subjected to a delay which is almost exactly equal to the 64μS period of one line scan. The delay has to be very slightly less so that the output from the delay line will correspond to an exact number of subcarrier half cycles during a line scan. A delay of exactly 64μS results in almost 283¾ cycles per line period. By reducing the delay to 63·943μS 283½ cycles of subcarrier per line period are accommodated. Hence the delay line is made to provide a delay of 63·943μS, with a tolerance of ±0·003μS. This very small deviation from a complete line period is of little consequence so far as colour registration is concerned since the time difference represents a very small ratio of the effective colour bandwidth and hence the colour resolution.

It will be recalled from our account of the basic features of PAL coding and decoding in the October 1971 issue that the polarity of the V chroma axis alternates between positive and negative values line by line while that of the U axis remains the same. In other words the V axis is positive on odd lines and negative on even lines as shown in Fig. 2. The result of these PAL alternations is that the signal delivered by the chroma channel is (U+V) on one line, (U−V) on the next (U+V) again on the next and so on line by line of a field. These alternating line-by-line signals are applied to the PAL delay line, adder and subtractor in Fig. 1.

U and V Signal Separation

Now the adder and subtractor also receive chroma signals which are one line behind those applied direct from the chroma terminal stage, since they have passed through the delay line. The adder thus receives simultaneously (U+V) and (U−V) on one line and (U−V) and (U+V) on the next line and so on. Since it is the job of the adder to *add* the direct and delayed lines of chroma signal we thus get from the adder (U+V)+(U−V)=2U on one line and on the next line (U−V)+(U+V) which is again 2U.

Similarly the subtractor receives simultaneously the same pattern of signals line by line and since it is the job of this network to subtract the delayed signal from the direct signal we get on one line (U+V)−(U−V) =+2V and on the next line (U−V)−(U+V)= −2V. Clearly then the adder always delivers U chroma signal and the subtractor ±V chroma signal line by line. Should the direct signal be subtracted from the delayed signal—which is quite permissible—the results are similar except that the subtractor delivers ∓2V signal!

The PAL decoding process thus neatly separates the V and U chroma components from the complex chroma signal. The separation is such that each chroma component is released from the quadrature modulated whole (see October issue) as an independent and phase insensitive signal. In fact each signal obtained in this way can be regarded as a double-sideband suppressed subcarrier signal, one carrying the U chroma information and the other the line-by-line phase inverted V chroma information. For detection therefore the subcarrier must be added accurately in frequency and phase at each demodulator. While a simple amplitude demodulator could be used for

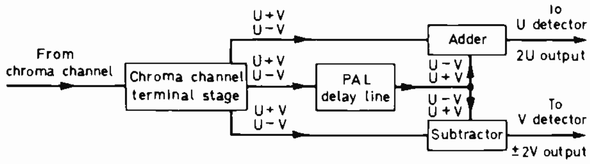


Fig. 1: Block diagram showing how the U and V signals are separated in a PAL decoder by using add and subtract matrix networks and a PAL delay line.

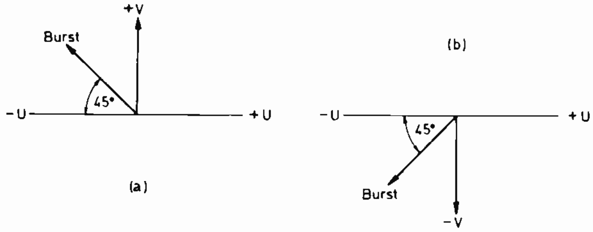


Fig. 2: How the phase of the V component of the chroma signal is inverted on alternate lines in the PAL system—(a) odd lines, (b) even lines with inverted V. The bursts swing about the −U axis on alternate lines.

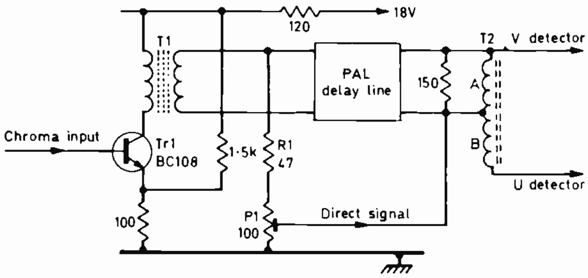


Fig. 3: Representative PAL delay line/matrix circuit. Addition and subtraction are carried out by windings A and B of the centre-tapped transformer T2.

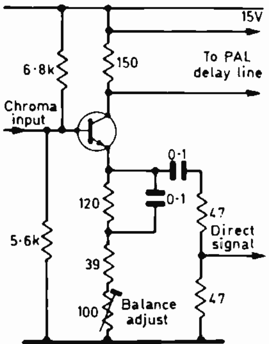
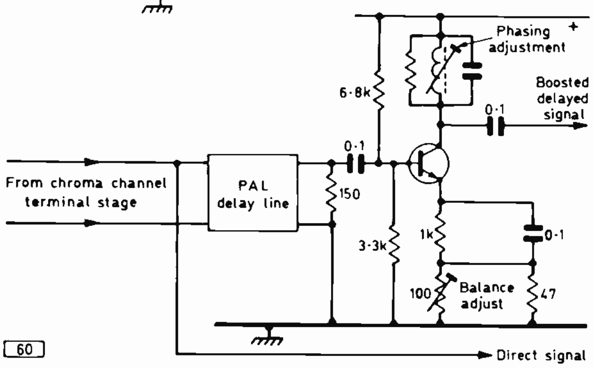
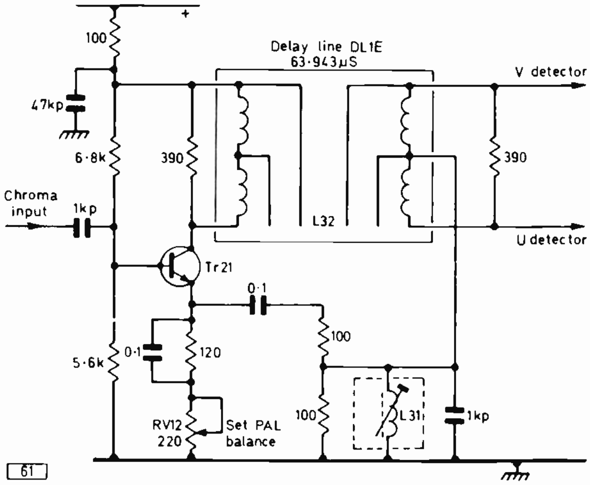


Fig. 4: It is more common to to drive the delay line from the collector of the delay line driver stage and to tap the direct signal from its emitter circuit.

Fig. 5 (below): Circuit in which a post delay line amplifier is used to make good the insertion loss introduced by the delay line.



60



61

Fig. 6: With more recent types of delay line the summing networks are contained in the delay line housing.

detecting each signal a more complex type of detector circuit is desirable to ensure that the colour-difference outputs swing correctly from zero over positive or negative values depending on the nature of the colour in the scene being televised.

Delay Line Circuits

Before we go on (next month) to the chroma detectors we must investigate the circuits corresponding to the block diagram shown in Fig. 1. A simple example is given in Fig. 3. Here Tr1 is the delay line driver transistor which receives the chroma signal at its base and couples it via transformer T1 to the delay line input terminals.

For correct operation the direct and delayed signals fed to the matrix (add and subtract circuitry) must be of equal amplitude and since the insertion loss of the PAL delay line is around 10dB there must be either gain of this amount in the delayed signal path or attenuation in the direct signal path. In the circuit shown in Fig. 3 attenuation is used in the direct signal path: the attenuation is provided by R1 and P1 which provides matrix balancing (if this is in error the display of Hanover bars on the picture will be encouraged).

The add and subtract operations are performed by the autotransformer T2. The direct signal is fed to the centre tap and since the two ends are in antiphase relative to the centre tap we get the adding and subtracting actions. For example the voltage across winding A and the voltage from P1 sum to give +2V on one line and −2V on the next line at the feed to the V detector while the voltage across winding B and the voltage from P1 sum to give 2U on each line at the feed to the U detector (also see Fig. 1).

A rather more common arrangement is shown in Fig. 4. The direct signal in this case is obtained from a resistive potential-divider across the emitter circuit of the driver transistor. The stage gain and balance are adjusted by a variable resistor in series with the emitter circuit.

A post delay line amplifier can alternatively be employed to combat the effect of the insertion loss of the PAL delay line: an example of such a circuit is shown in Fig. 5. Here the chroma signal is fed to the

—continued on page 131

SERVICE NOTEBOOK

G. R. WILDING

No Colour

In most colour sets the turn-on potential to make the chrominance channel operational on colour reception is obtained by rectifying the ident signal since this is present only when a colour transmission is being received. A simple rectifier and filter can be used for this purpose. A rather more complicated circuit is used in the Rank-Bush-Murphy dual-standard colour chassis however and is shown in Fig. 1. The balanced colour-killer detector circuit 5D5, 5D6 drives the colour-killer amplifier 5VT8. The turn-on potential obtained from the colour-killer amplifier is used as forward bias for the delay-line driver stage 5VT2.

On monochrome reception there is no ident input to the colour-killer detector circuit. The base of the colour-killer amplifier is connected to the positive l.t. line via 5R30, 5D5 which is forward biased and 5R32. In consequence 5VT8 is cut-off. The colour-killer detector is fed with antiphase squarewave signals obtained via 5C29 and 5C30 from the bistable circuit 5VT5, 5VT6. On colour reception the ident signal appears and is fed via 5C31 to the junction of the two diodes. If the synchronism between the bistable outputs and the ident signal is correct the colour-killer rectifier comes into operation and the potential developed across 5C43 switches 5VT8 on. The resultant current through 5R57 produces a turn-on bias voltage which is fed via 5R58 to 5VT2 base.

Called in recently to service one of these receivers we found normal monochrome reception but no colour. Our first action was to over-ride the colour-killer action by connecting a 15kΩ resistor from TP3 to the positive l.t. rail, thus biasing 5VT2 on. This action restored colour of a sort but although the blues were reasonably correct, colours of a strongly red or green nature had a flat almost sepia tone. This clearly indicated that the PAL V switching was not taking place and attention was directed to the bistable circuit. Voltage checks at the collectors of 5VT5 and 5VT6 revealed that the former was high and the latter low. A resistance test on 5VT5 then showed that its collector-base junction was open-circuit. On replacing this transistor normal colour reception was obtained. When loss of colour is corrected by over-riding the colour killer, check the source of the turn-on bias.

Weak Line Lock

There was weak line lock on a Murphy Model V179 and the hold control had been adjusted so many times that the track was quite worn around the locking point. The first move with this fault in receivers with flywheel line sync circuits is to check the discriminator diodes—in this model they are 3MR1 and 3MR2 and as in most Bush-Murphy receivers are encapsulated together with the interlace diode in a small plastic case. Tests showed that although the forward resistance of the diodes had certainly increased it was not to the extent we had expected—for in practice these diodes can go really high-resistance before affecting performance.

A triple-diode unit was not immediately to hand so we replaced it using three separate diodes. On re-test the line hold was marginally better but was still not up to standard. So we next changed the 100kΩ line hold control potentiometer 3RV2. There was a considerable improvement—worn tracks can play havoc with good timebase locking—but although the picture would hold over long periods and throughout repeated channel changes there was little tolerance each side of the locking position.

While making voltage checks on the timebase panel we found that pressure in the region of the diodes

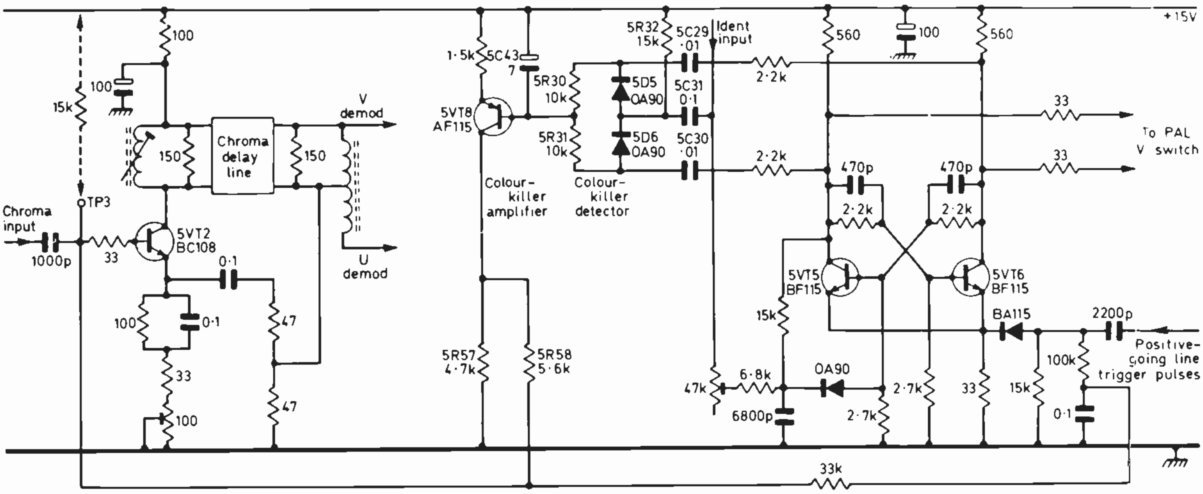


Fig. 1: The colour-killer circuit used in the Bush-Murphy dual-standard colour chassis.

could alter the line frequency and after further probing we discovered that 3C5 a 27pF capacitor which feeds the sync pulses from the sync separator to the discriminator circuit was at fault. After replacing this component pressure on the panel had no effect on line frequency while equally important the locking spread of 3RV2 increased to normal.

Intermittent Vision

A set fitted with the Thorn/BRC 1500 single-standard chassis intermittently developed a plain white raster though the sound would always continue unaffected. As the sound i.f. signal in these receivers is tapped from the video driver transistor only the video output stage or an intermittent short in the tube could be the cause.

On removing the back we found that when the fault occurred pressure in the centre of the hinged one-piece printed panel would always restore results. This narrowed attention to the transistor video output stage and we then found that when the white raster developed all voltage disappeared from this stage. Following through the circuitry we found that the 160V supply for this stage is supplied via R126 from the main HT4 rail and though it always remained at R126 it vanished from the printed circuit wiring on applying light pressure to the panel.

We then resoldered all the connections en route and experienced no further trouble. When investigating faults that come and go with pressure to a panel we always find it quickest to immediately note the effects on voltages rather than to try to locate the dry-joint visually.

Field Collapse

THERE was complete field collapse on a Bush Model TV148 and the PCL85 generator-output valve was very cool although the cathodes were glowing. Clearly the pentode section at least was failing to pass anode current. This could not be due to loss of anode voltage since this would result in a very heavy screen current, making the screen grid winding glow visibly and resulting in a high working temperature. The probable causes were either zero screen voltage or an open-circuit cathode bias resistor.

The latter was easiest to check—by connecting an ohmmeter from pin 8 of the valveholder to chassis—and a test showed "no reading". The cathode resistor, which also serves the triode section, is mounted to the right of the PCL85 and appeared to be all right. A further ohmmeter check proved it to be so.

On lowering the chassis however we found that there was a complete break in the printed wiring from pin 8 of the valveholder to the cathode resistor — although there was no visual break or suggestion that sparking had occurred at either end. Connecting a jumper lead across the two points restored a normal picture.

Although such breaks in printed circuits are not common this case does demonstrate that it is important to check suspect components directly and from their connection points before getting involved with the soldering iron.

COLOUR RECEIVER CIRCUITS

—continued from page 129

input of the PAL delay line in the usual manner but instead of the delay line feeding direct to the adding and subtracting transformer it feeds the base circuit of the amplifier transistor across a 150Ω matching resistor. The gain of the amplifier is adjustable by the variable resistor in its emitter circuit and this makes it possible to adjust the level of the delayed signal so that it is equal to that of the direct signal obtained from the delay line input—that is from the terminal stage of the chroma amplifier channel.

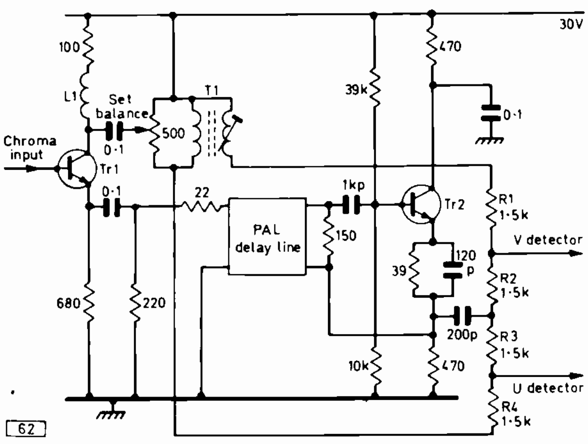


Fig. 7: In this circuit a resistive add and subtract network (R1-R4) is used in conjunction with a post delay line amplifier stage.

The PAL matrix circuit of the latest Pye group receivers is shown in Fig. 6. This has much in common with the circuits in Figs. 3 and 4 but with the difference that the summing is handled not by an external autotransformer but by windings incorporated in the delay line housing. The PAL delay line in this circuit is type DL1E. The variable inductor L31 provides a small degree of phasing adjustment while the gain of the driver stage is adjustable by RV12 for balancing.

To conclude this month's article a slightly different arrangement using a post delay line amplifier stage is shown in Fig. 7. Here the chroma signal is applied to the base of the delay line driver transistor Tr1. The delay line is fed from the signal at Tr1 emitter via a coupling which provides the required 150Ω delay line input impedance. The output of the delay line is fed to Tr2 base via a capacitive coupling and 150Ω matching resistor. Signalwise the collector of Tr2 is taken to chassis through the 0·1μF capacitor and since the emitter is loaded with a 470Ω resistor an output signal which is in phase with the base signal occurs across this resistor. The summing network consists of resistors R1/R2 and R3/R4. Antiphase direct signals from T1 are applied to each end of the matrix R1-R4 while the delayed signal is capacitively coupled to the junction of R2 and R3. The net result is similar to that of the less complicated scheme in for example Fig. 3 but in Fig. 7 the adding and subtracting operations are carried out in a resistive circuit. L1 provides a degree of high-frequency compensation rather like the peaking coils found in some video amplifier circuits.

Next month we shall pass on to the chroma detector circuits, their manner of working and the feed circuits from the reference signal source.

BASIC CIRCUITS FOR THE CONSTRUCTOR

FIELD TIMEBASE, POWER SUPPLY AND MISCELLANEOUS CIRCUITS

7

J.W.THOMPSON

WE come now to the final article in this series. The two remaining parts of the circuit (field timebase and power supply) will be described and an attempt made to fill in various gaps in the information given so far.

Field Timebase

The circuitry around V701 (a) and (b) may at first sight appear rather complicated but becomes more readily understandable if to start with certain components are overlooked. Before any reader gets an exaggerated impression of the writer's abilities as a timebase designer however let me hasten to add that this circuit is almost identical to that used in the Bush Model TV145. If then C701 and C704 are removed we are left with a multivibrator circuit: the anode of V701(b) is connected to the grid of V701(a) via C702 and the anode of V701(a) is connected to the control grid of V701(b) via C703. The cathodes of both halves of the valve are earthed to a.c. by C708 so under these conditions (with C701 and C704 removed) the circuit would act as a multivibrator in a similar way to the line oscillator circuits described last month.

Adding C701 changes the situation considerably: when V701(a) changes from the conducting state to being cut off, its anode voltage is unable to rise immediately because of the presence of C701 which charges slowly from the boost h.t. line via R703, VR701 and R702. The net result is that a relatively linear sawtooth waveform develops at V701(a) anode, the *duration* of the sawtooth ramp being determined by the time-constant VR703+R704/C702 while the sawtooth *amplitude* (i.e. picture height) depends on the time-constant R703+VR701+R702/C701. The output valve V701(b) amplifies the sawtooth waveform

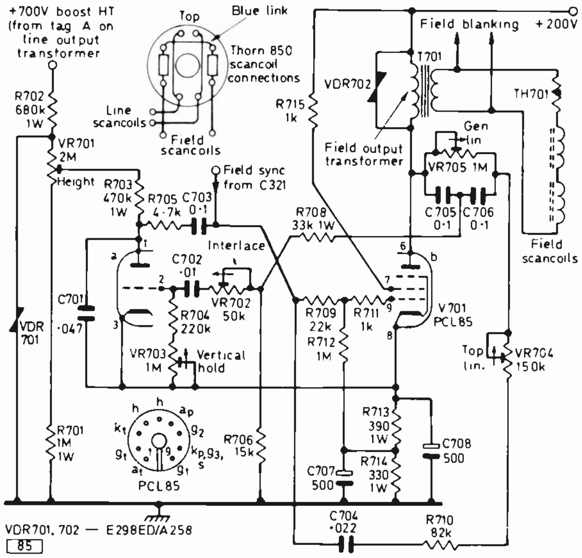


Fig. 1: Suggested field timebase circuit.

fed to it from V701(a) anode via C703 and T701 matches the resulting output voltage into the field scan coils. The waveform is linearised by negative feedback around V701(b)—C704, R710, etc.—and the two v.d.r.s in the circuit serve to stabilise the height (VDR701) and to limit the peak inductive flyback voltage across the primary of T701 (VDR702).

Isolated or Live Chassis?

An important consideration in the design of this receiver was that the chassis should be earthed. Whether or not this is necessary depends on individual requirements and details will be given towards the end of the article on how the power supply can be modified for "live chassis" operation for those constructors who do not require an isolated chassis.

Power Supply Circuits

The power supply is in three distinct sections: h.t., l.t. and heater supplies. The h.t. supply is derived from T702 and a bridge rectifier circuit. The h.t. smoothing circuitry is very effective and the level of ripple on the h.t. line is less than half that found on a normal domestic receiver. The l.t. supplies are derived from T703 via D708, D711 (negative rail) and D709, D710 (positive rail).

Stabilised LT Circuits

The l.t. supply stabilisation works as follows: zener diode D712 drains current via R717 and a stable reference voltage develops across it and is applied to the base of Tr703. A useful property of transistors is that their base-emitter voltage of about 0·6V (silicon) does not vary greatly with changes in collector current. In this case Tr703 emitter voltage is 0·6V lower than its base voltage, while the emitter of Tr704 is at a voltage 0·6V lower than its base voltage. The net voltage drop between the base of Tr703 and the emitter of Tr704 is thus 1·2V. When current is drawn from the supply (i.e. from the emitter of Tr704) the amount of current fed into the base of Tr703 is very much smaller—about ten thousandth of the output current in fact. This is due to the current amplification of the two transistors. As this input current is very small compared to the level of current in D712 the reference voltage is not altered and the supply voltage thus remains stable. The negative

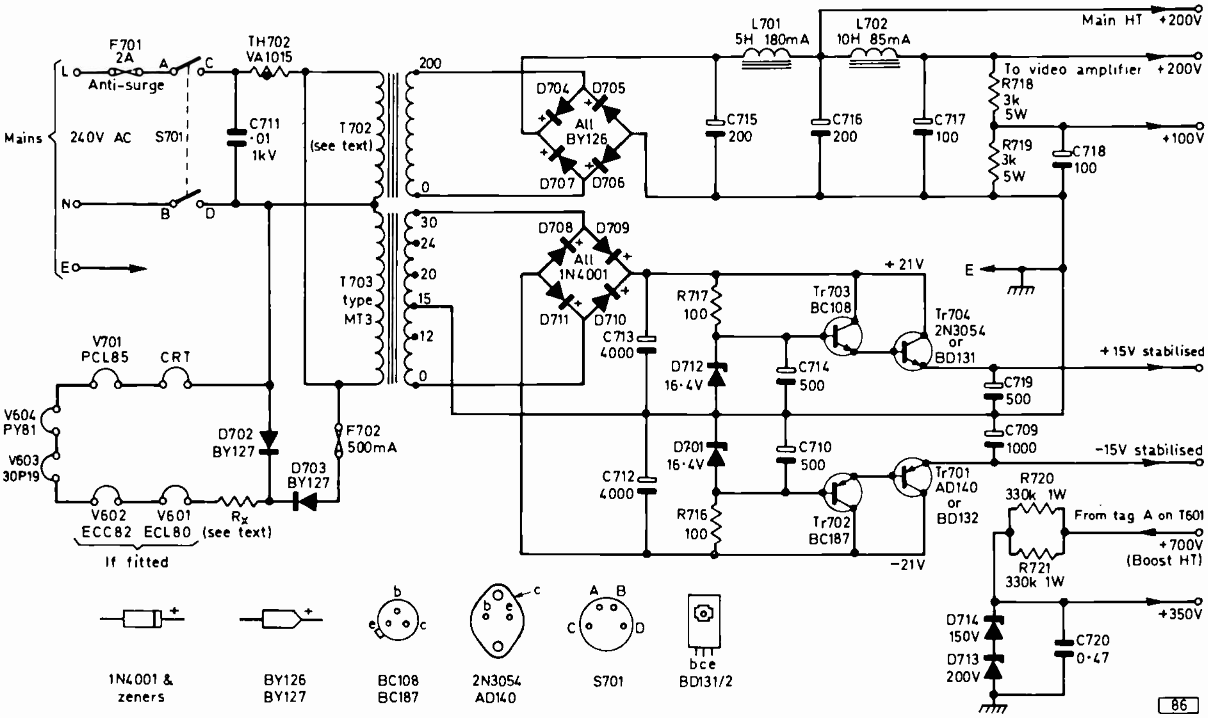


Fig. 2: Power supply circuits. The l.t. and 625-line brightness control feeds are stabilised.

stabilised l.t. power supply is a mirror image of the positive supply.

Circuit Protection

The l.t. supplies are not fuse protected because no conventional fuse would act quickly enough to prevent expensive damage in the event of supply short-circuit. Instead Tr702 and Tr703 are chosen to act as semiconductor fuses, thereby protecting the costly output transistors (Tr704 and Tr701). This means that l.t. "fuse" replacements cost around 10p a time, so be careful!

Heater Supply

The valve heaters are series connected between mains live and neutral via thermistor Th702, dropper diode D703 and dropper resistor *R*x. D703 supplies only positive-going half cycles of the mains waveform and thus reduces the available power without dissipating a corresponding amount of heat. The *effective* voltage at the cathode (positive end) of D703 is exactly 170V: by "effective" I mean that the voltage is *equivalent* to a d.c. voltage of 170V. Should D703 go short-circuit D702 will conduct the negative-going half cycles directly to mains neutral and fuse F702 will blow. The dropper resistor *R*x further reduces the heater voltage to a suitable level. Its value in this circuit is given by the expression: $Rx = \frac{1}{5}$ (1,700 – 10Vh); where *R*x is in ohms and Vh is the value of all the heater voltages in the heater chain added together. With the five valves and c.r.t. shown in Fig. 2 *R*x has the value 297Ω and could be made up from two Radiospares dropper sections, e.g. 250Ω + 47Ω. Valve heater voltage ratings will be found in any valve data book. Note that when measuring the heater chain voltages in this circuit a d.c. voltmeter will indicate three-fifths of the *effective* applied voltage (because of the use of D703 as a "dropper").

625 Brightness Feed

A further circuit provides the 350V supply for the brightness control (VR35) on 625 lines. The 700V boost h.t. voltage from tag A on T601 is dropped by R720/R721 and stabilised to 350V by the zeners D714 and D713. As zeners are rather expensive it is alternatively possible to use a v.d.r. for this purpose, though the stabilisation will not be as good. A single v.d.r., type E299DD/P354, may be used in place of D713 and D714—the v.d.r. polarity is unimportant.

Layout and Construction

Both the field timebase and the power supply circuits are best constructed on the same chassis as the line timebase. No layout difficulties should arise even with very long leads but there are four important points which should be observed: (1) The h.t. supply earth, the l.t. supply earth and the mains earth should all be connected to the same earthing tag on the chassis (see Fig. 2). *Do not* use a large number of independent earthing points or hum loops may occur. *It is essential that a good earth is connected* to the receiver chassis otherwise the chassis may become live in the event of transformer insulation breakdown or a heater-to-cathode short-circuit in one of the valves. (2) Transformers and chokes should be kept away from the c.r.t. to prevent raster distortion due to stray magnetic fields. (3) If a copper, brass or aluminium chassis is used it is possible to bolt Tr701 and Tr704 on to the chassis with a mica washer in between. If a steel chassis is used separate finned heatsinks must be provided. (4) The heater dropper resistor *R*x and thermistor Th702 should be mounted with long leads in a well-ventilated position. It is advisable to use fibreglass sleeving on the wires to these components.

Mains Transformer

It is possible to buy T702 "off the shelf": Barrie Electronics, whose address is given at the end of this article, can supply a suitable transformer (type 61). The primary is rated 0-200-250V and the secondary is 0-240V centre-tapped. For use in this circuit the mains input should be applied across the *secondary*, ignoring the centre tap, and the 0-200V section of the *primary* used to supply power to the h.t. bridge rectifier D704-D707. The power rating of the transformer is 100VA.

Alternatively a readily available transformer (Douglas type MT2) can be obtained and modified for use as T702 as follows. First remove the two Philips-head bolts which hold the laminations of the transformer together. Slide out and separate the individual laminations, separating into two piles: E-stampings and I-stampings. There are additionally two *long* E-stampings. Note that each lamination is coated with insulating lacquer on one side only and remember the correct side for this lacquer when reassembling the transformer. Remove the h.t. winding layer by layer and then the l.t. windings, leaving only the mains input winding at the centre. Do not damage the insulation around this winding. If a transformer other than the MT2 is used count the number of turns on the 6·3V winding.

Melt a few ounces of paraffin wax (available from most chemists) in a suitable container and dip about six sheets of paper in the wax—ordinary writing paper will do. The paper should be cut to the same width as the paper removed from the transformer. 950 turns of 30 s.w.g. enamelled copper wire should then be tightly close-wound around the transformer mains winding. Wrap a sheet of the waxed paper between each layer of the winding. There should be a gap of 1 cm. between the outside edge of the paper insulation and the start and finish of each layer of wire. Finally reassemble the laminations.

The suitability of other transformers must be determined by experiment but as a rough guide any transformer with overall dimensions *less than* 4×3½×3in. will probably not be suitable. The number of turns for the secondary winding is given by $N=31{\cdot}7n$ where N is the required number of turns and n is the number of turns on the 6·3V winding of the transformer.

CRT Mounting

The c.r.t. originally suggested for this receiver—type CME2306—employs a bonded faceplate and therefore no additional implosion protection is required. Four small mounting lugs are moulded on the corners of the faceplate but they are not drilled

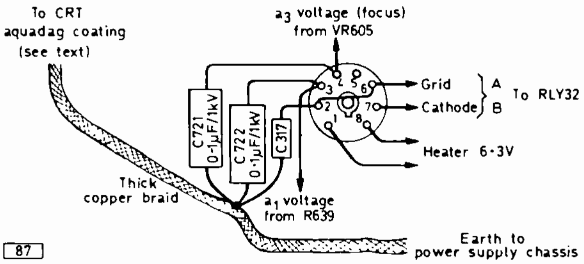


Fig. 3: CRT base connections (CME2306/A59-16W).

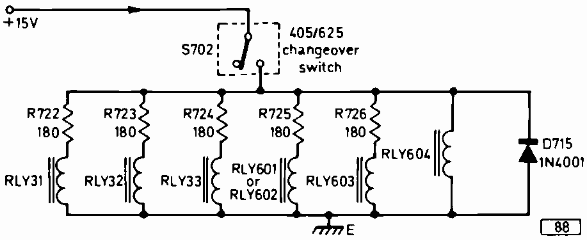


Fig. 4: Relay coil wiring.

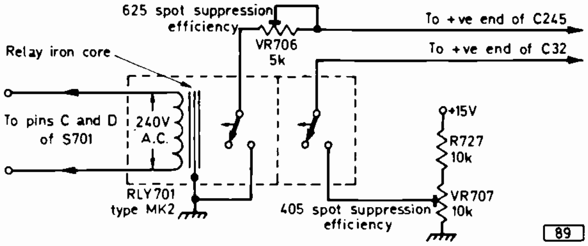


Fig. 5: Suggested switch-off spot suppression circuit. The relay contacts are shown with the receiver switched on, i.e. the relay coil is energised.

to accept bolts as in more modern tubes. Mounting must therefore be accomplished by cutting carefully shaped holes in two sheets of ½in. plywood. The front sheet will have a hole cut to the outside diameter of the faceplate, while the rear sheet will have a slightly smaller hole cut to fit the outside diameter of the glass bowl just behind the faceplate. The two sheets of wood are bolted together with the tube mounting lugs sandwiched between them. For this method of mounting to work satisfactorily a very good fit around the tube is necessary and experimenting first with cardboard templates is recommended.

The use of a more modern tube greatly simplifies this problem: the four fixing lugs are much larger and are drilled to accept 0 B.A. bolts. Only one sheet of plywood is necessary and the shaping of the hole is much less critical. In any case a modern tube such as the 20in. A50-120W/R will almost certainly give better picture quality.

As regards c.r.t. earthing the constructor should follow the wiring diagram shown in Fig. 3. Contact to the c.r.t. aquadag coating should be made by means of a long spring stretched from one corner of the tube to the other (but avoiding the e.h.t. connector!). The spring is attached to the thick copper braid shown in Fig. 3. For mechanical stability it is a good idea to mount C721, C722, C317 and the c.r.t. base socket on a small paxolin board. RLY32 may also be mounted on this board.

Relay Coil Wiring

Connections for the coils of the relays are shown in Fig. 4: D715 suppresses potentially damaging inductive switch-off voltages.

Spot Suppression Circuit

Figure 5 gives details of a circuit which will protect the c.r.t. against spot burns when the receiver is switched off. Under normal operating conditions the coil of RLY701 is connected directly across the mains. When the receiver is switched off the relay contacts close (opposite position to that shown in Fig. 5)

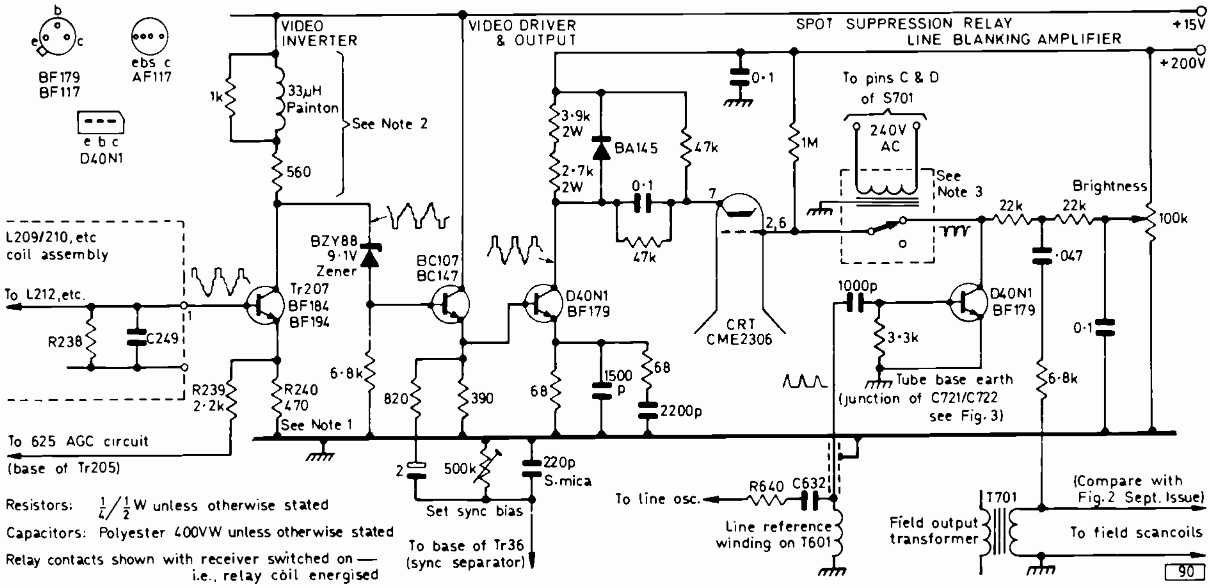


Fig. 6: Video circuit for single-standard (625 lines) operation. Notes: (1) R240 470Ω in this circuit. (2) Additional components in Tr207 collector lead. (3) Spot suppression relay—same type as in Fig. 5.

thereby earthing one end of VR706 and feeding an additional fixed positive bias from VR707 to the positive end of C32. Thus whether the receiver is set to 625 or 405 lines the effect is the same, the video amplifier is driven to peak white and nearly all the residual e.h.t. is discharged before the scanning has completely collapsed. The formation of the well known white spot at the centre of the screen is thus prevented. VR706 should initially be set for maximum resistance while the slider of VR707 should be set midway. Both are then adjusted to give optimum spot suppression.

Single-standard Video Circuit

Except for those living in areas where u.h.f. reception is still difficult it is expected that most readers who decide to build the receiver will require a single-standard version. In this case the parts of the receiver used for 405 lines only can be left out, i.e. the 405 vision and sound i.f. amplifiers and the 405 gated a.g.c. circuit.

Dual-standard compromises in the video amplifier can be avoided by the use of the improved video circuit shown in Fig. 6. The video driver (Tr207) in the 625 i.f. circuit is used as a video inverter instead of a conventional emitter-follower and it is then possible to use cathode drive to the c.r.t. A number of advantages result from this approach: (1) The contrast range available from the receiver is increased. (2) The field flyback blanking drive is increased because it is no longer necessary to centre-tap T701 with two 100Ω resistors (see Fig. 2 September). (3) Line flyback blanking can be easily incorporated. (4) The c.r.t. switch-off spot suppression circuitry is very simple. (5) The brightness control no longer requires a 350V supply: R720, R721, D713, D714 and C720 may thus be omitted.

Video Transistors and Components

Several points must be mentioned concerning both the dual-standard video amplifier described in the September issue and the single-standard video amplifier (Fig. 6). First, details of transistor base connections were not given in the September issue—they are now shown in Fig. 6. Secondly it should be realised that non-inductive resistors *must* be used for the 2W video output load resistors (R310, R39, etc.). Suitable carbon-film types are readily available. Finally the D40N1 transistors have turned out to be rather expensive—a suitable alternative is the Mullard BF179.

Even better video transistors have recently become available with V_{CER} ratings in excess of 300V. The following types can be used in place of the D40N1: Mullard BF338, Texas BF259, SGS-Fairchild SE7056. These transistors have been developed for use in colour TV RGB amplifier stages and will allow a much greater safety margin than the D40N1 or BF179 as far as h.t. voltage is concerned. Several samples of these 300V transistors were tested on a high-voltage transistor curve tracer and it appears from the transistors tested that manufacturers' ratings are on the conservative side. Short-term overloads of 350V were found to be permissible.

Live Chassis Operation

If 300V video transistors are used it is possible to remove T702 and to connect mains neutral instead of earth to the receiver chassis. Mains live is still fed to T703, but the main h.t. line should be derived from a single half-wave rectifier diode (BY127) with a 22Ω series resistor to limit the peak current. R719 should in this case be changed to 1·8kΩ and it may be found necessary to increase the value of C716 if ripple on the h.t. line is a problem. To comply with BS415 safety

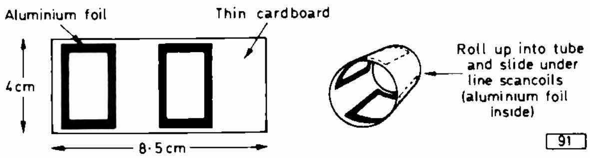


Fig. 7: Line linearity sleeve construction.

★ components list

Resistors:

R701	1M Ω 1W
R702	680k Ω 1W
R703	470k Ω 1W
R704	220k Ω
R705	4·7k Ω
R706	15k Ω
R708	33k Ω 1W
R709	22k Ω
R710	82k Ω
R711	1k Ω
R712	1M Ω
R713	390 Ω 1W
R714	330 Ω 1W
R715	1k Ω
R716	100 Ω
R717	100 Ω
R718	3k Ω 5W
R719	3k Ω 5W
R720	330k Ω 1W
R721	330k Ω 1W
R722-6	180 Ω
R727	10k Ω
Rx	Radiospares 0·3A dropper—see text

All ¼/½W carbon film unless otherwise stated

Variable Resistors:

VR701	2M Ω
VR702	50k Ω
VR703	1M Ω
VR704	150k Ω
VR705	1M Ω
VR706	5k Ω
VR707	10k Ω

Capacitors:

C701	0·047μF PE
C702	0·01μF PE
C703	0·1μF PE
C704	0·022μF PE
C705	0·1μF 1kV M
C706	0·1μF 1kV M
C707	500μF 25V E
C708	500μF 40V E
C709	1000μF 25V E
C710	500μF 25V E
C711	0·01μF 1kV M
C712	4000μF 25V E
C713	4000μF 25V E
C714	500μF 25V E
C715	200μF 350V E
C716	200μF 350V E
C717	100μF 350V E
C718	100μF 350V E
C719	500μF 25V E
C720	0·47μF PE
C721	0·1μF 1kV M
C722	0·1μF 1kV M

PE 400V polyester
E electrolytic
M mixed dielectric

Semiconductors:

Tr701	AD140 or BD132
Tr702	BC187
Tr703	BC108
Tr704	2N3054 or BD131
D701	Two BZY88/C8V2 zeners in series
D702	BY127
D703	BY127
D704-7	BY126
D708-11	1N4001 50V p.i.v., 1A
D712	As D701
D713	200V 1W zener
D714	150V 1W zener
D715	1N4001
VDR701	E298ED/A258
VDR702	E298ED/A258
Th701	With scan coils
Th702	VA1015

Miscellaneous:

V701	PCL85
F701	2A anti-surge
F702	500mA
L701	5H 180mA (CLF17D)
L702	10H 85mA (CLF16)
RLY701	Keyswitch type MK2/230V A.C. (WS169)
S701	D.P. on/off—may be with volume control
S702	S.P. 405/625 switch
T701	Thorn 850 field output transformer
T702	Douglas MT2 modified to give 190V at 0·25A—see text
T703	Douglas MT3
Scan coils	Thorn 850

(Numbers in brackets Home Radio catalogue numbers)

recommendations aerial isolator panels must be fitted on the tuner aerial inputs. These electrically isolate the aerials from the chassis and may be salvaged (or copied) from an old receiver. U.H.F. aerial isolators require very careful construction if signal attenuation is to be avoided.

Line Linearity Sleeve

Details are given in Fig. 7 of an adjustable linearity sleeve which may be inserted part of the way under the line scan coils to improve the picture linearity. Check that the sleeve does not become excessively hot or catastrophic damage to the c.r.t. may occur.

Corrections

It has been drawn to our notice that a couple of errors occurred in the circuit we gave in Fig. 6 in the July issue for using the TAA570 i.c. Pin 4 of L214 assembly should be decoupled to chassis by an 0·1μF capacitor instead of being connected direct to chassis and a 4·7kΩ resistor should be connected between pins 8 and 9 of the TAA570 for internal biasing purposes.

Finally an error unfortunately occurred in Fig. 4,

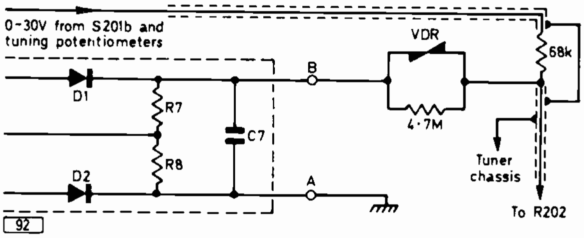


Fig. 8: Correct a.f.c. circuit connections.

October issue: the 68kΩ resistor should have been shown—see Fig. 8—between the feed from the tuning potentiometers and the output from the a.f.c. circuit.

Supply Details

The field output transformer is obtainable from Manor Supplies. Mains transformers, h.t. chokes, electrolytic capacitors, v.d.r.s, etc., are available from Home Radio Ltd., 240 London Road, Mitcham, Surrey. BF338 transistors may be obtained from Gurneys (Radio) Ltd., 91 The Broadway, Southall, Middlesex. Barrie Electronics, 11 Moscow Road, Queensway, London, W2, will supply T702. ■

YOUR PROBLEMS SOLVED

★ **Requests for advice in dealing with servicing problems must be accompanied by a 10p postal order (made out to IPC Magazines Ltd.), the query coupon from page 138 and a stamped, addressed envelope. We can deal with only one query at a time. We regret that we cannot supply service sheets or answer queries over the telephone.**

BUSH TV115

Complete loss of sync suddenly occurred, with very unstable line and field hold. Replacing the line and field oscillator valves and the video output pentode restored the line hold but the field hold is still unstable and will not lock.—G. Jackson (Aberdeen).

It seems as if the video amplifier bias stabilising resistor has changed value. This is 33kΩ, 2W and is the second from the top on the left side tag panel roughly in line with the brightness control. Its original colours—orange, orange, orange—may be difficult to recognise due to overheating.

GEC 2033

There are several vertical bars extending about 1in. from the left edge of the screen—on all channels. The flyback lines are also visible at the top of the screen and can only be eliminated by reducing the brightness to a setting below normal.—E. Cole (Fife).

It seems that there is a fault in the c.r.t. blanking circuit. Check the components connected from the brightness control to pins 2/6 of the c.r.t. base. This should include the three 0·02μF capacitors and the feed via a 1kpF capacitor (C235) and 330kΩ resistor (R234) from the line output transformer.

PYE 40F

There seems to be a problem with the integrated u.h.f./v.h.f. tuner. BBC-1 sound and vision on channel 1 and ITA on channel 9 can be tuned in satisfactorily. It is however impossible to tune out BBC-1 on channels 2-5. With just an ordinary medium-gain aerial BBC-1 can be faintly observed when tuning through channels 2-5. Could this be an oscillator fault?—R. Smedley (Braintree).

It seems to us that the signal is breaking through directly to the i.f. strip and we suggest you tune the 41·5MHz trap L4 carefully for minimum output.

KB KV006

I am having difficulty obtaining a full height raster with this set—all there is is a 2in. strip across the centre of the screen. The field output valve and its cathode components have been checked and found to be OK.—R. Cole (Borehamwood).

You will probably find that the 0·1μF capacitor C134 (750V) which smooths the feed from the boost rail to the field charging circuit has shorted to the h.t. rail. It is located behind the height control, from the junction of the control and a 680kΩ resistor. If this is not the cause check the 1·5MΩ resistor R85 from the height control to pin 1 of the PCL85.

BUSH TV103

The fault on this set is severe foldover at the bottom of the picture with stretching at the top. The PL84 field output valve and its cathode decoupler have been replaced, also the two linearity controls.—G. Barnard (Harlow).

It appears that C82 (0·02μF) in the linearity feedback loop—wired between the two linearity controls—is shorting and should be replaced.

GEC BT455

The disc type thermistor in the h.t. supply circuit has dropped out of circuit. I read in one of your articles that this was replaced with a tubular type in later GEC models. Would this be a suitable replacement and could you quote the type number?—L. Byford (Deal).

If all the sections of the dropper are intact we suggest you use a Radiospares TH3 thermistor. This is roughly equivalent to a VA1026. If any sections of the dropper have been shorted out use the higher resistance thermistor type TH1.

SOBELL 1000

After about 20 minutes the vertical hold goes and the lock cannot be held even with the control at the end of its travel. If the back is removed and one blows in the vicinity of the field timebase however the picture stops slipping. The set then operates all right with the back removed but the field starts slipping again as soon as the back is replaced.—M. Tracey (Bristol).

Change the small gray capacitor mounted behind the field hold control. This is the field sync pulse integrating capacitor (C123, 0·05μF). It may be replaced with an 0·047μF type.

KB KV001

There is sound only on 405, no picture. On 625 there is sound and a picture which is only about 5in. wide and with very poor linearity down the centre of the screen. The line output stage valves have all been replaced without improving results. There seems to be plenty of e.h.t.—G. Banford (Rochester).

First check the system switch to make sure that it is operating correctly. Then check that the oscillator h.t. voltage is OK—check the feed resistor R128 and the decoupler C110 16μF. If all is OK here check the switched capacitors in the line timebase—C122, C125, C128, C130 and C131. To check the e.h.t. switch the set off, disconnect the c.r.t. final anode lead, hold it close to chassis using a pair of insulated pliers then switch on the set and see if a blue spark about ½in. can be drawn from the chassis.

PYE 13U

The picture is very stable for about five minutes after switching on. Then a 3in. horizontal zig-zag strip appears across the centre of the screen and gradually creeps up or down and returns again. This picture break-up can be eliminated by turning the brightness control very high or low. The picture is more stable after about a couple of hours and the effect seldom occurs on 625.—S. Carter (Plymouth).

You seem to have a faulty line oscillator valve. This is the triode section of the PCL84 (V14) on the left-hand side. Also suspect the 32μF capacitor (C43) which smooths the HT2 line.

FERGUSON 705T

This set is slow to start. The picture takes two or three minutes to arrive before which there are fluttering images. When the picture does come on it is perfect.—G. Adams (Welwyn).

We suggest you check the ECC82 (V7) on the lower deck and the PCL84 (V5) on the upper.

HMV 2640

The screen went blank but with all valve heaters alight. Investigation showed that the protective resistor R145 in the HT2 rail was unsoldered. On resoldering this and switching on the PY801 efficiency diode became red hot.—D. Putman (Chertsey).

One of two capacitors in the line timebase has become short-circuit. Check C114 (220pF) from the efficiency diode cathode circuit to chassis and C113 (100pF) the feedback capacitor from the line output transformer to the grid circuit of the line output valve.

QUERIES COUPON

This coupon is available until January 17, 1972, and must accompany all Queries sent in accordance with the notice on page 137. Don't forget the 10p postal order!

TELEVISION JANUARY 1972

TEST CASE 109

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

? *The trouble with an HMV Model 2627 was reduced line scan, the picture width being little more than 6in. The first test was for h.t. voltage and as this was marginally lower than it should have been the h.t. rectifier was replaced. This increased the scan amplitude slightly. Further improvement resulted from replacement of the line output and boost diode valves but it was still impossible fully to scan horizontally and a half-inch gap remained at either side of the picture.*

The controls had virtually no affect on the symptom and there was no change at all when the linearity control was adjusted. The mains voltage was checked against the mains tapping and after checking almost all the smaller components associated with the line timebase to no avail it was concluded that the line output transformer must be at fault.

This was replaced but the symptom persisted! What component was overlooked by the service technician for a persistent symptom of this kind? See next month's TELEVISION *for the solution and for a further item in the Test Case series.*

SOLUTION TO TEST CASE 108

Page 91 (*last month*)

The incorrect colours of the standard colour bars detailed last month indicate insufficient or zero R – Y signal at the grid of the appropriate gun. This was confirmed by the technician connecting an oscilloscope to the grid pin of the c.r.t. red gun. Under normal conditions a peak-to-peak signal of around 180V is present here when the receiver is displaying the standard colour bars.

Complete lack of signal might indicate failure of the colour-difference output valve while a signal of lower than normal amplitude could point to trouble in the transistor preamplifier stage. When there is no colour-difference signal at all at the tube grid the oscilloscope is best transferred to the colour-difference preamplifier input (i.e. in this case the output from the R – Y detector).

The test made by the technician revealed zero R – Y signal at the c.r.t. red gun grid and this was later proved to be caused by R – Y output valve trouble, valve replacement clearing the fault.

Published approximately on the 22nd of each month by IPC Magazines Limited, Fleetway House, Farringdon Street, London, EC4A 4AD. Printed in England by Fleetway Printers, Crete Hall Road, Gravesend. Sole Agents for Australia and New Zealand—Gordon and Gotch (A/sia) Ltd.; South Africa—Central News Agency Ltd., Rhodesia and Zambia—Kingstons Ltd.; East Africa—Stationery and Office Supplies Ltd. Subscription Rate (including postage): for one year to any part of the world, £2·65. "Television" is sold subject to the following conditions, namely, that it shall not, without the written consent of the Publishers first having been given, be lent, resold, hired out or otherwise disposed of by way of Trade at more than the recommended selling price shown on the cover, and that it shall not be lent, resold, hired out or otherwise disposed of in a mutilated condition or in any unauthorised cover by way of Trade, or affixed to or as part of any publication or advertising, literary or pictorial matter whatsoever.

The largest selection

BRAND NEW FULLY GUARANTEED DEVICES

AC107	15p	AF115	17p	BC140	35p	BCY31	22p	BF272	80p	EC403	15p	ORP60	40p	2N918	30p	2N2714	25p	2N3704	15p
AC113	20p	AF116	17p	BC141	35p	BCY32	25p	BF273	30p	GET880	27p	ORP61	40p	2N929	22p	2N2904	25p	2N3705	12p
AC115	23p	AF117	17p	BC142	45p	BCY33	17p	BF274	30p	MAT100	15p	ST140	12p	2N930	25p	2N2904A	30p	2N3706	12p
AC125	17p	AF118	30p	BC143	40p	BCY34	20p	BF308	35p	MAT101	17p	ST141	17p	2N1131	20p	2N2905	25p	2N3707	13p
AC126	17p	AF124	21p	BC145	45p	BCY70	17p	BF309	37p	MAT120	15p	TIS43	40p	2N1132	22p	2N2905A	30p	2N3708	8p
AC127	17p	AF125	20p	BC147	17p	BCY71	30p	BF316	75p	MAT121	17p	UT46	27p	2N1302	17p	2N2906	25p	2N3709	8p
AC128	17p	AF126	20p	BC148	12p	BCY72	15p	BFW10	55p	MPF102	43p	V405A	25p	2N1303	17p	2N2906A	27p	2N3710	10p
AC141K	17p	AF127	20p	BC149	17p	BCZ11	20p	BFX29	27p	MPF105	43p	V410A	45p	2N1304	20p	2N2907	25p	2N3711	10p
AC142K	17p	AF139	33p	BC150	17p	BD121	85p	BFX84	20p	OC19	30p	2G301	19p	2N1305	20p	2N2907A	30p	2N3819	40p
AC151	15p	AF178	50p	BC151	20p	BD123	85p	BFX85	27p	OC20	50p	2G302	19p	2N1306	22p	2N2923	13p	2N3820	£1
AC154	15p	AF179	50p	BC152	17p	BD124	75p	BFX86	22p	OC22	30p	2G303	19p	2N1307	22p	2N2924	13p	2N3903	25p
AC155	17p	AF180	50p	BC153	27p	BD131	80p	BFX87	25p	OC23	33p	2G304	20p	2N1308	27p	2N2925	13p	2N3904	27p
AC156	17p	AF191	50p	BC154	30p	BD132	80p	BFX88	22p	OC24	45p	2G306	35p	2N1309	27p	2N2926		2N3905	25p
AC157	17p	AF186	45p	BC157	20p	BDY20	£1	BFY50	20p	OC25	25p	2G308	35p	2N1613	17p	(G)	12p	2N3906	27p
AC165	17p	AF239	37p	BC158	17p	BF115	22p	BFY51	20p	OC26	25p	2G309	35p	2N1711	20p	2N2926		2N4058	15p
AC166	17p	AFZ11	37p	BC159	20p	BF117	45p	BFY52	20p	OC28	40p	2G339	17p	2N1889	35p	(Y)	11p	2N4059	10p
AC167	20p	AFZ12	45p	BC167	13p	BF118	60p	BFY53	17p	OC29	40p	2G339A	15p	2N1890	45p	2N2926		2N4060	12p
AC168	20p	AL102	85p	BC168	13p	BF119	70p	BSX19	15p	OC35	33p	2G344	15p	2N1893	37p	(O)	10p	2N4061	12p
AC169	14p	AL103	85p	BC169	13p	BF152	35p	BSX20	15p	OC36	40p	2G345	15p	2N2160	60p	2N3010	80p	2N4062	12p
AC176	23p	ASY26	25p	BC170	12p	BF153	35p	BSY25	15p	OC41	20p	2G371	13p	2N2147	75p	2N3011	20p	2N5172	12p
AC177	20p	ASY27	30p	BC171	13p	BF154	35p	BSY26	15p	OC42	22p	2G371B	10p	2N2148	60p	2N3053	20p	2N5459	43p
AC187	30p	ASY28	25p	BC172	13p	BF157	45p	BSY27	15p	OC44	15p	2G374	17p	2N2192	30p	2N3054	50p	2S034	75p
AC188	30p	ASY29	25p	BC173	13p	BF158	25p	BSY28	15p	OC45	12p	2G377	27p	2N2193	30p	2N3055	63p	2S301	50p
ACY17	25p	ASY50	25p	BC174	13p	BF159	30p	BSY29	15p	OC70	15p	2G378	15p	2N2194	27p	2N3391	17p	2S302A	45p
ACY18	20p	ASY51	25p	BC175	22p	BF160	30p	BSY38	15p	OC71	9p	2G382	15p	2N2217	20p	2N3391A	20p	2S302	45p
ACY19	22p	ASY52	25p	BC177	17p	BF162	30p	BSY39	15p	OC72	12p	2G401	30p	2N2218	25p	2N3392	17p	2S303	60p
ACY20	20p	ASY54	25p	BC178	17p	BF163	35p	BSY40	30p	OC74	12p	2G414	30p	2N2219	27p	2N3393	15p	2S304	£1·10
ACY21	20p	ASY55	25p	BC179	17p	BF164	35p	BSY41	35p	OC75	15p	2G417	25p	2N2220	22p	2N3394	15p	2S305	£1
ACY22	19p	ASY56	25p	BC180	20p	BF165	35p	BSY95	12p	OC76	15p	2N388	30p	2N2221	22p	2N3395	20p	2S306	£1·10
ACY27	18p	ASY57	25p	BC181	22p	BF167	22p	BSY95A	12p	OC77	25p	2N388A	50p	2N2222	27p	2N3402	22p	2S307	£1·10
ACY28	19p	ASY58	25p	BC182	10p	BF173	22p	BU105	£3·90	OC81	15p	2N404	22p	2N2368	17p	2N3403	22p	2S321	60p
ACY29	30p	ASY58	25p	BC182L	10p	BF176	35p	C111E	60p	OC81D	15p	2N404A	30p	2N2369	15p	2N3404	32p	2S322	50p
ACY30	25p	ASZ21	40p	BC183	10p	BF177	35p	C400	30p	OC82	15p	2N524	55p	2N2369A	15p	2N3405	45p	2S322A	45p
ACY31	25p	BC107	10p	BC183L	10p	BF178	45p	C407	25p	OC82D	15p	2N527	60p	2N2411	50p	2N3414	20p	2S323	60p
ACY34	18p	BC108	10p	BC184	13p	BF179	50p	C424	17p	OC83	20p	2N696	12p	2N2412	50p	2N3415	20p	2S324	£1·20
ACY35	18p	BC109	11p	BC184L	13p	BF180	30p	C425	40p	OC84	20p	2N697	15p	2N2616	55p	2N3417	37p	2S325	£1·20
ACY36	30p	BC113	25p	BC186	27p	BF181	30p	C426	30p	OC139	15p	2N698	24p	2N2711	22p	2N3525	74p	2S326	£1·20
ACY40	15p	BC114	30p	BC187	27p	BF182	30p	C428	20p	OC140	17p	2N699	55p	2N2712	22p	2N3702	12p	2S327	£1·20
ACY41	18p	BC115	30p	BC207	11p	BF183	30p	C441	27p	OC170	15p	2N706	7p	2N2714	25p	2N3703	12p		
ACY44	35p	BC116	35p	BC209	11p	BF184	25p	C442	35p	OC171	15p	2N706A	8p						
AD140	40p	BC117	35p	BC209	11p	BF185	30p	C444	37p	OC200	25p	2N708	12p						
AD142	40p	BC118	25p	BC212L	11p	BF188	30p	C450	17p	OC201	27p	1N709	45p						
AD149	43p	BC119	45p	BC213L	11p	BF194	23p	C720	12p	OC202	27p	2N711	40p						
AD161	35p	BC125	35p	BC213L	11p	BF195	24p	C722	25p	OC203	25p	2Nu17	42p						
AD162	35p	BC126	35p	BC214L	12p	BF196	30p	C740	25p	OC204	25p	2N718	24p						
AD161/		BC132	25p	BC225	25p	BF197	35p	C742	17p	OC205	35p	2N718A	50p						
162(MP)	63p	BC134	30p	BC226	35p	BF200	45p	C744	17p	OC309	35p	2N726	27p						
ADT140	50p	BC135	30p	BC317	12p	BF222	80p	C760	17p	P346A	17p	2N727	27p						
ADZ11	£2	BC136	30p	BC318	12p	BF257	35p	C762	17p	P397	45p	2N743	17p						
ADZ12	£2·10	BC137	35p	BC319	12p	BF270	25p	C764	60p	OCP71	43p	2N744	17p						
AF114	17p	BC139	45p	BCY30	20p	BF271	17p	EC401	15p	ORP12	43p	2N914	17p						

DIODES & RECTIFIERS

AA119	8p	BY130	15p	OA10	22p
AA120	8p	BYZ10	35p	OA47	7p
BA116	22p	BYZ11	32p	OA70	7p
BA126	22p	BYZ12	30p	OA79	8p
BY100	15p	BYZ13	25p	OA81	7p
BY101	12p	BYZ16	35p	OA85	7p
BY105	15p	BYZ17	35p	OA90	6p
BY114	12p	BYZ18	30p	OA91	7p
BY126	15p	BYZ19	25p	OA95	7p
BY127	17p	OA5	17p	OA200	6p

74 Series T.T.L. I.C-s

DOWN AGAIN IN PRICE

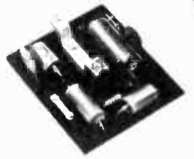
Check our 74 Series List before you buy any I.C's. Our prices are the lowest possible. All devices ex-stock.
Full specification guaranteed.

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
BP153 = 74153	Dual 4-line-to-1-line data	1·20	1·10	0·95
BP154 = 74154	4 to 16 line decoder	1·80	1·70	1·60

ANOTHER BI-PAK FIRST !

THE NEW S.G.S. EA 1000 AUDIO AMPLIFIER MODULE

*** Guaranteed not less than 3 Watts RMS.**



Especially designed by S.G.S. incorporating their proven Linear I.C. Audio Amp. TA/621 providing unlimited applications for the enthusiast in the construction of radios, record players, Audio and Stereo units. Also ideal for intercom systems, monitoring applications and phone answering machines. OTHER USES: *portable applications where supply rails as low as 9V are of prime importance.*

- Sensitivity 40 mV for 1 watt. VOLTAGE GAIN 40 dB but can be varied up to 73 dB for some applications.
- Signal to Noise Ratio 86 dB.
- Frequency response better than 50 Hz to 25 KHz for —3 dB.
- Normal supply Voltage 9—24V.
- Suitable for 8—16 Ohm loads.
- Overall Size 2 in. × 3 in. × ¾ in.
- Typical Total Harmonic distortion at 1 watt less than 1%.

* Supply Voltage (Vs) = 24V 15 ohm load.
Modual Tested and Guaranteed.
Qty. 1—9 £2·63; 10—25 £2·28 Price each
Larger quantities quoted on request. Full hook-up diagrams and complete technical data supplied free with each modual or available separately at 10p each.

All prices quoted in new pence   Giro No. 388-7006
Please send all orders direct to warehouse and despatch department

BI-PAK

P.O. BOX 6, WARE · HERTS

Postage and packing add 7p.
Overseas add extra for airmail.
Minimum order 50p. Cash with order please.

Guaranteed Satisfaction or Money Back

TELEVISION CLASSIFIED ADVERTISEMENTS

The pre-paid rate for classified advertisements is 4p a word (minimum 12 words), box number 7½p extra. Semi-display setting £2·50 per single column inch. All cheques, postal orders, etc., to be made payable to TELEVISION and crossed "Lloyds Bank Ltd." Treasury notes should always be sent *registered post*. Advertisements, together with remittance, should be sent to the Classified Advertisement Manager, TELEVISION IPC Magazines Ltd., Fleetway House, Farringdon Street, London, EC4A 4AD, for insertion in the next available issue.

EDUCATIONAL

LEC

COLOUR TELEVISION TRAINING

11 WEEKS' COURSE for men with Mono experience. Shorter appreciation courses by arrangement. Hours 10 a.m. to 1 p.m. Monday to Friday. Next course commences Jan. 17th. Prospectus from: London Electronics College, Dept. C1, 20 Penywern Road, London, SW5 9SU. Tel. 01-373 8721.

ENGINEERS—get a technical certificate. Exam. and Certificate Postal Courses in all branches of Engineering, Electronics, Radio and TV, Computers, Draughts, Building, etc. Write for helpful FREE BOOK. B.I.E.T. (Dept. H.6), Aldermaston Court, Reading, RG7 4PF.

BECOME "Technically Qualified" in your spare time, guaranteed certificate and exam Home Study courses in Radio, TV, servicing and maintenance, R.T.E.B., City & Guilds, etc., highly informative FREE Guide.—Chambers College (Dept. R105), Aldermaston Court, Reading, RG7 4PF.

RADIO AND TV Exams and Courses by Britain's finest home study School. Coaching for Brit.I.R.E., City and Guilds Amateur's Licence, R.T.E.B., P.M.G. Certificate, etc. Free brochure from British National Radio School, Russel Street, Reading.

TRAIN FOR SUCCESS WITH ICS

Study at home for a progressive post in Radio, TV and Electronics. Expert tuition for City & Guilds (Telecoms Techn's Cert. and Radio Amateurs') R.T.E.B., etc. Many non-exam courses incl. Colour TV Servicing, Numerical control & Computers. Also self-build kit courses—valve and transistor.

Write for FREE prospectus and find out how ICS can help you in your career.

ICS, DEPT. 560, INTERTEXT HOUSE, STEWARTS ROAD, LONDON SW8 4UJ.

Accredited by the CACC

AERIALS

U.H.F. AERIALS. Colour/black and white 625-line programmes, new design. 10 element kit £1·50, 18 element £2·15 (assembled add 40p). SPECIAL. Loft/outside installation kit with 10 element aerial, stand, fixing screws, clamp, plug, 20 metres cable, £4·00. Full instructions and postage paid all aerials, V.H.F. kits, lashing kits, s.a.e. lists. d.B. Aerials (TV). 2 Robert Street, Newport-on-Tay, Fife, DD6 8BL.

AERIALS *(continued)*

AERIALS

UHF: Set Tops **£2·10**, Outside: 9 ele **£1·25**, 10 ele **£1·90**, 11 ele **£2·50**, 12 ele **£2·55**, 18 ele **£3·25**, 20 ele **£3·50**. Multibeam 46 and Supremes **£5·50**.

All aerials supplied with clamps.

ANTIGHOST: Troubleshooters/Logbeams **£5**.

FM/VHF: H **£2·25**, 3 ele **£3·25**, 4 ele **£3·75**. Sterio 6 ele **£6**.

Motorized Units: Semi Auto **£20**, Auto **£25**.

All Aerials by leading makers.

ELECTRONICS, ACCESSORIES: Incl. Masts, Lashings, Plugs, Amps., Headphones, Meters, Stereo Cartridge Players, Cassettes, Tapes, etc., etc.

COAXIALE: Standard 100 Mtrs. **£4·50**. Low Loss **£7**, or per Mtr.

State channels for all TV Aerials/Amps. FM state wide band or channelized.

TERMS: CWO, COD, P & P **32½p**. Send **2½p** stamps for lists. Callers Welcome.

OVERSEAS customers welcome. Note New Zealand/Australia by sea, 7 weeks min. By Air quotations given.

JEFFRIES SERVICES

31 Hambrook St., Portsmouth. Tel. 28354

Direct from the Manufacturers

U.H.F. AERIALS

in EASY ASSEMBLY KITS

SAVE 40% on normal retail price

10 Element **£1·25**

14 Element **£1·50** 18 Element **£1·75**

Ready assembled add 20p.
allow 32½p. carriage and packing.
Please state which channels or group.

TRADE SUPPLIED, SEND FOR LIST

APEX AERIALS (T.V.)

ALBAN WORKS, MARY ST., JOHNSTONE, RENFREWSHIRE

BAINES for **HIGH FREQUENCY AERIALS AND FITTINGS**

UHF Aerials:
Multibeams: MBM 10 **£1·90**; MBM 18 **£2·65**; MBM 30 **£3·60**; MBM 38 **£5·10**; MBM 46 **£5·50**; Log-periodic wide band **£4·50**.
BBC I: Dipole **£1·75**; H **£2·50**; X **£2·40**.
ITA: 5 element **£2·00**; 8 element **£2·70**. Double arrays available.
Combined: Dipole and 5 **£2·70**; H and 5 **£4·10**.
FM: Dipole **£1·40**; 2 element **£2·00**.
Accessories: Lashing Kits—Wall Brackets—Clamps—Diplexers—Triplexers—Outlet Boxes—Poles—"J" "U" "V" Bolts—Guy Clamps—Co-ax 405 **5p** and UHF 625 **9p**. Plugs **7p**.
Pre-Amps: VHF OR UHF **£3·87**, postage paid. Masthead **£12·00**, postage paid.
Postage paid on aerials inland—please state channels when ordering. Accessories postage by weight. Mast clamp supplied with each aerial, 2 in. or 1 in.

R. BAINES
11 Dale Crescent, Tupton, Chesterfield

FOR SALE

VALVES EX. TV from 5p, 3p postage, speakers from 37½p, postage 10p. Valve cartons. Globe Electrics, 151a Brighton Road, Surbiton, Surrey. 01-399 7333.

"P.T." Mid 1959 to 1971, £10. "P.W." same £10. "P.E." to May 1967, £2. Post free U.K. Elliott, 29 Quested Way, Harrietsham, Kent.

HEATHKIT MODEL IM-13U Valve Voltmeter, as new £10. Tel. Vange 2804. 13 Chevers Pawen, Pitsea, Essex.

14in. VIDEO TV MONITOR 405-525-625 lines, spare tube, manufacturer's prototype, good working order. Transistor tuner and i.f. amplifier to drive monitor. £20 the lot. 64 Brooksfield, Welwyn Garden City.

SERVICE SHEETS

SERVICE SHEETS

(1925-1971) for Radios, Televisions, Transistors, Radiograms, Car Radios, Tape Recorders, Record Players, etc.

By return post with

FREE FAULT FINDING GUIDE

PRICES FROM 5p

Over 8,000 models available.
Catalogue 13p.

Please send stamped addressed envelope with all orders and enquiries.

Hamilton Radio

54 London Road, Bexhill, Sussex
Telephone Bexhill 7097

SERVICE SHEETS with Free Fault Finding Chart 35p, plus stamped addressed envelope. LESMAR, 15 Conholt Road, Andover, Hants.

SERVICE SHEETS. Radio, TV, etc. 8,000 models. List 10p. S.A.E. enquiries. TELRAY, 11 Maudland Bank, Preston.

SERVICE SHEETS *(continued)*

QUICK, EFFICIENT, SERVICE SHEET SERVICE

Stocks now cover over 10,000 Makes and Models. TV's Mono and Colour, Amplifiers, Tapes, Record Players, Test Gear, etc.

SERVICE SHEETS 25p plus large S.A.E.

MANUALS covering many Makes and Models. Enquiries welcome but S.A.E. please

CATALOGUE covering TV's, Mono and Colour, including Fault Finding Chart and Vouchers. Value 20p.

Price 20p plus S.A.E.—Radio, etc. catalogue also 20p.

— MAIL ORDER ONLY —

A.L.S. 21c Drydon Chambers, 119 Oxford Street, London W1R 1PB

✶ Service Sheets and Manuals ✶

COVERING RADIOs, TELEVISIONs, TAPE RECORDERs, RECORD PLAYERs, ETC. FROM 1933 UP-TO-DATE FROM 40P. EACH – 1971 SERVICE SHEET INDEX LIST 20P. – S.A.E. WITH ENQUIRIES PLEASE

◂ NEW BOOKS & PUBLICATIONS ▸	Price	+ Post
BEGINNER'S GUIDE TO RADIO by Gordon J. King. 7th Edition. 204 pages	£1.00	10p
BEGINNER'S GUIDE TO TELEVISION by Gordon J. King. 208 pages	£1.00	10p
RADIO VALVE AND TRANSISTOR DATA by A.M. Ball. 9th Edition. 232 pages	£0.75	15p
UNDERSTANDING THE SEMICONDUCTOR by C.N.G. Matthews. 128 pages	£1.00	10p
UNDERSTANDING TELEVISION by J.R. Davies. 512 pages	£1.88	20p
THE PRACTICAL AERIAL HANDBOOK by Gordon J. King. 232 pages	£2.70	15p
COLOUR TELEVISION PICTURE FAULTS by K.J. Bohlman. AM.Inst.E. Illustrated in Colour	£2.50	15p
T.V. FAULT FINDING BOOK by Data Publications Ltd. 405/625 Edition. 124 pages	£0.50	7p
1971–1972 MULLARD DATA BOOK. Data on Valves & Semiconductors	£0.30	5p
1970–1971 MULLARD DATA BOOK. Data on Valves & Semiconductors	£0.20	5p
TRANSISTOR EQUIVALENTS & SUBSTITUTES HANDBOOK by B.B. Babani	£0.40	5p
RESISTOR COLOUR CODE INDICATOR DISC	£0.10	3p

Send S.A.E. for 'FREE' List of Practical and Technical Books on Radio & Television now available to:-

BELL'S TELEVISION SERVICES

Albert Place, Harrogate, Yorkshire. Telephone 0423-86844

TRADER SERVICE SHEETS

40p each plus postage

We can supply Trader Service Sheets for most makes and types of Radios, Tape Recorders and Televisions—Manuals for some.

Cheques and open P.O.s returned if sheets not available.

OAKFIELD ENTERPRISES

LIMITED

29 CHURCH ROAD, TUNBRIDGE WELLS, KENT

Make	*Model*	*Radio/TV*

1971 List now available at 10p plus postage

If list is required indicate with X

From ....

Address ....

....

enclose remittance of ....

(and a stamped addressed envelope)

s.a.e. with enquiries please

MAIL ORDER ONLY (May T)

WANTED

CASH PAID for New Valves. Payment by return. WILLOW VALE ELECTRONICS, 4 The Broadway, Hanwell, London, W.7. 01-567 5400/2971.

SERVICE SHEETS purchased, HAMILTON RADIO, 54 London Road, Bexhill.

TOP PRICES PAID

for new valves, popular TV & Radio Types

KENSINGTON SUPPLIES

(A), 367 Kensington Street Bradford 8, Yorks

WANTED! New valves especially TV types. Cash waiting. Bearman, 6 Potters Road, New Barnet, Herts. Tel. 449/1934.

WANTED. Radio & TV Servicing 1964-65 Volume. R. Goodman, 26 Killarney Road, Wandsworth, SW18 2DX.

WANTED URGENTLY. January 1971 "Television," will pay.—HARPER, 24 Sutherland Street, York.

Complete volumes of back issues of Practical Wireless, Practical Electronics, (Practical) Television, Radio Constructor and Wireless World from 1960 onwards. Must be in good condition.

E. G. PAUL & CO. LTD., 43 Thistle Street, Edinburgh 2, 031-226 3407.

MISCELLANEOUS

RECORD TV sound using our loudspeaker isolating transformer. Provides safe connection to recorder. Instructions included. 70p plus 10p P&P. Crowborough Electronics (T), Eridge Road, Crowborough, Sussex.

LADDERS

LADDERS, 24½ft., £8·90, order C.O.D. Phone 02-993 5222. Home Sales, Baldwin Road, Stourport, Worcs. Callers welcome.

SETS & COMPONENTS

Brand New

HARTLEY OSCILLOSCOPES C.T.316

C.T.316 Oscilloscopes by famous maker. 3in. tube. *Specifications:* Time Base 0-75 micro/sec to 100 mil/sec, delay in 3 ranges, 5 micro/sec to 10 mil/sec. Y/amp at 3D.b.S. down, 0-75 mc/s to 5 mc/s at ± 5%. Calibrators at 10/100/1000 Kc/s ± 5%. Measures AC/DC volts 0-500V. Timebase facilities sine/pulse + or — waves. Y input is 50 PF × 1·5MΩ, single beam. AC mains 230-250 volt 100 watts. Built-in Y shift meter showing Y volts. Offered as new in maker's transit case, with accessories and instruction book. Price **£40** + p. & p. £1·50p.

A. H. THACKER

Radio Dept, High Street, Cheslyn Hay, Nr. Walsall, Staffs.

TOWERBY LTD

For Line Outputs and Deflector Coils

We have the Country's largest stock of Manufacturer's Original (or Authorised Replacement) Line Output Transformers for many "difficult" makes, including **Ambassador, Baird, Cossor, Decca, Dynatron, Ekco, Ferguson, G.E.C., H.M.V., K.B., Masteradio, Peto-Scott, Philips, Regentone, RGD, Sobell, Ultra,** etc. Also deflector coils output and oscillator transformers, inc. **Alba, Bush, Murphy.** Examples, L.O.P.T. **Murphy** 350/410/540/659/759, **£7·35; Bush,** TV80, TV95, TV96, **£7·35; Cossor** 950, **£3·87½; Ferguson** 306/308, **£3·97½; Philips** 1768U L.O.P.T. assembly, **£6·75; Ultra** 1984-200c, **£5·06.**
Rewind most L.O.P.T., **£4·50.**

SPECIAL OFFER

Ekco improved type for Models T221, 231, 310, all at **£2·25; Ferranti** 14T4 series inserts, **£1·25; Philco** 1019/1021, **£2·62½.** Terms: C.W.O. or C.O.D. (17½p), post-packing 30p; 2 or more L.O.P.T.s post/packing free.
All enquiries answered but regret no lists available. Same day delivery on most types.

TOWERBY LTD

MAIL ORDER DIVISION OF T.C.S. LTD.

70 STREATHAM HILL, LONDON, SW2

Tel.: 01-674 2185.

120 NEW ASSORTED Capacitors, Electrolytic, Mica, etc., and Resistors, ¼/20W, 85p, Post Free. Whitsam Electrical, 33 Drayton Green Road, London, W.13.

WITWORTH Transformers

Line out-put transformers
Manufacturers of the largest range in the country. All makes supplied. Free catalogue.
Modern
BAIRD, BUSH, GEC, PHILIPS.
Replacement types ex-stock.
For 'By-return' service, contact your nearest Depot:

London: 01-948 3702
Tidman Mail Order Ltd., Dept. PT.
236 Sandycombe Road,
Richmond, Surrey.

Birmingham: 021-643 2148
Hamond Components,
89 Meriden Street,
Birmingham 5.

Valves, Tubes, Condensers, Resistors. Rectifiers and Frame out-put Transformers also stocked.

CALLERS WELCOME

TOP 20 TV Valves, 10p; PL504, PL36, PY33, 15p, P&P 4p per valve, over 12 valves post free. Guaranteed tested ex-equipment, individually boxed. Resistors and capacitors all values and sizes. Leading manufacturers components and hi-fi equipment, 10% or more off. 13A plugs, 12p. Mains fuses, 20p for 10. Tools, etc., P&P extra on all items. Trade enquiries welcomed, discount for quantity. S.A.E. for list. L & D Components Ltd., 71 Westbury Avenue, Wood Green, N.22. 01-888 2701.

SOUTHERN VALVE COMPANY

44 Earls Court Road, London, W.8

SPECIALISTS IN QUALITY VALVES FROM TOP MANUFACTURERS; WE DO NOT CLAIM THE LOWEST PRICE, BUT GENUINE VALUE!

All new and boxed, some BVA. Send s.a.e. for list. Mainly British.

DY87	37p	PC86 & 8	50p	PCL805	45p	U193	35p	30L17	75p
DY802	45p	PC97	40p	PCL86	37p	U251	62p	30P12	70p
EB91	15p	PCF80	32p	PL36	52p	6/30L2	60p	30PL1	60p
ECC81	37p	PCF86	52p	PL81	46p	6BW7	60p	30P4MR	95p
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	**NOTE**	
EH90	45p	PCL83(s)	50p	U25	65p	30C15	70p	**BY100/BY127**	
EY51	50p	PCL84	37p	U26	60p	30FL1 & 2	75p	**equiv only 20p**	
EY86/7	37p	PCL85	45p	U191	65p	30L15	75p	**with resistor.**	

POST FREE OVER £2, BELOW 2½p EACH.
MAIL ORDER ONLY.

LARGE quantities of used TV spares for most models, 1952-64. Lopts, Tuners IF Strips, Time Base Panels Scan Coils, Frame Transformers, Knobs, cabinet Trim, etc. New manufacturers replacement parts, can be supplied, for more modern sets on receipt of an order deposit. S.A.E. for quotations. C.W.O. to TV Dismantlers, Foxhole, Whitstone, Holsworthy, Devon.

TV's TV's TV's

SPECIAL OFFER—LIMITED PERIOD ONLY

19" Slim Thorn 800 TV's 13 channel.
Good working order. Polished cabinets.
Only **£9·50** PLUS £1·50 Carr.

EX-RENTAL TV's (UNTESTED)

Complete with 13 channel tuners. Good cabinets.
Carriage £1·50 extra.

17" Semi Slim (90° Tube)	**£2·50**
17"/21" Slim (110° Tube)	**£4·50**
19" Slimline	**£6·50**
23" Slimline	**£8·50**
19" BBC2 Sets	**£14·50**

PERFECT SPEAKERS EX T.V.

Pm 3 ohm (minimum order two) 5 in. round, 8 in. by 2 in. rectangular—**12½p** each. Add 7½p per speaker p. & p.

VALVES EX EQUIPMENT

EB91	5p	30L15	12½p	PL36	22½p
EBF89	12½p	30P4	12½p	PL81	17½p
ECC82	12½p	PC97	17½p	PY81	15p
EC180	7½p	PCF86	17½p	PY800	15p
EF80	12½p	PC84	7½p	PY82	7½p
EF85	12½p	PCF80	7½p	PY33	22½p
EF183	12½p	PCC89	12½p	U191	17½p
EF184	12½p	PCL85	22½p	6F23	17½p
EY86	17½p	PCL82	17½p	30PL1	22½p
30PL13	20p	PCL86	17½p	30P12	20p
630LZ	12½p	PCL83	12½p	30F5	10p

Add 2½p per valve p. & p., orders over £1 p. & p. free

UHF TUNERS

For Ferguson 850 900 chassis. Adaptable for most U.H.F. Chassis **£2·50**, p. & p. 50p.

SLOT METERS—SPECIAL OFFER

Smiths Mk. 11 6d. Convertible to 5p. (Smiths Kit costs **35p** each £1 each inc. p. & pkg. or 10 for £5 inc. p. & pkg.)
Please write with SAE for quotations on any spares.

TRADE DISPOSALS (Dept. PT/TS)

Thornbury Roundabout, Leeds Rd., Bradford.
Telephone 665670

PHILIP H. BEARMAN

A leading name in valves and Tubes!

(Mullard, Thorn, Telefunken, etc.)

NEW MOSTLY BVA VALVES! Huge range by post service well known to the trade. Brief list of television types herewith, full list S.A.E. All types ex stock!

DY86/7	40p	PCF86	60p	PY82	47p	20L1	90p
EB91	22p	PCF801/2	59p	PY800/1	47p	20P4	90p
ECC82	42p	PCF805	83p	R19	80p	30C15	86p
ECL80	47p	PCF808	80p	U25	91p	30C17	91p
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
EY86/7	40p	PL36/8	83p	U301	85p	30PL1	86p
PC86 & 8	72p	PL81	75p	U801	99p	30P4MR	£1·00
PC97	42p	PL83	81p	6/30L2	86p	30P19	83p
PC900	52p	PL84	62p	6AT6	52p	30PL13	95p
PCC84	47p	PL500	86p	6BW7	78p	30PL14/5	95p
PCC89	58p	PL504	86p	6CD6G	90p	etc., etc.	
PCF80	50p	PY81	47p	6F23	90p	**Trade prices**	

POST FREE OVER £3·00, 2½p PER VALVE BELOW £3·00
LATEST NEW BY100/127 type silicon rectifier 15p, 33Ω res 5p!

Large bulb Imported PCF80 30p! Philips PCL805/85 54p!

Note. Ask for separate component and transistor lists. Mullard/Mazda data books 20p.

6 POTTERS ROAD, NEW BARNET, HERTS.

(Adjacent to Post Office)

Tel, 01-449/1934 & 449/1935 (Robophone)

Special quantity terms, lists, s.a.e. GIRO 34.361.4006

(Suppliers to H.M. Govt. etc.)

VALVE BARGAINS

Any five 40p, ten 65p, from the following: EB91, ECC82, EY86, ECL80, EF80, EF85, EF183, PC97, PCC84, PCC89, PCF80, PCF86, PCL82, PCL83, PCL84, PCL85, PL36, PY33, 6-30L2, 3OC15, 3OL15. P. and p. 5p.

M. ASHWORTH,
9 MANDEVILLE TERRACE,
HAWKSHAW, BURY, LANCS.

TELEVISION TUBE SHOP

BRAND NEW TUBES AT REDUCED PRICES

A28-14W (A28-13W)	£12·75
A31-18W	£12·50
A47-11W	£9·95
A47-13W	£12·50
A47-14W	£8·25
A47-26W	£10·75
A50-120WR	£12·50
A59-11W	£12·95
A59-13W	£13·50*
A59-15W	£9·95
A59-16W	£13·50*
A59-23W	£14·75
A61-120WR	£16·00
AW-21-11	£7·00*
AW36-21, 36-80	£5·75
AW43-80	£6·95
AW43-88, 43-89	£6·75
AW47-90, 47-91	£7·50
AW53-80	£7·50*
AW53-88, 53-89	£8·25
AW59-90, 59-91	£9·00
C17LM, 17PM, 17SM	£6·50
CME1201	£12·50
CME1402	£5·75
CME1601	£10·50
CME1602	£12·00
CME1702, 1703	£6·75
CME1705	£7·75
CME1713/A44-120	£14·50
CME1901, 1903	£7·50
CME1906	£12·50
CME1908	£7·75
CME2013	£12·50
CME2101, 2104	£8·25
CME2301, 2302, 2303	£9·00
CME2305	£14·75
CME2306	£13·50*
CME2308	£9·95
CME2413R	£16·50
CRM93, 124	£5·50*
CRM141, CRM142	£5·50
CRM171, CRM172	£6·50
CRM211, CRM212	£7·50*
MW36-24, 36-44	£5·50
MW43-69	£6·75
MW43-80	£6·75
MW53-20, 53-80	£7·50
TSD217, TSD282	£14·00†
13BP4 (Crystal 13)	£14·00†
190AB4	£9·25
230DB4	£11·25

†Rebuilt tubes also, at £7·00 plus bulb

*These types are FULLY rebuilt.

ALL TUBES ARE TESTED AND GUARANTEED FOR A MINIMUM OF 12 MONTHS

ADD 75p FOR CARRIAGE AND INSURANCE

COLOUR TUBES

19 in. and 22 in. having slight marks or scratches at £35 each

TELEVISION TUBE SHOP

48 BATTERSEA BRIDGE ROAD, LONDON, S.W.11. 228 6859

WE GIVE GREEN SHIELD STAMPS

SETS & COMPONENTS *(continued)*

AERIAL BOOSTERS

We make four types of Aerial Boosters. **L45** 625 U.H.F., **L12** V.H.F. TV. **L11** V.H.F. Radio, **L10** M/W & S/W. Price L45, L12 and L11 **£2·95**, L10 **£2·45**.

VALVE BARGAINS

Any 5=45p, 10=70p: ECC82, ECL80, EF80, EF85, EF183, EF184, EBF89, EB91, EY86, PCC84, PCC89, PC97, PCF80, PCF86, PCL82, PCL83, PCL84, PCL85, PL36, PY33, PY82, PY800, PY801, 30L15, 30C15, 6-30L2.

TRANSISTOR BARGAINS

We offer the following brand new marked transistors for sale. Any 5-**40p**, 10-**75p**:=BC113, BC171, BC117, BC135, BC153, BF115-**15p**, BF184-**15p**, BF200-**20p**.

PRINTED CIRCUIT BOARD

2-8 ins. by 4 ins. boards complete with etching compound and instructions—**40p**.

MAINS DROPPERS

Three section 33-33-33 Ohms. **9p**.

POST AND PACKING: Under **£1**, **5p**. Over **£1**, **10p**. S.A.E. for leaflets on all items. Money back guarantee if not completely satisfied.

VELCO ELECTRONICS

62A Bridge Street, Ramsbottom, Bury, Lancs.

CHROMASONIC ELECTRONICS

LOW NOISE HI-STABS

LOW NOISE HI-STABS

¼ watt 5% all E24 values 3 for **2p** plus p. & p. 6p for up to 50 resistors + **1p** for each additional 50.

POWER SECTIONS

7 to 20 Ω	22 to 36 Ω	at ·7A
40 to 100 Ω	120 to 270 Ω	at ·3A
—	726 Ω	at ·15A
300 to 560 Ω	—	at ·12A
1K Ω	—	at ·1A
—	2K Ω	at ·07A
20p. ea.	**25p** ea. p. & p. 6p per section.	

REPLACEMENT DROPPERS

37 + 31 + 97 + 26 + 168 Ω .. **50p**
14 + 26 + 97 + 173 Ω .. **50p**
30 + 125 + 2·85K Ω .. **50p**
p. & p. 7p ea.

AA119/20	**10p**	BC148	**12p**	BU105	**£2·75**
AC127/8	**17p**	BC157/59	**20p**	TAA661B	**£1·90**
AC176	**23p**	BC158/68	**15p**	TAA700	**£2·00**
BC147/9	**15p**	BF115/73	**25p**	PA237	**£1·55**

CARBON TRACK POTS, Single gang Log or Lin **12p**

1972 CATALOGUE 10p post free

P. & P. on all orders other than resistors 6p

56 FORTIS GREEN ROAD, LONDON N10 3HN

T.V. BARGAINS

Complete but untested TVs. 19 in. 405 lines, £5, 19 in. dual standard, E.G., Ekco 402, Sobell, 1000 series, Thorn 850, etc., £8 (less U.H.F. tuner). 19 in. dual standard with U.H.F. tuner, £12. Carriage and packing, £1.50. Lists. S.A.E. Personal callers welcome.

LINAVALE RADIO LIMITED

48 Hoe Street, London, E.17,
01-520-7546.

VALVES, VALVES, VALVES

Any ten of your choice 72½p, post 5p. 100 £5·50, post paid.

EF85, EF80, EB91, EBF89, ECL80, EF183, EY86, PCF80, PCC84, PL36, PY81, PCL82, PCL83, PCC89, PY33, PY82, PY800, PY801, PY88, PCL84, 30F5, 6BW7, PY801.

BOB'S,
2 St. James Street, Rawtenstall
Rossendale, Lancs.
Mail order ONLY.

R & R RADIO

51 Burnley Road, Rawtenstall
Rossendale, Lancs
Tel.: Rossendale 3152

TESTED VALVES—3 MONTHS' GUARANTEE

EBF80	15p	PCC84	15p	PY800	17½p
EBF89	17½p	PCF80	15p	PY801	17½p
ECC82	15p	PCL82	20p	U191	22½p
ECL80	15p	PL36	25p	30C15	25p
EF80	10p	PY33	25p	PCF86	25p
EF85	15p	PY81	17½p	PCL85	25p
EY86	20p	PY82	15p	PCL84	25p

Copper Laminate Board, for etching, 1p per sq.in. Double sided 1½p per sq.in. Any size cut, min. order 50p plus 10% P. & P.

Postage on Valves: one valve 4p, up to 6 2½p over 6 post paid.

NEW VALVES!

Guaranteed and Tested

24-HOUR SERVICE

1R5	·25	DCC90	·80	EF86	·28	PCL85	·37
1S5	·21	DF91	·14	EF89	·24	PCL86	·37
1T4	·14	DF96	·35	EF91	·12	PFL200	·51
3S4	·24	DK91	·25	EF183	·26	PL36	·47
3V4	·37	DK92	·35	EF184	·28	PL81	·43
5Y3GT	·25	DK96	·36	EL33	·54	PL82	·29
6/30L2	·53	DL92	·24	EL37	·75	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	UBF89	·29
30L17	·66	ECH35	·27	PCF80	·27	UCC85	·34
30P4	·56	ECH81	·26	PCF86	·43	UCH81	·30
30P19	·56	ECL80	·29	PCF801	·27	UCL82	·31
30PL1	·59	ECL82	·29	PCF802	·38	UCL83	·49
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

Postage on 1 valve 5p, on 2 or more valves 3p per valve extra. Any parcel insured against damage in transit 3p extra. Office address, no callers.

GERALD BERNARD

83 OSBALDESTON ROAD
STOKE NEWINGTON
LONDON N.16