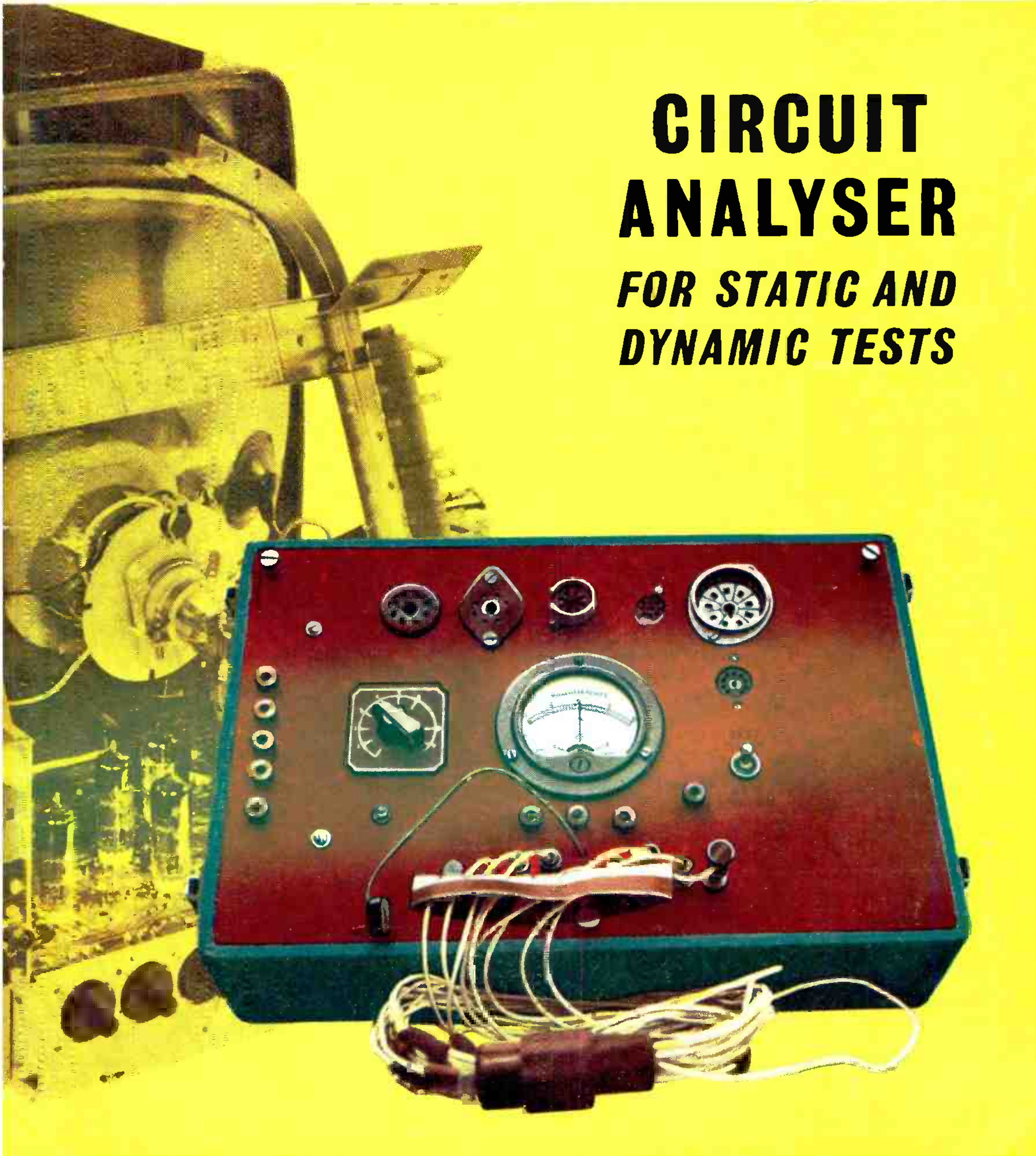
Practical
TELEVISION

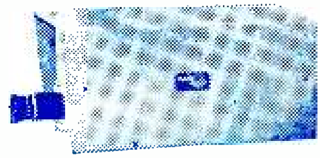
SEPTEMBER 1963 2/-

CIRCUIT ANALYSER
FOR STATIC AND DYNAMIC TESTS



BUILD A C.C.T.V. CAMERA!

An exciting new Hobby . . . made possible with these easy-to-buy, easy-to-build kits, supplied with step by step instructions. Ideal for the enthusiast and Technical students.



THE "BEUKIT" C.C. TELEVISION CAMERA KIT!

Completely Transistorised

The finest possible way to learn about transistors and TV Cameras!
The most exciting advance ever in Do-it-Yourself Electronics—specially designed and manufactured — NOT SURPLUS EQUIPMENT.

A World First! The Beukit Camera works with standard 405 line TV Receivers.

See it Now! Demonstrations held daily in our showrooms.

Buy and Build in Easy Stages!

- **KIT No. 1. £18.17.6** With specification, principles of vidicon tube, scanning assembly and optical system diagram.
- **KIT No. 2. £16.10.0.** With printed circuit board and associated components, circuit diagram, layout instructions and Instruction Manual.
- **Kit No. 3. £8.0.0.** With all transistors and semi-conductors.
- **Kit No. 4. £6.0.0.** With all metal work.

Plus 7/6 Post & Pkg. for each Kit. Send S.A.E. for full details of Kit. (Kits cannot be split. Instruction Manual cannot be supplied separately.)

Save Money and buy the complete Kit (less vidicon and lens) as illustrated above for only . . .

£48 *plus 7/6 P. & P.*

The Camera is also available factory assembled and tested, with vidicon less lens for 69 gns.

- Experimenter's vidicon £12 plus P. & P. 7/6
- SPECIAL BEULAH Z1 Economy Lens £11 (LOWEST PRICED LENS IN U.K.!) Fixed iris F2 1½in. An excellent lens, focus from 9in. to infinity. Half the price of other makes.

Order Now or see demonstration today.

A Member of the D.T.V. Group of Companies

BEULAH ELECTRONICS

Dept. PTV 126 HAMILTON RD., WEST NORWOOD, LONDON, S.E.27. *Tel: GIPsy Hill 6166*

Stamp for FREE LIST

DUKE & CO. (LONDON) LTD.

621/3 Romford Road, Manor Park, E.12
Liverpool St.—Manor Pk.—10 mins.

Phone ILFORD 6001/2/3

TAPE CABINETS 20/-
To fit B.S.R. and Collaro Studio Decks. Carriage 5/-.

Sw Volume Controls, Min. for Transistor Radios. 5K. 2/- each. 12 for 20/-. Post on one, 6d.

REGUNNED TV TUBES
21in., 99/6 17in., 79/6
15, 14, 12in., 59/6
Guaranteed One Year
Ins. and Carr., 10/-.
Add 10/- refundable on OLD TUBE. 110 Tubes in Stock.

Ex-Rental Tubes
15/- 121, 31/74, 36/24, 141, 14KP4 and others. Set tested. Carr. 5/-.

SPEAKERS 7/9 each
6in., 8in., 7in. x 4in. Money back guaranteed. Other sizes, few only. Ex. mfd. salvage. P.P. 2/3.

EXTENSION SPEAKERS 19/9
2-tone covered cabinet, 6in. PM speakers, switch and flex. Ideal for kitchen, sick-room, etc. P.P. 3/3.

TELEPHONE HANDSETS 15/6
P.P. 4/6.
G.P.O. standard pattern. House to Workshop, garage, inter-office, etc. Works off any small battery.

14 INCH £7.10.0
12 months' Full written Guarantee.
Part Exchange allowance
Legs 39/6 per set.
Shown working all channels in Shop. Personal collection advised, or insured.
Carr.
14in. 20/-
17in., 30/-

Only DUKE'S Can Offer This.

17 INCH £11.10.0
How do we do it? Sets are ex Rental. Already well maintained. We re-gun tubes as new ourselves. Valves and Parts are manufacturers' surpluses. *All sets have a written guarantee, covering tube, valves and all components.*

E.M.S. TELEVISION TUBES

***PROVED** with **A** reliability:-*

PACK A GREATER PUNCH THAN EVER
TRY ONE NOW AND SEE THE DIFFERENCE!

18 month guarantee with all our tubes

SIZE	PRICE	COST TO YOU WITH ALLOWANCE ON RECEIPT OF OLD TUBE
12in.	£4. 7.6	**£3.17.6**
14in.	£4.15.0	**£4. 5.0**
15, 16, 17in.	£5.15.0	**£4.15.0**

Carriage and Insurance 10/6 extra on all tubes

★ *BUY FROM ACTUAL MANUFACTURERS WHO **KNOW** HOW TO REBUILD A TUBE*

MARSHALL'S for TELEVISION LTD.

131 St. Ann's Road, Tottenham, London, N.15

STAMFORD HILL 3267 & 5555

Tubes

HIGHEST QUALITY— COMPARE OUR PRICES

Carr. & Ins. 12/6.

MOST MULLARD, MAZDA, COSSOR, EMITRON, EMI-SCOPE, BRIMAR, FERRANTI TYPES. PROCESSED IN OUR OWN FACTORY

	GUARANTEED 6 Months	GUARANTEED 12 Months
12in.	£2. 0.0	£3. 0.0
14in.	£2.10.0	£3.10.0
15–17in.	£3. 5.0	£4. 5.0
21in.	£3.15.0	£5.15.0

NEW TYPES
MW 31/74 £3.15.0
MW 36/24 £4.15.0
CRM 172 MW 43/64 £6.0.0

100 RESISTORS 6/6
Excellent. Sizes ½-3 watt.

100 CONDENSERS 10/-
Miniature Ceramic and Silver Mica Condensers, 3 pF to 5,000 pF. LIST VALUE OVER £5.

SILICON RECTS.
250V 500mA standard TV replacement. Top quality 8/6 (3 for 24/-).

13 CHANNEL TVs.
Table Models, Famous Makes. Absolutely Complete. These sets are unequalled in value due to huge purchase direct from source. They are untested, and not guaranteed to be in working order. Carr. etc., 15/-.
12in. **£2.19.0** 17in. **£6.19.0**

SPECIAL TEMPORARY OFFER. Due to huge Bulk Special Purchase we are offering MW 31/74 Tubes at the unrepeatable price of 29/-. MW 36/24 ditto, 39/-. P.P. 12/6. The above are guaranteed for 6 months.

P.M. SPEAKERS. 3Ω Top Makes.
6½in. 8in. **7/6** 5in. 7 x 4in. **8/6**

CO-AX, low loss, 6d. yd., 25 yds., 11/6, 50 yds., 22/-, 100 yds., 42/6. Co-ax Plugs 1/3. Wall outlet boxes 3/6.

BBC/ITA 14in. TVs.
With CRM 141 Tubes. Absolutely complete, tested for raster. Famous make, large purchase enables us to offer them at **£4.19.0**
Carr. 12/6.

NEW SHOP BRIGHTON

OPENING IN LARGE PREMISES

11-12 North Rd., BRIGHTON

With Widest Stocks, Keenest Prices: TV's, Radios, Valves, Transistors, Hi-Fi Equipment, Loudspeakers, Autochangers, Cables, Components, etc.

TURRET TUNERS
Most makes, your choice if available, with valve 16/-, less valves 10/-. S.A.E. enquiries.

TRANSISTORS
Guaranteed Top Quality
Huge reductions. **Red Spot** standard I.F. type now only 1/6; **White Spot** R.F. 2/-. **Mullard Matched Output Kits** (OC81D and 2-OC81's), 12/6. **Receiver Kits,** OC44 OC45(2), OC81D, OC81(2). six transistors. **24/-**

AF102	17/6	OC26	12/6	OC31	5/6
AF114	8/6	OC36	14/-	OC31D	5/6
AF115	7/6	OC44	5/6	OC32	7/6
AF116	7/6	OC45	6/-	OC170	8/6
AF117	7/-	OC71	5/-	OC171	8/6
AF127	9/6	OC72	5/6	XB104	5/6

DIODES. General purpose miniature equiv., GEX34 9d., 7/6 doz. OA10, 4/6.

LINE TRANS. S.A.E. enquiries.
Huge quantity, most makes at only **29/-**

CRM142 New Tubes **£5**

3 VALVE AMPLIFIERS. Kit of new parts, consisting chassis mains and output transformers, valves (P61, 6J6G, 6X5G) and all components. With full instructions for making high gain amplifier with separate base and treble controls, negative feedback, etc. Truly unusual value at **29/-**

RECTIFIERS. Silicon Diodes 125v. 500 mA. 2 in series make superior replacement for R.M.4 and R.M.5, etc., 8/- each. 250v., 50mA, 5/-; RM1, 5/3; RM2, 6/9; RM3, 7/6; RM4, 19/6; RM5, 19/6; 14A86, 17/-; 14A97, 19/6; 14A100, 19/6; 16RC1-1-16-1, 7/9; 18RA1-1-1-16-1, 6/-; 18RD-2-8-1, 14/-; 14RA1-2-8-2, 17/-; 14RA1-2-8-3, 20/-.

AM/FM RADIOS
Fantastic offer. 7 valves plus 2 diodes. Contemporary Cabinet. Top quality and finish A.F.C. A.V.C. Absolutely complete, Guaranteed 3 months. **£11**

TELEPHONE C.O.D. ORDERS DISPATCHED THE SAME DAY

★ GUARANTEED VALVES ★

by return of post

THE MOST ATTRACTIVE COMPETITIVE VALVE LIST IN THE COUNTRY

All valves are new and unused unless otherwise advised.

POST 1 Valve 6d., 2-11, 1/-. FREE for 12 or more valves.

3 MONTHS GUARANTEE In writing with every valve.

FREE TRANSIT INSURANCE. Satisfaction or Money back Guarantee on Goods if returned within 14 days.

OZ4	4/6	6K7	5/9	20D1	8/9	DL82	9/-	EZ40	6/6	U22	6/9
1A7GT	9/6	6K7G	2/-	20F2	9/6	DL92	5/-	EZ41	6/9	U24	12/6
1C5GT	7/6	6K7GT	4/6	20L1	16/-	DL94	6/6	EZ80	5/9	U25	10/6
1D5	7/-	6K8G	5/-	20P1	9/6	DL96	7/3	EZ81	6/-	U26	8/6
1D6	9/9	6K8GT	8/3	20P3	12/6	EA50	1/3	FW4/500	7/-	U31	7/-
1H5GT	8/9	6K25	8/6	20P4	17/-	EABC80	6/6	GT1C	12/6	U33	14/-
1L4	3/-	6L1	9/6	20P5	15/-	EAC91	4/-	GZ32	7/6	U35	12/6
ILD5	4/3	6L6	7/6	25A6G	8/-	EAF42	8/3	GZ34	11/6	U37	26/-
1LN5	4/6	6L6G	6/6	25L6GT	7/9	EB34	1/3	HK90	9/6	U50	4/9
1N5GT	8/9	6L18	7/9	25Y5G	8/-	EB41	5/-	HN309	19/-	U52	4/9
1R5	5/6	6L19	12/6	25Z4G	7/-	EB91	3/3	HVR2	9/-	U76	5/6
1U5	5/3	6LD20	7/9	25Z5	8/-	EBC33	4/9	KT33C	4/-	U78	4/6
1S4	7/6	6N7	7/6	25Z6G	8/-	EBC41	7/9	KT36	14/-	U107	12/6
1S5	4/6	6P1	9/6	27SU	17/6	EBC81	7/9	KT44	6/-	U191	11/6
1T4	3/-	6P25	8/6	30C1	6/9	EBF80	7/6	KT45	8/6	U281	9/6
2D21	5/6	6P28	9/9	30C15	11/6	EBF83	9/6	KT55	17/6	U282	15/-
3A4	4/-	6Q7G	5/6	30F5	6/-	EBF89	7/9	KT61	8/6	U301	12/6
3A5	8/9	6Q7GT	8/-	30FL1	9/6	EBL21	9/9	KT63	4/6	U309	6/6
3D6	4/-	6R7G	9/-	30L1	6/6	EBL31	17/6	KT66	13/6	U329	9/6
3Q4	7/-	6SA7	5/9	30L15	8/9	EC52	4/9	KT76	8/6	U339	11/6
3S4	5/-	6SC7	4/9	30P4	9/6	EC91	4/6	KT88	17/6	U404	6/-
3V4	6/6	6SG7	4/9	30P12	7/6	EC92	8/6	KTW61	5/9	U801	19/-
5R4GY	9/6	6SH7	3/-	30P19	13/6	ECC31	7/6	KTW62	6/6	UABC80	7/-
5T4	8/-	6SJ7	5/-	30PL1	9/3	ECC32	4/-	KTW63	5/9	UAF42	7/9
5U4G	4/9	6SK7	5/-	30PL13	9/6	ECC33	4/6	KTZ63	7/-	UB41	7/-
5V4G	7/6	6SL7GT	5/9	35C5	8/6	ECC34	9/-	L63	3/-	UBC41	7/6
5Y3G	4/9	6SN7GT	4/6	35L6GT	8/-	ECC35	5/9	LN152	6/6	UBC81	7/9
5Y3GT	5/6	6SQ7	5/9	35W4	6/-	ECC40	9/6	MU14	7/-	UBF80	7/9
5Y4G	9/6	6SS7	8/6	35Z4GT	5/6	ECC81	4/9	N37	10/6	UBF89	7/6
5Z4	9/-	6U4GT	9/6	35Z5GT	7/-	ECC82	4/9	N78	13/-	UBL21	12/-
5Z4G	7/-	6V6G	4/6	41	6/6	ECC83	6/-	N108	13/-	UC92	8/6
5Z4GT	9/6	6V6GT	6/-	42	6/6	ECC84	7/6	N152	8/3	UCC84	12/-
6/30L2	9/-	6X4	4/6	50B5	7/9	ECC85	7/6	P41	3/6	UCC85	7/3
6A6	3/9	6X5G	5/-	50C5	8/6	ECC88	11/6	P61	2/9	UCF80	13/3
6A7	9/-	6X5GT	5/6	50L6GT	7/6	ECF80	8/3	PABC80	8/-	UCH21	9/3
6A8G	7/9	6Y6G	7/6	53KU	9/6	ECF82	8/3	PC86	11/6	UCH42	7/3
6A8GT	12/6	7B6	9/-	61BT	17/6	ECH21	11/6	PC97	9/6	UCH81	7/9
6AC7	3/-	7B7	7/9	61SPT	11/-	ECH35	7/6	PCC84	6/6	UCL82	8/3
6AG5	2/9	7C5	7/3	62BT	13/6	ECH42	8/6	PCC85	7/9	UCL83	12/-
6AG7	6/9	7C6	7/6	75	5/6	ECH81	7/-	PCC88	11/9	UF41	7/6
6AK5	5/-	7H7	7/3	78	5/-	ECH83	8/6	PCC89	8/6	UF42	5/6
6AL5	3/3	7S7	8/9	80	5/6	ECL80	6/6	PCC189	13/6	UF80	7/-
6AM6	3/-	7Y4	5/-	83	9/6	ECL82	8/-	PCF80	6/9	UF85	7/6
6AQ5	6/-	7Z4	5/-	185BT	19/6	ECL83	10/6	PCF82	7/-	UF86	14/6
6AT6	5/-	8D3	3/-	185BTA	19/6	ECL86	10/3	PCF84	12/-	UF89	7/-
6AU6	7/-	10C1	11/6	807(A)	5/-	EF22	7/-	PCF86	11/-	UL41	7/-
6AV6	5/9	10C2	14/6	807E	4/9	EF36	3/3	PCL82	7/3	UL44	14/-
6B7	8/6	10F1	4/9	813	49/-	EF37A	7/-	PCL83	9/-	UL46	9/9
6B8G	3/-	10F9	10/6	832	14/-	EF39	4/6	PCL84	7/3	UL84	7/-
6BA6	5/6	10F18	10/-	866A	12/6	EF40	11/-	PCL85	10/-	UM80	9/6
6BE6	5/6	10LD11	14/6	954	3/9	EF41	8/-	PCL86	10/6	UR1C	7/6
6BG6G	15/-	10P13	8/6	955	2/3	EF42	6/9	PEN25	3/9	UU6	12/-
6BH6	6/-	10P14	9/6	956	2/-	EF50-BR	1/6	PEN45	8/6	UU7	9/6
6BJ6	5/9	10P18	7/-	1625	5/6	EF50(A)	2/6	PEN46	4/6	UU8	13/6
6BR7	8/6	12A6	2/3	5763	7/6	EF54	3/3	PL33	9/6	UY1N	11/-
6BR8	9/6	12AH8	9/-	9001	3/6	EF80	4/6	PL36	9/6	UY21	9/6
6BW6	6/9	12AT	6/6	9002	4/9	EF85	6/-	PL38	17/6	UY41	6/-
6BW7	5/-	12AT7	5/6	9003	5/9	EF86	7/6	PL81	8/3	UY85	6/-
6C4	2/3	12AU6	9/-	ATP4	2/6	EF89	6/9	PL82	6/6	VP4B	9/-
6C5	5/6	12AU7	6/-	AZ31	7/6	EF91	3/-	PL83	6/6	VP23	2/9
6C6	3/6	12AV6	6/9	AZ41	7/-	EF92	3/-	PL84	7/6	VP41	5/6
6C9	11/-	12AX7	6/6	B36	6/9	EF183	9/9	PL820	8/3	VR105	5/6
6CD6G	17/6	12BA6	7/-	C1C	8/-	EF184	9/6	PM84	9/6	VR150	5/-
6CH6	6/6	12BE6	6/6	CCH35	13/6	EK32	7/6	PX4	12/6	W76	4/9
6D2	3/3	12BH7	8/9	CL33	9/-	EL3	3/9	PX25	9/-	W81	7/3
6D3	9/6	12C8	5/6	CY31	7/6	EL33	7/-	PY31	8/-	X61M	11/-
6D3	3/-	12E1	17/6	D77	3/3	EL34	11/6	PY32	10/-	X63	8/6
6F1	4/9	12H6	1/9	DA30	11/6	EL35	6/-	PY33	11/-	X65	11/-
6F6	7/6	12J5GT	3/3	DAC32	9/9	EL38	12/6	PY80	6/6	X66	7/9
6F6G	4/6	12J7GT	8/-	DAF91	4/6	EL41	8/-	PY81	6/3	X76M	11/-
6F13	4/9	12K7GT	4/6	DAF96	7/3	EL42	7/9	PY82	5/9	X78	21/-
6F14	9/6	12K8	9/9	DF33	8/9	EL81	8/9	PY83	6/9	X79	21/-
6F15	9/6	12K8GT	9/6	DF91	3/-	EL84	6/6	PY88	9/-	X81M	9/-
6F13	6/-	12Q7GT	4/6	DF96	7/3	EL85	9/9	PY800	9/-	Y63	6/-
6F32	4/9	12SA7	7/-	DF97	7/6	EL91	3/9	PZ30	9/6	Z63	4/9
6F33	4/-	12SG7	4/6	DH63	5/6	EL95	6/6	R19	9/6	Z66	8/6
6H6	1/6	12SH7	3/6	DH76	4/6	EM34	8/9	RL18	11/-		
6J5	4/3	12SJ7	5/6	DK32	9/6	EM80	7/9	SP41	2/3		
6J5G	3/-	12SK7	4/6	DK91	5/6	EM81	8/6	SP61	2/-		
6J5GT	4/3	12SN7GT	6/9	DK92	7/-	EM84	8/9	SU25	16/-	100's	
6J6	3/6	12SQ7	8/6	DK96	7/3	EM85	9/6	SU2150	4/6	TYPES	
6J7	8/6	13D3	5/6	DL33	7/6	EN31	16/-	T41	6/9	NOT	
6J7G	4/9	14S7	14/6	DL35	7/6	EY51	7/6	TDD4	8/6	LISTED	
6J7GT	7/6	19AQ5	7/9	DL63	8/-	EY86	7/3	U14	7/6	S.A.E.	
6K6GT	6/-	19BG6	14/-	DL75	6/-	EY88	9/6	U18	7/6	ENQS.	

Post: 2 lbs. 2/-, 4 lbs. 2/6, 7 lbs. 3/6, 15 lbs. 4/-, etc. (C.O.D. 2/- extra). ALL ITEMS LESS 5%, AND POST FREE IN DOZENS. Send 6d. for list of 1,000 snips.

TECHNICAL TRADING CO.

RETAIL SHOP
350-352 FRATTON ROAD, PORTSMOUTH.
MAIL ORDER ONLY **DEVONION COURT, PARK CRESCENT PLACE, BRIGHTON, 7, SUSSEX**

Practical Television

AND TELEVISION TIMES

VOL. 13, No. 156, SEPTEMBER, 1963

Editorial and Advertisement Offices:

PRACTICAL TELEVISION

George Newnes Ltd., Tower House Southampton Street, W.C.2.

Phone: Temple Bar 4363.

Telegrams: Newnes. Rand, London.

SUBSCRIPTION RATE
including postage for one year
To any part of the World £1.9.0

Contents

The Editor will be pleased to consider articles of a practical nature suitable for publication in "Practical Television". Such articles should be written on one side of the paper only, and should contain the name and address of the sender. Whilst the Editor does not hold himself responsible for the manuscripts, every effort will be made to return them if a stamped and addressed envelope is enclosed. All correspondence intended for the Editor should be addressed to The Editor, "Practical Television", George Newnes Ltd., Tower House, Southampton Street, London, W.C.2.

Owing to the rapid progress in the design of radio and television apparatus and to our efforts to keep our readers in touch with the latest developments, we give no warranty that apparatus described in our columns is not the subject of letters patent.

Colour Consistency

THE past few weeks have been momentous in the history of colour television. Engineers of BBC, ITA, the equipment manufacturers, the ITV companies, the receiver manufacturers and the GPO have spent days at demonstrations and nights in debates in an endeavour to find a solution to the problem of international standardisation of television colour systems.

It has not merely been the consideration of the rival NTSC, SECAM and PAL systems that has given rise to this spate of oratory. Permutations and combinations have been added by variations in other parts of the originating television chain, such as colour TV cameras, videotaping, telecine, separate luminance camera tubes, etc., etc., ad infinitum. To complicate matters, all of the basic systems and their associated studio colour cameras and equipment have their own special advantages and disadvantages.

Some organisations have gone to the trouble to circulate questionnaires to a section of the public, asking their opinions on the most important requirement of colour television. Analysed, the answers boil down to one simple request: complete accuracy of colour reproduction of the original, whether it be facial flesh tones, colours of costumes, or scenery.

This is a public opinion in which questionnaires can give a misleading answer. The public don't know what they really want! Experience in colour photography, particularly in the film industry, has established the fact that **colour consistency** is a far more important factor.

The average person is no more able to detect absolutely accurate colour balance than he is able to detect perfect pitch in music. On the other hand, he notices with alarm the minute changes of musical pitch arising from the joining together of music recordings made at different times and at very slightly different speeds.

Let us hope that in their quest for colour accuracy the back-room boys will not let us in for a system in which every TV camera changeover leads to mental acrobatics by the viewers, and incessant knob twiddling on the receivers.

From the practical and working point of view, colour TV must from the outset be able to cope with cuts from live camera to camera caption, film or colour slide without revealing the discrepancies of nearly all the colour TV systems (or combinations thereof). While the only safe way of attaining colour continuity or consistency at present is to use colour motion pictures, we believe that the following should be the immediate objectives:

(1) Consistency of colour from shot to shot.

(2) Ability to use colour cameras in existing monochrome studios without extra lighting, ventilation, etc.

(3) Accuracy of colour reproduction.

These are the principles that guided the film industry through the troublesome waters of colour photography. The television industry would do well to follow suit.

Our next issue dated October, will be published on September 19th.

TELETOPICS

U.H.F. Network for BBC 2

THE first u.h.f. station to carry the BBC second television programme, BBC 2, on 625 lines will be at the Crystal Palace, London, and will be brought into service in early April, 1964. It will serve about ten million people in London and the Home Counties. During 1965 the corporation hopes to open further high-power stations in the Midlands, Central Scotland (Lanarkshire), South Wales, Lancashire, South Yorkshire, Northern Ireland, the Isle of Wight and North-East England.

The remaining nine high-power stations of those so far approved, which it is hoped to open in 1966 or soon afterwards, will be in the Bristol Channel area, Norfolk, Anglesey, Kincardineshire, South-East England, Nottinghamshire, Suffolk, North Yorkshire and Northamptonshire. These 18 stations should serve about 75% of the population of the United Kingdom.

In the u.h.f. bands (Bands IV and V) it is inevitable that, within the service areas of the main stations, there will be pockets in the shadow of hills where reception is unsatisfactory. A number of low-power relay stations will be needed to fill in these shadow areas and it is planned to put the construction of these stations in hand in the respective areas in the same order as for the main stations.

O.B. UNITS FOR EAST EUROPE

A COMPLETE four-camera television outside broadcast vehicle and a complete three-camera studio is to be supplied by Marconi's for Bucharest. This is the first order to be received by this company from Rumania since before the Second World War, when Marconi's supplied the majority of broadcasting equipment to that country.

A similar O.B. vehicle has been ordered from Radio Television Belgrade.

Separate Luminance Colour TV

AMONG the contributions from British electronic equipment manufacturers to the recent series of demonstrations held in order to evaluate the three main colour coding systems were pictures obtained from "separate luminance" cameras.

The advantage of the separate luminance system is that high-quality pictures require only one-third of the studio illumination needed by other colour TV systems—in fact the lighting requirements are similar to those for black and white pictures.

Separate luminance cameras developed by both EMI and Marconi's seen in operation use four separate camera tubes. One of these tubes produces a high-quality luminance signal while the other three produce the red, green and blue signals which are then combined to give the two-colour, or chrominance, signals used in transmission.

Another version introduced by Marconi's uses only three tubes. In this camera the red and blue components of the light input are directly converted into electrical signals in two of these tubes while the luminance signal is produced separately by the third tube. The green component can then be derived from these three signals.

Separate luminance cameras can be used with the NTSC, SECAM and PAL coding systems.

Teaching and TV

EXPERIMENTS in teaching methods using closed-circuit television are being made at Chicago University.

Installation of the equipment has been carried out by the American manufacturing associates of the Rank Organisation.

The television system is being used primarily to experiment in ways of applying TV in education and to provide a method of remote observation and study of classroom procedure, student reaction and student-teacher behaviour patterns in classroom situations.

The closed-circuit network covers 55 classrooms spread throughout four separate buildings and has been wired for remote sending and/or receiving of televised programmes.

COMBATING CONTINENTAL INTERFERENCE

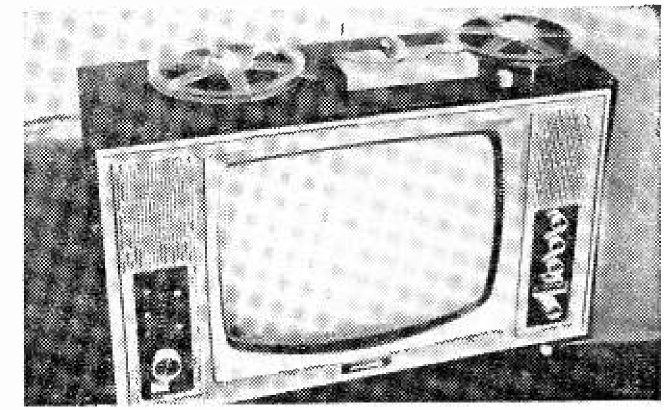
THE BBC's Skegness television relay station was brought into service early in August. This new station will provide improved reception for people in the town of Skegness and reduce the effect of interference from Continental stations which has frequently marred reception in East Lincolnshire during the summer.

The power of the BBC's relay stations at Folkestone and Hastings was increased on 1st August. This increase in effective radiated power will result in better coverage of these two service areas where some viewers have experienced difficulty in receiving BBC programmes.

First Domestic Vision Recording Equipment

THE first vision recording equipment for domestic use, known as "Telcan", will shortly be available either as an insert unit for incorporation in new TV receivers or as a separate unit. The recorder employs a double-track system and an 11in. spool of ordinary $\frac{1}{4}$in. tape provides 15 minutes of programme per track. For video recording, the tape runs at 120in./sec; the equipment may also function at $3\frac{1}{2}$in./sec for normal audio recordings.

The recording can be played back on the receiver whenever required.

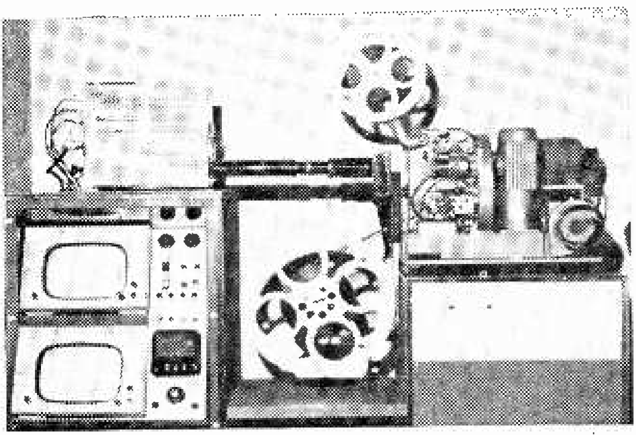


The illustration on the right shows the "Telcan" sound and vision recorder built into a standard receiver.

NEW COMPACT TELE-CINE UNIT

A NEW 16mm vidicon tele-cine unit designed and constructed by Automatic Information and Data Service Ltd. for Tyne-Tees Television is enclosed in a single console measuring no more than 57in. by 20in. wide and 56in. high, including a working desk and spool rack.

The equipment is built to 405-line standard broadcast specifications adapted from standard Vidiaids equipment and incorporates projector, camera, control panel with two $8\frac{1}{2}$in. monitor screens, transistorised video processing unit and a waveform monitor.



Left: The new tele-cine unit built for Tyne-Tees Television.

SIX MORE ITA STATIONS

THE Independent Television Authority's plans for building six further v.h.f. 405-line stations have been approved in principle by the Postmaster-General.

These six stations, all of which should be on the air by the end of 1964 or early in 1965, will bring Independent Television programmes to about one million new viewers and will improve reception for some 600,000 others. They will join the authority's network of 22 transmitters, which now brings Independent Television to 97% of the population, and will increase this figure to over 98%.

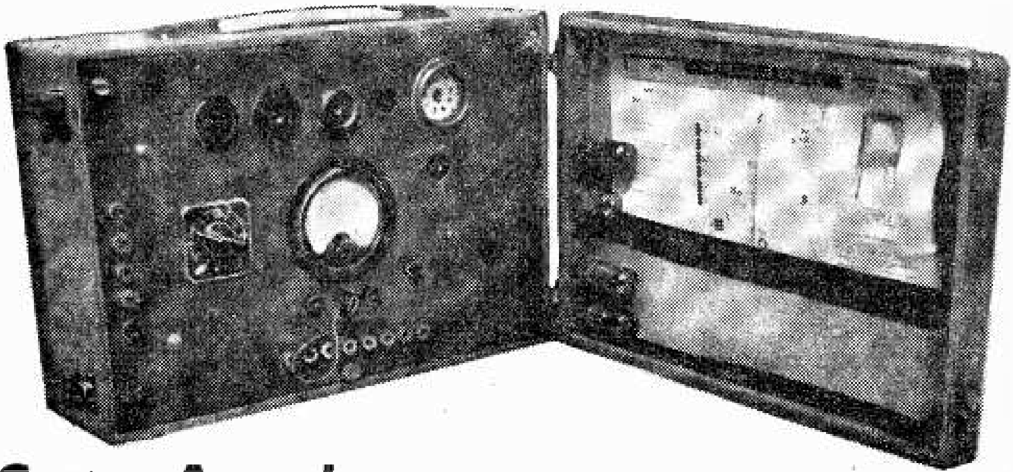
"See-as-you-bore" with C.C.T.V.

A NEW technique for borehole inspection using a closed-circuit television camera, which offers several advantages over conventional methods, was recently demonstrated on the Leeds-Sheffield motorway.

When surveying sites for bridges, cuttings and tunnels it is essential to ascertain the geological structure of the ground and the positions of any cavities such as old mine workings or shallow-holes caused by water seepage. Conventional methods necessitate boring a small hole and dragging out cores of different strata for inspection, but it is obviously impossible to extract specimens of cavities.

When using the television technique a 7in. diameter hole is bored and a cylindrical camera in a special housing is inserted to inspect strata and cavities. A constantly changing picture of the composition of the walls as the camera is lowered is shown on a television receiver above ground.

The closed-circuit television equipment used on this demonstration was supplied by EMI Electronics Ltd.



Set Analyser

FOR STATIC AND DYNAMIC TESTS

by G. E. Cappello

SOME set analysers, when applied to modern equipment, introduce instability. The unit described here has proved to be fairly successful, this being made possible by the use of a simple modern innovation, the anti-parasitic bead. I.F. strips, video amplifiers, sync stages and timebase oscillators have been successfully tested without any instability being introduced. Perhaps, in odd cases, the analyser may cause some oscillators to cease functioning, but in many instances when searching for signals, this action is desirable.

The ability of the tester to bring almost to your finger tips inaccessible test points, suggests compensation enough for its construction and also for any expense incurred in purchasing some materials.

CONSTRUCTION

The analyser is housed in a case taken from an old battery portable radio, and a hardboard panel is fitted in the rebated edges in place of the original panel. Fig. 1 shows the panel layout. After all drilling was completed, the underside of the panel and all edges were treated with a coating of shellac.

With all the components in position, the wiring was carried out as shown in Fig. 2. Note that the flying lead must be long enough to reach all sockets. Should only an external meter be desired, this will of course permit one to dispense with a panel meter and its associated switch.

The h.t. metal rectifier and heater resistance are included to enable valve rectifiers in a.c./d.c. receivers to be checked, and will actually operate the set in the absence of a new valve. The metal rectifier should be capable of delivering 100mA or more, and the heater resistance should have a value of somewhere between 21 and 50Ω to equal the resistance of the valve.

In the author's model, one expediency is the employment of two dust core washers that happened to be handy, in place of the ferrite beads. These washers measured 1in. diameter by $\frac{3}{16}$in. thick. With a sharp drill and using light pressure, nine holes were drilled round the diameter of each washer of sufficient size to allow threading the thin plastic wires for connection to each of the nine wander-plug sockets.

CONNECTING CABLES

The 20in. long, seven and nine-way connecting cables may demand attention, although lengths of these cables already bunched and with plugs attached may be obtained from some surplus equipment dealers. A dust core disc was used at the plug-end of the cable, but instead of drilling this, nine slots were filed across the edge around the circumference of the disc by means of a thin rat-tail file. The dust core was inserted in among the wires, so that one wire fitted in each slot, and finished by a wrapping of plastic tape to secure it.

In order to facilitate plug selection, a numbered spacer made from a piece of thin fibre card, 4in. x 2in., is threaded on each wire at the wander-plug end. Centrally along the length of each card nine equidistant holes are punched, starting $\frac{1}{8}$in. from the edge and finishing within the same limits. The wires are threaded through the holes, the card is then bent in two halves down and back from the plug ends, and a piece of plastic tape wrapped round the length holds it to form a shallow

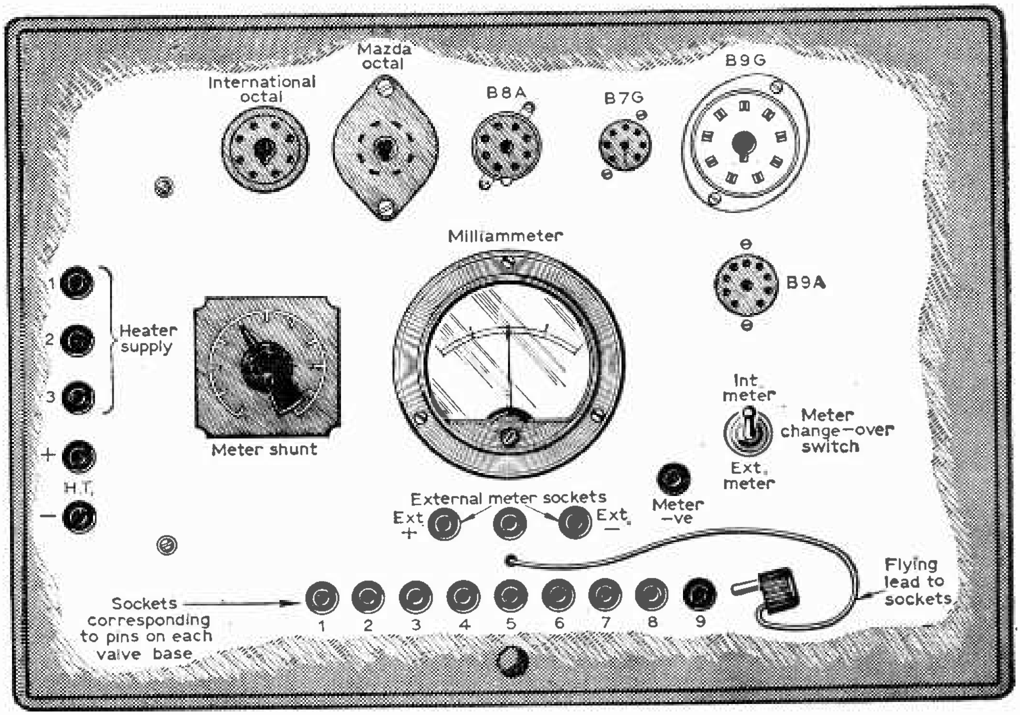
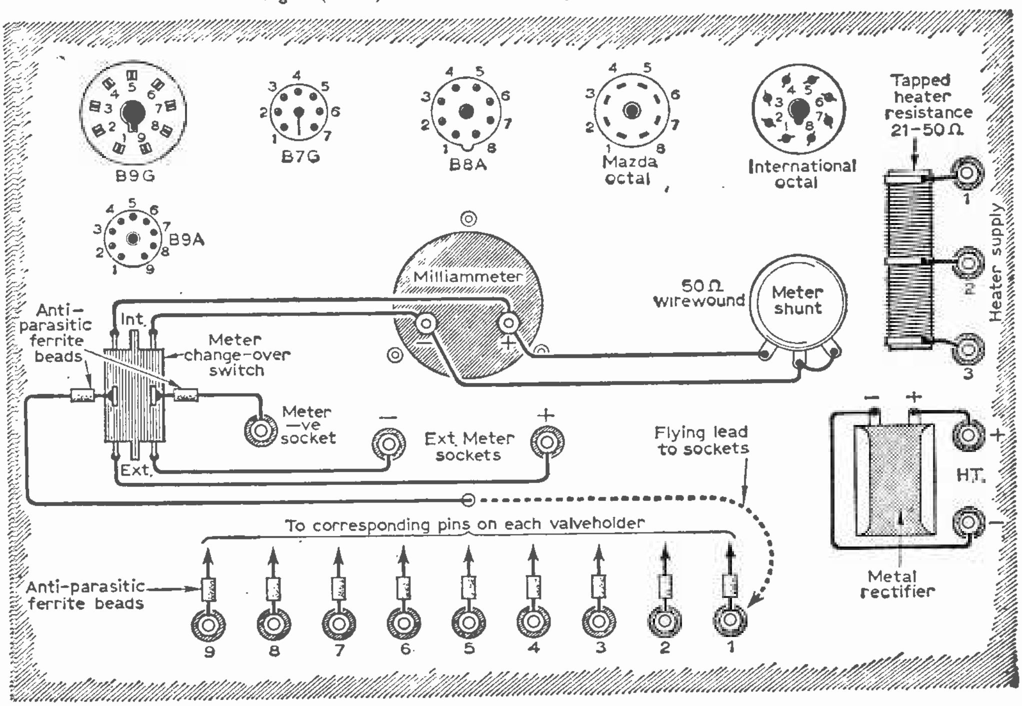


Fig. 1 (above)—Top of panel layout showing arrangement of components.

Fig. 2 (below)—Underside view of panel showing wiring.



envelope. This is now numbered along its length to correspond with pin and plug numbers.

SERVICE SHEETS

To add the finishing touches to the instrument a pocket for housing service sheets is incorporated in the lid. This can be made up as follows. Cut a sheet of strong cardboard to the same size as the inside of the lid area, and secure neatly by means of plastic tape stuck around the edges of the cardboard and to the inside rim of the lid.

Stick a length of 2in. wide plastic tape across the centre of the cardboard and cut a slot with a razor blade, starting ½in. or so from one end, and right along to within the same limits of distance from the other end. Open out a little the pocket thus formed.

Three or four of those blue plastic valve base pin protectors can be screwed down on the inside edge of inside the lid, by small screws through their centres, to provide storage facilities for valves.

CALIBRATION

The meter included in the prototype is a centre-zero type, 1mA f.s.d. is scaled five to ten each way. This meter is shunted by the 50Ω potentiometer.

A rough calibration can be made as follows. With the potentiometer set at zero, i.e. almost a short across the meter, and a nine-pin cable plugged into the panel, select an i.f. or radio h.f. pentode stage. Remove this valve and in its place plug in the nine-pin adaptor. Set the meter switch to external meter, and connect a multimeter to the external sockets.

At this stage we have to arrange the analyser panel connections. Let us assume that the valve is an EF80; the anode is pin 7, so remove No. 7 plug from its socket and replug it in the panel meter socket. Valve data tells us this particular valve gives about 10mA at the anode, but under working conditions there are the "load line" characteristics, consequently with the set-up just described, the calibrations thus obtained must be termed reference figures. Otherwise, calibrating the meter to various values will require a standard source of output of the valves.

Proceeding with the reference calibration, switch on the receiver and as it warms up note the reading on the external meter, now switch over to the panel meter and slowly rotate the potentiometer from zero position until the same reading is obtained, then mark this on the dial.

Continue the operation with screen and cathode tests by interchanging the electrode plug connections, and switching from external meter to the panel meter, marking the dial each time. The advantage of using a centre zero meter is that a reversing switch is not necessary when measuring cathode current.

RECTIFIER TESTS

Considering the h.t. rectifier, its application with the inter-change of plug connections is similar to the analyser tests. Rectifiers of the B7G and B9G class will make use of the analyser cables, and for other types adaptor plugs can be made up.

The test procedure is as follows. Assuming a PY82 is suspect for low output, remove the valve from its holder and in its place plug in the nine-pin connector. From the base pin numbers we see that pin 7 is the anode, therefore select No. 9 wander-plug and connect it to the h.t. negative socket.

In the same way the heater connections (pins 4 and 5) are plugged across the required resistances and we have a substitute rectifier from which any difference of performance may be gained.

STATIC EMISSION TESTS

With the aid of the analyser panel, a "stunt" valve test can be performed without the use of any high tension and bias voltage whatsoever. For identification call it the static emission test, also electrode leakage test under simple space charge conditions.

The valve is plugged into its holder on the panel, its heater is connected to a filament transformer of the required voltage, the panel meter is set to read 1mA f.s.d. To complete the operation, the wander lead is plugged into the control grid socket and a jumper lead connected between the meter socket and the valve cathode.

After repeated experiments, a current value indicating an efficient valve was found to be between 450—550μA.

Keeping the valve still in this position, connect the positive lead of a high reading ohmmeter (20—50MΩ range), to the valve cathode. Apply the negative lead to any other electrode. On touching the screen grid the ohmmeter pointer will jump right over as though indicating a short, this is because the screen grid acts as an anode. But at the anode and other electrodes no reading, or only a very small reading, should be observed.

There seems to be some relation between this static test and actual dynamic tests, since if a given valve delivers only say 100μA or so, this surely points to the fact that the valve has reached the end of its useful life. Similarly, should an output of 700—1,000μA or even more be obtained, it will be obvious that the valve should be discarded.

Proof that odd faults can be detected by this simple means is given in the following example: on one valve this test revealed the screen to have developed a high resistance, by giving a reading of 5MΩ instead of the meter reading as for a short. If, however, this same reading is obtained at the anode it indicates a leak sufficient to impair the action of the valve under actual working conditions.

With a little practice this "snapshot" testing will be time-saving and revealing.

In this same way two very useful tests can be made on double diodes and twin triodes. Often we wish to know how equal the two halves are in output, and this is particularly important with twin triodes used in valve voltmeters and TV circuits. The same applies to diodes. It is surprising the discrepancies readily shown up by this static test. In the case of a triode the ohmmeter reads the same short on the anode as does the screen in the case of a pentode. ■

TOWARDS 625

A Guide to TV Conversion

PART THREE OF A SERIES DESCRIBING THE CONVERSION OF VINTAGE 405-LINE SETS TO RECEIVE 625-LINE PROGRAMMES

CONTINUED FROM PAGE 511 OF THE AUGUST ISSUE

by D. ELLIOTT

TO start this month's article we will consider the intercarrier sound channel. In Fig. 7 (last month) a 6Mc/s signal is produced at the vision detector by the sound and vision carriers intermodulating as the result of the circuit non-linearity. The 6Mc/s signal is the difference between the sound and vision frequencies, and this signal takes on the frequency-modulation of the original sound signal. Thus, the exercise is to feed the 6Mc/s signal away, through an amplifier, to an f.m. detector.

In Fig. 7 we have transformer T4 across whose primary is developed the 6Mc/s intercarrier sound signal. The secondary is arranged as a "link" winding to feed a similar winding on the inter-channel sound amplifier input.

405-LINE SOUND CHANNEL

Fig. 9 shows the sound channel of our typical experimental receiver. Here V9 is the sound i.f. amplifier receiving the sound signals from the tuner output or from the anode circuit of the common i.f. valve; V10 the second i.f. amplifier valve and detector diode; and V11 the a.f. amplifier (triode section) and output stage (pentode).

This is a fairly conventional circuit, variations of which will be found in almost all sets of the vintage specified. Instead of the detector diode being contained in the second i.f. amplifier valve, it may be one of the diodes of a double-diode valve such as an EB91, and instead of the sound interference limiter being in the a.f. channel (note that MR1 of Fig. 9 is the interference diode) it may well work in

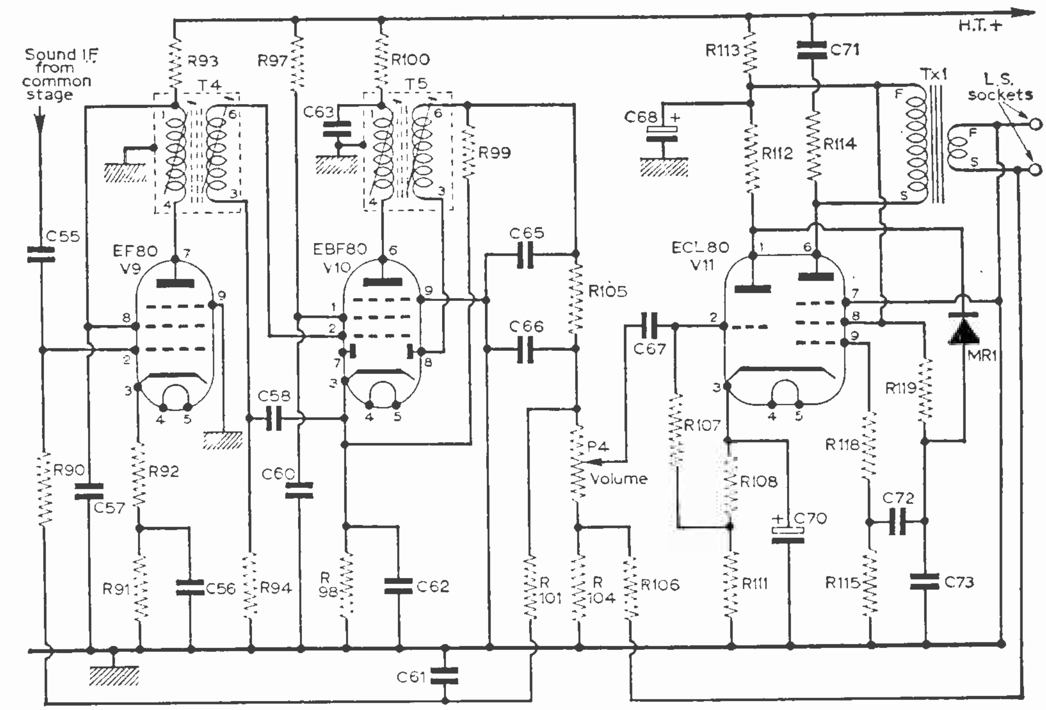


Fig. 9—The sound channel of the 405-line receiver used for the 625-line conversion.

conjunction with the second diode of either a valve such as V10 or a double-diode. The second diode in V10 (on pin 7) was employed as a clamp, but this is uncommon.

At this juncture it can be said that the audio channel in the 405-line set can be used quite successfully in the 625-line conversion. This means that V11 stages can remain as shown in Fig. 9 from the slider of the volume control onwards—see Fig. 10.

Normally, the f.m. detector of the 625-line conversion will provide adequate sound interference suppression without additional circuits, bearing in mind that the impulsive interference at u.h.f. is considerably below that at v.h.f. Thus, the original sound interference limiter circuit can usually be abandoned. Such would happen in circuits where the original limiter is the second diode or semiconductor diode, but in the circuit of Fig. 9 the original sound limiter was allowed to remain as it has no connection with the circuits under modification. It will be seen from Fig. 9 that the limiter diode is MR1 in the audio channel.

625-LINE SOUND CHANNEL

Fig. 10 reveals how the original sound channel of Fig. 9 is revised. Stage for stage, the gain at the 6Mc/s intercarrier frequency is greater than that at the conventional sound i.f.'s. While two sound i.f. stages are often required in a 405-line set, therefore, a similar gain at 6Mc/s is possible using just one stage.

The only intercarrier amplifier in Fig. 10 is V9. This is really a modified sound i.f. amplifier, the output of which feeds a balanced ratio detector. The intercarrier sound signal derived from the vision detector circuit at T4 is fed to V9 via T5, while T6 is the discriminator transformer which operates the ratio detector.

BALANCED RATIO DETECTOR

The ratio detector proper features a double-diode valve V10, transformer T6 and the associated components. V10 of Fig. 9 is thus removed and its place is taken by the double-diode V10 of Fig. 10. By adopting this method the series-connected heater chain is not unduly disturbed, for the EB91 takes 0·3A heater current, as does the original EBF80. If there is any trouble in fitting in an extra valve (though this may help with the balance if a valve in some other part of the circuit has been removed—such as V6 considered last month in Part 2) then semiconductor diodes may be used instead of a valve for the ratio detector. GEX34's are suitable for this application and are readily available at no great cost.

The ratio detector in Fig. 10 is rather special and was chosen mainly to ease the construction of T6. It is also simple to get going correctly. The output of the ratio detector is fed to the top of the volume control via the 0·1μF capacitor, and the slider of the volume control feeds audio to the grid of the triode audio amplifier in exactly the same way as in Fig. 9. This method saves quite a bit of messing about in the sound channel, for in all sets of the type specified the sensitivity at the grid of the triode is just about right to accept the signal given by the ratio detector and provide full output without distortion. A little de-emphasis may be required, but on the experimental prototype there was sufficient treble cut in the audio section without adding more. However, if the treble is too overpowering, a 500pF capacitor connected between the junction of the 47kΩ resistor and the 0·1μF capacitor at the top of the volume control (Fig. 10) solves the problem.

CONVERSION NOTES

The wiring around V9 stage can remain essentially to the original pattern. Care should be taken to avoid extra long connecting wires on the decoupling components, and the components chosen for such application in Fig. 10 give a reasonable degree of neutralisation, bearing in mind the high slope of the EF80 and the lowish frequency. Neutralisation is also necessary to prevent V9 from acting as a reactance valve—a function which would detract from the limiting action.

The 2·7kΩ preset resistor in the diode anode circuit allows the balance of the ratio detector to be adjusted in terms of maximum a.m. rejection. The sync pules of the televison signals, for example, tend to produce buzz in a misaligned or poorly balanced 625-line sound channel, but this can be

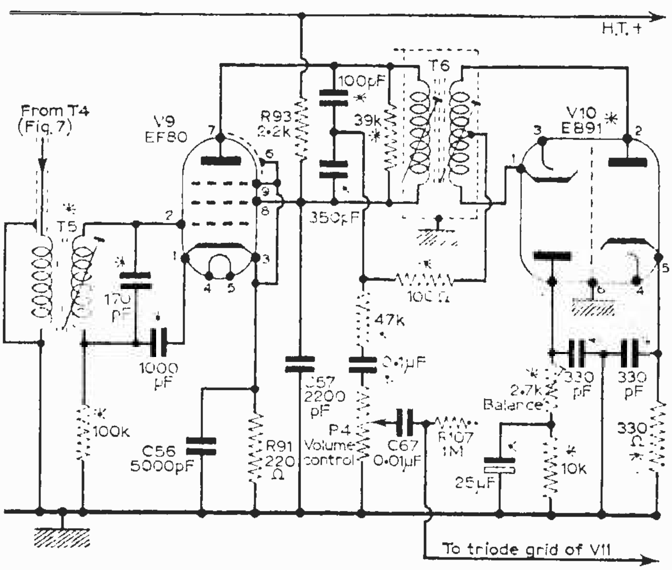


Fig. 10—Showing how Fig. 9 is altered to provide intercarrier amplification and f.m. detector. V9 is the intercarrier amplifier, V10 the ratio detector and the audio channel remains as V11 of Fig. 9. Where a component has its equivalent in Fig. 9 it is given the same reference number; components with an asterisk have no equivalent in Fig. 9.

considerably minimised by carefully adjusting the preset resistor to the null point.

TRANSFORMERS

The sound input transformer T5 is wound on an Aladdin former Type PPF16411/6 and uses core Type PP5985/16002 for tuning. The secondary winding (that connected to the control grid circuit of V9) comprises 20 turns close wound 24s.w.g. enamelled-covered wire. The primary "link" winding is just a single turn of the same kind of wire wound on a thin card former directly over the centre of the secondary winding. Note that the "link" winding on L4 (Fig. 7 last month) connected to the "link" winding on T5 via screened cable. A thin coaxial cable is suitable.

The discriminator transformer T6 is wound on an Aladdin former Type PP5938/6 and is tuned by dust core Type 500/900. The primary winding (anode) is first wound with 45 turns of 42s.w.g. enamelled-covered wire, turns close wound and starting at ¼in. up from the base of the former. The tapped secondary winding is wound on top of the primary on a thin card former to allow sliding adjustment. This comprises 70 turns of the same type of wire close wound, tapped at 35 turns.

To facilitate coil construction, top plate Type PP5939 can be used to support the coil lead-out and connecting wires. This transformer must be screened by can Type D/TV2.

LINE TIMEBASE

The line oscillator has to be changed from the original repetition frequency of 10,125c/s to the 625-line frequency of 15,625c/s and the line output stage has to be re-designed to respond efficiently at this new frequency. At this stage it must be said that unless a lot of money is spent on rebuilding the line timebase optimum efficiency is rarely possible. We must recall that the conversion exercise is purely experimental; but, nevertheless, in most cases quite good results are possible in the line and e.h.t. departments by reorganisation in the oscillator and transformer replacement in the output.

It is not possible here to detail a specific mode of alteration as this will depend upon the type of line oscillator and line output stage used in the experimental 405-line receiver. Indeed, on some models good 625-line results are possible by doing little more than changing the time-constant in the oscillator circuit so as to shift the repetition frequency from the 405-line 10,125c/s to the 625-line 15,625c/s.

LINE OSCILLATOR CHANGE

In view of the widely differing line oscillator circuits to be found in sets of the vintage specified for conversion, an existing 405-line oscillator circuit is not given. However, in Fig. 11 is given a cathode-coupled multivibrator line oscillator of basic 405-line design converted for 625-line operation. The circuit is conventional, variants of which will be found in sets purchased for conversion.

The circuit remains as per its original design except for two main components. These are the feedback time-constant and the charging capacitor, indicated R1 and C1 in Fig. 11. R1 may or may not be preset, but if it is a fixed resistor its value will often be higher than that shown for R1 in the diagram. The best thing is to take out the fixed resistor and put a preset (100kΩ) in its place. This may then be adjusted for optimum 625 line hold

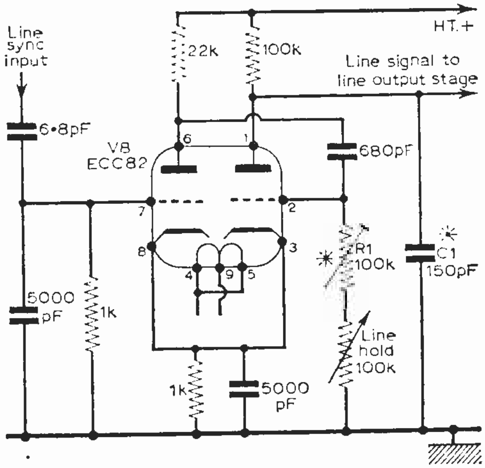


Fig. 11—Cathode-coupled multivibrator line oscillator circuit modified from 405-line working (10,125 c/s) to 625-line working (15,625 c/s) by changing the time-constant resistor R1 and the charging capacitor C1. These components (marked with an asterisk) are the only ones in the multivibrator which need to be changed. For 405-line working, C1 is usually about 300pF while R1 may be a fixed resistor. To avoid having to try different fixed resistors to achieve line hold control balance, a skeleton preset can be employed in R1 position, supported in the wiring close to the main line hold control.

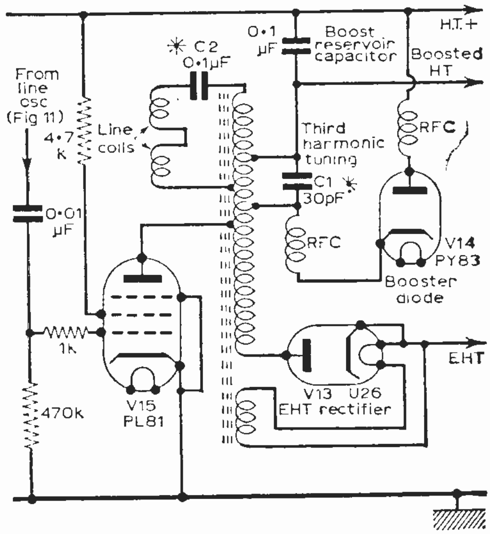


Fig. 12—The components marked with an asterisk need to be reduced in value by approximately 50% when changing from 405 to 625 lines. C1 is the third harmonic tuning and C2 the line scan correction capacitor. C1 in particular should have a high peak voltage rating.

with the main line hold control at range centre. The adoption of this artifice often saves a lot of trouble in changing the value of a fixed resistor in order to secure optimum line hold balance. Open skeleton presets are highly suitable for this purpose and are readily available at about 2s. each.

For 405-line working, C1 is about 300pF and it remains only to halve this value for 625-line working. The waveform and mark-to-space ratio of the multivibrator are unaffected by these changes. However, the same may not be true with modified blocking oscillators, and for that reason it is recommended that a line blocking oscillator is removed and its place taken by the circuit of Fig. 11. This circuit has been proven. Any other kind of line oscillator circuit employing the basic multivibrator technique should be replaced with a circuit like that in Fig. 11. Sometimes a triode-pentode valve is used instead of a double-triode, but this does not matter, as the pentode is usually wired as a triode anyway. If there is a great deal of difference between the circuit and that in Fig. 11, the latter should be adopted completely.

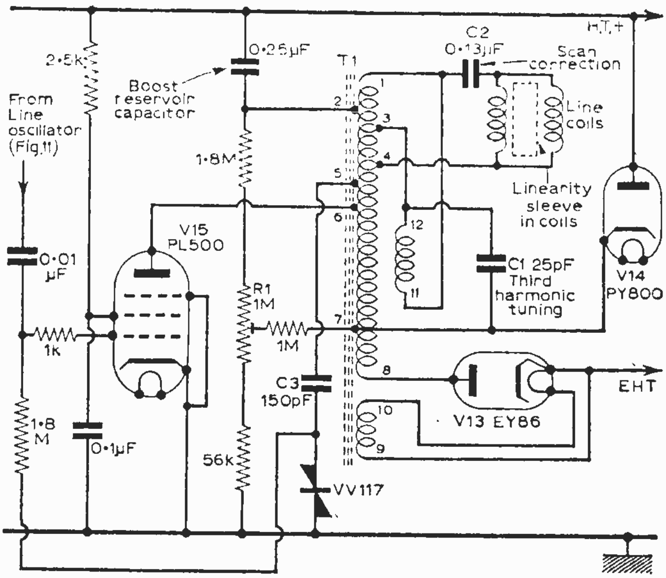


Fig. 13—The circuit of a recent line output stage for 625-line operation. This uses modern valves and automatic stabilisation as explained in the text. This kind of circuit should only be used in conjunction with a wide-angle tube.

Sets which use the line output valve and the line output transformer in part of the line oscillator circuit should, again, have the circuit re-arranged to that of Fig. 11. Note that the ECC82 recommended has a centre-tapped heater. With the two heater sections in series the rating is 0·3A 12·6V, thereby fitting in with the heater chain plan originally adopted. For this mode of heater connection, the centre-tap pin (pin 9) should not be connected.

LINE OUTPUT STAGE

Before spending too much money in the line output state its performance should be checked when it is in receipt of a 15,625c/s line drive signal. In some sets the line scan will be somewhat or slightly below the full scan of 405 lines, while in other sets there may barely be any change at all. Usually, however, the e.h.t. voltage is less at the higher frequency than at 10,125c/s. This is because the line output stage is designed for optimum efficiency at 10,125c/s. If both the e.h.t. voltage and scanning power decrease the net effect on the screen will be a full scan but a dimmer than normal picture or raster. The scan will be maintained because of the reduced e.h.t. voltage (remembering that the scanning power requirements are less as the e.h.t. voltage is decreased). Another effect which may show is poor e.h.t. regulation. This results in the picture "blowing up" as the brightness control is turned up, eventually disappearing altogether.

If these symptoms are present in only small degrees, then it may not be considered worth while to do much conversion work in the line output stage. On the other hand, if the e.h.t. and line scanning efficiency is well below standard something will need to be done to improve matters. Recent models (and some within the group under consideration) employ third harmonic tuning on the line output transformer. This tuning, of course, is related to 10,125c/s, meaning that if the frequency is considerably altered the tuning will be well off. On 625 lines the frequency increase is about 50% so the least that can be done is to restore the third harmonic tuning.

THIRD HARMONIC TUNING

In Fig. 12 is shown a circuit of the type of line output stage that may be encountered. There may be differences in detail between this and that in the experimental receiver, but if the "auto-transformer" type of line output transformer is employed, then there will be very little difference. If there is a great deal of difference, then see later.

In Fig. 12, C1 is the third harmonic tuning capacitor. For 405-line working the value will probably be about 60pF or thereabouts, and by halving this value (to 30pF in the case of the above) the third harmonic tuning is restored. Note that this capacitor has a high peak voltage rating, and it is desirable to use a component with a rating of at least 5kV. These capacitors can be obtained easily at about 1s. 6d. each.

Another capacitor in the line output stage with a similar peak voltage rating is C2 in Fig. 12. This is for scan correction. Again, this should be approximately halved for 625-line working.

625-LINE OUTPUT STAGE

If the experimental receiver uses an old type of line output stage and adjustment to the value of the

—continued on page 561

SERVICING TELEVISION RECEIVERS

By L. Lawry-Johns

No. 93: FERGUSON 406T, H.M.V. 1870, MARCONIPHONE VT157

APART from the aspects discussed last month, other points worth checking in the video stage are R50 (5·6kΩ) and R51 (47kΩ). The latter sometimes changes value damaging R50. This fault also causes heavy current flow through R52 and R53, and all four resistors should be checked for correct value.

No Picture

If the sound is in order but there is no picture and no raster on the screen when the brilliance is advanced, listen for the line timebase whistle and remove the plate covering the centre section. If there is no whistle, first notice if the valves PL36 and PY81 are lighting up. Quite often the PL36 will be found unheated although all the other valves are glowing normally (except the EY86 of course). This is because the glass envelope of the valve cracks thus destroying the vacuum although the heater element itself is still intact (if it wasn't none of the heaters would work as the series chain would be broken).

A new PL36 should restore normal working in this case. If the line whistle is quite audible (and therefore the PL36 is working) note whether the EY86 (V9) is lighting and whether there is evidence of healthy e.h.t. to its top cap.

If there is no heater glow in the EY86 but there is a high potential to the top cap it is reasonable to assume that the valve is defective and a replacement should be fitted.

These points of course follow closely what has been written so many times in previous articles and it is not proposed to repeat more of what must be regarded as routine in tracing line timebase defects. Suffice it to say that the timebase consists essentially of the triode section of a PCF80 (V6) working as part line oscillator to the PL36 output with feedback from the line output transformer and R73 via C66 and C67.

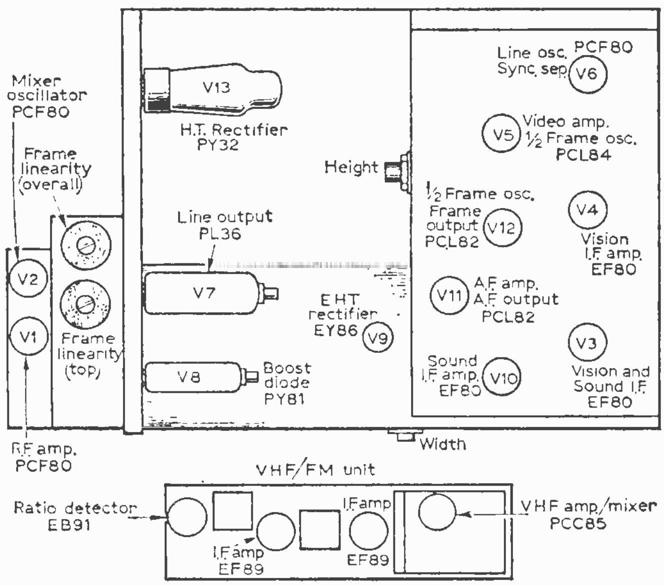


Fig. 5—Layout of receiver showing positions of valves.

Faulty PY81

We are often asked the reason for the following effect which can be quite alarming.

The receiver is switched on and appears to warm up in the normal manner and the sound starts to come through but as the line timebase whistle starts, it stops abruptly and so does the sound, a bright light is reflected from the back of the receiver which turns out to be the PY32 heater glowing brilliantly, together with that of the PL36 which is not quite so immediately obvious.

Now in these few brief moments quite a lot can happen if the set is not immediately switched off. The PY32 can develop a heater-cathode short which leads the repairer to believe that this is the primary fault until a new PY32 (PY33) is fitted when the same effect occurs, the difference being that when the PY32 is at fault the valve lights up at once on switching on, whereas when the PY81 *only* is at fault up to two minutes can elapse before the fault occurs. The PL36 can also fail in the meantime so it behoves the repairer to proceed with caution except when switching off, which should be done right sharply. Failure of V6 will cause V7 to overheat severely.

Striations

Attention is drawn to R133 1·5kΩ which is wired across the width coil. If this resistor becomes open-circuited the picture will be marred by vertical bars, bright from the left, fading to the centre.

Frame Timebase

The frame output valve is the pentode section of V12 PCL82. The circuit is quite conventional and does not give a lot of trouble.

Attention is drawn to R120 (470Ω) and C105 (100μF) both of which can become defective. R120 changes value and C105 becomes open-circuited, both defects causing the bottom of the picture to cramp more than the top giving egg-shaped distorted, short legs and long heads. If R120 falls in value to any extent, the valve can be overrun and can fail rapidly, probably drawing grid current resulting in fold-over at the bottom. A new valve may appear to overcome the fault but this will have a short life if R120 is not replaced. Cathode bias voltage should be 14·5V.

The oscillator consists of the triode section of V12 and the triode section of V5 (PCL84, video amplifier pentode), cathode coupled by R111 and C99.

Lack of Height

Even loss at top and bottom should direct attention to R115 (470kΩ).

If the hold control is at one end of its travel check R112 (220kΩ), whilst if weak lock is experienced check W11 (OA81 or OA91) frame pulse shaper and associated components and R101 (1MΩ) to pin 3 of V6.

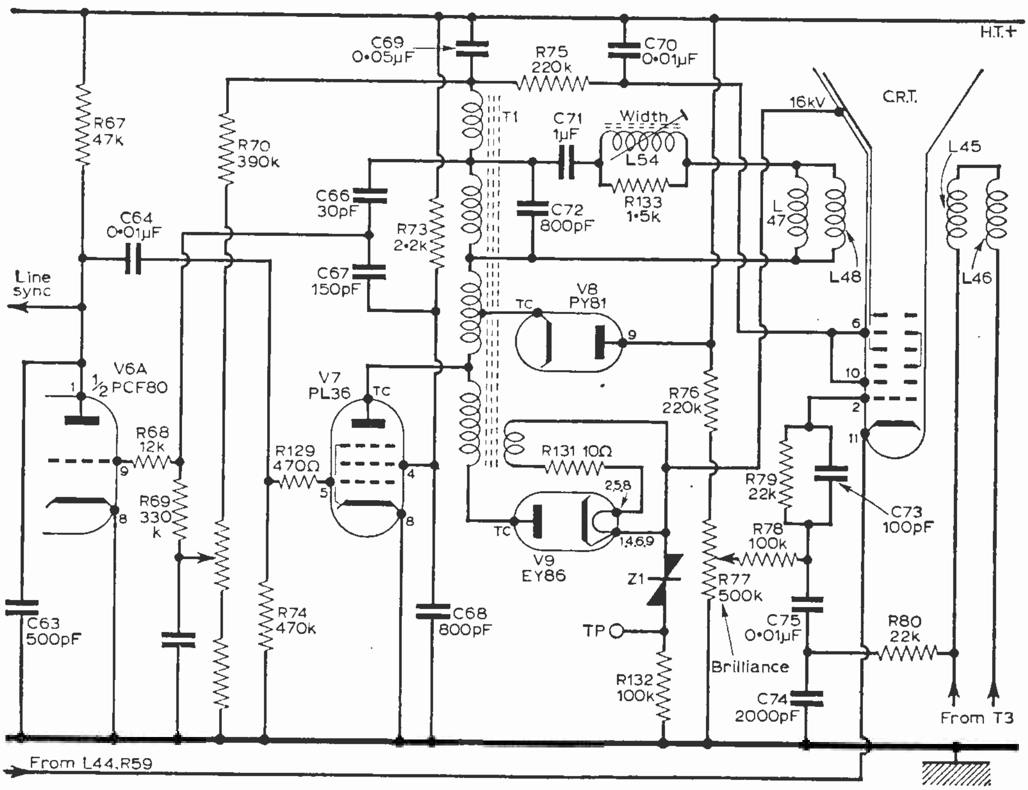


Fig. 6—Line timebase circuit and c.r.t. supply system.

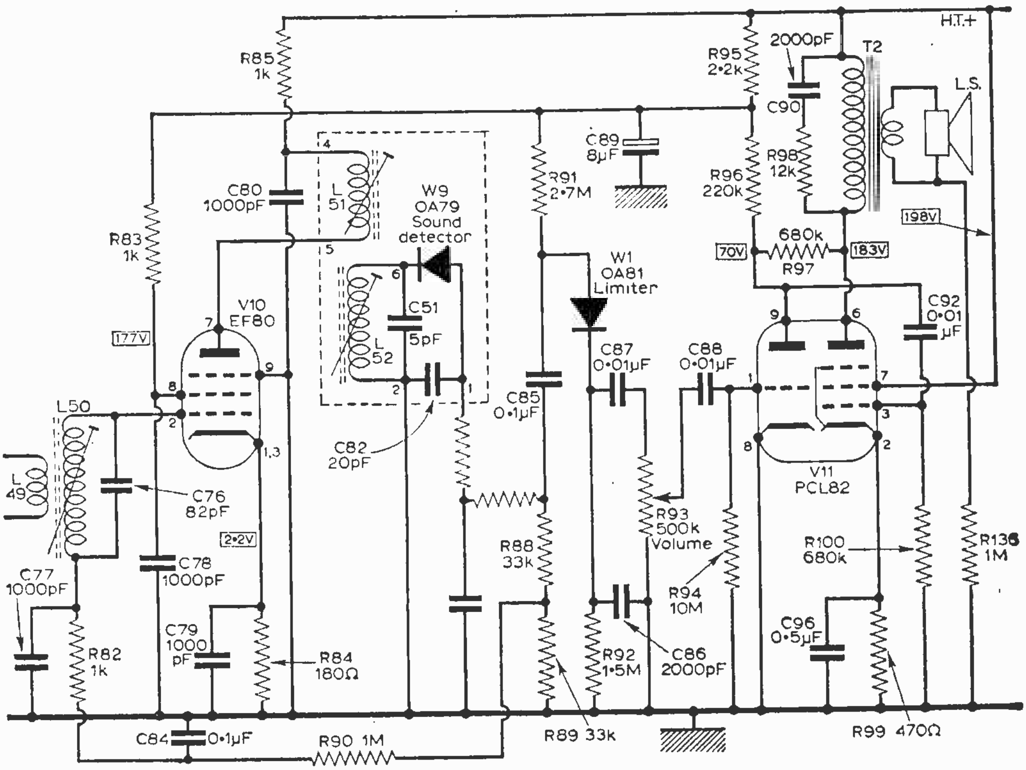


Fig. 7—Sound i.f., detector and a.f. stages.

Sound

The sound output valve is V11 pentode section. Distortion which is unaffected by signal strength may be caused by V11 drawing grid current. As in the case of V12 this is often caused by R99 (470Ω) changing value (check cathode voltage, 14·5V). It is repeated that a PCL82 will rapidly fail if the bias resistor is of the wrong value.

Very weak and distorted sound can be caused by R96 (220kΩ) going high, to pin 9 of V11. It is worth while checking C92 (·01µF) for leakage.

Distortion on Strong Signals

When distortion is experienced and this is directly affected by the setting of the contrast control check R91 2·7MΩ (Red Mauve Green) h.t. resistor to W10 (OA81 or OA91) sound noise limiter.

Distortion experienced on f.m. radio only (models so fitted) should direct attention firstly to the aerial as multipath signals (reflections or ghosts) can cause severe distortion.

Tuner Unit

This is of the Fireball type which has been extensively covered in past issues.

For the benefit of readers who are unable to refer to these issues we would mention one or two of the more useful hints on servicing of these units.

The cover of the tuner unit is removed by unspringing the bottom and lifting backwards and upward to clear the top tags. The coil disc is then revealed secured by a centre nut and washer. The most common fault is for the silver plated studs of this coil disc to become tarnished giving rise to poor contact with the bow leaf bank. Remove the nut and washer, pull off the disc and the studs can then be cleaned and polished. A little light oil applied to the studs will delay further oxidisation.

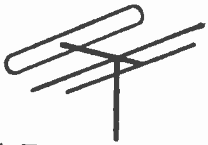
Avoid damaging the rather fragile coils on the rear of the disc. The bank of leaf contacts should not be tampered with at all as this can spoil the tuner completely and necessitate a replacement.

The oscillator coil is adjusted by a thin trimming tool inserted from above and held almost vertically to adjust L7. No other coils can or should be adjusted and the two screws on the front of the tuner should be left alone.

Freeing the Cabinet

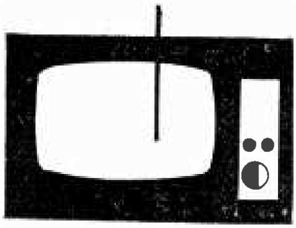
Remove the back cover and unplug loudspeaker connections at the top right-hand corner of the cabinet. Unscrew centre insert screw of the tuner

—continued on page 564



A MONTHLY COMMENTARY

Underneath the Dipole



BY ICONOS

HOPE at last! Last month I referred to the gloom which permeated the atmosphere of the ITV companies—in the production and engineering departments, if not in the "top brass". Bill Ward, the Production Controller of ATV, has stated, "*I think the era of the kitchen sink plays is nearly over, and I thank heaven for it! I'm sick and tired of squalid sleaziness. What I would like to see is more up-beat television drama, reflecting life — but life with hope, not life with despair and despondency!*".

Warming up to his theme, Mr. Ward added, "*I'd like to put out more pure entertainment — the of show that makes people sit back afterwards and say, 'Oh, I did enjoy that'!*" Here, at last the initiative taken by a television executive which will help the ITV Tam ratings, the peace-of-mind of viewers, and—indirectly —the productivity of the country as a whole. That is if the ITV companies listen to the golden words of Bill Ward and leave the perpetuation of down-beat and smut to the BBC.

Future Changes

Bill Ward has all kinds of new ideas of presentation, including the use of mobile video tape for recording exterior scene inserts, which are edited and incorporated into sequences shot in the studio. That is to say, the complete television play of the future will be all on video tape, with no filmed inserts. "*The quality of filmed and video taped material is different both visually and on sound*", he says.

Thus, he proposes a system which will give continuity of atmosphere, style of production technique, and a more frequent use of exterior scenes. This is an aim I applaud, though I do not altogether agree with the method he proposes.

Such a system envisages that the end product will be 405-line video tape, obtained after various recording transfers have been made from joined video tape to completely "clean" video tape —still on 405 lines suitable for Britain only. To sell this product abroad, a further transfer has to be made by telerecording to 35mm film, from which, in turn, optical reduction prints have to be made to 16mm film. The final quality, pictorially, is almost always dreadful, reminiscent of the photographic values of an early Edison Kinetoscope film.

Fortunately, we don't see these horrible pictures on British TV. Film is a world currency, which can be played off a telecine in television stations everywhere, lends itself flexibly to editing and dubbing foreign dialogue on it. The Americans have learned this and put most of the shows intended for world sales direct on to motion picture film.

I would have thought that the German system of Electronic-Cam was a much greater commercial value. This uses television techniques on the studio stages but the recording is made directly onto film in motion picture cameras. The cameras are instantly started and operated by vision mixers in the television manner, and the whole operation is fast and efficient, totally unlike the leisurely Victorian-like traditional film studio methods of working.

Of course, unless the telerecording of a British show on film happens to attain a reasonable quality (which it rarely does) it stands no comparison with the polished American filmed show—and this may well affect the financial returns on an important British export. The time has come when the home market alone cannot support really big and expensive TV epics.

Furthermore, it becomes clearer and clearer that the major contribution of programme material for colour television will be originated on 35mm colour cinema film. Certainly, this will apply to colour television plays for many years, if not for other TV programme items.

The practical effects of Bill Ward's "All Video Tape" policy will be to isolate British television production from the rest of the world, unless pathetically low quality standards in black and white or colour visuals are considered suitable for the export market. Standards conversion of video taped colour from 405 lines to 625 or 525 is about 15 years away!

Colour TV

Like the Editor of this journal, and many others in the industry, I have been watching colour demonstrations of NTSC, SECAM and PAL, the products of U.S.A., France and Germany respectively. These have been seen allied to British and Dutch experimental camera designs apart from cameras from their own countries. The permutations and combinations seem to have been infinite. The net result for me has always been a most painful headache.

Having long passed the stage when the very novelty of colour television engenders the enthusiasm which biases judgment, I think that a lot of work has to be done to make any of the systems worth considering. Certainly, I think that the television receiver industry should first show itself capable of producing a high quality black and white receiver.

The average mass produced TV receiver of today is distinctly less good than that of, say, six years ago, when many ordinary receivers included a measure of d.c. restoration to keep blacks black—and no nonsense!

At any rate, as I write these notes, the NTSC system seems to be slightly ahead as a European and world choice. However good or bad any of the competing systems are, this system is already in public operation and has a couple of years' start in practical usage. This was the view of Mr. F. N. Sutherland, Deputy Chairman and Managing Director of the Marconi Company.

"As the world's largest exporter of television transmission equipment, I would like to make a plea for world-wide standardisation", he said. *"This can only be effected on the international standard which is already in daily use in North and South America and Japan"*. I hope someone listens to that plea and agreement can be reached. Then, progress will be rapid.

Background Music

Looking at down-beat plays is bad enough, with their mumbling actors and inconclusive endings. whelming blast of background noise and music is adding injury to insult to viewers.

Take the BBC play *"You Can't Throw Your Mates"*, the story of which was set in a factory where productivity was held up by cussedness of both management and men. Dialogue was lost and the whole thing became intolerable—one reached for the changeover switch and the quiet relief of ITV's *"Late Summer"*, an Armchair Theatre production from ABC-TV.

Why do television directors and technicians pour this unintelligible cacophony of sound in our ears? There must be a reason, and I will hazard a guess. They rehearse the play until they know every word, no matter how indistinct an actor speaks. They listen to results in control rooms which have perfect hi-fi loudspeakers running at a high level of sound, completely different from the average viewers' set.

This over-elaboration of sound accompaniment, whether of effects or music, seems to be the modern trend on radio and also in the London live theatres that put on musical shows. The orchestras seem to have lost the soft pedal altogther. Plot lines, lyrics, dialogue and action all suffer interference from the orchestra.

What is more, dramatic and tragic points in the presentation would gain considerably by the orchestras playing as quietly as possible.

But no—they go sawing away on their strings with all the feeling of skilled butchers enthusiastically attacking carcasses of meat. This theatrical fortissimania has obviously spread to television producers on all channels. Fortunately, viewers retain the right to make the crucial decision—to switch off. Isn't a little peace and quiet heavenly at times?

Wing Pullers

There is a sadistic element in the make-up of most school boys. It may take the form of a drawing pin placed appropriately on the seat of the teacher's chair. On the other hand, it might reveal itself in a much more sinister manner—more rare, fortunately—of removing wings from live bluebottles. These nasty little lads are called "wing pullers" as distinct from "leg pullers".

I strongly suspect that the BBC have recruited quite a few "wing pullers" to their staff, especially to the production and actors responsible for their satirical epics. Soon, we'll be having *"TWTWTW"* back with us doing their usual wing pulling on viewers, insulting left, right and centre, mocking religion, royalty, public personalities and others.

The ITV companies, and their personnel, are rarely in step. They disagree with one another violently on policies of production, presentation and engineering. But one thing united them a few months ago. That was when *"TWTWTW"* attacked Capt. Brownrigg, the General Manager of Associated Rediffusion. Rarely have I seen—or heard—ITV engineers so unanimously condemnatory of the night-club element in the BBC.

Capt. Brownrigg is well known and popular in professional television circles, but certainly not well known to the general public. There was no possible excuse for this attack, ITV executives and staffs consider that in this particular item, the BBC reached a new low in bad taste.

They look forward to somebody taking legal action when the next "wing pulling" sessions of *"TWTWTW"* starts. The actors' names haven't been announced yet, but I expect we will be seeing an aggressive man who does atrocious imitations, two fat fugitives from a harem, the man who looks like a barker outside a strip club, and the little man with a particularly poisonous personality. There may be different actors doing the performing, but this is the usual sick night-club format, which is as set in its formula as the characters in a Victorian melodrama. Like the audiences at these old blood-tub theatres, I retain the right to hiss. S—S—S—S!!!

CIRCUIT PRACTICE AND DESIGN PRINCIPLES FOR

OSCILLOSCOPE TIMEBASES

CONTINUED FROM PAGE 517 OF THE AUGUST ISSUE.

BY
M. L. MICHAELIS

WHEN considering the design of an oscilloscope timebase, the anode characteristics for the valve it is proposed to use should be consulted, and the smallest value of anode load for RL selected which gives satisfactory bottoming at an anode current within the ratings of the valve for the h.t. supply voltage to be used.

A simple plan is to select a point as high up on the knee-rise of the valve's anode characteristics as possible, e.g. the point on it where the anode-line for half the normal grid-bias of the valve enters the knee. This point can be joined to the position on the voltage axis of the graph corresponding to the h.t. supply voltage it is intended to use. The slope of this line, expressed in volts per milliamp, then gives a suitable value for RL, expressed in kilohms. This may come out anything between 47kΩ and 200kΩ, or even other values, depending on the valve type. The value of R should then certainly not be less than RL, as already at equality stroke and flyback take equal time; it should preferably be much greater than RL. The values of C must then be chosen to give the desired final timebase ranges.

As a very rough guide, the time of duration of the sawtooth stroke lies roughly between the value of C (microfarads) and R (megohms) multiplied together, and a third of this value; the times are expressed in seconds. Exact values must be determined by trying various capacitors empirically in a circuit under construction.

These design considerations apply to virtually any Miller timebase circuit, i.e. certainly to the popular versions selected for further discussion below. It should be pointed out *clearly* that the difference between the individual circuits is not in the action of the Miller-Integrator portion, but in the method of producing and applying the driving relaxation waveform. Some words are therefore advisable, before discussing examples of complete Miller timebases, regarding the production and application of the relaxation waveforms.

Relaxation Driver

We shall see that the required relaxation drives are usually either square waves or very short pulses (spikes), depending upon the actual circuit. The ultimate drive required for a Miller timebase is, of course, a square wave pulse, as we have already seen; those actual circuits requiring merely a short spike thus generate the required square wave internally once they receive a spike. The drive signal, furthermore, may sometimes be required positive and sometimes negative, and it often requires to posses a definate d.c. reference level. The following discussion of relaxation driver circuits will thus have to deal with the basic generators, which are principally multivibrators, with amplitude limiters (clippers), with polarity inverters and with d.c. level fixing circuits (d.c. restorers or "Clamps").

Fig. 8(a) shows the basic multivibrator, consisting of a two-stage resistance-capacitance coupled amplifier with the output coupled straight back into the input. The circuit is thus highly unstable, as already mentioned earlier in this article, and it now remains to examine the useful consequences of this instability.

When switched on, one of the two valves will be driven hard to maximum current, giving a large negative-going anode-voltage change, which is coupled to the grid of the other valve, cutting it off,

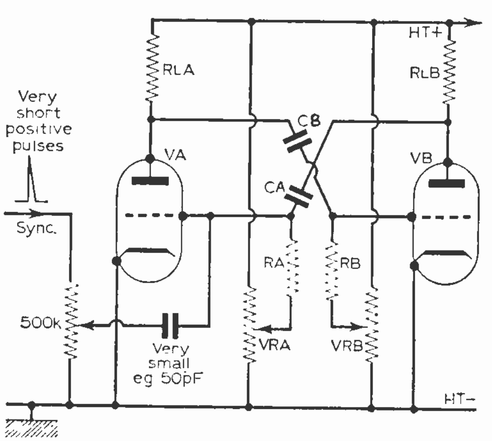


Fig. 8a—The basic multivibrator for supplying driving square waves for Miller integrators and other applications.

thereby producing a positive-going anode-voltage change coupled to the grid of the first valve, assisting the heavy conduction of this valve.

This situation, of one valve drawing saturation anode current and the other cut-off, remains until the associated anode-fall of the conducting valve ceases to be felt at the cut-off valve by virtue of the coupling capacitor having charged through the gridleak of the second valve.

The second valve then starts to conduct, giving a tiny voltage drop at its anode, which is coupled to the formerly conducting valve, reducing current slightly there The resulting anode-rise is coupled back to the grid of the valve just cutting-on, assisting the process. The effect is thus cumulative until the valves have changed over their roles; the first is now cut off and the second conducting heavily.

By a similar sequence the roles change over once again after a time determined by the coupling capacitor and gridleak of the valve now cut off.

Square Wave

It is thus clear that, since the valves are alternately either conducting heavily or cut off, and since the transition between these states is always extremely rapid, the output waveform at each anode is a virtually pure square wave of amplitude equal to the maximum anode-swing, which can be a large portion of the h.t. supply voltage. The time of duration of that part of each cycle during which a particular valve of the pair is cut off (i.e. its anode at h.t. potential) is determined by the charge time-constant of its grid capacitor and gridleak, and the charging-drive voltage selected on the h.t.-bleeder potentiometer to which the gridleak is returned.

If both grid-circuits are absolutely identical, then the valves conduct for equal times alternately and the output is a fully symmetrical square wave. If the grid-circuit time-constants (different values of C and/or R) chosen are different, then we get an asymmetric square wave output, i.e., pulses of preferred and opposite polarities respectively, from the two anodes. We thus see that variation of the appropriate gridleak of such a multivibrator, if it is being used as the screen-drive generator for a simple Miller Integrator, affords the sawtooth-amplitude control we spoke of for the Miller timebase output.

Multivibrator Design Considerations

The time for which each valve remains cut off is given for typical cases as approximately half the time in seconds given by the product of the associated gridleak (megohms) and grid-coupling capacitor (microfarads). The sum of the individual times for each valve gives the total time for one cycle and thus determines the frequency. Incidentally, if normal amplifiers "motor-boat" the fault is generally due to some feedback establishing multivibrator conditions, and the frequency is then determined in a similar way.

The switch-over times are negligible for general considerations of approximate frequency, provided that the gridleaks are much larger than the anode load resistors. If this last condition is not satisfied the square waves from the anodes will be much distorted; the transients will then not be sudden transitions between the two voltage limits but will be exponentials between the two limits, taking a major portion of the duration of each part-cycle.

This consideration here is far more vital than the similar one in the case of the Miller Integrator because failure to observe it destroys even that part of the output waveform which interests us here. The time constant of the gridleak and coupling capacitor (determining the rest-time in each state) should be at least 10 to 20 times as great as the time constant of the coupling capacitor and anode load (determining the switch-over time).

Good design practice is to make the anode loads of the triodes around 50kΩ, sometimes even much less, and the gridleaks approximately 1MΩ; certainly at least 500kΩ or so.

The aiming voltage on the h.t. bleeder should not be too small so as to place the cut-on voltage of the valves on an early portion of the entire recovery exponential. The rise rate is then still quite fast at the point of cut-on, so that slight h.t. voltage fluctuations do not reflect as severe frequency-jitter of the multivibrator. If, for example, the gridleaks were taken to chassis, the aiming voltage of the exponential recovery is only very slightly above cut-on, which thus takes place at a late time in the recovery, where rate of voltage rise with time is slow, and thus slight voltage fluctuations cause large fluctuations in exact time of cut-on and switch-over.

High Value Gridleak

Sometimes the gridleaks are taken direct to full h.t. positive, but this is only permissible if the gridleaks have a resistance high enough to limit the resulting grid current when the valves conduct to a safe value. Taking half a milliamp as tolerable grid current in triodes such as the ECC81, etc., the gridleak in kilohms must be at least twice as large as the h.t. voltage. This condition is usually satisfied anyway once the above stipulation of high gridleak resistance in relation to anode load is satisfied.

A common practical arrangement places a 250kΩ potentiometer, in series with a 270kΩ fixed resistor at its bottom end, across the h.t. supply. The gridleaks go to the slider, so that the aiming voltage can be varied between full h.t. and half h.t. This gives a convenient range of fine frequency control. Course frequency and symmetry control is achieved by using switches to select various sizes of coupling capacitors.

If a separate h.t. bleeder potentiometer is used for each valve, then the symmetry of the square wave may be controlled for individual part-cycles. However, if this is not desired, the coarse capacitor selection sufficing for the purposes envisaged, then both gridleaks may be returned to the slider of a single potentiometer. The slider should then be decoupled to chassis by an electrolytic of about 8μF capacity.

Synchronisation

If the values in the grid circuits are chosen such that the undisturbed repeat frequency is slightly less than the frequency of repetition of brief positive voltage spikes fed in, as shown in Fig. 8(a), then these spikes can lift the grid of the cut-off valve prematurely to cut-on coincident with their arrival and thus force the multivibrator to run in synchronism. This feature is most important in practical oscilloscope circuits. The sync spikes can be obtained from the signal waveform to be displayed on the oscilloscope, for example, and will thus force the multivibrator to run at a subharmonically related frequency, which is necessarily followed by the timebase then driven from the multivibrator, and thus gives a steady trace on the c.r.t. screen because all display-cycles fall in phase with each other.

Triggering

In triggered circuits the multivibrator is arranged to be incapable of oscillation at all when left alone by means of biasing one valve to beyond cut-off by a d.c. voltage. Figs. 8(b) and 8(c) show two popular circuits for such an arrangement. The input spikes of voltage, again positive, now lift the normally cut-off valve to cut-on, causing a switch-over in the usual way to block the other valve, normally conducting, for a time given in the usual way by its grid circuit components.

After completion of this time the change-over takes place, in the usual way, back to the original conditions. But no self-recovery is then possible as the cut-off valve then remains cut off by the d.c. bias until the next trigger spike arrives. The circuit therefore always stops after a single flip-flop response to each trigger and is thus called a univibrator or "flip-flop". The response-cycle can be made very much faster than the trigger interval, so that transient displays are improved in the way already discussed in the first article.

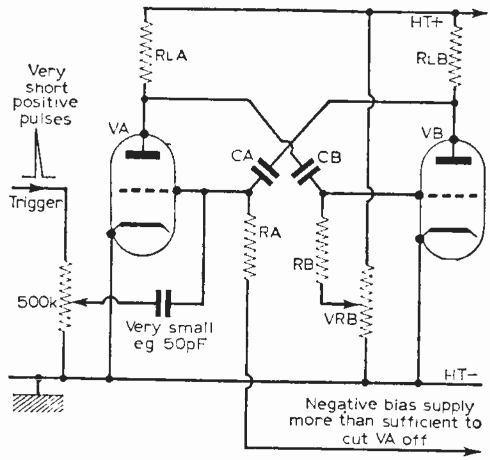
A disadvantage of Fig. 8(b) is the time constant on the grid of the valve normally biased beyond cut-off. This is an unnecessary item, as it serves no useful purpose, and is in fact a hindrance, because it imposes a dead time after each response cycle during which new trigger spikes are ineffective. This is troublesome if some trigger intervals are little longer than a response cycle. The cathode-coupled univibrator of Fig. 8(c) is a very popular arrangement avoiding this difficulty, as it dispenses entirely with the superfluous CR element.

Bias to cut off the left-hand triode is obtained from the cathode resistor voltage drop of the conducting triode, which is not hindered in conducting because the gridleak goes to h.t. positive. But the left-hand triode grid goes to the slider of a potentiometer set to a voltage slightly less than the cathode voltage by an amount enough to hold the left-hand valve cut-off. The closer the slider of the 100kΩ potentiometer is raised up to the cut-on point, the greater the "trigger sensitivity", because the required remaining trigger amplitude is then smaller. If the slider is advanced beyond the point of static cut-on, of course, the circuit will burst into free oscillation.

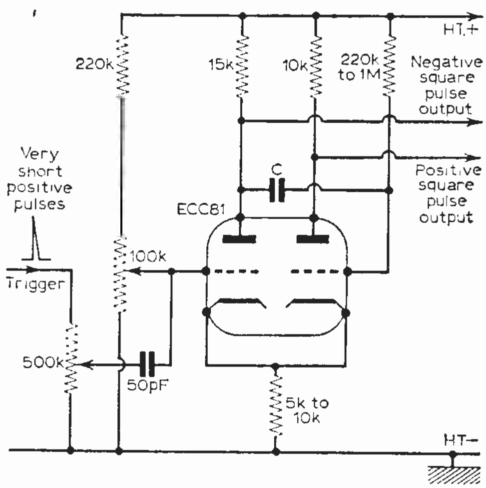
Self Oscillation

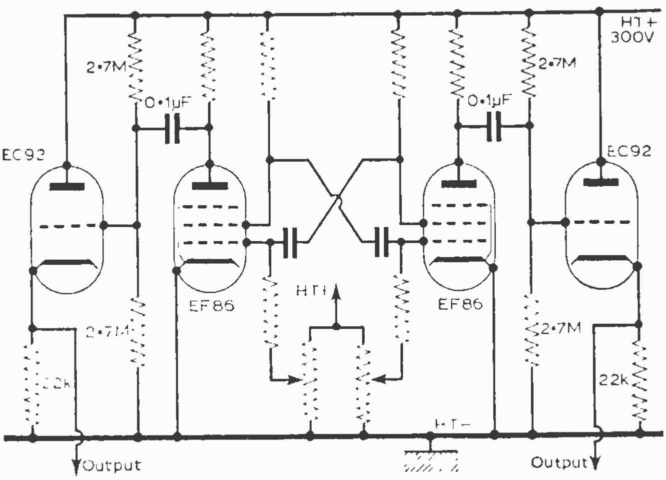
If in some versions the circuit tends to produce a short sequence of response pulses of diminishing amplitudes instead of a single response pulse per trigger input, a trouble that may occur when operating near the self-oscillation threshold, i.e. at maximum usable sensitivity, the author has sometimes found that the inclusion of additional individual cathode-resistors in each valve (some 1 to 2kΩ), in addition to the common resistor, improved performance. This can lead to a state where the left-hand triode does not rest cut off but rests at low current, and the other one rests at high current. The roles change over temporarily in response to a single trigger, giving a single response and less tendency to damped self-oscillation.

There are numerous variations to the basic multivibrator and univibrator circuits, yet the above remarks should suffice for a general understanding of individual circuits that the reader may meet in practice.



In triggered circuits, a variant of the multivibrator is used. In Fig. 8b (above) is a basic univibrator and in Fig. 8c (below) is an improved arrangement.

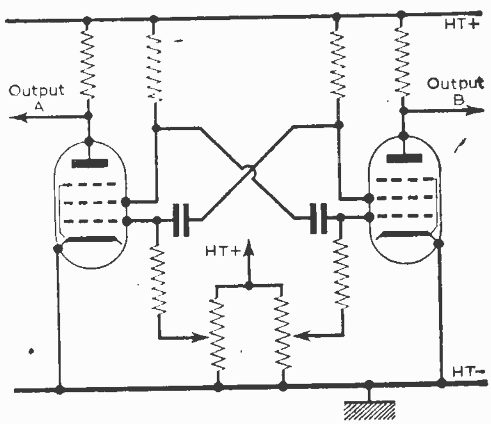




Where it is required to produce better and faster transitions on the output square waves, it is usual to use a high speed multivibrator. In Fig. 9a (below) is the basic circuit of such an electron-coupled multivibrator. In Fig. 9b (left) is a development of the arrangement incorporating output cathode followers.

High-speed Multivibrators

Fig. 9(a) shows the electron-coupled multivibrator, where pentode valves are used, the "triodes" between cathode/grid/screen in each case forming the actual basic multivibrator. The anode circuits, being free of the coupling capacitors, produce better and faster transitions on the output square waves. This arrangement can be useful at the higher frequencies and may naturally be used in logical extension in any of the basic multivibrator circuits. If the stray capacities to chassis present in the anode circuits due to the connection of the circuits to which the outputs are fed prove troublesome at very high frequencies (they limit the maximum rate of transition in the square wave because of the time required for them to follow charge), then cathode-follower coupling of the outputs may be resorted to. This is shown in Fig. 9(b) and is quite common in good quality high-speed oscilloscopes of modern design. It is, of course, only then necessary to use two cathode-followers if *both* polarity outputs are required; usually one suffices.



Next month's instalment will include a description of squarers, limiters, clippers and d.c. restorers.

TV ALIGNMENT WITHOUT INSTRUMENTS

ONE of the most frustrating problems encountered by the "do-it-yourself" television enthusiast is a misaligned receiver. While the average enthusiast owns the "basic" instruments of his hobby—such as moving-coil movements, a multimeter or two and probably a home-made broadcast band alignment oscillator—rarely does he possess the specialised equipment demanded for the "professional" alignment of the many tuned circuits in the modern set. Thus he either tries to make do with what is at hand or is compelled to take the set round to his local radio shop or more fortunate friend for attention.

This article is written for the many thousands of enthusiasts who are without alignment equipment; it is also hoped that the article may help those of us whose job it is to perform repairs and adjustments actually in the field (e.g. in the home of the viewer).

Firstly it must be stressed that this article is not intended in any way to disparage test equipment, for no matter how skilled one may be in the art of alignment without instruments the optimum in terms of overall performance can only be achieved by the careful and "studied" application of instruments. There is much literature on this subject.

For those who are studying to become professional service technicians and enthusiasts whose wish it is to rise to the level of the "professional" operator this kind of text should be thoroughly absorbed; it may also help to read up the basic requirements of alignment in conjunction with this article, as a good knowledge of the techniques (coupled with as much practice as possible) is an essential ingredient.

Sensitivity

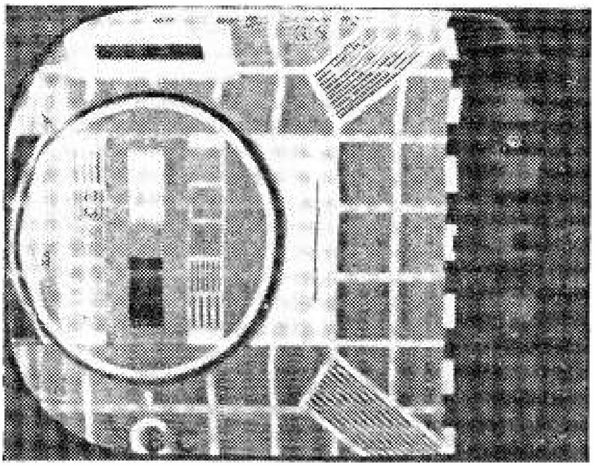
To be proficient in "instrument-less" alignment one must try to visualise what happens to the response curve of the set in relation to the sound and vision carriers when a core or trimmer is adjusted. One must also cultivate a sort of "sensitivity" to the symptoms of misalignment as displayed on a picture or test card.

The same kind of "sensitivity" is acquired by motor enthusiasts; while it is now generally agreed that optimum tuning is possible only by electronic means, such equipment cannot be transported to the side of a race track, for instance. Nevertheless, the skilled motor enthusiast is able to set the ignition timing to an extremely high degree of accuracy simply by being "sensitive" to the slight change of engine noise on tick-over as the timing is adjusted . . . . so it is with the skilled television enthusiast.

Over the years the author has completely aligned many misaligned television sets by ear and by looking at the results on the screen as the cores are adjusted. To test the point again of recent weeks the author put his own domestic set totally out of alignment and set-to to realign it without instruments. The realignment was so successful that the family considered that the pictures were better than before! This should not be taken to suggest that one attempts the exercise initially on the family set; far better to work on a more elderly model or on "old faithful" which the existing family set has replaced.

Check Layout

The first thing to do is to get to know the layout of the chassis and the positions of the various tuned circuits, coils and slugs. This is not as difficult as it may seem and in Fig. 1 we have given a block diagram of the appropriate stages in a typical receiver. Most sets that will be dealt with will feature a multi-channel tuner of some kind, though there may be some earlier ones with Band I-only front ends. However, tuner or otherwise the stages will be v.h.f. amplifier (double triode cascode



by
K. Royal

amplifier in tuner or EF80-type pentode in Band I-only set), followed by the frequency changer. This stage usually has a single valve, such as a triode-pentode in a tuner (with the triode as the oscillator and the pentode as the mixer), or an EF80 type of valve in a Band I-only set working as a self-oscillating mixer.

In the multi-channel tuner or Band I-only front end all the tuned circuits with the exception of the image rejector (if fitted) are tuned to signal frequencies. These are changed to sound and vision i.f.s at the output of the mixer and are fed into the sound/vision i.f. coupling L6 (Fig. 1). This tuned circuit may be partly on the tuner and partly on the main chassis, in which case a screened can with cores in top and bottom will be present between the tuner and the common i.f. valve. Note that all multi-channel tuners have an i.f. coil or transformer in any case.

The common i.f. stage has its own output coupling to (a) the vision i.f. stage (L8/L9) and to (b) the sound i.f. stage (C1 or coil). The input to the sound i.f. is also tuned (L13) as is also the output and coupling to sound detector (L14/L15). The common i.f. stage or first vision i.f. stage often features a single tuned circuit which looks rather like a sound rejector but is tuned to the adjacent channel (e.g. 1·5Mc/s from the vision carrier)—L7.

—continued over

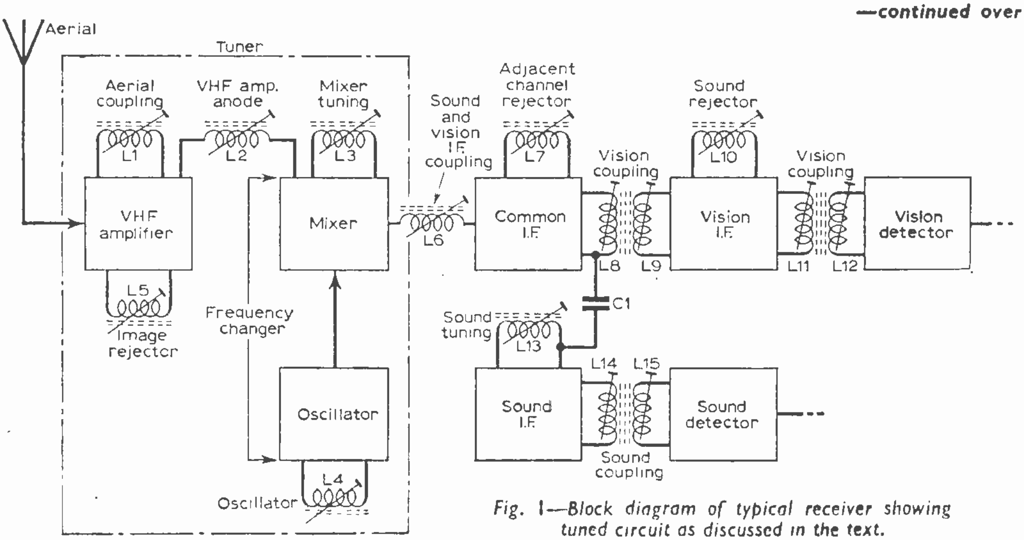


Fig. 1—Block diagram of typical receiver showing tuned circuit as discussed in the text.

The main sound rejector (tuned to the sound i.f.) is embodied in the vision i.f. amplifier stage (L10) and it is usual for the sound tuning (L13) also to act as a sound rejector, the two together giving something like 50-60dB of rejection when correctly tuned. The vision i.f. stage is then coupled to the vision detector by two tuned circuits (L11/L12).

The idea, then, is to locate these stages and the tuned circuits which are associated with them. It certainly helps if a chassis layout plan or service sheet or manual of the set can be acquired—but this is not always possible. The importance of actually identifying the tuned circuits before any adjustments are made to them must be stressed. This is essential even if it means tracing the circuits from stage to stage if there is any doubt as to the purpose of a coil or transformer.

Although information as to the purpose of a tuned circuit can sometimes be gleaned by carefully adjusting it under controlled conditions on a test transmission, for example, it is a thorough waste of time and effort to adjust randomly and without purpose any tuned circuit hoping by this means to bring the set into alignment. This would be rather like setting down a monkey at a typewriter and hoping that he may type a best-seller . . . he probably would in the end!

Signals and Responses

In **Fig. 2** is shown what is required of the tuned circuits. Three things are given to us for free! These are (i) the sound carrier, (ii) the vision carrier and (iii) the 3·5Mc/s spacing between the sound and vision carriers. These things are constant and give our milestones on the road to instrument-less alignment.

Actually there are other things, too: (a) sound modulation and (b) vision modulation. Thus we have information concerning bandwidth and signal identification; we also have a set upon which to identify them . . . . what more do we need?

It is our job, therefore, to adjust the tuned circuits so as to tailor the sound and vision responses as shown in Fig. 2. When these have been obtained the sound and vision modulation will be able to pass through the set and provide correct sound and pictures. If the "tailoring" is wrong then we shall know about it all right from the loudspeaker and picture tube.

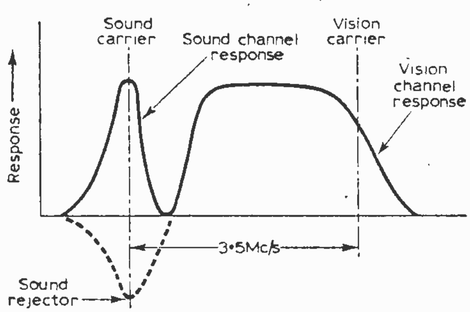


Fig. 2—Showing how the sound and vision carriers should fall in relation to ideally aligned sound and vision channels. The sound rejector response is in the vision channel and nearly (but not quite) corresponds to the maximum sound carrier position.

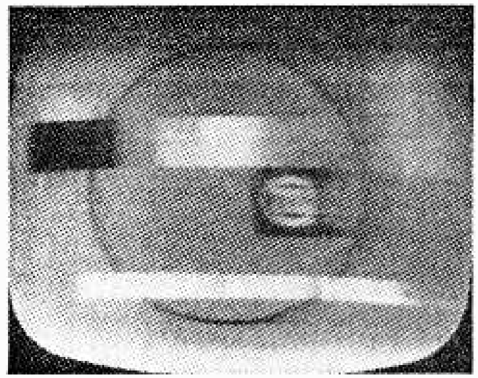
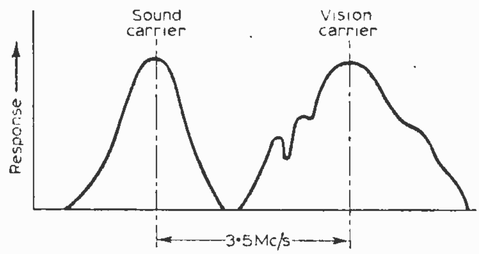


Fig. 3 (above)—Very poor definition resulting from peaked vision i.f. channel tuned circuits. Fig. 4 (below) Shows how the overall response may look.



Complete Misalignment

Let us suppose that the set that we have in for repair is completely out of alignment but otherwise in good order. We should be getting virtually no sound or trace of picture. What, then, is the first thing to do? Before we can tailor the sound and vision responses it is imperative that we get the sound and vision carriers approximately correct i.f.-wise. This can be accomplished by peaking the sound channel to the approximate sound i.f. and then adjusting the front end tuned circuits to secure a trace of sound from the loudspeaker. This is the first hurdle which to negotiate requires the strongest possible local-channel aerial signal (BBC preferably if the set is multi-channel) and maximum gain of the amplifier sections of the set. The latter simply calls for maximum setting of the contrast, sensitivity (if fitted) and volume controls, while the former demands a good, high-gain aerial orientated for the best pick-up.

Rough Setting

All the sound i.f. tuned circuits should be located and the cores in the coils should be set to their approximate mid-former positions. This, at least, will make the sound i.f. channel slightly responsive. The next thing is to adjust the local oscillator in the tuner section (L4, Fig. 1) until the sound signal is heard in the loudspeaker; as the sound may be very weak at this juncture it may be necessary to hold an ear close to the loudspeaker grille while the oscillator core is adjusted.

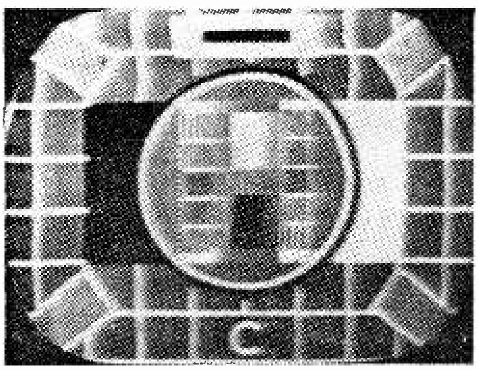
On multi-channel tuners the oscillator core is often accessible through a small hole in the cabinet immediately below the channel selector knob; but note that the core which is in line with the hole is that corresponding to the channel to which the tuner is adjusted. Thus it is necessary to set the channel number *before* extracting the knob, otherwise the core related to a different channel will be adjusted.

Adjustment should be made with a very thin, non-metallic knitting needle shaped as a screwdriver blade at one end, and the fine tuning control should always be at range centre whenever adjusting the oscillator core of a tuner.

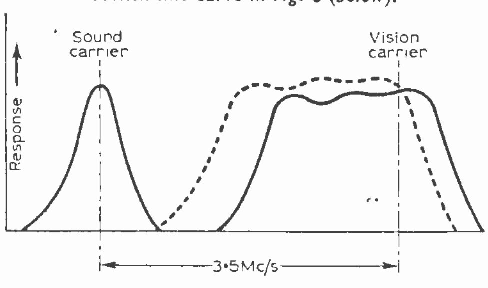
On Band I-only sets the aerial, v.h.f. anode and mixer tuned circuits (L1, L2 and L3 in Fig. 1) should next be adjusted to make the sound as loud as possible. These adjustments are rarely possible on sets with multi-channel tuners as the corresponding cores are actually in the formers of the coil biscuits and they are not easily accessible for adjustment (or misadjustment!). If the sound is still very weak the i.f. sound coil or transformer of the tuner (L6 in Fig. 1) should be adjusted to make it louder.

Sound i.f.s.

The next move is to get the sound i.f.s properly in tune. Prepare a non-metallic knitting needle at one end to fit the i.f. tuning cores (or acquire the correct non-metallic adjusting tool if special "key-type" cores are used) and adjust L15, L14, L13 and L8 in that order for the loudest sound. During this exercise it will be necessary to reduce the settings of the volume control and possibly the contrast control to avoid overloading.



To eliminate the smear effect shown in Fig. 5 (above) the whole of the vision response curve requires to be shifted towards the sound carrier, as shown by the broken-line curve in Fig. 6 (below).



Now if it is discovered that the sound i.f. transformer cores (L14 and L15) are either right in or too far out for maximum sound output the oscillator is slightly out of tune and readjustment here becomes necessary. Adjust the oscillator core first one way and then—after test—the other way until the sound i.f. transformers peak with the cores approximately ⅛in. to ¼in. *below* the top of the formers. Repeat the sound i.f. alignment very carefully with the minimum setting of contrast and/or sensitivity for the best results. It is extremely important now *not* to touch these cores again nor the core of the oscillator (nor the fine tuning, which should be at mid-range).

So far, then, we have tailored the sound channel response and have set the sound and vision carriers in relation to this. It now remains to tailor the vision channel response around our fixed vision carrier position while at the same time attend to the sound rejectors.

Vision i.f.s.

At this time by turning up the contrast and brightness control something should be seen modulating the raster—even though it may not be a picture. These controls should be turned up and L9, L11 and L12 adjusted until picture modulation appears on the screen. Theoretically the picture (if one can be locked) should be dancing about in sympathy with heavy passages of sound, since the sound rejectors are still out of tune; but it should be possible to lock a picture by carefully adjusting the frame and line hold controls.

Rough Sound Rejection

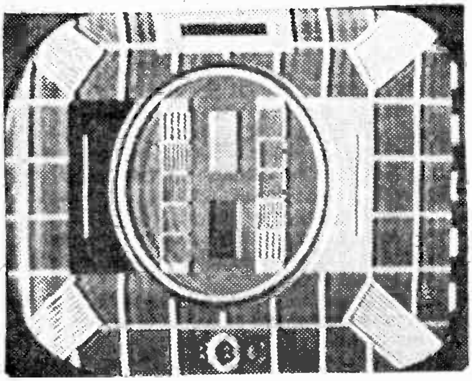
The picture will be very poorly designed at this time, as shown in Fig. 3, and if one were able quickly to view the overall response it would look something like that in Fig. 4. However, the immediate problem is to establish approximately correct settings for the sound rejectors.

The main sound rejector should first be adjusted for minimum sound-on-vision interference—that is, L10 in Fig. 1. If the symptom is troublesome still then the sound tuning (sometimes called sound take-off—L13 in Fig. 1) should carefully be adjusted about the maximum sound output point for *minimum interference,* bearing in mind that maximum sound output on this circuit does not quite correspond to maximum rejection.

Widening the Vision Passband

The overall response may still look something like that in Fig. 4, so it is now necessary to widen the vision response curve as per that in Fig. 2. This is best accomplished during a transmission of Test Card C. Firstly L8 and L9, the first vision i.f. coupling, should be adjusted for maximum brightness of the picture, not taking notice of definition; then the final vision coupling, L11 and L12, should be tuned *not* for maximum brightness but for maximum definition as indicated by the resolution of the frequency gratings on the test card. A good picture at this stage will not be obtained and something like that shown in Fig. 5 should be aimed at. At this stage the vision response may look like that shown in full line in Fig. 6.

The idea now is to shift the whole of the response curve slightly towards the sound carrier, as shown



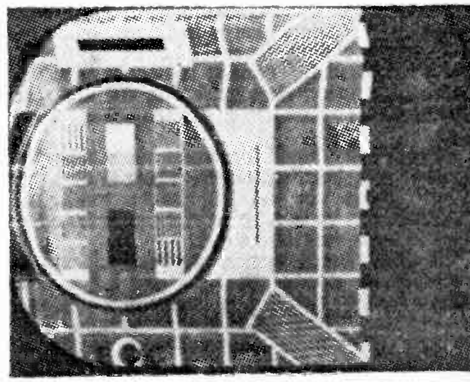
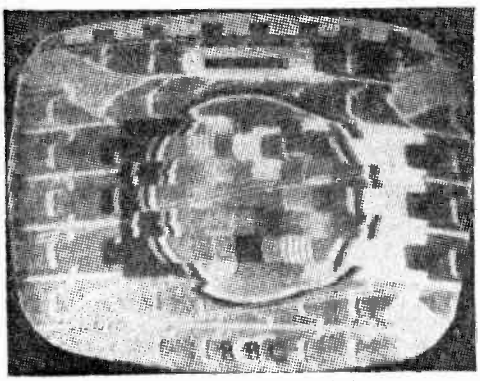
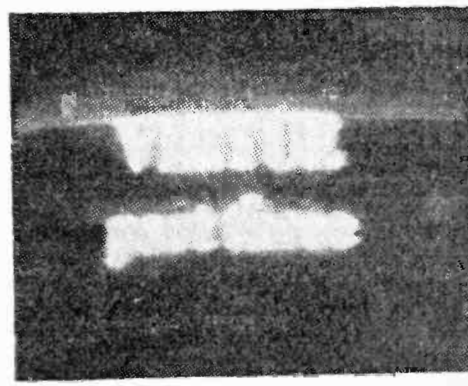


Fig. 7 (top left)—Excessive "overshoot" caused by the vision response being too far towards the sound carrier. Fig. 8 (top right)—False line lock for detecting sound-on-vision interference. Fig. 9 (bottom left)—Poor vision channel high-frequency response. Fig. 10 (bottom right)—The symptom of flaring after white.





by the broken-line curve in Fig. 6. On most sets this means screwing out the cores in L8, L9, L11 and L12 by about one turn. If the response curve is shifted too far towards the sound carrier excessive overshoot (" ringing ") will occur on the picture, as shown in Fig. 7; sound-on-vision interference may also rise again to a high level. Should either of these things happen *each* core of the vision i.f. couplings should be screwed in just a fraction of a turn until the best resolution is secured without overshoot or excessive interference. There may, however, be just a little sound-on-vision, since we have not yet optimised the sound rejectors—a job which we do next.

Critical Sound Rejection

The critical settings for the rejectors is best established by slipping the line lock until a black vertical band either cuts the picture in half or appears on the right-hand side of the screen, as shown in Fig. 8. Nothing more should be done until a tone is transmitted on sound. The volume control should then be turned right down and the tone should be observed as a ripple on the edge of the test card. This is the most sensitive condition for the display of sound-on-vision interference and the rejectors may be carefully adjusted in turn (e.g. L13 and L10, Fig. 1) until all traces of it disappear. The line may then be locked and the volume control turned up.

Optimum Definition

We have now almost completed the task of alignment without instruments, but before we can be fully satisfied we must try to get the best possible definition, but now we should only adjust the vision i.f. couplings just a little one way or the other, returning the original setting of core if there is no improvement.

If our adjustments result in the vision carrier falling too far down the sloping side of the vision response curve the picture will tend to " ring " and break into bad sound-on-vision; if the carrier is too far the other way then we may get a severe display of pulling-on-white, as shown in Fig. 9, and flaring after whites may occur (Fig. 10) if the Fig. 9 symptom is cleared by adjusting the fine tuning control. Remember that all through the alignment process the fine tuning has remained as carefully set in the first place.

Sound/Vision Compromise

The alignment exercise is finalised by adjusting the common i.f. tuner input coupling (if fitted) and the i.f. transformer or coil on the tuner (always fitted) for the best compromise between picture brightness, definition and sound. ■

DX-TV

A MONTHLY FEATURE FOR DX ENTHUSIASTS

by Charles Rafarel

WE all know what can happen to the Band I BBC picture at certain times of the year when quite suddenly it develops "herring bone" pattern. The layman usually receives these additional "trimmings" to his picture with considerable annoyance, and often calls in the service engineer or writes to the BBC to complain, reasoning that "It must be the BBC's fault as the ITA picture is perfect".

Many readers of PRACTICAL TELEVISION will have been able to explain to these less well informed viewers that the real cause of the trouble is quite beyond the control of the BBC and is due to "foreigners" sabotaging our pleasures! It is also becoming clear that a few of our readers at least have already realised the wisdom in the saying "If you can't beat 'em, join 'em"!

This select few have come to be regarded as slightly eccentric by their friends. They put their aerials up the wrong way round and their conversation is punctuated by strange sounding phrases about the CCIR system, OIRT, inter-carrier sound, the TVE programme they saw from Madrid last night, etc. But most strange of all, they seem to actually welcome their BBC picture being unviewable!

I myself have been interested in DX TV for a very long time. In fact my first DX was in 1934 with 30 line gear. I can therefore appreciate the enthusiasm of today's newcomers. It is because of my long association with long distance television reception that I have been asked to organize a DX TV feature in which we hope to cover many aspects of this fascinating hobby. It is proposed to deal with the subject under two main headings:—

(1) To explain the principles of propagation and reception, to discuss the various European systems and how to cope with them, and to show that this hobby need not be a very expensive one to pursue.

(2) To assist with the indentification of "mystery" Test Cards and opening captions, to advise on station identification from programme contents, to keep up to date with new transmitters as and when they open in different parts of Europe, and to note changes in types of test card etc.

One of the most difficult problems encountered is the vexed question of accurate lists of transmitters, and the complete absence of published test card details. But through the help of a Continental DX TV organisation, I have European contacts on both sides of the Iron Curtain and am therefore favourably placed for station identification. We therefore ask you to send us your problems on identification of TV transmitters (together with photos or sketches where applicable), giving time of reception and channel and we will do our best to answer them.

For those already receiving DX TV I have a few items of news:—

(1) *Finland* has recently opened its first Band I transmitter (Helsinki, Channel E2) and I, together with other DX TV experimenters, both here and on the Continent, have been getting good signals from it, so watch out for a new "test card" with the letters "T.E.S." at the bottom, it could be a new country for you. Finland previously operated in Band III only.

(2) *Yugoslavia* will shortly be opening two new transmitters in Band I channels E2 and E4 at Belgrade. Up until now Yugoslavia used Band III only.

(3) The same applies to a new station due to open this year in Sofia, *Bulgaria*, in Band I channel OIRT 1. I will give you further information including test card details as soon as it becomes available.

Just a few notes re DX conditions this year:—April, May and the beginning of June appears to have been at least as good and probably better for Sporadic "E" reception than the corresponding periods of 1961/62. There was a falling off of conditions mid-June to mid-July, but a further recovery was noted at mid-July.

Tropospheric reception has, however, certainly been much more difficult this "summer" and obviously this is linked with the unsettled weather prevailing. I hope we may look forward to better conditions in the autumn and early winter.

The DX season for this year is now well under way and I suggest that would-be DX'ers take advantage of the relative lull late in the year to get organised for the 1964 season. To this end I propose next month to start a beginners section which will deal with various aspects of DX reception, both by Sporadic E and Tropospheric propagation, and to indicate briefly how to get started, what the problems are and how to resolve them.

To those already initiated into the mysteries of DX TV, let me have your problems and questions and I will do my best to answer them. May I conclude this first introductory article by saying by way of encouragement to one and all that my own modest efforts have resulted in the identification of over 80 different stations in 21 countries received here. And that is not the best score in Europe.

THE HENLOW wide-band OSCILLOSCOPE

A high quality instrument specially developed for television application

de.igned and described by

D. R. BOWMAN

Part Four

CONTINUED FROM PAGE 496 OF THE AUGUST ISSUE

Mains Transformer Construction

IF a mains transformer T1 of the type specified in the components list (July issue) is hard to obtain, a suitable component may be wound by hand. The core area should be between 2½ sq. in. and 3 sq. in.; the window size for 1½in. E and I laminations would be 2¼in. by ¾in. This would wind at 4½ turns/volt, giving a primary winding of 1,080 turns of No. 26 gauge enamelled wire, tapped at 990 and 900 for mains adjustment. Allowing ⅛in. for the cheeks of the bobbin this would amount to ten layers, insulated by thin waxed paper, and the length of this winding would then be 0·2in.

The 300V secondary would require 1,350 turns of No. 34 gauge wire, winding at 100 turns/inch. This gives seven layers which with insulation as for the primary would be ⅛in. high, leaving ¼in. in the window space for the remaining high voltage and heater windings.

The 900V winding could consist of 4,050 turns of No. 40 gauge wire, in 11 layers amounting to 1/10in. at most with insulation, but this winding must be very well insulated from the other windings by Empire tape.

The secondary heater windings could be wound side by side in the remaining space. The first, of 30 turns No. 20 gauge wire (6·3V for the valve heaters) would occupy 1·2in., while the winding for the cathode ray tube heater would be 30 turns, tapped at 20 turns for 4V, of No. 22 gauge wire, this would fit nicely into the rest of the winding—about 1in.—with plenty of room for insulation.

The above specification is a little tight for hand winding, but by choosing a larger size of laminations the window space problem will be eased. The same number of turns/volt can be used for the larger transformer, but if a larger number of laminations is selected to give a rectangular rather than a square centre leg, the volts/turns may be reduced, shortening the windings. This cannot be carried too far however.

If, as is quite allowable, an old mains transformer is stripped down to provide laminations, the turns/volt can be ascertained from the windings removed.

The primary, if of sufficiently heavy gauge, can be left in place and the new windings added on top. A transformer of generous proportions should be selected to give a little elbow-room in winding.

Auxiliary Heater Transformer

The auxiliary heater transformer T2 should be readily available from normal suppliers. Two suitable types made by Elstone (MT/LT2) and Osmabet respectively have current ratings of 3A, and will consequently provide a good margin of safety. The physical dimensions of T2 are also of some importance, since the space available for this component is not excessive.

T2 should be wired up to supply the heaters of the Y-amplifier valves V8—V12, and also connected to the switch S2 so that it supplies either V7 or the calibration circuit depending upon the setting of the switch.

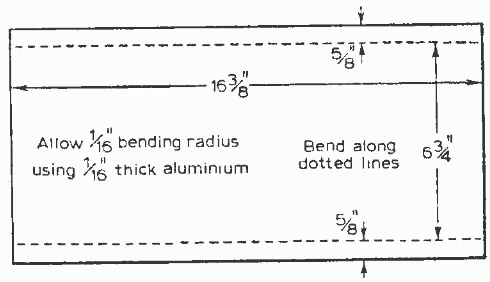
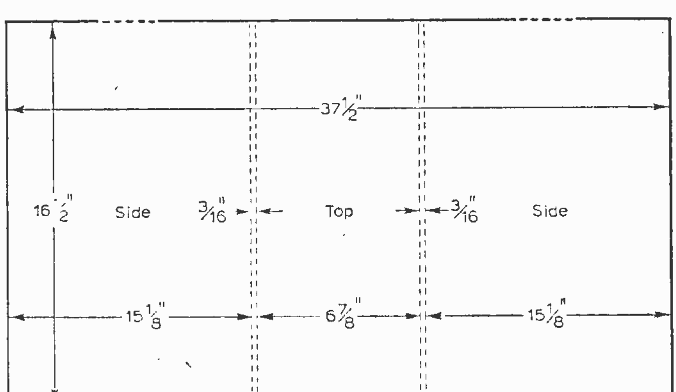


Fig. 13 (above)—Lower chassis drilling dimensions.

Fig. 12 (below)—Cover for the oscilloscope.



The mains transformer T1 provides heater current for valves V1 to V6 and V14. (This is an amendment to the information previously given on page 447 July issue.)

Chassis Assembly Details

The upper deck will be mounted about 6in. above the lower chassis. If the front panel of the instrument and the support carrying the socket of the cathode ray tube are fixed to the lower chassis, they form a good means of mounting the upper chassis in place. The structure will not be very stable, and will need some kind of bracing; but when the cover is fitted and screwed into position a very strong and rigid assembly will result. However, before the cover is put in place it will be necessary to carry out some or all of the setting-up procedure, and the aim should be to provide enough bracing for reasonable stability without involving screws or bolts which project outside the limits of the bottom chassis. Countersunk screws provide a good solution to this problem.

Individual constructors may have their own ideas concerning the physical arrangement and fabrication of the metal work. Providing the various points already stressed with regard to critical components and wiring are observed, there is of course no reason why the main structure should be built in a somewhat different form to that employed in the original design.

However, for those who wish to follow the mechanical design of the prototype, dimensioned drawings are included of the several pieces of metal that collectively make up the oscilloscope assembly.

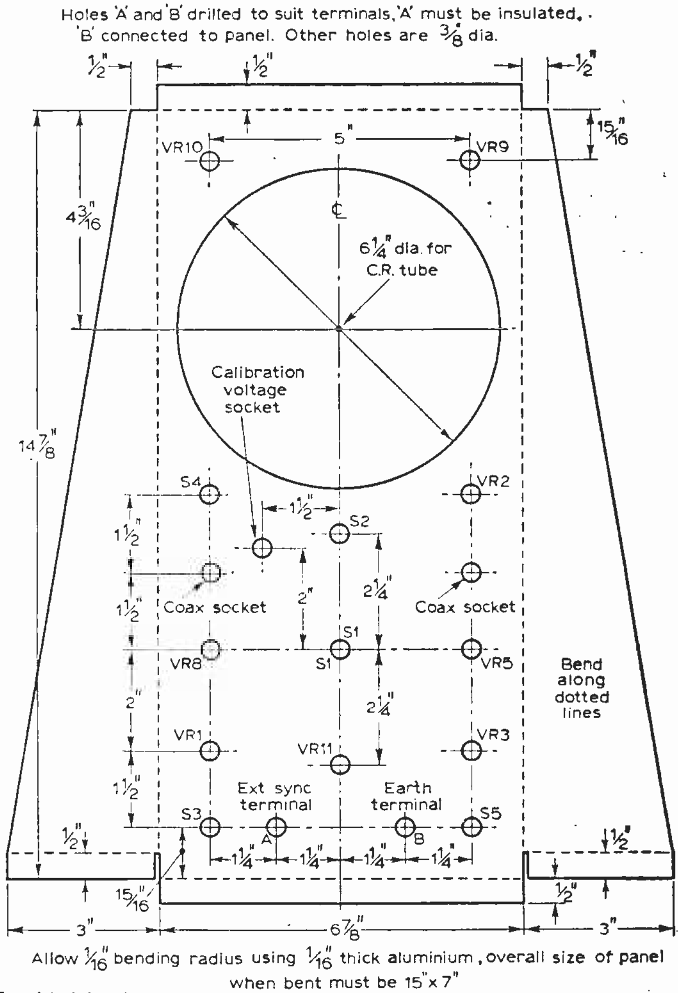
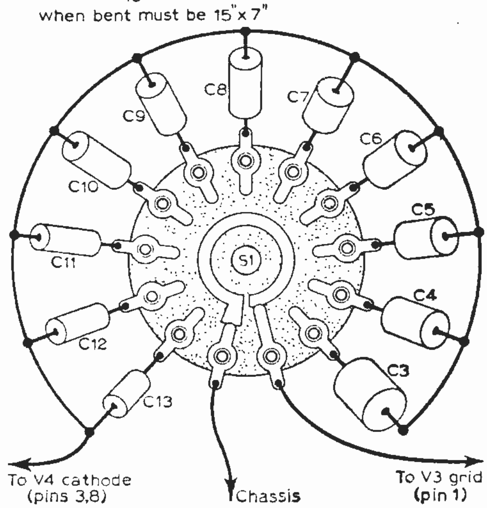


Fig. 14 (above)—Lower panel drilling.

Fig. 15 (right)—Wiring details for S1.



Drilling and Bending Details

In Fig. 14 are details of the drilling and bending for the front panel. It should be noted that if the recommended $\frac{1}{16}$in. aluminium is used a bending radius of $\frac{1}{16}$in. must be allowed for at each dotted line. For example, the finished width of the front panel is 7in., but it will be seen that in Fig. 14 a dimension of $6\frac{7}{8}$in. is indicated between the dotted lines. The missing $\frac{1}{8}$in. will be contributed from the two side flanges ($\frac{1}{16}$in. from each) when these are bent.

The bottom chassis is made from a sheet of aluminium according to the details given in Fig. 13. Drilling details for the components are not included, but this should not provide any difficulty, since the actual components may be used as templates. A recommended layout of the major items on this bottom chassis will appear in a following article.

It should be mentioned at this stage that in the final paragraphs of Part I (June 1963) reference was made to "zinc-metal box" and "zinc-metal screen". The material in both cases should, of course, be mu-metal.

Dimensional details of the upper chassis will be included in the component layout diagram for this portion of the instrument which will appear in the next article.

The cover for the oscilloscope is prepared from a single sheet of aluminium, cut and bent according to the dimensions given in Fig. 12. Since minor discrepancies may arise between the specified dimensions and the actual model produced, this cover should not be prepared until the main assembly has been completed. Then, the measurements given in Fig. 12 can be modified should this prove necessary in order to give a good fit.

Front Panel Wiring

The arrangement of the operating controls, sockets, etc., is shown in Fig. 16. The various components should be fitted on the panel and as much of the wiring as is feasible at this stage carried out. It will be necessary to leave most of the flying lead until the final assembly work is reached, as it will then be possible to estimate closely the length required in each case.

Details of the wiring for the X range switch S1 are given in Fig. 15 while switch S2 is treated in similar detail in Fig. 17.

The wiring of the c.r.t. base and associated components appears in Fig. 18. This wiring should next be completed as far as possible, and then the base and the front panel can be put on one side pending the final assembly of the oscilloscope.

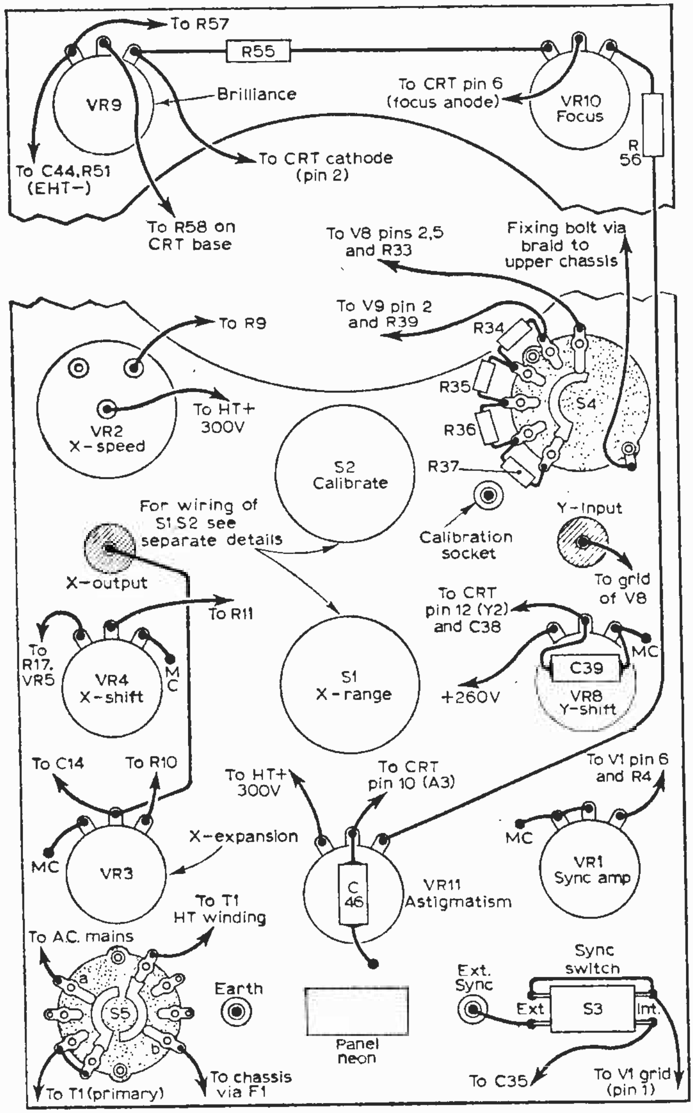


Fig. 16—Layout of controls, sockets and wiring.

The Graticule

In order to obtain good visibility with the VCR97 tube it is advisable to make the tube project a little—about ¼in.—from the front panel; this is because of the curvature of the tube face. A flat-faced tube would be best mounted so that it projected little if at all. The hole for the VCR97 is cut just 6·25in. diameter, and then the tube can be inserted into and withdrawn from its base from the front.

A graticule is a very great convenience in any serious work, especially if it can be removed at will and if it can be rotated to line up the dividing lines as required. For example, the slope of a wave at any given point can be measured easily in this way.

Aluminium Supports

In the prototype four strips of aluminium are fixed to the inside edge of the hole in the front panel and bent at right angles so as to project at right angles to the panel. These act as supports and guide for the graticule, which is made in the following way.

A tin in good condition is selected from the domestic waste; its diameter should be quite close to 6·25 in.. This is cut short if necessary so that the bottom and about 1in. of the side is retained. A hole about 5·5in. diameter is cut in the bottom, and any sharp or jagged edges removed carefully. Light tapping with a small hammer may be useful, against a hard backing, to achieve a smooth and professional looking finish.

Scribing the Graticule

A circle of Perspex is now cut so as to fit snugly inside the tin, and is ruled carefully with a scriber point with lines 1cm apart in two directions at right angles. A grid of lines 1cm apart is thus produced. These lines may now be inked with black ink, very carefully lest thick lines result. The Perspex disc is now bolted into position in the tin, and the four aluminium strips projecting from the front panel may be bent slightly so that the graticule is held firmly in position. If necessary the aluminium strips may be cut down a little so that the graticule lies as near as possible to the tube face without touching it. It may be that a suitable polish tin will be available, and if it has a rounded rather than a wired edge the appearance will be improved.

CONTINUED NEXT MONTH

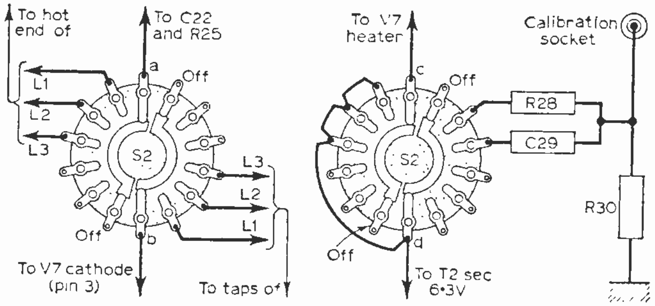
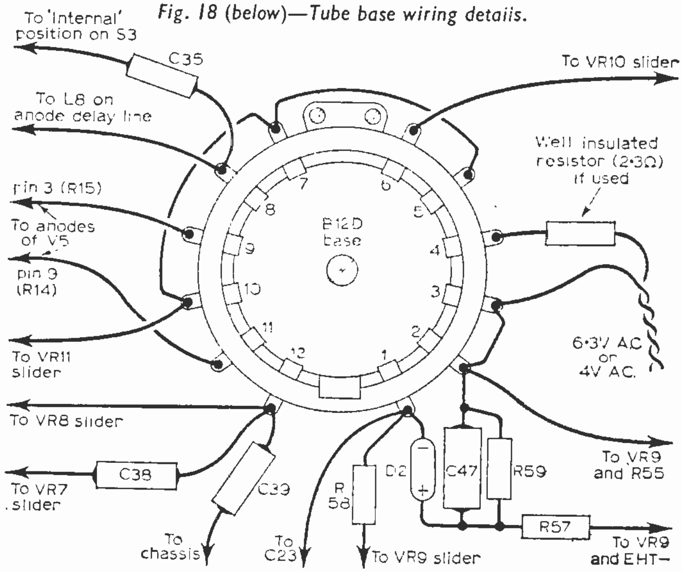


Fig. 17 (above)—Wiring details of S2.

Fig. 18 (below)—Tube base wiring details.



TOWARDS 625 LINES

—continued from page 540—

line scanning coil coupling capacitor fails to improve the 625-line performance (try also altering the value of any capacitor connected in parallel with the line scanning coils or in parallel with the width and/or line linearity inductor), then one may consider using a really up-to-date circuit.

Such a circuit is shown in Fig. 13. Here the Mullard PL500 line output valve, the PY800 booster diode and the EY86 e.h.t. rectifier valve are employed. The amplifier is driven direct from the line multivibrator (see Fig. 11) and it also features stabilisation.

A proportion of the line flyback pulse is rectified by the non-linear resistance Type VV117, and the d.c. voltage developed across C3 is fed back to the control grid of the line output valve V15 rather like an a.g.c. potential. If the stage is heavily loaded due, for example, to excessive beam current on a peak white picture, the rectified pulse voltage fed back is less than when the stage is only lightly loaded. The reduction in voltage at the control grid effectively "turns up" the stage power and thus counteracts the extra heavy loading. The converse happens as the load is decreased and the picture becomes less bright. In this way good e.h.t regulation is maintained, as also is the scanning power in the event of fall in h.t. line voltage.

A transformer suitable for this application and numbered as shown is available, together with matching scanning coils. The preset resistor R1 is for setting the optimum point for the stabilisation. This preset also affects the width to some extent.

Care must be taken when completely rebuilding the line output stage, for modern transformers and valves in a circuit such as that of Fig. 13 produce scanning power suitable for 110° wide-angle picture tubes and an e.h.t. up to 18kV, both of which may be too much for the older style tube used in the experimental chassis. If possible, a reasonable line scan should be obtained by making adjustments to the third harmonic tuning and to the scan coupling circuits, as already described. The new circuit as shown in Fig. 13 could possibly be accommodated advantageously in a more recent model undergoing conversion to 625-line operation.

CONTINUED NEXT MONTH

PRINCIPLES AND PRACTICE OF COLOUR TELEVISION

PART 3

BY G. J. KING

CONTINUED FROM PAGE 492 OF THE AUGUST ISSUE

SO far we have studied the basic principles of colours and we have seen how they can be added together and subtracted from each other to produce the many hues. We have also seen how the three primary colours of a televised picture are separated by the camera so as to produce three signals corresponding to the red, green and blue colour information. We ended last month's article by seeing that a picture in full colour can be obtained by feeding each of the colour signals in isolation to red, green and blue picture tubes so that the colour separations are caused to add on a common viewing screen.

This type of system, which uses three separate transmission circuits, is called the "simultaneous colour television system", and since it requires almost three times as much radio space as a monochrome television system it is employed mainly in closed circuit television networks.

Sequential Systems

The type of colour system in use in America and elsewhere and that under experiment in Great Britain is called the "sequential colour television system". This employs only one transmission circuit and instead of the information on the three colours being transmitted simultaneously it is transmitted sequentially. That is to say, the red information is followed by the green information, while the green information is followed by the blue information (though this order of colours may not always apply).

It should be understood at this juncture that contemporary colour television systems do not transmit all the colour information of one complete picture or field (e.g. frame) in one go. The colour information is broken down either into one line (the line sequential system) or even into one picture element (the dot sequential system). The speed of switching from one colour to another is so great that due to the "persistence of vision" the eye "integrates" the sequential sections (lines or dots) into a complete picture in full colour.

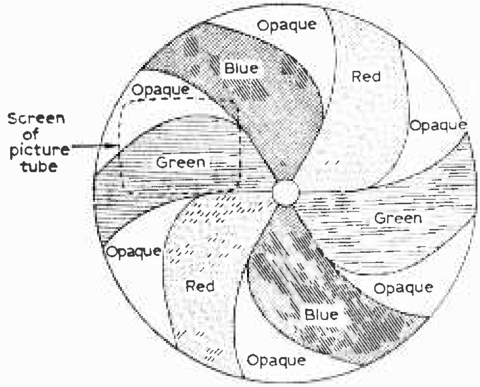


Fig. 15—Colour disc used with the early CBS colour television system. The system employed a normal scanning arrangement coupled to the colour filter viewing disc which was rotated in synchronism with a corresponding disc at the camera.

Scanning Disc System

One of the first colour vision systems adopting the sequential technique made use of a so-called "colour disc" (see Fig. 15). The camera was set to "view" the scene through the rotating disc while the viewer was positioned to look at the screen of the picture tube through a rotating disc of a similar kind. Both the camera and the picture tube were of the type designed for ordinary monochrome (black and white) television.

The discs carried three sets of colour filters, one for each primary colour, and that at the receiver was kept in perfect synchronism with its counterpart at the camera by a special synchronising signal.

With the system developed by the Columbia Broadcasting System of America successive frames were scanned in the colour sequence, red, blue, green, red, blue, green and so on. Normal interlacing was used and a complete picture in colour was created every one-twentieth of a second, using six fields or frames. Disc synchronism was achieved by comparing the output voltage of a small generator driven from the spindle of the motor turning the receiver colour disc with a 120c/s signal derived from a timebase operated discriminator circuit. If the speed of the motor turning the receiver disc tended to alter, then a correction voltage was produced by the discriminator, which varied a magnetic brake and thus brought the motor speed back into synchronism. At the correct speed there was zero correction voltage.

To avoid flicker a higher than normal frame timebase speed is required with this system (120c/s was used in the CBS system) and if each frame is to have the same number of lines as a parallel monochrome system, then the video bandwidth requires to be several times above that for monochrome. The system is thus wasteful of bandwidth and in this respect has little to offer over the simultaneous system. By reducing the line frequency from 262·5c/s to 187·5c/s per frame the CBS arranged for their early system to occupy no more radio space than the standard 525-line system but, of course, this resulted in a reduction in the overall definition of the picture.

The mechanical problems associated with the colour disc colour system make it almost a domestic impossibility. It is difficult to visualise a colour disc of about 42in. in diameter spinning in front of a 19in. picture tube! Even a 9in. tube called for a 22in. diameter disc.

Although the scanning disc colour system—which was worked on by Baird as early as 1928—has gone through various stages of development it still remains mostly mechanical and will not be used for future colour systems. One other problem with it is "colour fringing" due to the fact that one complete *field* is scanned in one colour and the following *field* in another colour and so on—requiring six fields (three pairs of colours) to give one complete colour picture, this, then, is really a "field sequential system".

Dot Sequential System

An optical system using the dot sequential technique has been shown by the author (see "A New Idea for Colour TV", Service Engineer supplement of RADIO AND ELECTRICAL RETAILING, December, 1962). This employs a special viewing

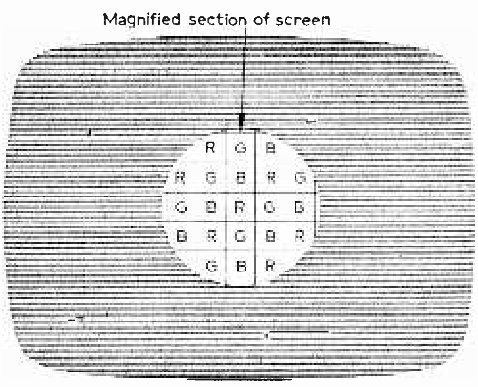


Fig. 16—An optical dot sequential colour system. Special screens composed of a large number of groups of tricolour filters are arranged to register correctly at the picture tube in relation to a smaller scale screen at the camera tube.

screen in front of the receiver and a similar, reduced scale screen at the camera.

Each screen is composed of a large number of closely-spaced groups of red, green and blue filters (Fig. 16). The scene viewed by the camera is thus "colour coded". For example, red picture elements pass through the red filters, green ones pass through the green filters and blue ones pass through the blue filters. With combination colour, of course, light passes through the red, green and

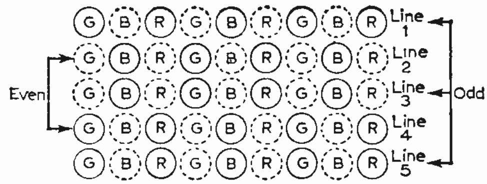


Fig. 17—The colours in the full-line circles occur in field one on odd lines and in field two on even lines, while the colours in the broken-line circles occur in field three on odd lines and in field four on even lines. This double scanning artifice causes the interlacing not only of adjacent fields but also of adjacent colour dots or elements. Dot interlacing increases the picture definition for a given bandwidth.

blue filters in accordance with the colour make up, as does white light.

The video signals derived from the ordinary monochrome camera are thus "modulated" with pulses corresponding to the colours in the picture. Viewed on a monochrome set, therefore, a signal so encoded appears to be composed of a fine mesh of extremely small, monochrome squares which are invisible at normal viewing distance. However, when this same picture is viewed through the filter it resolves in full colour.

The foregoing explains the basic principles only. There are several snags and problems in terms of colour indexing at the extremes of the scan, of "locking" the colour index, of bandwidth, definition and so on; the system is still in the experimental stages on a closed-circuit network. Nevertheless, it serves as an adequate introduction to the basic dot sequential technique.

Contemporary colour systems are also based on the dot sequential system, incorporating dot interlacing, but the function is essentially electronic as distinct from the previously described optical arrangement.

At the transmitting station the colour camera tubes are switched from one to the other over each picture element so that we get, say, a signal from a dot of green picture element, followed by a signal from a dot of red picture element, followed by a signal from a dot of blue picture element and so on.

Lines one, three, five etc. of an "odd" field are scanned in the normal monochrome manner with the signals changing in terms of colour along the lines, as described. This scan is then followed by an interlaced scan (as in monochrome systems) made up of lines two, four, six and etc. of an even field.

These account for a normal interlaced picture over two fields (one and two), but to get the colour dots themselves to interlace, the dots are displaced horizontally one picture element on the next two fields (three and four). The idea is illustrated in Fig 17, where the colours in full-line circles are in field one on odd lines and in field two on even lines, while the colours in the broken-line circles are in field three on odd lines and in field four on even lines.

Line Sequential Systems

For the sake of completeness we will just look in at the line sequential system of colour television.

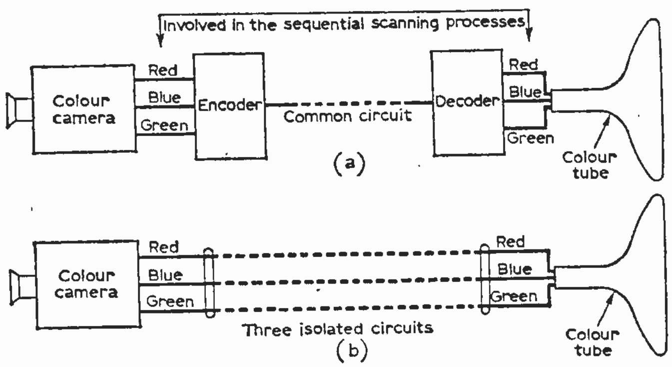


Fig. 18—Colour-wise the sequential system at (a) is similar to the simultaneous system at (b). See text.

Here the colour is changed or switched over the common circuit from the camera not at field frequency, as in the colour disc system, nor at element frequency (3 to 4Mc/s), as in the dot sequential system just described, but at line frequency. There are various methods and sequences of colour scanning at line frequency, but none of these permit a satisfactory system; not only is line registration difficult but interlace flicker is also bad. For these and other rather technical reasons, the line sequential system is no longer considered a feasible proposition for colour television.

Field sequential is out for mechanical reasons, as discussed earlier; line sequential is out for slightly different technical reasons, so it means that only the dot sequential system is left, and, as already intimated, it is this which is used in the current systems using a radio transmitter.

Before we go on, let us get a few things clear in our minds. A sequential arrangement is required *only* when a colour system is to be transmitted over the air. All the factors that we have discussed with regard to sequential scanning, therefore, have nothing at all to do with the formation of the colour picture! They simply create a method whereby the monochrome plus the colour information may be injected into a common circuit or radio network.

At the receiver we have still got to restore the signals corresponding to the original colours, such as the output video from the colour camera system. These signals are required to apply either to three separate colour picture tubes (e.g. monochrome tubes with colour filters in front) or to the three guns of a tricolour picture tube, such as the shadow-mask tube.

At the station end there is an "encoder" which, in effect, switches the colour information into a common circuit at the sequential frequency, while at the set end there is a "decoder" which separates the colour information fed sequentially over the common circuit and restores the basic colour signals for application to the colour display device —see Fig. 18(a).

With the simultaneous system exactly the same things happen colour-wise, but with three isolated circuits and no encoder or decoder—Fig. 18(b).

Next month we will look at the shadow-mask colour picture tube and this will be followed by details of the transmitting and receiving techniques.

Part 4 will deal with the heart of the modern colour receiver—the shadow-mask tube.

SERVICING TV RECEIVERS

—continued from page 543—

knobs and remove knobs. Remove panel or escutcheon. Remove the two 2B.A. screws at rear of base-board and push cabinet shell forward and then back.

Then remove front control knobs as follows. Rotate the knob until a slit is observed in the shaft behind the indicator disc. Insert a narrow screwdriver blade through the slot and behind the spring clip. Pull the knob off easing the clip with the screwdriver so that it doesn't bite on the shaft.

With the knobs removed the cabinet can then be eased forward until it is clear of the receiver.

Adjustments

The mains adjustment provides two voltage ranges: 200—220V and 230—250V. If the receiver is to be used on 220V or 250V, which are the upper limits of the two settings, an additional ballast resistor is provided on the chassis near the mains input, R130, and this is brought into the circuit by removing the shorting link across it, or simply cutting the wire.

Picture Squaring

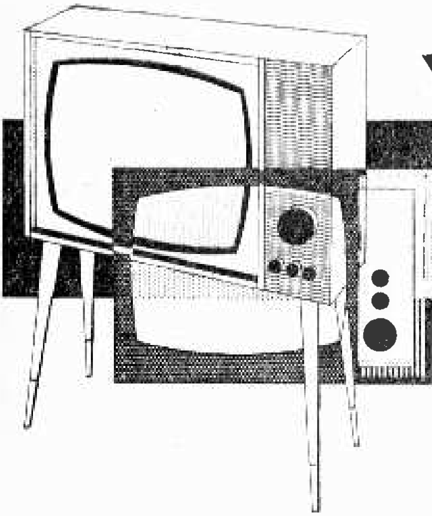
Slacken off the brass locking screw on the deflector coil clamp assembly and rotate the complete assembly as required, keeping the assembly as far forward as possible to avoid corner shadowing. Tighten locking screw after adjustment.

Picture Shift

The picture may be moved by rotating the shift clamp around the tube neck. The small knob on the clamp varies the extent of the movement.

This device must be kept well up to the scanning assembly as it tends to affect the optimum setting of the ion trap magnet on the rear of the tube neck which is always set for maximum brilliance. ■

SERIES CONTINUES NEXT MONTH



Your Problems Solved

Whilst we are always pleased to assist readers with their technical difficulties, we regret that we are unable to supply diagrams or provide instructions for modifying surplus equipment. We cannot supply alternative details for constructional articles which appear in these pages. WE CANNOT UNDERTAKE TO ANSWER QUERIES OVER THE TELEPHONE. The coupon from p. 571 must be attached to all Queries, and a stamped and addressed envelope must be enclosed.

ULTRA V72

The picture and sound are normally good on both channels. On occasions however, the picture disappears leaving the raster with a ragged edge on the right. Sometimes a very weak picture is left, but which rolls very fast. The sound remains unaffected. The picture may be restored by turning the channel selector switch on to another channel and then back again.—R. Wiseman (Wednesbury, Staffordshire).

When the vision fault occurs, try tapping the neck of the tube with the handle of a screwdriver. If this restores vision, suspect a heater/cathode short in the tube.

INVICTA T114

This set has recently developed a fault in the line oscillator section. I can excite this into oscillation by touching the grid of the pentode section of V16. It will then continue to work until the set is switched off again. I have substituted three ECL80's and changed R87, R89, R90, R91 and C62, all to no effect.

When V16 is working, all the voltages are correct. — F. G. Denton (Lee-on-the-Solent, Hampshire).

Suspect poor insulation in the frame blocking oscillator transformer.

DEFIANT 41

The trouble is a splitting of the picture, occurring at a camera change, a programme change or, on ITV, at a break for commercials. The picture can be temporarily restored by adjusting the line hold control.

Occasionally the picture breaks up completely and then it is only possible to restore the picture by switching the set off for a few minutes.

I suspected the valve 6/30L2, and being unable to obtain one, used its equivalent (a B729) as a substitute. However, this only gave a complete break up of picture and which was impossible to correct.—A. Gill (Doncaster).

The B729 is not quite the same as the original valve. However, you may be able to balance the line hold control with the B729 by setting the line hold control to the centre of its range and then altering the value of the resistor connected to the line hold control until correct line lock is secured.

PHILIPS 492U/15

With the height control at maximum, the picture fails to fill the screen by $\frac{1}{2}$in. top and bottom. The picture varies from being clear to blurred with the focus control set at maximum.

The screen can nearly be filled by advancing the brightness or contrast controls, but then the blurred effect worsens.

Also, after this set has been on for about eight minutes, the picture starts to roll, and will lock for short periods of time only.—B. C. Perkins (Birmingham).

Low h.t. line voltage should first be suspected, and in this connection we would advise a check of the h.t. rectifier valve. If this is normal, then there could be two separate faults. One in the frame timebase and the other a low emission e.h.t. rectifier. The latter can be checked by valve substitution, and the former, apart from checks of the frame valves, may require more detailed tests on the associated components.

K.B. KV 35

Some three months ago the picture started to " tear " on both BBC and ITA, but more severely on BBC. By substituting valves. I have improved it slightly and in fact, it seemed to be all right for three or four weeks, but recently it has started again. Changing valves and a check on resistor and capacitor values has not revealed the fault.

It is now only " tearing " on ITV, and is the

worst in the top half of the picture.—D. J. Nun (Dartford, Kent).

If the picture, apart from the tearing effect, is of normal contrast, check the sync separator valve and associated components. A leak in the capacitor connected to the control grid of the sync valve sometimes causes the symptom described.

PHILIPS 1114U/15

Since fitting a Cyldon P10L tuner to this set, I can receive ITA programmes perfectly but the BBC will not tune sound and vision together; it is either good sound and no vision or vice versa. I have tried adjusting the coil cores of both the tuner and the set but without improving the situation.—D. G. Fitch (Tunbridge Wells, Kent).

This trouble indicates that the sound and vision i.f. stages of the receiver are somewhat out of alignment. They were probably adjusted at one time for optimum BBC reception before the tuner was installed. Before abandoning the exercise, it would be as well to have the overall alignment attended to.

PYE V4

This set's c.r.t. is showing signs of weakness and I would like to install a new 17in. tube. I would also like to fit a channel tuner. I would be obliged if you could advise me as to what tube and tuner would be suitable in each case.—S. J. Deago (Wallasey, Cheshire).

This receiver will accept a 17in. MW 43/69 without electrical modification.

The easiest tuner to fit is the Brayhead 16S, and if you are in a weak signal area, we advise you to wire it into the circuit rather than use the plug-in method. This enables the former mixer to be used as an extra I.F. stage.

MURPHY V214

Whilst replacing the volume control on this set, I noticed the remains of some form of surge limiter with a low value resistor wired in parallel, situated above the smoothing choke. They are wired between the switch and the voltage selector. I later discovered that these two components were not shown in the original wiring diagram.

I would be most grateful if you could tell me what these components are and what form of surge limiter could be fitted in this position.—W. J. Hardy (Slough, Buckinghamshire).

The surge limiter you mention was an afterthought added in later production. By using a Mullard VA1015 you can replace both the limiter and its shunt resistor by the one component.

PHILIPS 1115U-15

I have a Brayhead 10S turret tuner which I wish to fit to this receiver. At the moment there is one plug fitted to the multi-lead. Could you please give me any instructions for carrying out this operation?—J. Bowman (Wallsend-on-Tyne).

Connect a short PVC lead from a Brayhead 10BA1 adaptor plug (which is required for the "plug-in" conversion) to an earth point as near the mixer valveholder as possible. Remove the cap from the adaptor plug. Cut the shorting link between pins 6 and 7 from pin 6. Remove the shorting link between pins 1 and 8. Remove the EF80 r.f. valve and the EF80 mixer valve from the set and plug the adapter into the mixer socket. Finally, insert the r.f. plug (this should be a type 9BA for this receiver) into the r.f. valveholder.

PYE VT17

The picture will suddenly wobble sideways and distort. This affects both channels and happens about every five minutes.

The tuning and horizontal hold controls have no effect on the situation and the aerial which has been checked with another receiver, is in working order. The sync separator and line oscillator valves and the discriminator diodes have been replaced, as has the h.t. metal rectifier.—A. J. Hardy (Norwich).

The PCF80 line oscillator valve should be replaced. This is at the back of the set near the mains plug.

ALBA

I have recently had a reconditioned tube fitted to this set and now there is a double image on the screen. Also this set, which has been free from faults for some years, now takes about half-an-hour to warm up.—J. B. Howe (South Shields).

Change the PCF80 line oscillator valve which is just to the right of the tube as viewed from the rear.

PYE CTM4

The picture suddenly split in two with the right hand half of the picture occupying the left hand part of the screen and vice versa. The picture itself is not clear and sharp as it should be, and there is streaking and stretched distorting as well.

I have changed the sync separator, oscillator and line output valves but with no result, and have checked or substituted most of the capacitors associated with the oscillator valve.—T. W. Coates (Birmingham 16).

We suggest you check the 3·3kΩ screen grid feed resistor to the PL81, and also its 25μF cathode bias bypass capacitor.

K.-B. N.V.40

The line hold control is very critical on this receiver. At its mid-way position an unsteady picture can be held for a short time, after which it jumps to a false line lock. The picture then breaks up into a multiple of images across the screen. This situation may clear itself up after a short period of time or else re-setting of the line hold control may correct the fault. But this fault will always re-occur.

The line output, line multivibrator and sync separator valves have been replaced. The line hold and linearity controls have also been replaced.

I suspect the line multivibrator valve, as I have found that these double-triodes can be very critical.—A. Gillies (Campbeltown, Argyll).

We agree that the line multivibrator is a weak point and a new valve (12AU7 or ECC82) should be fitted. However we are more inclined to suspect the 12AT7 a.f.c. cathode follower and detector and associated components. Since you

do not mention this valve and stage, we must advise you to check them thoroughly.

BUSH TV83

After replacing V5 (PCF80) which appeared to be overheating, a very weak picture developed and also a loss of sync. Operation of the contrast control has no effect whatsoever.—R. Hewson (London, S.W.19).

An internal short in V5 can damage the OA70 vision detector crystal diode and this is probably what has happened. Another possibility is, however, that the 33kΩ resistor from h.t. (pin 3) to pin 7 may have decreased in value and also damaged the 220Ω bias resistor.

SOBELL T21

The horizontal hold has gone completely on this receiver. I have checked all the valves without finding any at fault. I have adjusted the coil at the bottom of the chassis but I am unable to lock the picture.—A. Hunt (Great Yarmouth, Norfolk).

You should check the front right side ECC82 as viewed from the rear. With a new valve fitted, apply the hold key and adjust the core of the front right side oscillator transformer to make the picture hover. Release the key to lock the picture.

If there is no locking pulse, check the nearby PCF80 and associated components.

QUERIES COUPON

This coupon is available until SEPTEMBER 19th, 1963, and must accompany all Queries sent in accordance with the notice on page 567.

PRACTICAL TELEVISION, SEPTEMBER, 1963

FERGUSON 546T

The fault is vision-on-sound which occurs on both BBC and ITA. When a good picture is tuned in on the fine tuner, a harsh hum can be heard. I have checked both tuner valves and also the vision and sound circuit valves. I have tuned the oscillator coils and the i.f. transformers. The main electrolytic capacitors have also been tested and found to be in working order.

The fault first occurred after I had replaced the sound output transformer and thermistor.—J. Mathews (Forest Gate, London).

This could be modulation hum as distinct from vision-on-sound. In the latter case misalignment, overloading or a tuner fault would be responsible, and such is not likely to have happened from simple sound transformer replacement. However, the former could result from a badly misplaced wire in the audio channel or due to breakdown of a filter capacitor.

TEST CASE -10

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.

? *After replacing the line output transformer of a well-known receiver, an experimenter was amazed to find that the interlace performance was very much impaired. Prior to the replacement, it was possible to secure an almost 50:50 interlace over the entire locking range of the control while after the repair critical frame hold adjustment was required to obtain even something like a 40:60 interlace. Most of the time bad pairing was in evidence.*

What is the most likely cause of this trouble, and what factors should first be examined.

See next month's PRACTICAL TELEVISION for the solution to this and for another problem.

SOLUTION TO TEST CASE 9

(Page 523 last month)

Last month the symptom of corona was revealed. Since the white, horizontal lines across the picture remain in a definite pattern—often in a vertical column—one can be sure that the corona or flashover is occurring at line timebase frequency.

The classic cause of this symptom is poor insulation between the windings of the line output transformer, and in seven out of ten cases the transformer is responsible and replacement is required for a complete cure. The corona or flashover takes place at almost exactly the same time during each line cycle and for that reason the interferences dashes or lines are placed pretty well evenly below each other—e.g., at the same place on each line.

Corona or discharge after the e.h.t. rectifier—after the pulse voltage has been rectified—causes random white spots on the screen, as distinct from "synchronised" dashes or lines. It is thus easy to tell whether the discharge is before or after the e.h.t. rectifier.

Note, however, that pulse voltage exists at high level in several areas of the line output stage and poor insulation in any of these could cause similar symptoms; and these account for the remaining three out of ten cases of the trouble. In particular, the connections from the line output transformer to the line scanning coils (especially if screen cable is used), the width and linearity inductors and associated components and the circuits connected to the anode of the line output valve and the cathode of the booster diode should be checked very carefully.

Unfortunately, a conclusive proof of the fault often demands the trial replacement of a suspect part.

Published on the 22nd of each month by GEORGE NEWNES, LIMITED, Tower House, Southampton Street, London, W.C.2, and printed in England by WATMOUGHS LIMITED, Idle, Bradford; and London. Sole Agents for Australia and New Zealand: GORDON & GOTCH (A/sia), Ltd. South Africa and Rhodesia: CENTRAL NEWS AGENCY, LTD. East Africa: EAST AFRICAN STANDARD LTD. Subscription rate including postage for one year: To any part of the World £1.9.0.

BOOKS REVIEWED

INTRODUCTION TO TV SERVICING

By H. L. Swalluw and J. van der Woerd; published by Centrex Publishing Company and distributed in the U.K. by Cleaver-Hume Press Ltd., 10-15 St. Martin's Street, London, W.C.2.

272 pages, 8in. x 5½in. Price 45s.

THIS is the second (enlarged and revised) edition of this work, which appeared originally in 1955. The authors have taken the opportunity to bring the book completely up-to-date and the descriptions of servicing techniques are based on tests made on the latest TV receiver available.

The book is aimed at service engineers with a good knowledge of basic radio principles and practice who wish to acquaint themselves with TV servicing. The authors surely intend this to be a yardstick rather than a literal division for there can hardly be many practising service men who are not familiar to some degree with TV work. The statement however serves to indicate the approach and the degree of knowledge required for the prospective reader.

The "meat" of the book is preceded by a section devoted to a technical explanation of receiver operation and this is based on a modern circuit which is provided as a loose-sheet in a folder. This is very lucid and (most important) includes a description of the intercarrier sound system and other modern developments.

The remainder of the book describes fault finding stage-by-stage and is essentially practical with full details of the use of test gear. It is lavishly illustrated with oscilloscope traces, picture faults, bar patterns, etc. The book will be of pertinent interest to service engineers inasmuch as it deals exclusively with CCIR transmission and reception and will be very helpful in dealing with the dual-standard receivers now appearing on the market.—D.C.

TRANSISTOR TELEVISION RECEIVERS

By T. D. Towers, M.B.E., M.A., B.Sc., A.M.I.E.E., Grad.Brit. I.R.E.; published by Iliffe Books Ltd., Dorset House, Stamford Street, London, S.E.1.

194 pages, 9¾in. x 7in. Price 55s.

NOW that transistor TV receivers are beginning to prove practicable, this book will be of considerable interest to both designers and the keen amateur enthusiast. Basically, the author (Chief Applications Engineer of Newmarket Transistors Ltd.) has gathered together information on transistor TV sets from all over the world—Britain, U.S.A., Germany, Russia, Japan—and contrasted and compared the designs for each section of the receiver. Nearly 190 diagrams are included, from single stages to complete receiver sections.

Apart from the main chapters, Mr Towers includes an introductory chapter setting the scene and concludes with a useful chapter on servicing transistor TV receivers. This is the first book of its kind and will undoubtedly be well-thumbed by those wishing to keep abreast of current developments and to prepare for the future.—W.N.S.

TRADE NEWS

New Range of U.H.F. Aerials

THE introduction of Aerialite's Golden Gain range of u.h.f. television aerials has been marked by the incorporation of a new technique in multi-element aerial design. This technique takes the form of a 5-element "Add-on" boom, having one end sleeved to fit over the end of the main aerial. Thus it is possible with this unit to convert the six, eleven and eighteen element arrays to eleven, sixteen or twenty-three element aerials. This may be desirable where extra signal strength is required.

The boom of the aerial is made from aluminium of rectangular cross-section, and this carries the solid aluminium rod elements. The wide-band planar folded dipole is pressed out of sheet metal, angled for strength and is accurately impedance matched to the downlead.

All the aerials in this new range are gold anodised to resist corrosion and to provide an attractive finish. The manufacturers are *Aerialite Limited, Hargreaves Works, Congleton, Cheshire.*

ALL TELEVISION, TAPE RECORDER & RADIO COMPONENTS SUPPLIED

LINE OUTPUT TRANSFORMERS. All popular types available brand new exact replacements, fully guaranteed. A selection from our stock:

PHILIPS 1768, 2168, STELLA 8617, 8917 etc. 90/-
MURPHY 240, 250 55/-. 280, 310, 410 etc.... 59/-
EKCO T164 to 383 (U25 types) 55/-. (U26 types) 57/-
FERRANTI T1001 to 1023 etc. (U25 types) 55/- (U26 types)... ... ... 57/-
FERGUSON 306 to 606 etc., **PHILCO** 1000 etc. 67/6
PYE V4, V7, V14, VT17, CTM17 etc. ... 53/-
HMV 1840 to 1854 60/-. 1865 to 1921 ... 67/6

ALSO L.O.T.s Available for

Alba	Marconi
Bush	Pam
Cossor	Pilot
Decca	R.G.D.
Defiant	Regentn.
G.E.C.	Sobell
K.B.	Ultra
Invicta	Etc.

Postage & Packing for above L.O.T.s 3/6. C.O.D. 2/6 extra.

★ **Also available for all sets** ★

SCAN COILS. Frame output transformers, line and frame oscillator trans. width/linearity coils, sound output trans., mains trans., control knobs, electrolytics. Rectifiers, dual vol. controls, tuners, etc

C.R.T.s—Rebuilt with new guns by long est. Nat. Co. Gtd. 12 mths.

MULLARD, MAZDA, BRIMAR, EMISCOPE 14in.	£4 7 6	Plus
MULLARD, MAZDA, BRIMAR, EMISCOPE 17in.	£4 10 0	Carr
MULLARD, MAZDA, BRIMAR, 21in............	£6 10 0	10/-

TAPE RECORDER/CHANGER SPARES. Drive belts, heads, pulleys, motors, styli, etc., for most British and some foreign makes.

SPECIAL OFFER. Rexine covered tape recorder cabinet, size 13½ x 12 x 8in., 15/-, plus postage and packing 5/-.

TUNER UNITS. Fireball, incremental and turret types—replacement service available.

STANDARD COMPONENTS. Resistors, Capacitors, Electrolytics, Drive Cord, Pilot Lamps, Vol. Controls, Presets, Ion Traps.

SALVAGED COMPONENTS. Large selection available including tuner units, loudspeakers, transformers, valves etc.

CAR ALARM. Complete fool proof, easy to fit unit 59/6, p.p. 2/6.

Your enquiries welcome, prices by return; or prompt despatch C.O.D.

MANOR SUPPLIES

64 Golders Manor Drive, London, N.W.11

Tel. STO 5667 SPE 4032 (8.30-10 p.m.)

Better, Brighter Picture Tubes

BRAND NEW THROUGHOUT

excepting glass

12in.	£4.10.0	14in. ...	£5. 5.0
15-17in. ...	£5.15.0	21in. ...	£7.15.0

New Silver Screen and Aluminising. All makes Mullard. Mazda, Emiscope, Cossor, Brimar, Emitron, etc.

REBUILT MULLARD AND MAZDA TUBES

12in.	£3. 0.0	14in. ...	£4. 0.0
15-17in. ...	£4.10.0	21in. ...	£6.10.0

All Tubes Fully GUARANTEED 12 MONTHS. Dispatch same day. Cash with Order. Carriage and Insurance 10/-.

S.T.S. Ltd.

35 POUND STREET, CARSHALTON, SURREY

Telephone: WALLINGTON 9665

EXCEL in ELECTRONICS

Through this ICS 3-way Training Method:

1 MASTER THE THEORETICAL SIDE

From basic principles to advanced applications, you'll learn the theory of electronic engineering, quickly and easily through ICS. That's because each course is set out in easy-to-understand terms.

2 MASTER THE PRACTICAL SIDE

ICS show you how to develop your practical abilities in electronic engineering—*alongside* your theoretical studies. It's the only sure way to success. All training manuals are packed with easy-to-follow illustrations.

3 MASTER THE MATHEMATICAL SIDE

To many this aspect is a bitter problem. Even more so because no electronic engineer is complete without a sound working knowledge of maths. But new ICS teaching makes mathematics easier to learn.

THERE IS AN ICS COURSE FOR YOU!

For your career or your own business courses are available in:

Radio and Television Engineering, Industrial Television, Radio and Television Servicing, VHF/FM Engineering, Electronics, Computer Technology and Programming, Electronic Technicians, Servomechanisms, Telemetry, Instrumentation, Principles of Automation and Calculus for Electronics.

And for your hobby, there are practical "learn as you build" radio courses as well.

Member of the Association of British Correspondence Colleges.

POST THIS COUPON TODAY FOR **FREE** *BROCHURE TO:*

I.C.S., Dept. 163, INTERTEXT HOUSE, PARKGATE RD., LONDON, S.W.11

NAME ....

ADDRESS ....

....

OCCUPATION .... AGE 9.63

INTERNATIONAL CORRESPONDENCE SCHOOLS

RATES: 4/- per line or part thereof, average five words to line, minimum 2 lines. Box No. 1/- extra. Advertisement must be prepaid and addressed to Advertisement Manager "Practical Television", Tower House, Southampton St., London. W.C.2.

SETS & COMPONENTS

SALVAGED VALVES TESTED ON A MULLARD HIGH SPEED VALVE TESTER

AC/P	2/6
B36	2/6
B329	4/-
D1	2/6
D36	2/6
D77	2/6
DAF91	4/-
DD4	2/6
DD41	2/6
DDL4	2/6
DF91	4/-
DH77	4/-
DK91	4/-
EA50	1/3
EB34	1/3
EB41	1/3
EBC33	2/6
EBC41	4/-
ECC33	2/6
ECC34	2/6
ECC81	4/-
ECC82	4/-
ECL80	4/-
EF50	1/3
EF80	2/6
EF91	1/3
KT33C	1/3
KT61	2/6
KTZ41	2/6
L63	2/6
N308	4/-
N329	4/-
N339	4/-
N369	4/-
N379	4/-
P41	2/6
P61	2/6
PCC84	5/-
PCF80	5/-
PCL82	4/-
PCL83	5/-
PEN45	2/6
PEN46	2/6
PL33	4/-
PL81	5/-
PL82	4/-
PL83	4/-
PL84	4/-
PY31	4/-
PY81	4/-
PZ30	2/6
SP41	1/3
SP42	2/6
SP61	1/3
U31	4/-
U251	4/-
U329	4/-
UF42	2/6
VP4	4/-
W77	2/6
Z63	2/6
Z66	2/6
Z77	1/3
Z90	1/3
Z719	2/6
4TPB	2/6
6AL5	2/6
6AM6	1/3
6BW7	4/-
6BX6	2/6
6C6	4/-
6D6	4/-
6F12	1/3
6F13	1/3
6J5	2/6
6J7	2/6
6P25	2/6
6P28	2/6
8D3	1/3
9D6	2/6
10F1	4/-
10P13	4/-
10P14	2/6
12BH7	4/-
20F2	4/-
20P1	2/6
20P3	4/-
20P5	4/-
25L6	2/6
30C1	5/-
30C15	5/-
30L1	5/-
30PL1	4/-
30PL13	4/-
32	2/6
42	2/6
43	2/6
807	4/-

EXAMPLES

FULL CATALOGUE 9d.

VALVE HOLDERS

American Octal .. .. 5/- doz.
Noval .. .. .. 9d. each

RESISTORS

Card of ½W Resistors. 72 values covering complete 10% range. 24/- per card.
Full range of separate Resistors, Condensers, etc.

VARIABLE CONDENSERS

3-50pf concentric trimmers 3/- doz.

GEC CRT'S (SALVAGED)

SPECIAL OFFER

12in. G.E.C. 7102 .. 10/- ea.
Personal Callers Only
35 M/cs, 16 M/cs 10 M/cs. INCREMENTAL OR TURRET TUNERS LESS VALVES. EX-RECEIVERS 12/6.
We can often supply for the actual set you want the tuner to fit. But cannot guarantee what channels are fitted.

TRANSFORMERS

CRT Boost Transformers. 2V, 4V, 6V, 10V, 13V. State which required. 12/6 ea.
Heavy Duty Output Transformers. 6 ratios from 13 : 1 to 43 : 1 .. .. .. 25/- ea.
Miniature Output Trans... 3/9 ea.
Standard Output Transformers, Multi-match .. 10/- ea.
Transistor Driver: 1-1 CT 10/- ea. 3.6-1 CT 12/6 ea.
Transistor Output: 6.6-1 CT 10/-ea. 9.2-1 CT 10/-ea.
Microphone Transformers, ratio 65 : 1.. .. .. 35/- ea.

I.F. TRANSFORMERS

Standard 465 kc/s.. 12/6 per pair
Midget 465 kc/s .. 16/- per pair

AUTO TRANSFORMERS

250W .. .. .. 67/6 ea.
100W .. .. .. 27/6 ea.
50W .. .. .. 20/- ea.

TRANSISTORISED FAULT FINDER

Enables faults to be located quickly. Consists of a two-transistor, multi-vibrator in a box. Complete with battery. 32/6

CRYSTALS
GENUINE MULLARD. Boxed

OA5	6/-	OA81	3/-
OA70	3/-	OA85	3/-
OA79	3/-	OA91	3/6

TRANSISTORS

OC16W	48/-	OC72	8/-
OC19	48/-	OC75	8/-
OC26	25/-	OC76	8/-
OC44	11/-	OC78	8/-
OC45	10/-	OC81	8/-
OC70	6/6	OC82	18/-
OC71	6/6	OC170	17/6

TERMS: C.W.O. or C.O.D.

Orders under £1, P. & P. 1/3.

Open till 11 p.m. most days.

3d. stamp for list or 9d. for full catalogue

Dept. PTA

Arion Television

Maxted Road, S.E.15 NEW X 7152

SETS & COMPONENTS
(continued)

"HEATHKITS" can now be seen in London and purchased on H.P. Free Brochure. DIRECT TV REPLACEMENTS LTD., 126 Hamilton Road, West Norwood, SE27. GIPsy Hill 6166.

TELEVISION TUBES

TWELVE MONTHS' GUARANTEE

TUBES FOR ALL British-made Sets available from stock.

BUY DIRECT — BUY CHEAPER

	£	s	d
12in. Types, now only	3	2	6
14in. „ „ „	4	2	6
15in. „ „ „	5	2	6
16in. T 901 MW 41-1	5	2	6
17in. Types now only	5	2	6
21in. „ „	6	2	6
19in. latest 110 degree	6	17	6
23in. „ „ „	7	12	6

Carriage British Railways passenger 12/6. Deposit £2.12.6, balance £1 monthly.

CATHODE RAY TUBE SERVICE

35 Broomwood Road, St. Paul's Cray Kent.

Phone: Orpington 21285

HENLOW OSCILLOSCOPE. S.A.E. for free component list. AJAX ELECTRONICS, 572 Fulham Road, London SW6.

TV SPARES

Fully Guaranteed Makers Parts.
Telephone orders sent same day.
Line Output Transformers.

Ekco T221, 231, 311, 284, TC208, T310, T331, T327, TU209, T248, TC267, all **62/6.**
Ferranti T1001-5, **62/6;** 14T3-6, **47/6.**
Murphy V240/250, **62/6;** V270/280, **79/6.**
Pye V4-7, UT4-7 and **Pam** 906-53, **55/-.**
H.M.V. 1840-9, 2805-5902, only **62/6.**
Bush TV53, **79/6;** TV24C, TV80 etc., **89/6.**
Philips 1768U, **92/6;** 1114-5, 1437-46, **89/6.**
Masteradio T917, TE7T, T409-12 etc., **75/-.**
Alba T301, 304, 394, 484, 494, **55/-.**
Cossor 930-8, **58/6; Ferg.** 992-8, **62/6;**
Baird P2014/7, 21147, **59/6.**
L.O.P.T.s. FOR ANY MAKE and MODEL supplied. USED trans., often available, ask for quote. SCAN COILS.
Ekco T221, T231, etc. **Pye VT4-7,** both **50/-.**
Used 14in. ex-Rental 13 Ch. sets: **Pye/ Ferg./Sobell, 10/-** each. MIN Lots of **20.**
Lots of 6 for **£5.** (Callers only).
110 Con. Kit, **125/-;** 625 LOP, **90/-.**
Double-Six Transistor, comp. with leather case, bat. earphone, etc., limited supply **82/6.**

Free Insurance and Quantity discounts
Callers Welcome. Open all day Saturdays
Terms: C.W.O. or C.O.D. Post & Pack 4/-

TELEVISION CONSUMER SERVICES LIMITED

8 CRAY PARADE, MAIN ROAD, ST. PAULS CRAY.

Tel. Orpington 30566, also Rod 7917 autophone.

FOR SALE

BARGAIN OFFER. .New Valves. three months guarantee. Limited supply: PCF80 **6/6,** PCC84 **6/3,** PL81 **7/-,** ECL80 **6/-,** EY86 **6/3,** EY51 **6/3,** ECC82 **5/6,** U25 **7/-,** PY32 **8/-,** EF80 **4/-,** PCL83 **8/6,** PCL82 **7/-.** C.W.O., Post. Insurance Free. S.A.E. enquiries: J. RENNARD, 55 Risholme Terrace. Horsforth. Leeds. Yorks.

1,000 TELEVISIONS, all makes, from **£3** working, **10/-** not. Callers only. 9 till 6. including Sats. 39 Whitehorse Lane, Stepney, London.

METAL RECTIFIERS

RECTIFIERS—CONTACT COOLED
14RA1282 (FC101) type 250 v., 250 mA **13/6;** 12RA1283 (FC31) type 250 v. 300 mA **17/6;** 350 mA, **19/6;** EC1, **13/-;** FC116, **7/6.**
RECTIFIERS—FIN TYPES
Equivas. for RM4 250 v., 250 mA. **13/6;** RM5 250 v., 300 mA, **17/6;** 14A989 400 mA, **18/6;** 14A86 **16/6;** 14A97 **19/-;** 14A100 **22/6;** 14A949 **20/-;** LW7 **17/6;** LW15 **20/-;** EK6 **20/-.**
MULTIMETERS from **39/6.**
Stamped envelope for full latest selection and bargain offers.
Under £1 P. & P. 6d., over £1 Post Free.
NO C.O.D.

DURHAM SUPPLIES

175 Durham Road, Bradford 8, Yorkshire

EXCEPTIONAL TRANSISTOR Portable Tape Recorders, value **£8/19/6,** complete with crystal microphone, earphone, spools, tape, batteries, instructions, presentation box (extra tapes, 100ft **4/6**), ideal gift, **£6/19/6.** Satisfaction guaranteed. Postage packing 2/6. TOMLINS, 156 Lewisham Way, New Cross, SE14.

VALVE CARTONS at keen prices. Send 1/- for sample and list. J. & A. BOXMAKERS, 75a Godwin Street, Bradford 1.

E. R. NICHOLLS

46 LOWFIELD ROAD
Off Shaw Heath, STOCKPORT

BUMPER PARCEL

100 Assorted Resistors.
50 Assorted Condensers.
1 5in. 3 ohm Elac Speaker.
1 Isolating Transformer.
4 Terminal Blocks.
2 Rotary Toggle Switches.
1 Small Chassis containing 60 components.
2 Westectors.
2 Thermistors.
110 Cartridge Fuses.
All for 20/-. Post Free in U.K.
20ft. Steel Telescopic Mast, **50/-.**
High Stab Resistors, **6d.** each.
List now ready for Paper Block Condensers, Valves, Oscillators, Test Sets. S.A.E. Please.
Mail Order and Retail Shop:
46 Lowfield Road, Off Shaw Heath, Stockport, Cheshire.

WANTED

NEW VALVES WANTED. EY51, EY86, PL81, PCC84, PCF80, PCL82, PCL 83, PY81, R19, 30P19, U25, etc Best cash prices by return. DURHAM SUPPLIES, 175 Durham Road, Bradford 8, Yorks.

A PROMPT CASH OFFER for your surplus brand new Valves and Transistors. R.H.S., Beverley House, Mannville Terrace, Bradford 7.

NEW VALVES and Transistors, boxed or unboxed. Any quantity for cash. WITWORTH TV SERVICE, 32a All Saints Road, North Kensington. London W11. PARk 9972.

(Continued on next page)

SERVICE SHEETS

SERVICE SHEETS, Radio and TV 4/- each. List 2/-. All orders dispatched on day received. Also Manuals for sale and hire. S.A.E. please. Mail orders only. SULTAN RADIO. 29 Church Road, Tunbridge Wells, Kent.

SERVICE SHEETS (30,000) 3/- each with S.A.E. DARWIN, 19 George Street. St. Helens, Lancs.

TRADE SERVICE SHEETS offered by retired engineer. If I haven't got it you won't get it! All 4/- each by return. Please include large S.A.E. Mail orders only. ETZIONI, 80 Merrion Avenue, Stanmore, Middx.

SERVICE SHEETS

For all makes of Radio and Television—1925-1963. Prices from 1/-.
Free fault-finding guide with all Service Sheets. Please send S.A.E. with enquiries. Catalogue of 6,000 models, 1/6.
Special offer of 125 Radio/TV Sheets covering many popular models, 21/-
All types of modern and obsolete valves. Radio and TV books. S.A.E. lists/enquiries.

HAMILTON RADIO
Western Road, St. Leonards, Sussex

WHY TOLERATE DELAY when we can supply your Radio or TV Service Sheet by return of post at 4/- each plus postage. List 2/-. Also Manuals for sale and hire. S.A.E. with inquiries, please. Mail orders only to: S.P. DISTRIBUTORS, 44 Old Bond Street, London W1.

FREE ADVICE with Service Sheets. Thousands available at 4/- each with S.A.E. (state faults). All components supplied cheaply by return. HANDLEY, 112 Baysham Street. Hereford.

FAULT-FINDER FILES, showing common faults that each receiver is prone to and other useful servicing information 2/- each. List 9d. plus postage. Mail orders only. S.P. DISTRIBUTORS, 44 Old Bond Street. London W1.

SERVICE SHEETS, Radio TV, 5,000 models. List 1/-. S.A.E. inquiries: TELRAY, 11 Maudland Bk., Preston.

SERVICE SHEETS, also Current and Obsolete Valves for sale. JOHN GILBERT TELEVISION, 1b Shepherd's Bush Road, London W6. Tel.: SHE 8441. Nr. Goldhawk Rd. Station.

BOOKS & PUBLICATIONS

FIND TV SET TROUBLES in minutes from the great book "The Principles of TV Receiver Servicing". 10/6 all book houses and radio wholesalers. If not in stock from: Secretary, I.P.R.E., 32 Kidmore Rd., Caversham, Reading, Berks.

EDUCATIONAL

THE INCORPORATED Practitioners in Radio and Electronics (I.P.R.E.) Ltd. Membership Conditions booklet 1/-. Sample copy of I.P.R.E. Official Journal 2/- post free. Secretary, 32 Kidmore Road, Caversham, Reading, Berks.

HAVE YOU EVER SEEN T.V. TROUBLES?

That is "Pin-Point T.V. Troubles in 10 minutes" we mean! Thousands of *Practical Television* readers already own and use "T.V. Troubles" every day. Designed for use by amateur or expert, this amazingly practical manual shows you how to find the trouble in any T.V. circuit FAST!

A simple cross-index tells you where you'll find cause of trouble, handy check charts then help you accurately locate the EXACT trouble spot! You will eliminate hours of aggravation, cut out waste time, because this new Coyne system will help you get right down to the heart of the trouble in minutes.

Over 700 trouble spots are covered in the 340 cross-index pages. Included are 50 time saving check charts as well as 290 diagrams and photos together with explanations of circuits and designs.

YOU CAN USE THIS BOOK RIGHT ON THE JOB—NO NEED TO MEMORIZE!

This Pin-Point Book was designed especially for on-the-job trouble shooting. You simply turn to the indexed section, locate the circuit description and check-charts, and in minutes you have the trouble spot located and ready for repair.

NO COMPLICATED THEORY OR MATHEMATICS. Just practical circuit description, service methods and trouble shooting techniques to help you make faster T.V. repairs.

EVEN AN EXPERT CAN SAVE TIME BY USING "T.V. TROUBLES"

Here is a way to reduce "thinking time"

All the logical reasons for each problem are stated in black and white—you use your skill to take it from there!

Don't miss out any longer. Time wasted now locating t.v. faults could be saved by quick reference to this lightning fast t.v. problem answer book. Send for your trial copy now, then when you decide to keep it (as we are sure you will), pay only 5/- per week until completed.

The price? Only **38/6** plus postage.

FREE ELECTRONIC DATA HANDBOOK WITH EVERY ORDER

IRONCLAD GUARANTEE

This book must be able to earn you more than its cost within two weeks or your money refunded!

FREE TRIAL OFFER!

TERMS ONLY 5/- PER WEEK!

To SIM-TECH BOOK CO. Dept PVP2
West End, Southampton, Hants.

☐ Please send "T.V Troubles" for a full seven days' free trial. If not delighted I may return the manual, post paid, without further obligation on my part. Otherwise I will pay cash or 5/- weekly until paid. (No extra for interest if paid regularly.)

☐ Tick here if enclosing full price (we pay postage). Same 7-day money back guarantee. Postage charges 1/6 extra. Overseas customers please send full amount (including Ireland).

Name ....

Address ....

....

City .... County ....

PADGETTS RADIO STORES

OLD TOWN HALL
KNOWLER HILL
LIVERSEDGE, YORKS.
Telephone: Cleckheaton 2866

COMPLETE TV SETS UNTESTED

Bush 12in. 13 channels. TV24C ..	.. 30/-
Bush 14in. 13 channels. TV43 ..	.. 70/-
Bush 14in. 13 channels. TV53 ..	.. 75/-
Pye 14in. 13 channels, V14C console ..	50/-
Pye 14in. 13 channels. VT4 ..	.. 50/-
Philips 14in. 2 and 10 channels. 1446 ..	35/-

We have 17in. TV Sets with rough cabinets, coils fitted 2 and 10, at 50/-. Carriage on any TV Set 10/- per B.R.S. Well packed but sent at owner's risk.

Valves Removed from TV Sets. Tested on Mullard Valve Tester, and are 100% as new. Three months unconditional guarantee. POST FREE.

ECL80	2/-	10C2	5/-	PY80	5/-
ECC82	5/-	10F1	1/-	PY81	4/-
EY51	2/6	10P13	5/-	PY82	5/-
EBF80	4/6	10P14	5/-	PZ30	4/-
EB91	9d.	20D1	3/-	PCF80	4/6
EF91	9d.	20P1	5/-	PCC84	4/6
6SN7	2/9	20L1	5/-	EAC91	1/6
6F1	1/-	185BT	8/6	PL83	5/-
6F13	2/-	U281	5/-	PL33	4/-
		U282	5/-	B36	4/-
6F14	5/-	U329	5/-	N37	5/-
6F15	5/-	KT36	5/-	6J5	3/-
6LD20	5/-	PL81	5/-	27SU	5/-
PCL82	6/-	PL82	5/-	U12	4/-

EF80 1/6 or 10/- per doz. Grade 2 EF80 for test purposes, 4/- doz.

New Valves Ex. Units. POST FREE. ARP12 1/6, 6 for 5/6, box of 50 20/-, IT4 2/-, AR8 2/-, ARTP2 2/-, APT4 2/-, APP37 2/-, 6K7 2/-, 6K8 4/-, 5U4 3/-, 6SN7 3/-, 6V6 3/-, 6V6GT 4/6, VR150/30 2/6, 6C4 2/-, EL91 1/9, EF91 1/9, EF50 1/-, 6/- doz., 6F6 2/6, 5Z4 5/6, 6X5 4/6.

P.M. Speakers. Removed from TV Sets. All perfect condition. Rola and Plessey. 6 x 4in., 5/-; Goodman and R. and A., 7 x 4in., 6/-; Rola and R. and A. 6½ in. round, 3/6; 6in. Dish, round, 5/-; 8in. round, 6/-. Post on any speaker, 2/-.

TV Tubes Picture Tested. Reclaimed from TV Sets. 12in., 17/-, 14in., 30/-. Carr. 7/6. 6 months unconditional guarantee.

Mixed Mains Droppers. Removed from TV chassis., 10/- per doz. Post free.

TV Tubes. Completely rebuilt and refaced. 12 months guarantee. Old glass not required. 12, 14, 15 and 17 ins. Any make. Special trade price of £3.15.0. Carr. insurance, 7/6.

Metal Rectifiers, removed from TV chassis, mixed, 12/-per doz. Post free.

RES/CAP. BRIDGE 39/6 p. & p. 2/6

Checks all types of resistors, condensers
6 RANGES
Built in 1 hour. Direct reading.
READY CALIBRATED
Stamp for details of this and other kits.
RADIO MAIL (Dept. VP)
Raleigh Mews, Raleigh Street, Nottingham

NYLON - P.T.F.E.

ROD, BAR, SHEET, TUBE, STRIP, WIRE
No quantity too small
List on application

ALUMINIUM, LIGHT ALLOYS
BRASS, COPPER, BRONZE

H. ROLLET & CO., LTD.

6 CHESHAM PLACE, LONDON, S.W.1
BELgravia 4300
Works:
36 ROSEBERY AVE., LONDON, E.C.1
Branches at Liverpool, Manchester, Birmingham, Leeds