PRACTICAL

TELEVISION

3/0

JUNE 1969

BUILD THIS INTEGRATED CIRCUIT TV HEARING-AID

ALSO INSIDE

EARLY TV CAMERA TUBES

AND

TESTING VIDEO CIRCUITS

PADGETTS RADIO STORE

OLD TOWN HALL, LIVERSEDGE, YORKS

Telephone: Cleckheaton 2866

Indicator Unit Type 26. Size 12x9x9in. with outer case, fitted with 2½in. C.R.T. type CV1526, 9 B7G valves, clean condition, but not tested. 32/6, P/p 10/-.

New 12in. Speakers with built-in Tweeter, 3 ohm or 15 ohm—6 watt max, 28/6. Post paid.

Tube Unit 116A. Complete with VCR97 tube Mumetal, screen and EF50 valves good condition but not tested 22/6, Carriage 10/-.

Perspex Implosion Screens. Removed from TV sets 14in. and 17in., 6 for 12/-. Post paid.

Speaker output. Transformer removed from TV. 3 ohm. Secondary 6 for 10/-. Post paid.

Reclaimed TV Tubes with six months' guarantee 17in. types AW43/88, AW43/80, 40/-. MW 43/69 30/- 14in. types, 17/-. All tubes 12/- carriage.

Speakers removed from TV Sets. All PM and 3 ohms and 8x5in., 6/6. Post and packing 3/6.

6in Round, 3/-, P/p 3/-. 6 for 24/-, post paid.
6x4in. 3/-, P/p 3/-. 6 for 24/- post paid.
7x4in. 5/-, P/p 3/-. 6 for 34/- post paid.
5in Round, 3/-, P/p 3/-. 6 for 24/- post paid.
Slot Speakers, 8x2½in., 5/-, P/p 3/-. 6 for 30/- post paid.
24 Way Plug and Socket. Ex units 1/6, P/p 1/-. 12 for 14/- post paid.

Untested. Pye K.B., R.G.D. Ekco 17in. TV sets. Bush 17in. TV sets, 50/- each, carriage 15/-. Passenger train, double rate.

VALVE LIST

Ex. Equipment, 3 months' guarantee

Single Valves Post 7d., over 3 Valves p. & p. paid.

ARP12	1/6	PCL83	5/-	6K7	1/9
EB91	9d.	PL36	5/-	6U4	5/-
EF85	3/-	PL81	4/-	6V6	1/9
EBF80	3/-	PY33	5/-	6P28	5/-
ECC81	3/-	PY81	1/6	10P13	2/6
ECC82	3/-	PY82	1/6	185BT	8/6
ECC83	4/-	PZ30	5/-	20D1	3/-
EF50	1/-	U191	5/-	20P1	5/-
EF91	9d.	U251	5/-	20P3	2/6
EY51	2/6	U281	5/-	30PL1	5/-
EY86	5/-	U282	5/-	30P12	5/-
KT36	5/-	U301	5/-	30F5	2/6
PCC84	2/-	U329	5/-	30FL1	5/-
PCF80	2/-	6B8	1/8	6/30L2	5/-
PCL82	4/-	6BW7	2/6		

BRAND NEW LINE OUTPUT TRANSFORMERS

ALBA 655, 565, **77/6.**
DYNATRON TV30, TV35 **48/6,** TV36 **70/-.**
EKCO T231, T284, TC267, T283, T293, T311, T326, T327, T330 **48/6.** TMB272 **68/6.** T344, T344F, T345, TP347, T348, T348F, TC347, TC349, TC356, T368, T370, TC369, T371, T372, TP373, TC374, T377A, T380, T380F, T381, T382, TC386, T393, T394, all at **70/-.**
FERGUSON 306T, 308T **48/6** each. 406T, 408T, 416, 436, 438, 506, 508, 516, 518, 536, 546, 604, 606, 608, 616, 619, 636, 646, 648, 725, 726, 727, 3600, 3601, 3602, 3604, 3611, 3612, 3614, 3617, 3618, 3619, 3620, 3621, 3622, 3623, 3624, 3625, 3626, 3627, 3629 **65/-.**
FERRANTI T1001, T1002, T1002/1, T1004, T1005 **48/6.** T1023, T1024, T1027, T1027F, TP1026, T1057, T1057F, T1058, T1061, T1063, T1063F, T1068, T1068F, T1071, T1072 **70/-.**
G.E.C. BT302, BT304 **62/6.**
H.M.V. 1865, 1869 **48/6.** 1870, 1872, 1874, 1876, 1890, 1892, 1894, 1896 **65/-.**
PILOT PT450, 452, 455, 650, PT651, P60A, P61 **82/6.**
PHILCO 1962, 1967, 1967M, 1019, 1020, 2021 **82/6.** 1029, 1030, 1035, 1036, 1040, 1050, 1060 **82/6.**
PYE V200, V400, 200LB, 210, 220, 300F, 300S, 310, 210S, 410 **60/-.**
Please state part No.
ULTRA 1770, 2170, 1772, 1782, 2172, 1771, 2171, 1775, 2175, 1774, 2174, 1773, 2137, 1980c, 1984c, 100c, 200c, 2380, 2384, 1984, 1985, 1986, 1980, 1980a, 1780, 2180, 2181, 2183, 2182, 1871, 1783 **78/-.**

Guarantee. *Post and Package* 4/6. *C.O.D.* 6/-.
All new components inserts are guaranteed for three months from the date of invoice subject to the breakdown being due to faulty manufacture or materials.

D. & B. TELEVISION (Wimbledon) LTD.

80 MERTON HIGH STREET, S.W.19

01-540 3513 01-540 3955

NEW VALVES

Guaranteed Set Tested

24 HOUR SERVICE

1R5	5/6	ECH35	5/6	PCL83	8/9
1S5	4/3	ECH42	10/6	PCL84	7/-
1T4	2/9	ECH81	5/9	PCL85	8/9
3S4	5/9	ECL80	6/3	PCL86	8/3
3V4	5/9	ECL82	6/3	PFL200	11/9
6AQ5	4/6	ECL86	7/6	PL36	9/3
6L18	6/-	EF37A	6/-	PL81	7/-
30C18	8/6	EF39	3/6	PL82	6/9
30FL1	13/6	EF80	4/9	PL83	6/9
30FL12	14/3	EF85	5/9	PL84	6/3
30FL14	11/9	EF86	6/3	PL500	12/9
30P4	11/6	EF89	4/9	PL504	13/3
30P19	11/6	EF183	5/9	PY32	10/-
30PL1	13/6	EF184	5/3	PY33	10/-
CCH35	9/9	EH90	6/-	PY81	5/-
CL33	17/6	EL33	8/3	PY82	5/-
DAC32	6/9	EL41	10/3	PY83	5/3
DAF91	4/3	EL84	4/9	PY88	6/-
DAF96	6/3	EY51	7/3	PY800	7/3
DF33	7/6	EY86	6/-	PY801	6/6
DF91	2/9	EZ80	3/9	R19	6/3
DF96	5/11	EZ81	4/6	U25	12/9
DK32	6/9	KT61	8/3	U26	11/6
DK91	5/6	KT66	15/9	U191	12/3
DK96	6/6	N78	14/6	UABC80	5/9
DL35	4/9	PABC80	6/9	UBC41	8/3
DL92	5/9	PC86	10/3	UBF89	6/3
DL94	5/9	PC88	10/3	UCC84	7/9
DL96	6/9	PC97	7/9	UCC85	6/6
DY86	5/3	PC900	7/6	UCF80	8/-
DY87	5/3	PCC84	6/3	UCH42	10/6
EABC80	5/9	PCC89	9/9	UCH81	7/-
EBC41	8/-	PCC189	11/6	UCL82	6/9
EBF80	6/-	PCF80	6/3	UF41	9/6
EBF89	5/9	PCF82	5/9	UF89	6/6
ECC81	3/9	PCF801	6/6	UL41	10/3
ECC82	4/3	PCF805	8/6	UL84	6/9
ECC83	4/9	PCF808	11/9	UY41	6/6
ECC85	5/6	PCL82	6/9	UY85	5/3

Postage on 1 valve 9d. extra. On 2 valves or more, postage 6d. per valve extra. Any parcel insured against damage in transit 6d. extra.
Office address, no callers.

GERALD BERNARD

83 OSBALDESTON ROAD
STOKE NEWINGTON
LONDON, N.16

110 SEMICONDUCTOR PROJECTS

For the home constructor

R. M. MARSTON, technical author and design consultant.

This is a book which will appeal equally to the electronics amateur and to the professional engineer. 110 different circuits are described and the operation of each one is explained in simple and precise terms. The main feature of the book is that it fulfils a long-awaited need for readable information on these devices.

CONTENTS

30 Silicon-Planar Transistor Projects
15 Field-Effect Transistor Projects
20 Uni-Junction Transistor Projects
15 Silicon Controlled-Rectifier Projects
30 Integrated-Circuit Projects.

124 pages 110 illustrations.

25s. net case 26s. by post.

18s. net student edition 19s. by post.

ILIFFE BOOKS LTD

42 RUSSELL SQUARE, LONDON, W.C.1

VOL 19 No 9
ISSUE 225

JUNE 1969

Question of Timing

IN THE August leader last year it was suggested that the traditional "show time" of the radio and TV industry was ill-conceived now that public exhibitions have been wholly replaced by trade-only shows. The basic argument was that since Autumn marks the beginning of the main selling season, the Spring would be more logical and lucrative. For successful marketing requires that production runs are linked to the likely response from dealers and wholesalers.

Therefore, by holding trade shows in the Autumn, the products displayed are unlikely to be available, at least in quantity, until the following Spring, when sales are beginning to fall off. But by holding previews in the Spring, manufacturers would have a good idea of likely sales in order to have the goods ready for delivery at the right time—the Autumn.

A hopeful sign that the message is beginning to filter through is that this year several companies have been holding Spring trade previews. These were mainly "kite flying" exercises as many of the models shown were prototypes, including a few pieces made up specially for the occasion to gauge dealers' reactions. Now that the trend is under way let us hope that more companies will get their production cycle more neatly geared with sales.

And is it too much to hope that the radio/TV side of the industry will eventually follow the lead of the audio manufacturers? They are also beginning to introduce details of new models to the trade early in the year, but go one step further and follow up with their annual public exhibition in the Autumn. Perhaps this is one reason why the audio field is experiencing an unprecedented boom, while the radio and television side is gloomily suffering a setback.

W. N. STEVENS, *Editor*

THIS MONTH

Teletopics 388

Integrated Circuit TV Hearing-Aid *by K. Royal* 390

Video Amplifiers—Part 2 *by K. T. Wilson* 393

Television Receiver Testing—Part 12 —Video Circuits *by Gordon J. King* 396

DX-TV *by Charles Rafarel* 400

Converting 405-only Sets for Dual-standard Operation 401

Fault Finding Focus—A.G.C. Circuits—Part 2 *by S. George* 402

Underneath the Dipole *by Iconos* 406

Early TV Camera Tubes—Part 1 *by I. R. Sinclair* 408

Installing and Servicing Colour Receivers—Part 9 *by P. G. Alfred* 412

The PTV Videoscope—Part 3 *by Martin L. Michaelis, M.A.* 416

Servicing Television Receivers—Bush/Murphy TV125/V849 series *by L. Lawry-Johns* 420

Vidtronics *by Baynham Honri* 423

Workshop Hints *by Vivian Capel* 426

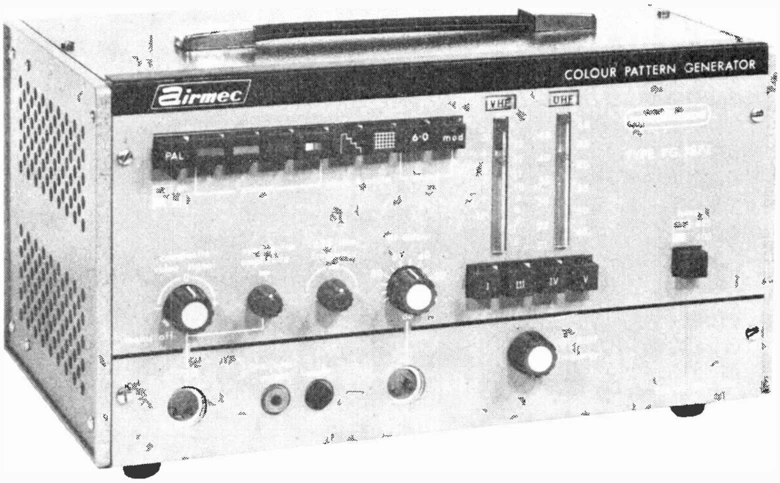
Your Problems Solved 428

Test Case 79 429

THE NEXT ISSUE DATED JULY WILL BE PUBLISHED JUNE 20

TELETOPICS

NEW COLOUR PATTERN GENERATOR



TO meet the need of test and service engineers and students for a simple to use colour pattern generator Airmec have introduced the NordMende Type FG387Z. This can be used for testing black-and-white as well as colour receivers and the test pattern is in accordance with NTSC/PAL system standards. The instrument is mains operated, weighs 10lb., and is basically a modulated tunable signal generator covering the normal i.f.s and the standard Bands I, III, IV and V carrier frequencies. Internal audio and video modulation are provided and the output signal is selected by push-button controls which are both letter and pictorially coded.

The following test signals in all carrier frequency and i.f. channels are provided: (1) colour picture in either one of the three primary colours red, blue or green for purity adjustment; (2) six vertical colour bars (standard colour bar pattern to 75% saturation) for PAL decoder and matrix alignment; (3) crosshatch pattern for convergence and linearity adjustments; (4) monochrome shaded vertical bars pattern; (5) sound channel carrier (unmodulated) spaced 6MHz from the video carrier; (6) sound channel carrier frequency modulated at 1kHz. The crosshatch pattern only is also available on 405 lines for Band I monochrome receiver linearity adjustment.

The three output sockets on the front panel provide: (1) r.f. output from which a video and/or audio modulated signal complete with sync pulse may be taken to the receiver aerial socket, with level controlled by a continuously variable attenuator over a range in excess of 60dB from approximately 5mV; (2) composite video output continuously variable from 1·3V p-p positive through zero to 1·3V p-p negative; (3) line sync pulse output (625 only) the frequency of which is variable ±4%

The video pattern and line sync frequencies are derived by division from the crystal-controlled burst frequency, but the sync pulse frequency can be varied slightly each side of the nominal value. On 405-line output the sync frequency is fixed and the crosshatch pattern locked to it.

Airmec Instruments Ltd., High Wycombe, Bucks.

NEWS FROM THE ITA

The first of three new v.h.f. TV transmitters—to replace the original ones with which the ITA began its transmissions in the London area in September 1955—has been delivered to the ITA station at Croydon. Despite its preoccupation with the new country-wide 625-line u.h.f. television network the ITA is currently giving a major facelift to the Croydon v.h.f. 405-line transmitting station. Installation of these new v.h.f. transmitters—to come into service this summer—underlines the intention of continuing the 405-line transmissions in Band III for many years to come.

The new transmitter units will comprise three 5kW Pye vision transmitters together with associated sound transmitters, combining units and aerial switching units, etc. Power will remain unchanged at 350 kW e.r.p. from the directional aerials which are carried on a 500ft. tower.

Engineer-in-Charge of the ITA Croydon station is G. E. Tagholm, MBE, and the technical staff total twelve. The v.h.f. transmitters are being installed in a new building which will also house a colour control room for the 625-line u.h.f. service and from which the ITA Channel 23 u.h.f. transmitter to be installed at the BBC Crystal Palace site and several satellite relay stations will be remotely controlled.

ITA is currently spending over £10 million on the first phase of its new u.h.f. transmitter network, for the electronic converters required to continue the 405-line transmissions derived from 625-line programme sources, and for 14 colour control centres such as the one at Croydon.

The new 675ft. mast at Emley Moor was brought into operation less than a month after the previous mast collapsed.

LATEST TV SETS

This month's announcements from the setmakers include news of the first single-standard colour sets. These, from Dynatron, are the 22in. Blenheim Model CTV3 and Copenhagen Model CTV4 and the 25in. Carlton Model CTV5. Recommended prices have not yet been announced. Also from Dynatron are two new black-and-white receivers featuring the new tube sizes, the Buckingham Model TV201 (£104 10s. 0d. or £106 10s. 0d. depending on finish) with 24in. tube and the Richmond Model TV200 (£94 or £95 15s. 0d.) with 20in. tube.

The Thorn/BRC 1400 chassis is used in three new releases, the Marconiphone Model 4649 (£77 12s. 0d.) which features a 20in. tube and two Baird models from Radio Rentals, the 8691 with 20in. tube and 8693 with 24in. tube.

The Pye group 368 hybrid chassis is used in three new Ferranti releases, the 20in. T1176 (£85 10s. 0d.) and 23in. Models T1173 (£93 13s. 9d.) and T1175 (£88 1s. 9d.). There are also two new colour models from Ferranti, 19in. Model CT1167 (£304 9s. 8d.) and 25in. Model CT1166 (£346 4s. 9d.).

FUTURE BRC RELEASES

A portable TV model featuring a new 17in. square-type tube is being shown at the BRC trade show at present touring the UK. The set, in the Ferguson and Ultra ranges, is a dual-standard black-and-white one. Also on show are single-standard colour models with 19 and 25in. tubes.

NEW VIDEOTAPE RECORDERS

Four new videotape recorders have been announced by Bell & Howell Ltd., Alperton House, Bridgewater Road, Wembley, Middx. These are the 2910B and 2910E monochrome recorders at £2,200 and £3,000 respectively, the latter model incorporating editing facilities, and the 2920 and 2930B colour recorders (to PAL specification) at £2,580 and £3,380, the latter model again having editing facilities. These models use standard NAB 8in. reels with 2,150ft. of lin. tape. These are priced at £23.15.0. per reel.

THE PRACTICAL WIRELESS/TELEVISION FILM SHOW

This year's film show commenced with W. Norman Stevens, Editor of Practical Wireless and Practical Television, welcoming readers to Caxton Hall and introducing Ian Nicholson of the Mullard Films and Lectures Division. Mr. Stevens asked the audience to fill in the questionaires they were given when they entered the hall. These sought details of the type of articles readers would like to see. As far as the staff are concerned Practical Wireless and Practical Televison are the readers' papers, Mr. Stevens said, and we try to provide what we feel is the majority verdict. To do this we need comments and letters from readers.

The film, entitled "It's the Tube that Makes the Colour", described the manufacture and operation of Mullard ColourScreen colour tubes and also showed how colour pictures are received.

After the film Mr. Nicholson gave a lecture entitled "Purity, Convergence and All That". He explained that a shadowmask tube in effect comprises three independent cathode-ray tubes—one for each of the primary colours. All these tubes have one common vertical and horizontal deflection system. Deviation from ideal picture reproduction occurs for one main reason—the fact that the three guns cannot all be mounted on the axis of the tube itself. It is because of this that most of the extra adjustments involved in setting up a colour receiver arise since this causes geometrical errors between the three rasters produced. Mr. Nicholson then gave a clear explanation of the various adjustments and their effect on the screen display.

The meeting was then opened to questions from the audience. On the question of the developments we can expect to see in the future of colour TV Mr. Nicholson said that progress would lie in the use of integrated circuits which would give greater reliability and improved performance. Integrated circuits would be the subject of Filmshow '70 and Mullard are at present working on the production of the film.

VALRADIO EHT TRANSFORMER

Valradio Ltd., of Browells Lane, Feltham, Middx., announce a can-type e.h.t. transformer providing a 25kV 350μA supply suitable for projection models and also for shadowmask colour tubes when separate line output and e.h.t. generation circuits are used. It is recommended that the unit is used with a feedback regulator.

PYE GROUP SPARES

The Pye group spares stores at Cambridge have now been closed. Orders for spares for Pye, Ekco, Ferranti, Invicta and Pam receivers should in future be sent to Combined Electronic Services Ltd., 604 Purley Way, Waddon, Croydon, CR9 4DR. CES is the combined Philips and Pye group service organisation.

NEW HIGH-POWERED UHF TRANSMITTERS FOR BBC

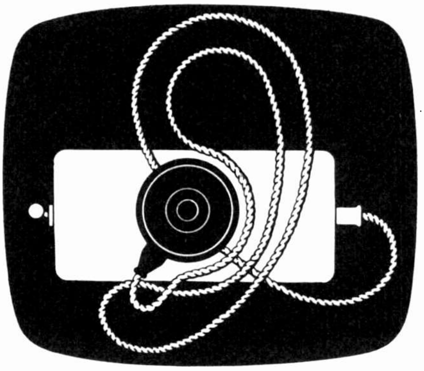
Two high-powered u.h.f. television transmitting systems are currently being installed in London by The Marconi Company to put BBC-1 on the air in colour and also to improve the reception of BBC-2. The equipment will feed two separate 80kW TV signals with associated sound signals to a single aerial at Crystal Palace. Four 40kW transmitters with associated sound transmitters will be employed in groups of two, operating in parallel, to give the two 80kW vision signal outputs. The existing pair of Marconi 25kW transmitters will be moved to Divis to put BBC-1 on u.h.f. in Northern Ireland.

All the video, sound and r.f. circuitry it solid-state apart from the vapour-cooled output klystrons (made by the English Electric Valve Company) and an intermediate valve amplifier. A diode modulation system produces the highest quality linear modulation—an essential for colour operation.

TRADE REFERENCE BOOK

The 40th edition of the "Electrical and Electronic Trader Year Book, 1969" has now been published at 35s. 0d. (postage 2s. 6d.) by Iliffe Technical Publications Ltd., Dorset House, Stamford Street, London, S.E.1. This is an invaluable guide for all in the trade.

Integrated Circuit TV HEARING-AID



K. ROYAL

HARD-OF-HEARING people can participate fully in television by (1) running the sound channel fairly hard; (2) using an ordinary deaf-aid; or (3) using an earpiece or headphones connected to the set's sound channel. All these have disadvantages: (1) can cause severe discomfort to other viewers with normal hearing in the same room or, indeed, to near neighbours; (2) not only precipitates exhaustion of the normal deaf-aid batteries but the sound quality can be poor if the viewer is far from the set due to sound reflections in and about the room; (3) often means modifications to the set to ensure perfect electrical isolation between the mains supply side of the set and the listener's ear. Nevertheless (3) would appear to be the best way of solving the problem and firms specialising in deaf-aid electronics can supply such devices for connecting to sets which are perfectly safe to listener and set in all aspects.

Self-contained Unit

However the design featured here is a completely self-contained device yielding the facilities of (3) but without the need to make electrical connections to the set. Various ways of inductive pickup were first experimented with but trouble was experienced from magnetic radiation from the field and line timebases. It was then decided to make a small, self-contained amplifier complete with microphone and battery (of relatively high capacity, since for this application the device does not have to be personally carried) which could be stood close to the set, in line with the speaker, so as to achieve the maximum direct-sound-to-reflected-sound ratio. A thin cable can then be taken from the device over virtually any distance in the room to the listener's earpiece. This technique avoids the excessive gains associated with some ordinary deaf-aids but does call upon the output stage to handle a little more signal power than is commonly used in personal aids.

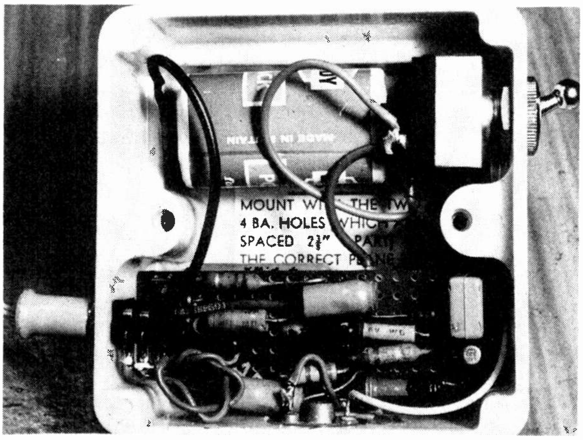


Fig. 1: Inside view of the author's prototype.

A device after this style was first constructed roughly, using a dynamic microphone, to prove the theory. As quite reasonable results were obtained it was decided to go ahead with a proper prototype, but this time based on a smaller, lighter crystal or ceramic microphone unit. With the dynamic microphone, three transistor stages ensured sufficient gain, while all the power required was given by an OC75 output transistor and PP4 9V battery loaded into a magnetic-type, medium-impedance earpiece.

It was found that amplification suitable for a person whose hearing had deteriorated by approximately 50 per cent could be obtained by running the set's speaker at normal listening volume with the microphone up to 6in. from the speaker. Of course increased sound levels could be obtained by placing the microphone closer to the speaker—which is why it was necessary for the output stage to deliver sufficient, undistorted power—while reduced sound levels simply involved moving the microphone away from the speaker. Owing to this great flexibility a volume control—or, more accurately, a gain control—was not found necessary and was not used in the final prototype.

However one problem to do with changing over to a piezo (ceramic or crystal) microphone was electrostatic pickup from the TV set. It was found that some of this energy emanated from the tube face and some from the line output stage and e.h.t. section through the cabinet if not metallised properly on the inside. This did not happen with all sets tried with the device, but where the symptom—a rough whistle superimposed on the amplified sound in the earpiece—was present it could be tamed simply by lining the inside of the plastic case of the deaf-aid with tin-foil of the kind used in the kitchen for wrapping meat, etc., prior to cooking in the oven.

Input Matching

To retain the low-frequency response with a piezo microphone demands a load of a megohm or so. A load below this value, as presented by the input impedance of an ordinary bipolar transistor for example, tends to cut the bass and lift the treble too much, leading to the need for equalisation. The

★ components list

Resistors
R1 2MΩ
R2 1·5k Ω
R3 15k Ω
R4 56k Ω
R5 10k Ω
R6 10k Ω
R7 1k Ω
R8 27k Ω
R9 10k Ω
R10 1k Ω
All ½W or smaller

Capacitors
C1 0·1μF
C2 5μF El.
C3 16μF El.
C4 5μF El.
C5 16μF El.
C6 25μF El.
All electrolytics miniature at least 12-15V working

Semiconductors
Tr1 TAA320
Tr2 OC75
Tr3 OC75

Miscellaneous
MK electric box with top cover and cork for base
PP4 9V battery with pair of clips
SW1 S.P.S.T. toggle switch
Crystal microphone insert, "Electroniques" Mic 38-1
Miniature jack socket and matching plug, "Electroniques" MJ600A2C and MJP6002C/US
Medium-impedance magnetic earpiece with suitable length of thin cable
Piece of Veroboard

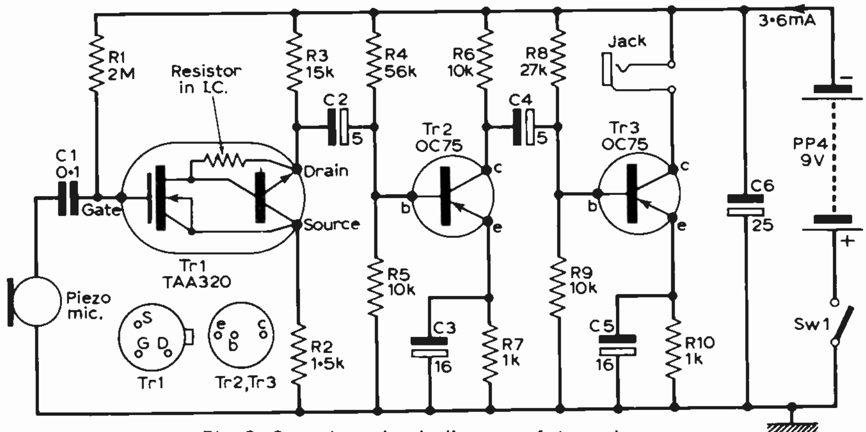


Fig. 2: Complete circuit diagram of the unit.

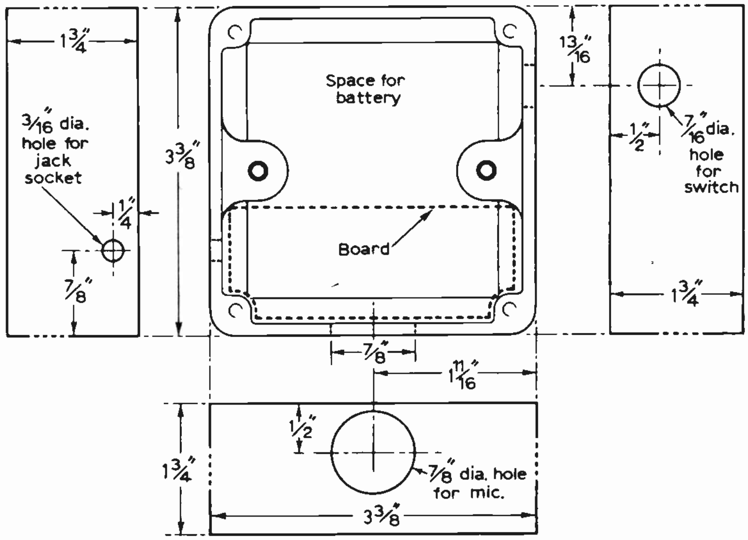


Fig. 3: Detailed plans for drilling the MK box (half scale).

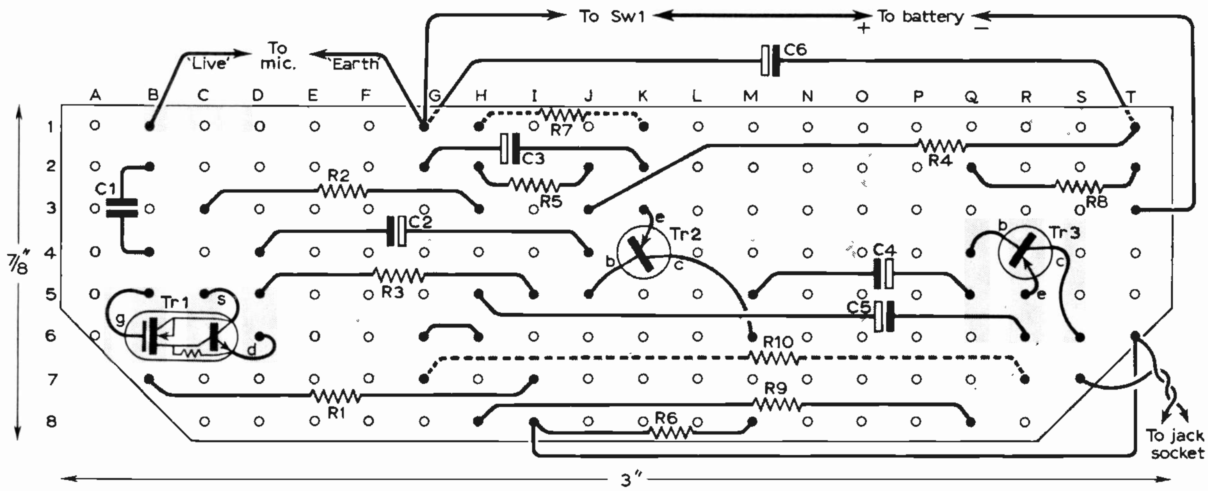


Fig. 4: Veroboard layout. Note that f.e.t.s. are very sensitive to static discharged through the device via the gate electrode and to avoid the possibility of damage to the gate oxide layer due to this cause the leads of the TAA320 are shorted by a clip when supplied. The clip is arranged so that it need not be removed until the i.c. has been mounted on the Veroboard. R7, R10 and C6 are on the conductor side of the board.

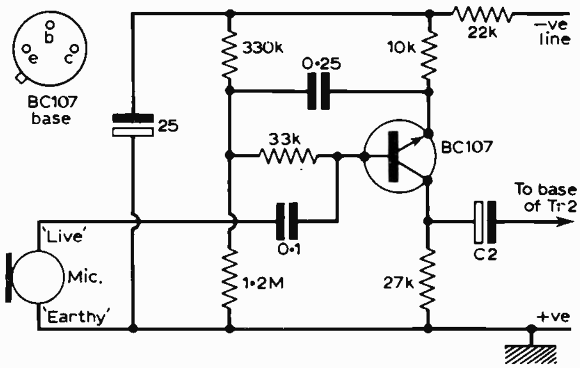


Fig. 5: Alternative front-end using a bootstrapped BC107.

trouble can be solved by bootstrapping the input transistor so that it appears to the microphone as a high impedance. This technique was in fact adopted on one of the first prototypes, and could still be used if required (see later). However it was decided after a bit of further experimentation to use a field-effect input transistor (f.e.t.) which presents an absolutely ideal load to a piezo microphone, and during the course of operations the very latest Mullard TAA320 field-effect integrated-circuit (i.c.) became available. This is a remarkable device—and not all that costly—which integrates a m.o.s.t. f.e.t. with a bipolar transistor in a TO-18 encapsulation (the same as used for some single-unit transistors), the i.c. also containing a resistor. The equivalent circuit of the i.c. is shown at the first stage Tr1 in the circuit diagram (Fig. 2).

With the TAA320 i.c. and a crystal microphone insert it was found that adequate sensitivity and good reproduction quality could be obtained with a circuit containing only two bipolar transistors, Tr2 and Tr3, giving a total of three semiconductor devices. The set-up also made it possible for a partially deaf person to participate in a general group discussion by placing the aid, microphone upwards, in the centre of the table. This scheme was found to provide a better overall balance of sound under such conditions than a simple deaf-aid contained in the clothing of the deaf person. Indeed apart from its use as a deaf-aid an amplifier of this type could have other applications, especially in view of its very high input impedance.

Circuit Description

The circuit which was eventually evolved is shown in Fig. 2. The TAA320 is followed by two OC75s; but other similar bipolar transistors could be used without much trouble. Apart from the i.c. input stage the circuit is very straightforward. Capacitive coupling between the stages was adopted mostly for the sake of simplicity and to avoid having to select very accurate resistor values while allowing the use of a whole range of pnp transistors in the second two stages without involving design complications.

It will be seen that the equivalent circuit of the i.c. takes the form of a f.e.t. d.c.-coupled to a bipolar transistor, making it particularly suitable for impedance conversion, matching from very high to medium and low values. The crystal microphone insert is coupled to the gate electrode, the impedance of which is virtually equal to R1 (i.e. 2MΩ). Owing to this high impedance C1 does not have to be a very large value. The collector of Tr3 is loaded straight into a medium-impedance magnetic earpiece. This was found to give the best sensitivity, although quite good results were obtained with a low-impedance earpiece of 15Ω or thereabouts. A crystal earpiece could be used by connecting in Tr3 collector circuit a resistor of about 2.2kΩ and coupling the earpiece across this via an 0.1μF capacitor.

While a switched jack socket could be employed—the amplifier switching on when the jack plug on the earpiece cable is inserted—it was considered best to incorporate a separate toggle-type on/off switch, SW1 in the circuit.

Construction

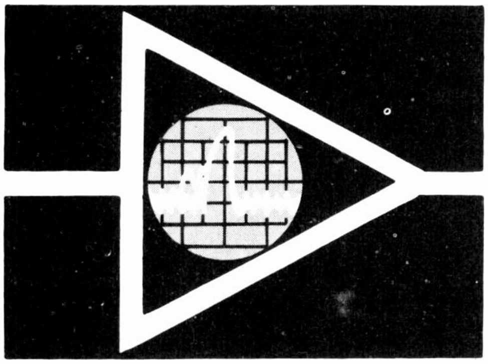
The construction of the circuit is closely tied to the required size of the unit, and after experimenting with different housings it was decided to adopt an MK electrical switchbox of about $3\frac{1}{4} \times 3\frac{1}{4} \times 2$in. These are readily available from most electrical shops in either white or brown plastic. They are normally used for housing switches or plug-sockets, and matching 'blanking off' plates are available to use with them. In the prototype such a plate forms the top lid, secured by a pair of screws. The bottom of the box is neatly finished off with a thin piece of cork cut to shape. This can be obtained from most popular stores in various guises and can be stuck on to the bottom of the box with a good adhesive which takes to plastic. It thus gives a good non-slip base to the unit allowing it be stood on polished surfaces without scratching.

Inside the box on each side of the threaded screw mouldings are two small steps which will accommodate a circuit board measuring 3 x $\frac{7}{8}$in. provided two corners are cut off as shown in Fig. 2 which, in fact, shows the circuit board used in the final prototype. It consists of a piece of Veroboard cut so that the printed copper conductors run across the short dimension. A cut with the conductors running across the long dimension was tried but difficulty was experienced in obtaining the required number of interconnections for the components without making too many cutouts along the conductors.

Figure 1 shows the inside of the finished unit. The completed circuit board can be seen in the section at the bottom of the photograph, the top section, which is identical in size and finish, accommodating the battery and on/off toggle switch. The whole lot, complete with jack socket (at the left-hand end of the board) and base of the microphone insert, fits snugly and neatly inside the box. The front cover photograph shows the outside appearance and the position of the microphone insert; here, too, the earpiece is plugged into the jack socket on the left.

The microphone insert selected has a flange on its inside periphery which can be pushed into a hole of suitable diameter cut in one side of the MK box and retained in position by Bostik or a similar compound. The rear face of the insert can be seen at the bottom of Fig 1. One terminal is "earthy", forming the metal body of the microphone, while the other one is connected to Tr1 gate electrode via C1.

—continued on page 427



VIDEO AMPLIFIERS

K.T. WILSON

PART 2

When we wish to extend the range of an amplifier to higher frequencies there are three basic methods. One is to use very low impedances at inputs and outputs. Suppose the input shunt capacitance of a stage is 50pF. This represents an impedance of about 3kΩ at 1MHz. If the input impedance is 3kΩ equal currents flow in each branch (the condition of 3dB down) so that half the voltage gain of the previous stage is being lost at this frequency. If, however, the input impedance is 1·5kΩ the same loss will occur at 2MHz and if the input impedance is 1kΩ the 3dB loss will occur at 3MHz and so on.

Emitter-follower Coupling Stage

Using low impedances makes stage gains low and an alternative method is the use of emitter-followers (or cathode-followers). In an emitter-follower there is no signal at the collector and the signals at the base and emitter are in phase. In such conditions there is no Miller feedback and the input impedance of an emitter-follower is high. At the same time the output impedance is low so that the emitter-follower forms a perfect matching stage between two com-

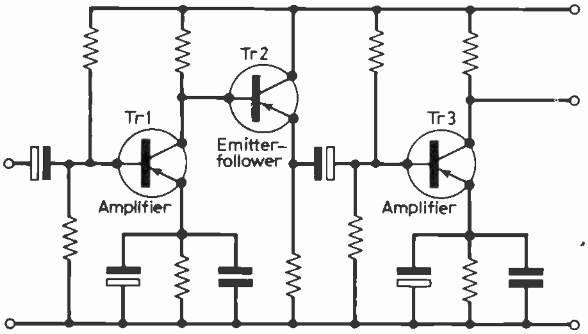


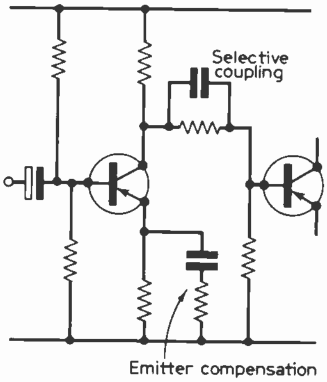
Fig. 8: Use of an emitter-follower stage to couple two common-emitter amplifier stages.

mon-emitter amplifiers. The collector of the first stage can now use a higher load for greater gain since it feeds the low input capacitance of the emitter-follower, and the low output impedance of the emitter-follower feeds the high input capacitance of the next amplifying stage. Fig. 8 shows a video amplifier using this technique.

HF Boost Techniques

In some cases impedances are fixed or can be lowered only by an unacceptable reduction in gain. One good example is the output of a vidicon to its video amplifier. With a target capacitance (plus strays) of 15pF and a bandwidth of 5MHz, the ideal target load would be 2kΩ. Since the output current of a vidicon is for an average scene only 0.2μA, the voltage at the input of the amplifier would be 0.4μV which is less than the noise voltage in the resistors. In this case a higher load *must* be used: we can correct high-frequency losses but we cannot remove noise which is stronger than the signal. In this application a load of about 180kΩ is usually used so that the response at 5MHz is well and truly down and at some point in the amplifier a boosting stage must be used which has low gain at lower frequencies but whose gain rises to a peak at 5MHz to compensate for the losses at the input. A similar situation arises in tape recording where the high-frequency losses due to the size of the head gap are compensated by high-frequency boosting in the amplifier.

The usual methods of high-frequency boosting used are selective emitter decoupling and selective coupling between stages. When selective emitter decoupling is used the emitter resistors of several stages are bypassed by small capacitors so that the stage gain of the amplifier is lowered by negative feedback at low frequencies. As the frequency is increased, the impedance of the capacitor in the emitter circuits becomes less and the gain increases. In CCTV video amplifiers one (at least) of these



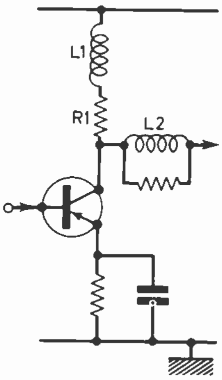


Fig. 9 (left): Use of selective coupling and decoupling. Fig. 10 (right): Use of peaking coils. The inductance of the coils is given by the formulae

$$L1 = \frac{R1^2 \times Cs}{10} \text{ and } L2 = \frac{R1^2 \times Cs}{3}$$

where R is in kΩ, Cs in pF and L in μH. The factors of 10 and 3 are chosen to give the required degree of overshoot and can vary considerably from one design to another.

emitter capacitors is variable so that the frequency of maximum boost can be adjusted.

Selective coupling consists of coupling two stages by a resistor which has a small-value capacitor in parallel. Once again the gain is limited at the low frequencies because the resistor forms a potential divider with the input impedance of the next stage; at high frequencies the impedance of the resistor is bypassed by the lower impedance of the capacitor. Fig. 9 shows an example of these two types of boosting in a video amplifier.

Another method of h.f. boosting is the well-known method of using an inductor to tune the stray capacitance to the frequency which is to be the upper limit of bandwidth (Fig. 10). This is used in nearly every TV receiver video amplifier and is probably the cheapest effective method of extending bandwidth up to 1.5 times the uncorrected bandwidth. In video amplifiers of more than one stage this method is seldom used because of the cumulative effect of the overshoot which it causes and the danger of oscillation at the tuned frequency.

Negative Feedback

The third method of obtaining level response is the use of negative feedback. The load for each stage is chosen for the best working condition and negative feedback is applied to reduce the gain and broaden the bandwidth. Though feedback is more effective when applied over a large number of stages, there is a danger of the feedback becoming positive at the highest frequencies due to the accumulated phase shifts in several stages and negative feedback in video amplifiers is thus usually applied over only two stages of amplification (excluding emitter-followers).

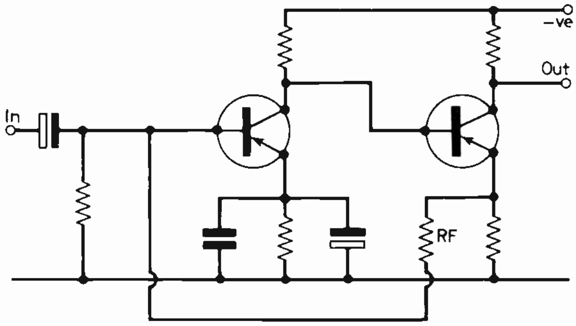


Fig. 11: Feedback pair: the feedback resistor RF determines the gain of the pair and also stabilises the d.c. working bias.

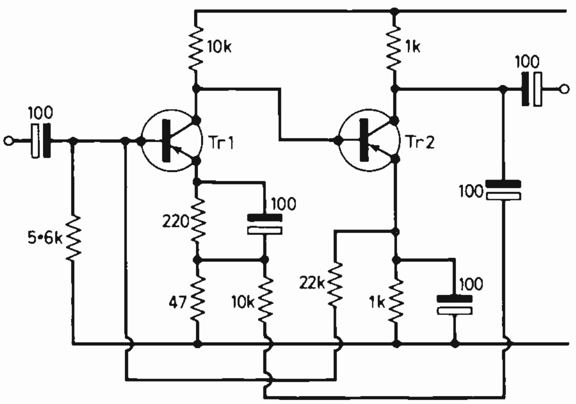


Fig. 12: Video amplifier (30dB gain up to 10MHz) using negative feedback. The 22 kΩ resistor between Tr2 emitter and Tr1 base is for d.c. stabilisation only. Tr1 and Tr2 can be any r.f. transistor (OC171, AF119 etc.) and the line voltage should be close to the maximum permissible. Bypass each of the 100 μF electrolytics with a 1,000 pF mica capacitor.

One popular method is to use feedback pairs (Fig. 11) as if they were one transistor and to build up the video amplifier out of such pairs. A more recent method is to use feedback over each stage (Ref. 1) so that each stage depends much more on the feedback resistors and capacitors than on the transistors. This approach is greatly to be recommended for the amateur since no knowledge of the transistor parameters (other than cut-off frequency) is needed. Ref. 1 shows a 40dB, 10Hz—20MHz video amplifier using two OC170 transistors based on this principle. Fig. 12 shows a video amplifier using negative feedback for extending the frequency response.

Gain-bandwidth Barrier

If we take a single transistor or valve amplifier stage and measure its gain and bandwidth for various different loads we find that the product gain × bandwidth remains constant for each type of transistor or valve used. This is not surprising, for each transistor has its built-in capacitance and its own maximum gain and the ratio of the two has a maximum value which cannot be changed. This gain-bandwidth product is constant for valves right up to the frequency where the time of one cycle equals the time that an electron in the valve takes to move from cathode to grid (at a speed of over 6,000 miles per second!). For example, if a valve has a *GB* of 200MHz, we can expect a gain of 200 at 1MHz, 100 at 2MHz, 20 at 10MHz, 10 at 20MHz, 2 at 100MHz and so on, and this relation should hold good to 1,000MHz or so. In transistors because of the much slower movement of electrons the gain-bandwidth product holds up to the cut-off point (quoted in the makers' literature). Some manufacturers quote the frequency at which the gain is one so as to indicate the upper limit of use.

Because the gain-bandwidth product is a barrier to the bandwidth which can be obtained from one stage, it is also a barrier to the bandwidth which can be squeezed from an amplifier, but the gain-bandwidth product of a complete amplifier can be greater than the *GB* of one stage. For example, if we take two valve stages, each with gain of ×10 and a bandwidth of 20MHz and we connect them together, assuming that no losses occur in the connections, the gain is now 10×10=100 and the bandwidth is now 20/2=10MHz so that the *GB* is now 10MHz×100=1000 instead of the 200 which we had for each stage. In general the *GB* for a complete amplifier has a value of $\frac{G^nB}{n}$ where n is the number of identical stages if there is no interaction. In practice this condition of no interaction is never achieved and the *GBs* of complete amplifiers are less than might be expected.

Use of Positive Feedback

There are two ways of breaking the *GB* barrier, neither method being well known. One is shown in Fig. 13 where pairs of transistors have selective

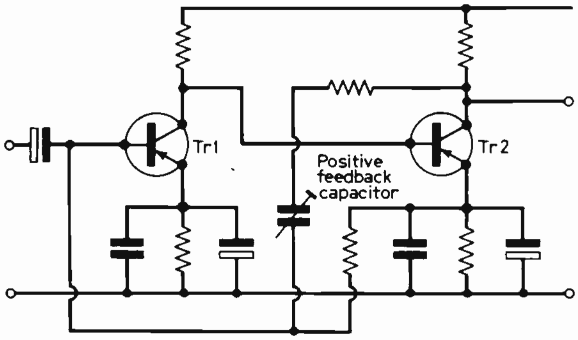


Fig. 13: The use of selective positive feedback with a pair of transistors to boost h.f. gain.

the line will now arrive in turn at each valve grid with *no* attenuation due to the stray capacitances. Correspondingly there will be an amplified signal at each anode in turn and to add these together we need only connect the anodes by another transmission line which cancels the effects of the anode stray capacitances and which terminates in a load resistor equal to the characteristic impedance of the line. The net effect is that the whole amplifier behaves as if it were a single stage using a valve whose gm is equal to the sum of all the single valve gms (for example 20 valves with gm of 15 behave as one valve with a gm of 300) and the input and output capacitances are zero. The gain depends on the number of valves used and the bandwidth on the ratio of inductance to capacitance in the line.

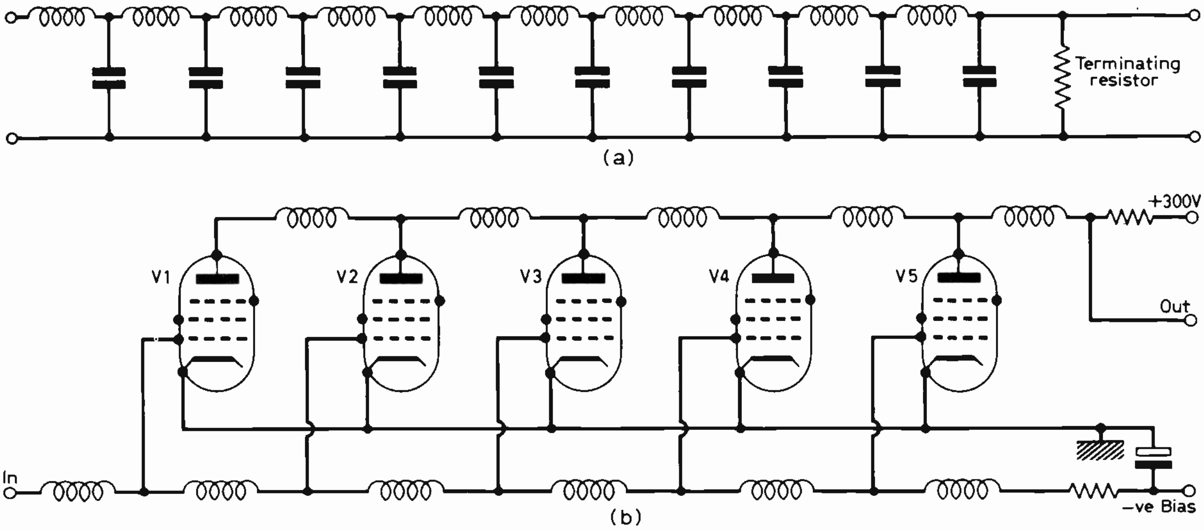


Fig. 14: The travelling-wave or distributed amplifier.

positive feedback used to boost gain at the higher frequencies. This method can achieve very high *GB* products but is extremely critical because the slightest change in the feedback capacitors can cause the amplifier pair to oscillate. Nevertheless this method has been used in the video amplifiers of studio TV cameras.

Travelling-wave Amplification

The other method is known as travelling-wave amplification; it has been used, notably for amplifiers in oscilloscopes of very wide bandwidths (up to 1000MHz), and is of great interest because of the possibilty of making thick-film circuit amplifiers of this type. If we take a transmission line consisting of series inductors and shunt capacitors (Fig. 14(a)) and terminate it in a resistor whose value is equal to a value called the characteristic impedance—a quantity which can be calculated from the inductor and capacitor values used—then a pulse fed in at one end of the line travels at a fixed speed down the line and is completely absorbed by the resistor at the other end with no reflection. The line behaves as a perfect transmitter of all frequencies.

Suppose now that we make each of the shunt capacitors (Fig. 14(b)) of the line the grid-cathode capacitance of a high *GB* valve (for example a frame-grid pentode). A signal fed to the open end of

This technique is well established with valves and may well be usable with m.o.s.f.e.t.s but is difficult to apply to bipolar transistors due to the feedback capacitance between the collector and base when common-emitter connections are used.

Experimental Work

The experimenter wishing to build video amplifiers of wide bandwidth, whether for CCTV or for an oscilloscope, must have some means of checking performance for voltage peaks, oscillation or other irregularities. For this a good signal generator and an oscilloscope whose bandwidth is at least twice that of the circuit being measured are required. Such equipment is not cheap, especially when bandwidths of 25MHz are in use, and cheaper options such as r.f. wattmeters must be used for detection. If no such equipment is available, then designs of the type shown in Ref. 1 should be used because of their considerable latitude to differences in construction. No design is infallible, but these amplifiers come closer than any others I have ever used.

Reference

Ref. 1: An Engineering Approach to the Design of Transistor Feedback Amplifiers. E. M. Cherry, *J. Britt, I.R.E.*, February 1963.

TELEVISION RECEIVER TESTING

Part 12 by Gordon J. King

VIDEO CIRCUIT TESTS

In this final article of the series we shall look at tests applied to the video stages of contemporary sets, including the vision detector, video amplifier and noise limiter.

The vision detector and video amplifier of a recent dual-standard set (Defiant 901 and 301) are shown in Fig. 1. The detector is diode D1 and the amplifier one of the pentode sections of a PFL200. The other pentode section is used as the sync separator. These two stages of course have to handle both the 405 and 625 standard vision signals. The standard-change switching is controlled by switch sections S1 which are parts of the main standard-change switch, all ganged to a common control. S1A and S1B change the detector polarity while S1C alters the biasing of the video amplifier to suit the signal drive applied to its control grid.

It will be seen that with S1A/B in the 625-line position as shown, the cathode end of D1 is at chassis potential (from the d.c. point of view) while in the 405-line position the polarity is reversed by the anode of D1 being switched to chassis by S1B via L2. This is necessary to suit the negative-going picture signal of the 625 standard on one position and the positive-going picture signal of the 405 standard on the other. Although this switching takes care of the polarity of the drive signal to the video amplifier control grid, the fact remains that the two signals have different datum levels.

Try to visualise a 405 signal at black level. The voltage at the anode of the video amplifier adjusts to correspond to this, while the technique is to adjust the brightness control—thereby regulating the tube bias—until the raster *just* blacks out. Now with picture signal the grid drive increases positively increasing the anode current of the video amplifier valve. This causes the anode voltage to fall, thereby making the tube cathode more negative than its just-biased-off setting, which is the same as the grid going more positive with respect to the cathode. The picture tube thus swings away from beam current cut-off and glows in accordance with the instantaneous values of the picture signal.

When a 625-line signal is at black level the drive to the control grid of the video amplifier valve is towards maximum negative value. Again, the anode voltage settles down to such a drive condition and the tube is biased (by the brightness control) for black as before. However when the picture signal swings towards white the video drive is towards a *less negative* value—the same as saying that it swings towards a positive value—and the conditions so far as the picture tube drive is concerned are the same as on 405 lines.

Assuming d.c. coupling from the vision detector to the control grid of the video amplifier, the basic difference is that the valve is driven *up* the anode characteristic on 405 lines and *down* on 625 lines. This means that the amplifier biasing must be changed to accommodate the nature of the drive signal, assuming that the valve is to work towards the centre of its characteristic (i.e. class A conditions). In Fig. 1 S1C performs the biasing change by switching out all but the 12Ω cathode resistor and associated bypass capacitor on 625 lines and switching in an extra 12Ω and 180Ω resistor with separate bypass capacitors on 405 lines. Thus on 625 lines the anode current is high to start with, the signal driving it down, while on 405 lines the current is relatively lower, the signal driving it up.

In this circuit the intercarrier sound signal is extracted from across L4 in the video amplifier anode circuit. This means that the amplifier must have a bandwith up to 6MHz to pass this signal. L4 in conjunction with the 68pF capacitor tunes over 6MHz. L5 in association with the parallel 1·8kpF capacitor in the cathode circuit tunes to 3·5MHz, which is the 405 standard intercarrier, and since all this carrier does is to put dots on the 405 display the tuned circuit here acts as a rejector, putting a dip in the response at the offending frequency and thereby deleting the intercarrier dots.

The video signal across the 3·3kΩ video amplifier anode load is a.c. coupled to the picture tube cathode through the 0·15μF capacitor, L6 and the parallel 8·2kΩ resistor. The picture tube grid is set at a fixed d.c. potential by the voltage-dependent resistor (v.d.r.) and the 220kΩ resistor, and the tube biasing is controlled manually in this model by the brightness control being returned to the tube cathode circuit via a 330kΩ resistor. It is for this reason that the video signal has to be coupled via the 0·15μF capacitor; but reasonable black-level clamping is achieved by the d.c. coupling to the cathode through the brightness control circuit. This technique leaves the tube grid available for the line and field blanking pulses which are applied as shown in the circuit.

AGC Link

It will be seen that S1B introduces diode D2 and its associated components in the 625-line position (the network being shorted to chassis in the 405-line position). This commonly used technique puts a little of the d.c. component of the vision signal on the a.g.c. line on 625 as a means of avoiding blocking which could happen due to the negative-going picture modulation causing overloading at the control grid of the video valve. This sort of overloading can tend to clip off the sync pulses and hence the negative a.g.c. potential at the sync separator grid. In the 405-line position S1C also shorts to chassis the intercarrier feed from the video valve anode. The resulting 3·3pF shunt capacitance is of very little consequence on the lower definition 405 standard.

The *RC* network in the screen grid of the valve and the capacitors across the cathode resistors all

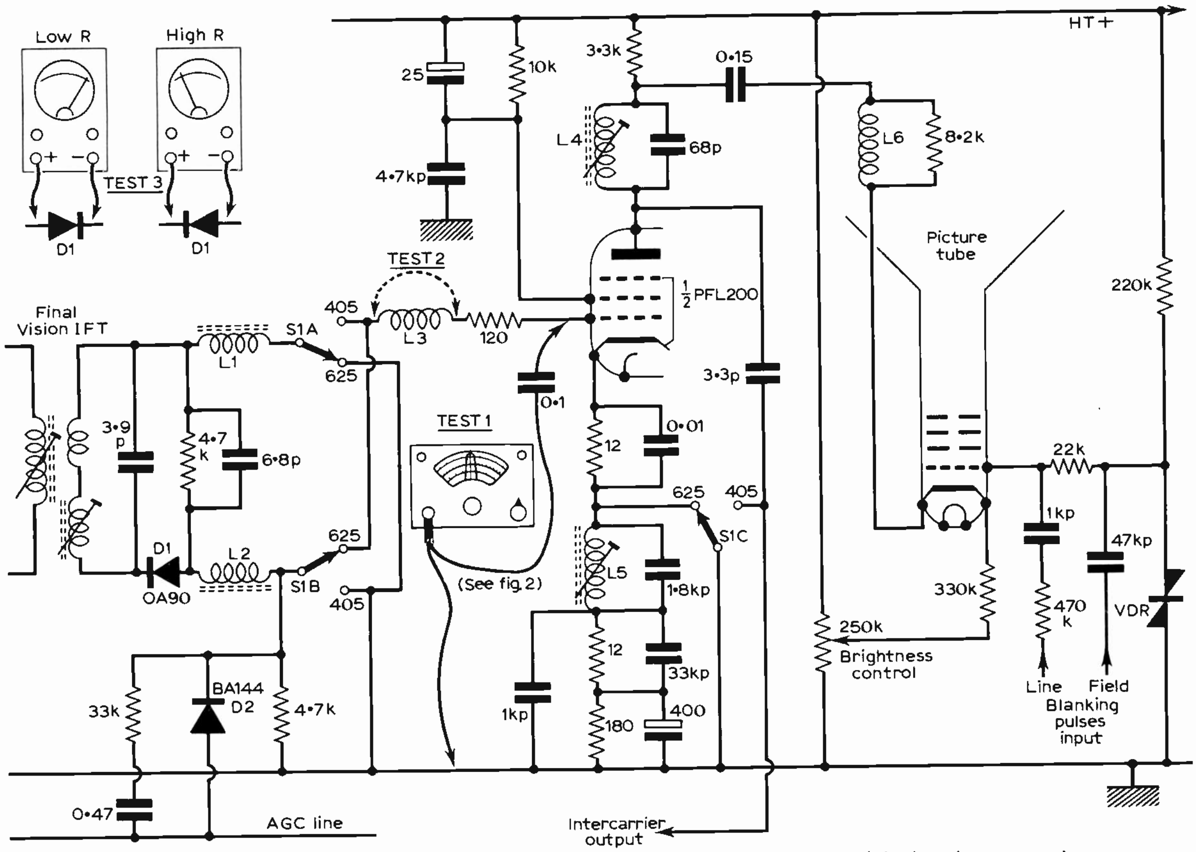


Fig. 1: The detector, video amplifier and tube biasing circuits of a recent model, showing test points.

help to tailor the response characteristics and compensate for h.f. roll-off. L3 and L6 have similar functions, the former also serving to block the i.f. signal.

Basic Video Tests

The best way of checking the basic performance of the video amplifier is to inject a signal falling within the video passband into the control grid circuit of the valve (Test 1). If the stage is working then the screen will display dark and light shaded bars of vertical or horizontal disposition depending on the frequency chosen, low frequencies giving horizontal bars and high frequencies vertical ones. A typical display from Test 1 is shown in Fig. 2.

It is possible to use the 50Hz signal on the heater chain if a generator is not available (where a silicon diode is used in the heater chain the supply is pulsating d.c. however) but care should be taken to ensure that the signal sampled is at the low-potential end of the chain (e.g. that across the picture tube heater is all right) and that isolation is provided by an $0{\cdot}1\mu F$ coupling capacitor as that shown between the generator and the video valve grid in Test 1. Testing at 50Hz will produce the typical hum bar on the screen. One not uncommonly comes across the symptom of good sound and raster but no picture. It is true of course that such trouble could lie somewhere between the sound take-off (on 405 lines) in the i.f. channel and the input to the vision detector (i.e. in the vision only i.f. stage(s)); but often the symptom is caused by a fault in the vision detector, video amplifier or signal couplings in this area of the set. Some of the early 405-line only models displayed this symptom due to the small inductor between the output of the vision detector and the control grid of the video valve going open-circuit (the equivalent of L3 in Fig. 1).

However since the control grid circuit is often returned to chassis (via the detector load) through this inductor on more recent models, such a fault not only removes the video signal but also upsets the video valve biasing, reflected in abnormal action of the brightness control. Consider for example L3 going open-circuit. The video valve would then have a floating control grid which might result in a rise in anode current, a fall in anode voltage and a bright raster almost out of brightness control range. Should the control grid be returned to chassis through a separate resistor located at the grid side of L3 in Fig. 1, however, L3 going open-circuit would affect only the video signal coupling and not the biasing.

Thus a quick test for this inductor is merely to short it out, as shown by Test 2 in the circuit. If the inductor is faulty the vision (and normal brightness control action) will be restored; but the component should be replaced or repaired as soon as possible to secure optimum picture quality. It not uncommonly happens that a dry-joint develops between the end of the winding and the termination wire, in which case cleaning the wire ends and resoldering quickly solves the problem.

Fig. 2: Low-frequency screen test tone display.

L1 or L2 (Fig. 1) could also develop an open-circuit or intermittency. Test 2 applied to each inductor in turn will soon prove the possibility.

The vision detector diode is not particularly easy to test, especially when it is hidden away in the screening can of the final vision i.f. transformer as it often is. If one has an oscilloscope it is an easy matter to monitor an off-air vision signal across the detector load resistor (the 4·7kΩ resistor in the circuit), looking for a display similar to that shown in Fig. 3 with the scope running at about half line frequency. Alternatively it is possible to measure a d.c. voltage across the load resistor on a high-resistance voltmeter when an r.f. signal at vision frequency is applied at the aerial socket (or at i.f. to the control grid of the first vision i.f. valve).

If tests in the aerial, tuner and i.f. sections prove that the first circuits are working, while a video section check—as just detailed—indicates that all is well from the video valve grid to the picture tube cathode, then it might well be worth testing the vision detector diode by substitution or with an ohmmeter after first extracting it (or at least disconnecting one side of it) from the detector circuit. The ratio between forward and reverse current should normally be not less than 100 : 1 (it is usually much more than this). Thus with the ohmmeter connected to the diode one way round a lowish resistance should be measured and a significantly higher resistance value should be recorded with the test probes reversed (Test 3). If the diode reads very high in both directions it is possibly open-circuit; low resistance in both directions could indicate a junction short-circuit. Make sure that the correct replacement (or an equivalent) is used to avoid loss in picture definition.

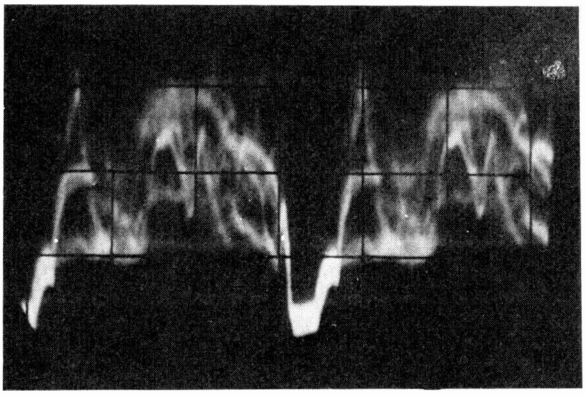


Fig. 3: Two vision signal lines at the detector load.

Tube Biasing

Trouble in the video stages can also give rise to complete "unbiasing" of the picture tube and severely impaired picture definition, with ringing, overshoot, black-after-white and so forth. If the video valve loses emission for example the voltage at its anode will rise (because there will be less voltage drop across the anode load resistor) and this will be communicated direct to the cathode of the picture tube, which is the same as the grid going less positive (or negative with respect to the cathode), an effect that will tend to back-bias the tube, often to the extent of making it impossible to secure a raster even with the brightness control fully advanced.

In Fig. 1 this trouble is less likely to occur owing to the a.c. coupling from the video valve anode to the tube cathode; but the same symptom could be caused in this kind of circuit by a decrease in the value of a resistor in the brightness control circuit proper or an increase in value of a resistor feeding the positive potential to the tube grid. The v.d.r. developing a short or low resistance on the other hand will pull down the grid voltage with respect to that on the cathode from the brightness control, thereby back-biasing the tube.

Figure 4 shows the type of picture tube feed circuit in more common usage with the tube cathode d.c. coupled to the video valve anode (through the 82kΩ resistor in this case with the parallel 0·22μF capacitor giving a degree of a.c. coupling to boost the higher frequencies) while the tube grid is taken direct to the slider of the brightness control through a pair of resistors forming a potential-divider for the field blanking pulses. The standard-change switch section S1 merely introduces extra video compensation (L2) on 405 lines, L1 only being in circuit on 625 lines.

The video valve is half a PFL200, the same as in the circuit of Fig. 1, the other half section working as the sync separator. This valve is to be found in quite a few recent all-valve *and* hybrid models, and it is noteworthy that it can develop a fault which impairs the line and field synchronising performance on both standards, but usually more on 405 than on 625 lines. It seems that the valve develops grid-current symptoms, aggravated if the mains voltage tapping is incorrectly adjusted, so that after the set has been running for a while the line hold becomes very critical with the field flicking in and out of lock too at the slightest provocation such as on a burst of interference and sometimes on changes in picture content. The best test here is to substitute the suspect valve with one known to be in good order. Some of the early versions of the PFL200 were more prone to this trouble than are recent versions.

The brightness control circuit in Fig. 4 might seem a bit involved. The control proper is padded at the top and bottom with fixed resistors, the top terminating at a positive potential and the bottom going to chassis via the earthy pole of the mains on/off switch. The idea of returning the control circuit to the neutral-mains side of the on/off switch is to prevent the formation of a delayed spot of light on the screen each time the set is switched off. With the control grid circuit so connected the tube grid rises to a high positive potential when the set is switched off due to the earthy side of the brightness control being disconnected. This makes the tube highly conductive and the resulting rapid rise in beam current almost instantly discharges the e.h.t. reservoir capacitor, thereby making it impossible for a switch-off spot to linger on the screen. It is particularly important for sets employing this artifice to be connected to the mains supply so that mains neutral is on the chassis side of the on/off switch.

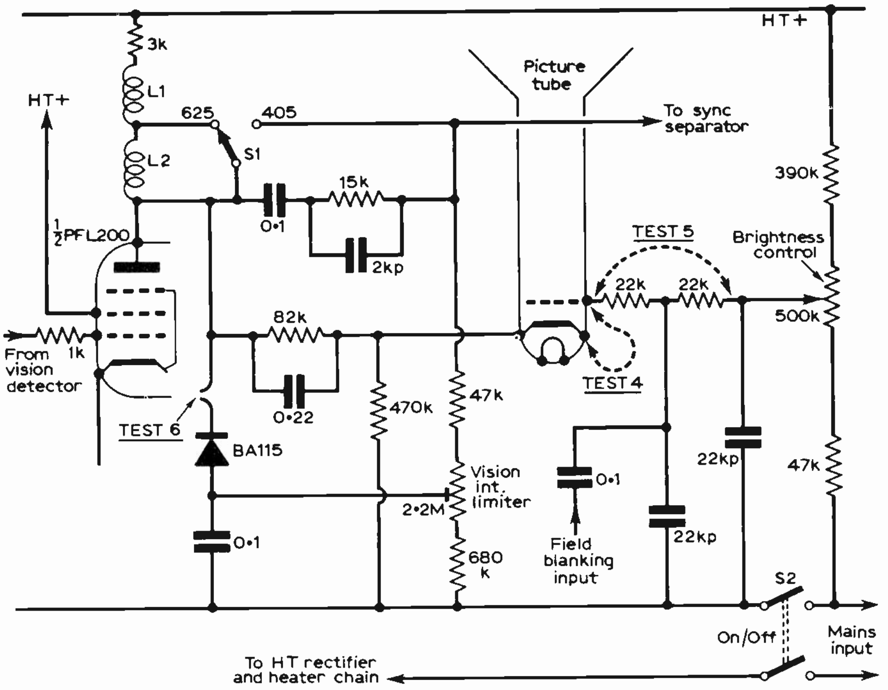


Fig. 4: Circuit with video amplifier direct coupled to the tube, showing test points. A vision-interference limiter is also incorporated in this circuit.

A quick test to see whether or not incorrect biasing of the picture tube is responsible for the lack of a raster—assuming that the tube first and second anode voltages are normal—is to short-circuit between the grid and cathode on the tube base, as shown by Test 4. This test must be performed quickly and the short removed to avoid over-running the picture tube; but if it results in the return of the raster then one can be sure that something is amiss with the tube biasing, either relative to the video valve anode circuit and its d.c. coupling to the tube cathode or to the brightness control circuit proper.

If a picture tube whose grid carries a series resistor —like the two 22kΩ resistors in Fig. 4—to the slider of the brightness control develops a grid leak or runs into a little grid current, the resistive path acts as a load and a positive potential develops on the grid relative to the cathode. This turns on beam current and may make it impossible to delete the screen illumination even by turning the brightness control right down. A quick test for this trouble is to short-out the resistance, as shown by Test 5 in Fig. 4. If this restores normal tube working the tube could be at fault.

Tube Blanking

The resistance in the tube grid circuit might be included to facilitate application of the blanking pulses and in this event when the short is applied flyback lines will possibly appear on the picture. Moreover, most circuits feed the blanking pulses to the tube grid circuit through capacitors and an electrical leak in such a component could also reflect a positive potential (extra to that from the brightness control) to the grid and give symptoms similar to those attributable to picture tube trouble.

Not all sets use line blanking, but the vast majority of recent models use field blanking. The technique is very simple, negative-going pulses being injected into the tube grid circuit, as we have seen, so that on the retrace strokes the screen is effectively blanked out to avoid the display of the flyback lines. To see whether or not the blanking system is working, disconnect the blanking pulse feed to the control grid resistors and scrutinise the picture for short, horizontal lines (field retrace displays). If these occur with the blanking removed and disappear with it connected the system is obviously working correctly. The field blanking pulses are generally taken from across the secondary of the field output transformer, via an 0·1μF capacitor. Sets with line blanking also pick up the line blanking pulses from across the line scan coils via a 1kpF capacitor.

Vision Interference Limiter

The circuit (Fig. 4) also shows a vision interference limiter, the BA115 diode and associated components connected to the video valve anode. This diode is set by the 2·2MΩ preset potentiometer to conduct on the peaks of interference pulses thereby preventing large amplitude pulses reaching the tube cathode. Incorrect biasing of the diode due to changes in resistor values or incorrect setting of the preset could result in conduction on peak-white picture signal, an effect which dramatically reduces the highlight displays. However since a low-emission picture tube can produce similar symptoms it is often a good idea to disconnect the limiter circuit, shown by Test 6, to prove conclusively whether it is this or the picture tube that is causing the effect. Few modern sets incorporate a vision interference limiter circuit.

A low-emission video valve is a further possible cause of crushing on whites, as also is its incorrect

—continued on page 407

DX TV

A MONTHLY FEATURE FOR DX ENTHUSIASTS

CHARLES RAFAREL

At last I can report an overall improvement in DX conditions. SpE has shown a significant improvement: it is still early for this but April and May should give us what we have been waiting for! The past month has shown an increased range of countries and if openings have still been infrequent there has been greater variety and interest in them. First the SpE log here for the period 7/3/69 to 4/4/69:

10/3/69 USSR R1 and Czechoslovakia R1, W. Germany E2, Czechoslovakia R2.
12/3/69 Czechoslovakia R1 (very good).
13/3/69 Czechoslovakia R1, Poland R1.
14/3/69 Czechoslovakia R1, USSR R1 and Austria E2a.
15/3/69 Czechoslovakia R1, W. Germany E2, Sweden E2.
16/3/69 Norway E2.
20/3/69 Czechoslovakia R1.
23/3/69 Spain E3.
29/3/69 USSR R1.
30/3/69 W. Germany E2.
31/3/69 USSR R1, W. Germany E2, Yugoslavia E4 and Sweden E4.
1/4/69 USSR R1, Czechoslovakia R1.
2/4/69 Sweden E2.

The real joy however was a pretty good Trop opening from 7/3/69 to 9/3/69. There was some evidence of its beginning on 6/3/69 when the French Band III stations began to build up. This continued through the 7th and by the 8th things were really swinging with W. German and Dutch u.h.f. bursting in—always quite an event in my area of Central Southern England. They had alas gone again by the morning of the 9th but the French u.h.f. came in well during the early part of the day. Down here the log included Holland Chs. 27, 29, 31 and 32, W. Germany Chs. 21, 22, 25, 29 and 35 (good for this area but other areas did better, see readers' reports later). I had one bit of good fortune: while my local BBC-2 Ch. 24 was off the air I managed Troyes France Ch. 24 for a new one.

NEWS AND REPORTS

NTS Smilde Holland Ch. 47 has been received by F. Smales of Pontefract. This looks like a new one to me as I cannot recall seeing it in the official lists so far and the same goes for his u.h.f. Denmark Ch. 31.

During the recent Trop u.h.f. opening I noted on two occasions that ORTF2 France have now got a coloured lady announcer (very attractive she is too!); please DXers note this and do *not* submit claims for Central African u.h.f.-DX on the strength of what you see on your screens! It has happened in Band I before over Portugal so I am not joking!!

We gave a list of new Belgian u.h.f. stations in our last issue and following our predictions we are delighted to hear that I. Beckett of Buckingham and P. Beard of Folkestone have already logged Oostvleteren Ch. 49.

Our old friend A. Papaeftychiou of Cyprus says that Lebanon Maasa el Chouf Ch. E4 has now raised its power and this should help here. He also says that the captions state "Secam Emission" which seems to indicate colour tests.

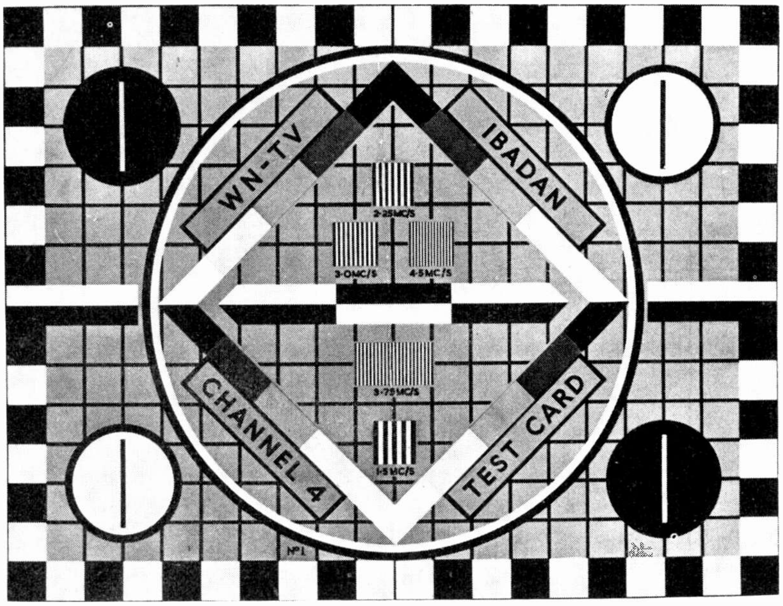
Ferdy Dombrowski of Milwaukee USA reports his own reception of BBC-1 Ch. B1 sound on 28/2/69 and Mel Wilson of Rochester NY received it by Aurora on 2/2/69. They had French Ch. F2 sound as well, so our congratulations to them both.

The u.h.f. opening is the main source of our correspondence this month and I quote to start with the log of F. Smales for the 4th, 5th and 6th March, starting rather earlier than here in the South. He had u.h.f. W. Germany on Chs. 27, 28, 29, 30, 32, 33, 34, 40, 42 and 43, E. Germany Ch. 34 Brocken Sweden on Chs. 23 Uddevalla and 43 Hörby, Holland on Chs. 27, 29, 31, 32, 39, 45 and 47 Smilde (? new station). Then he gets really exotic with Denmark Test card on Ch. 31 (this is our first report of this) and continues with Spain on Ch. 24 Madrid and Ch. 31 Barcelona. This is really excellent. He is of course in the North of England and the distances are really great. He found Band III was profitable as well with Denmark Ch. E7, Sweden E8 and Holland E6 and E7.

Following earlier CDX (Colour DX) reports P. Beard of Folkestone has been doing very well once again. During the recent good conditions he logged Belgium Ch. 49 Oostvleteren, his colour DX was from W. Germany Ch. 35 Kiel and Ch. 37 unidentified; he also got good Dutch colour and sound from Ch. 27 Lopik and Ch. 31 Roermond, also black-and-white from Ch. 29 Goes. French negative colour images (this I have yet to see on a colour TV set) were received from Ch. 21 Lille and Ch. 25 Caen and, very interesting, the low-power relay station on Ch. 34 at Boulogne (once again our predictions were correct). I am wondering if he realised that both Oostvleteren and Boulogne are vertically polarised signals? I have a feeling that his aerial may well have been horizontal which would make the reception even more remarkable.

Talking of unorthodox aerials we have a log

DATA PANEL-27 NIGERIA: GOVERNMENT AND WEST NIGERIAN TV (WNTV)



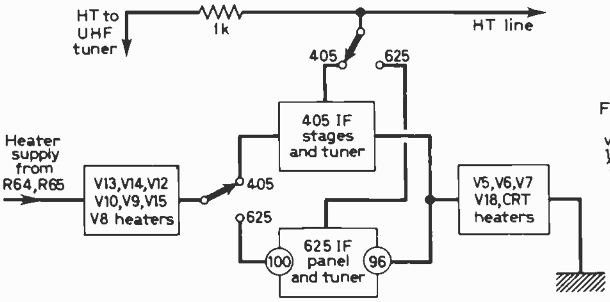
Information and photo by courtesy of E. Baker, Blyth, Northumberland.

WNTV Test Card as photo carrying either Ibadan Channel 4 or Abafon Channel 3.
Channels in Band I:
E2 Ibadan 6kW horizontal, Government TV.
E3 Abafon 60kW horizontal, WNTV.
E4 Ibadan 1·5kW horizontal, WNTV.
E4 Jaji 48kW horizontal, Kaduna TV.
E4 Ibadan is shortly to raise its power to 50kW.
The stations at Enugu E2 and Aba E4 have now been destroyed in the Nigeria-Biafra war. Enugu had been received in Great Britain.
Times of transmission:
Government Stations: Weekdays 17.00 to 23.30 GMT, Sundays 16.00 to 22.30 GMT.
WNTV: Weekdays 17.00 to 22.00 GMT, Sundays 17.00 to 22.30 GMT.

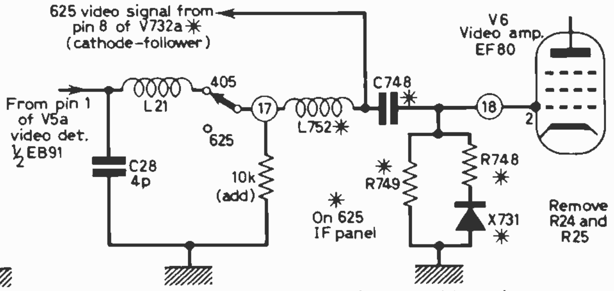
from Brian Still of Ansty Sussex of his u.h.f. reception on a Band II single horizontal dipole! With this and a converted Bush model TV66 with u.h.f. tuner he logged France Chs. 21 Lille, 25 Caen and 34 Metz, plus Holland on Chs. 27 Lopik, 29 Goes and 32 Goes. He goes on to say that he is going to erect an 18-element u.h.f. aerial with provision for rotation.

CONVERTING 405-ONLY RECEIVERS FOR DUAL-STANDARD OPERATION

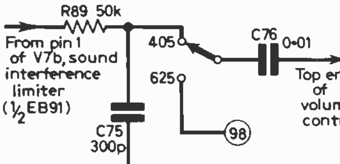
Following the recent interest amongst readers A. H. Rushton supplied details of his conversion of a Decca Model DM17 using the Philips conversion panel. These are shown below: numbers in circles are the Philips panel tag numbers. Many other Decca models of the period are similar to the DM17.



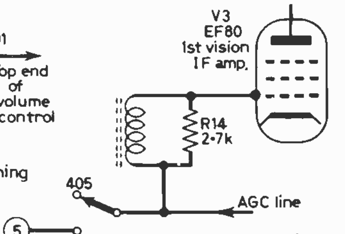
(a) Heater and HT switching



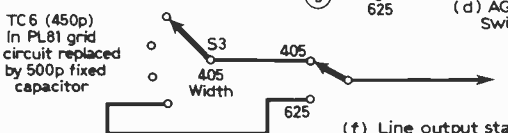
(b) Vision input signals to video amplifier grid



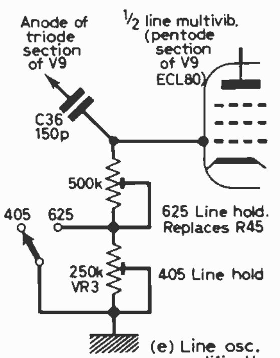
(c) Audio switching



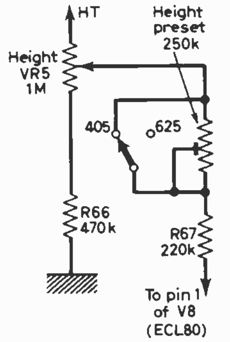
(d) AGC connection. Switch not essential



(f) Line output stage modification



(e) Line osc. modification



(g) Height equalisation

fault finding FOCUS

S. GEORGE

AGC CIRCUITS—2

LAST month we covered the basic operation of a.g.c. circuits and in this instalment we intend to cover the practicalities of diagnosis and fault location in these often quite involved circuits. Taking valve types first, since they still form the bulk of receivers in use, in almost all instances we saw that a.g.c. is derived from the negative grid voltage developed by the sync separator backed off by a slight positive potential tapped from the contrast control. In those Pye-Ekco and Bush-Murphy models that use high-level contrast control by means of a potentiometer shunted across the video load the preset sensitivity control still operates on this basic principle to delay the onset of a.g.c. to the r.f. amplifier.

Concentrating on this mean-level system therefore we shall next list common symptoms, causes and best diagnostic action.

Contrast control only slightly increases gain

This is not usually an a.g.c.-contrast control fault and is commonly caused by insufficient aerial input or a receiver defect that results in low gain.

It must be borne in mind that in these a.g.c. systems advancing the contrast control does not turn the contrast or gain on as a volume control turns on the required degree of sound, but instead attenuates what a.g.c. may be present. If therefore signal strength is low the positive potential provided by the contrast control has negligible negative a.g.c. voltage to offset or wipe out and seemingly has no effect.

Most older sets are much less sensitive than current receivers and there are several of these models, excellent in every other way, which tend to give the impression that the contrast control is not really functioning properly since it has such a small effect. While the gain of these receivers is quite adequate for average signal inputs, unless aerial siting is particularly good it is generally necessary to have the contrast setting close to maximum.

If however the contrast control in any particular receiver originally had plenty of effect and has gradually or suddenly lost it the cause will most likely be due to reduced receiver gain or an aerial defect. The first thing to notice is if picture grain has increased, indicating loss of emission in the r.f. amplifier or an aerial fault.

If in doubt about the aerial try an indoor type and if this gives equivalent or better results than the existing roof or attic type then an aerial fault seems certain. Try the effect of running the receiver with the coaxial plug removed from the cable and the inner conductor only contacting the central coaxial socket aperture. If this results in improved or similar performance which degrades when the outer braiding is contacted to the outer aerial socket ring, the aerial will probably have an element disconnection, loss of insulation or partial short-circuit across the coaxial cable. If the grain is particularly severe on Band III, the chances are that the r.f. amplifier will be in need of replacement.

If the picture is grain free this would indicate one or two possibilities, (a) impaired receiver gain due to a defect after the tuner, e.g. weak i.f. valve, faulty vision detector diode or open-circuit decoupler etc. or (b) that the receiver gain is normal but the contrast control is failing to supply the usual positive potential to offset the negative a.g.c. potential. The latter possibility can be checked by temporarily short-circuiting the a.g.c. rail to chassis with the contrast at maximum and noting if gain increases. If gain does increase then the contrast control or associated components are at fault.

The most common cause is an open-circuit or dry-jointed high-value resistor linking the contrast-control slider with the a.g.c. rail. Such resistors are always in the megohm range and tend to increase still further in value after years of service. A further possibility is that the limiting resistor at the h.t. supply end of the control is practically open-circuit or dry-jointed. If there is a break in the control track it will be self-evident by causing unvariable maximum and minimum sensitivity each side of the fracture.

In most printed circuit receivers the a.g.c. rail is indicated by small lettering. Where this is obscured or non-existent it is best located by looking for the clamp diode or checking for points fed by high-value resistors which are slightly negative with respect to chassis and which fall to zero when the aerial plug is removed.

Contrast control only slightly reduces gain from maximum

This fault is not so common and the most likely causes depend on the degree of control remaining. If a fair measure of control exists it could be that either the r.f. or i.f. valve is slightly soft and drawing grid current to greatly offset the a.g.c. voltage. Check replacement of these valves is the best immediate action. Should it be found that the valves are normal the next step is to discover why only a small a.g.c. voltage is present although a strong signal is received.

This could be due to many reasons but to narrow down the field of inquiry carefully look for any other coincident symptoms. Is sync lock weak, is the picture "soot and whitewash" on v.h.f. and is the preset sensitivity control operative?

Next on chassis inspection are there any signs of resistors overheating? Very often, particularly in modern receivers where resistors may work close to their maximum wattage ratings, a reduction in value may occur resulting in symptoms which might take a lot of meter work to discover. On the other hand if a careful visual inspection is made first the discoloration that always accompanies major value reduction will have been immediately apparent.

If sync lock is weak this would suggest that the common cause was the sync separator failing to develop the grid potential normal for the signal level, or that a defect earlier in the receiver was in some way inhibiting its action. Sync separators only pass current during pulse periods, generally have a long life and give little trouble, but the preceding video stage handling high currents and considerable peak voltages breaks down much more commonly. The video circuit anode, screen and cathode resistors are always composition types to avoid the inductance of wire-wound ones and probably change value more frequently than resistors in any other part of the receiver.

Should the video stage bias increase and if the grid is directly coupled from the detector on 405 this will result in reduced amplification of the dark picture signals and sync pulses on this system as they are both of low carrier amplitude. Reduced amplitude sync pulses at the sync separator grid naturally impair sync pulse output but, what is equally important, the negative grid voltage will be reduced. This then reduces the degree of control of the contrast potentiometer, the extent depending on how much the video pentode is overbiased.

As composition resistors decrease in value after prolonged use or overload in most instances excessive bias is caused not by the cathode bias resistors increasing but by a reduction in the value of the stabiliser (if fitted) connected from h.t. to the valve cathode. So automatically replace any discoloured resistors since they are sure to have changed in value.

In a high-gain modern receiver if it is impossible to reduce the contrast to an acceptable level the resulting excessive gain will result in cross-modulation producing sound-on-vision and vision-on-sound. This gives the impression that the receiver is completely out of alignment, unstable or that a major decoupling capacitor is open-circuit. That sound-on-vision and vision-on-sound is brought about by lack of a.g.c. or contrast control and not by misalignment can be verified by operating the set from a low-gain indoor aerial or even a short length of wire when stable if weaker reception should be obtained.

Contrast completely inoperative with gain at maximum

This is generally caused by a complete short-circuit across the a.g.c. rail and chassis, either because of a solder blob, wire strand or defective clamp diode. Due to the very low voltages involved, shorting capacitors can be discounted.

Intermittent gain variation

Dry-joints and intermittently open-circuit a.g.c. feed resistors are the most common cause, and the best way of locating them is by lightly probing and pressing in the suspect areas.

Severe contrast control action

This is quite a rare fault but the symptoms can be puzzling inasmuch as once maximum gain has been achieved with only a small control movement further advancement produces a flat monotone picture devoid of any real contrast. The cause is the clamp diode going open-circuit so that when the contrast control has wiped out the negative a.g.c. it can then swing the grids of the controlled valves positive so that excessive anode current passes only slightly affected by the signal.

AGC lock-out

This can only occur on 625 due to the fact that on this system negative modulation is employed so that increasing picture brightness reduces modulation depth. As the sync pulses occupy the region from 77% (blanking level) to 100% this means that on predominantly dark scenes when signal amplitude will average close to the blanking level the a.c. detector output will be low but the d.c. level high.

A.G.C. depends on rectified a.c. signal content so that in these circumstances it will be low resulting in high gain. This further increases signal strength during predominantly dark scenes so that the last i.f. valve could be run close to saturation point and would thus tend to clip the sync pulses. This then still further reduces the a.g.c. so that ultimately the set could be operating at maximum gain on a strong signal causing loss of sync and overdriven final stages.

To prevent this occurring most dual-standard models incorporate an overload diode connected with its cathode to the vision detector output and its anode to the a.g.c. rail. Thus when the a.g.c. voltage is low during the conditions just described the negative detector output will be high and will flow through the overload diode to augment the a.g.c. potential. There are other forms of overload protection and many variations of the basic overload diode circuit but as we are concerned here only with basic a.g.c. faults if lock-out develops the first suspect must be this additional diode.

AGC voltages

Because of the extremely high resistive feeds employed on valve a.g.c. rails, when voltage testing all potentials measured must be regarded as indications rather than precise values. Normally when a negative voltage is present meter application will increase the set's gain and thus prove that the a.g.c. potential is at least reaching one of the two controlled valves. This voltage should always drop to near zero when the aerial plug is removed or the set is switched to a dead channel position.

In most dual-standard KB-RGD receivers, however, there is a preset a.g.c. control taking a negative supply from the grid of the line output pentode so that at all times and on both systems there is a small negative voltage present which can be increased to limit high signal inputs. The complete a.g.c.-contrast control system is shown in Fig. 1 and it will be seen that both the 405 and 625 controls are

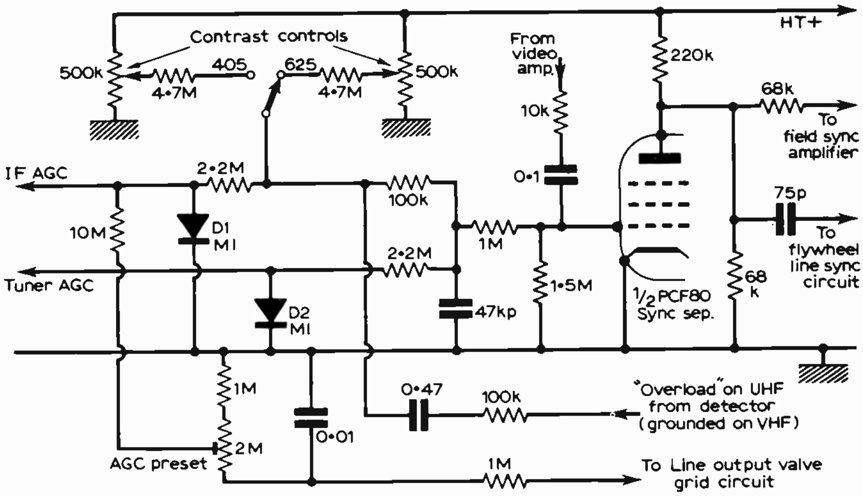


Fig. 1: A.G.C.-contrast circuitry used in many KB/RGD models.

presets brought into circuit by the system switch. Overall receiver gain is therefore regulated by (a) sync separator grid voltage which is in turn determined by signal strength, (b) the contrast control setting and (c) the adjustment of the a.g.c. preset control. Clamp diodes D1 and D2 ensure that the bias to the i.f. and r.f. valves never goes positive due to excessive advancement of the contrast controls.

Figure 2 shows the basic high-level contrast control system used in both fully valved and hybrid Pye-Ekco receivers. When used in the former the a.g.c. system follows the conventional mean-level technique. High-level contrast control circuits give little trouble and if a break should develop in the potentiometer it would become immediately apparent. If a break developed in the peaking coil or either of the 3.3kΩ load resistors operation would continue but picture quality would be impaired.

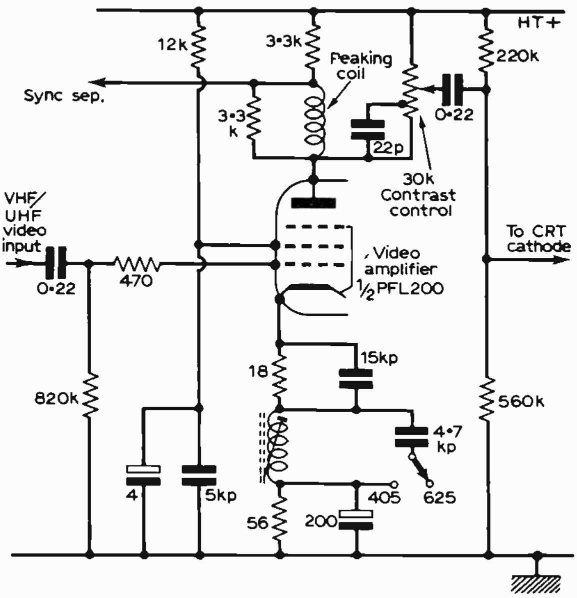


Fig. 2: High-level contrast control system as used in many valve-only and hybrid Pye/Ekco models.

In this particular example a.c. coupling is employed from the vision detector to the video amplifier valve grid and from its anode to the c.r.t. Bias therefore remains unaltered at the class A position on both systems, the cathode switch merely tuning the associated coil to 3.5MHz on 405.

Valve a.g.c.-contrast control systems therefore fall into one of two general categories and in practice when a fault develops it is a reasonably simple matter to follow the fairly stereotyped circuitry without a service manual. It is easy to pick up the feed from the sync separator grid, the positive supply from the contrast control, the clamp and overload diodes and to follow the supply to the tuner and i.f. amplifier.

Transistor AGC circuits

When it comes to transistor circuits however although they broadly follow a basic pattern individual variations and normal working voltages are such that it becomes essential to have the appropriate service manual to hand. Whilst in valved receivers the mere presence of a negative voltage on the a.g.c. rail which varies with the contrast control setting and channel selection is ample evidence that the system is operating, in transistor receivers forward bias to the controlled stages is always present and must increase with rising signal strength, even small variations producing a large effect.

This raises a vital point. While forward a.g.c. is always employed in hybrid and transistorised TV receivers the polarity and movement direction of this voltage with respect to chassis depends on (a) whether pnp or npn transistors are employed and

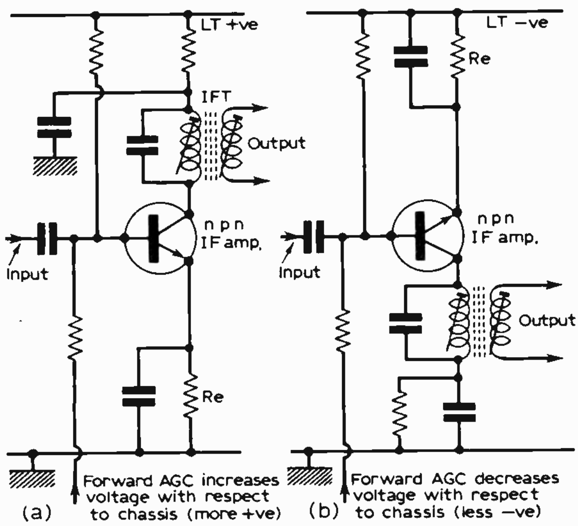


Fig. 3: Application of forward a.g.c. to transistor i.f. amplifier stages.

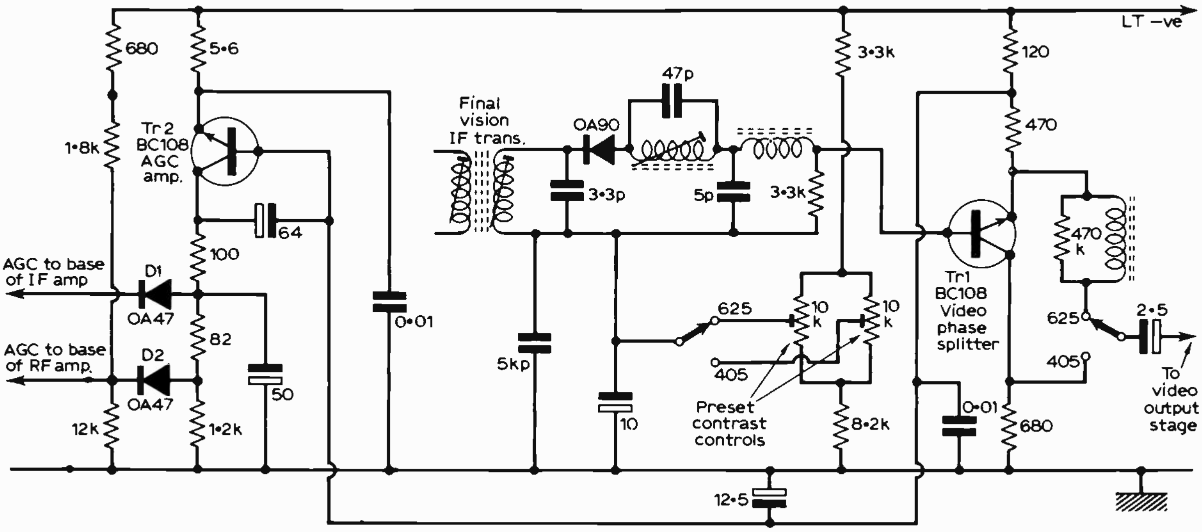


Fig. 4: Transistor a.g.c. system used in many Pye/Ekco models.

(b) whether a negative or positive l.t. supply is used. This forward a.g.c. can either rise or fall *with respect to chassis* although it will always increase the base to emitter potential. This is illustrated in Fig. 3(a) and (b) which shows two identical npn i.f. amplifiers but with example (a) fed from a positive l.t. rail and example (b) fed from a negative rail. To increase forward bias to (a) the base must be made more positive with respect to the emitter and therefore to chassis also. With example (b) however increasing the base potential with respect to the emitter means lowering the base (a.g.c. rail) potential to chassis. In the latter instance therefore, and this commonly occurs in transistor designs, increasing the forward bias is caused by reducing the a.g.c. rail potential. This is not always so but is the general practice when collectors and not emitters are chassis connected.

If the emitters are chassis connected shorting the a.g.c. rail to chassis can remove most of the forward bias, but if the collectors are chassis connected shorting the a.g.c. rail to chassis is equivalent to applying almost the full l.t. across the base and emitter of the controlled transistors with possibly disastrous results. While therefore shorting *valve* a.g.c. rails is permissible and indeed makes a simple but effective test of a.g.c. operation. transistor a.g.c. rails must never be shorted.

Another difficulty with diagnosing faults in transistor circuits is that there are generally one or two diodes employed to switch the a.g.c. to and from the r.f. and i.f. stages as signal strength varies. Their correct operation depends on their exact biasing, and for this reason also it becomes essential to have a circuit diagram to hand to check the applied voltages.

Voltage checks will usually soon indicate the root cause of an a.g.c. fault but due to the several stages that may be involved, all of necessity d.c. coupled, a fault at the a.g.c. take-off point can cause incorrect voltages throughout the system. If therefore the a.g.c. rail voltage is incorrect keep checking back to the point of origin until the instigating voltage inaccuracy is found. It may be found necessary to check as far back as the video amplifier or transistor phase-splitter depending on the circuitry involved.

As a typical example of transistor a.g.c. circuitry Fig. 4 shows the system employed in many Pye-Ekco receivers. The a.g.c. source is the video phase-splitter Tr1 with its base fed from the single v.h.f./u.h.f. detector and forward biased by the settings of the separate v.h.f./u.h.f. preset contrast controls. The main user contrast control is a high-level arrangement similar to that shown in Fig. 2. Although the vision detector diode is held at the same potential above chassis as Tr1 base this has no effect on detection since both sides of the diode are at equal potential.

Rising signal strength on both systems being negative-going to chassis results in a rising (negative) emitter potential which progressively reduces the collector current in the a.g.c. amplifier Tr2. On no-signal and at maximum gain Tr2 is bottomed, i.e. passing maximum current, so that its collector and emitter voltages are close, 17·5V and 17·6V respectively. As sensitivity is reduced or signal strength increases, the reduced forward bias to Tr2 effectively increases its emitter to collector resistance and its collect voltage falls.

The collector feeds the a.g.c. rail so that a reduced potential is applied via D1 to the base of the vision i.f. amplifier. Having its emitter connected to the negative l.t. rail this transistor then increases its collector current to reduce its gain.

At low signal inputs D2 remains reverse biased so that the r.f. amplifier stage gain remains at maximum to maintain best signal-to-noise ratio. However, on strong signals and when Tr2 collector drops to a sufficiently low value D2 conducts to reduce r.f. gain while D1 becomes cut-off leaving the i.f. amplifier stage gain at a fixed low value determined by a preset in the base circuit of this transistor. D1 and D2 therefore function as switches biased on and off by Tr2 collector potential.

Overall therefore as the base of the phase-splitter Tr1 is made more negative either by signal strength or the setting of the preset control the a.g.c. amplifier conductivity reduces to reduce the a.g.c. rail potential to chassis and thereby lower amplification. Thus if a fault develops that alters Tr1 static or operating conditions the entire a.g.c. system will fail to operate normally.

If a service manual is not to hand this does not

—*continued on page 427*

UNDERNEATH THE DIPOLE

THE temporary local TV headquarters at televised race meetings used to be well and truly identifiable by the enormous mobile telescopic transmitting mast used for the microwave link back (sometimes via intermediate links) to the parent BBC or ITV studios concerned, together with bulky mobile control rooms. Now the outside broadcast engineers, producers and interviewers seem to be able to cope with all mod. cons (electronic) on the spot, with colour TV and hand-held microwave link cameras feeding pictures to elaborate control rooms containing videotape machines, slow-motion devices, standards converters and what (electronically) have you.

Time has marched—pardon me—cantered on since 1937 when Douglas Birkinshaw first took an early Emitron TV camera outside the BBC's first high-definition television studios at the Alexandra Palace, N.22. On the grassy slopes overlooking the Alexandra Park race course he was able to pick up in very longshot a horse cantering down the straight, followed by the " also rans " (out of picture). They were making history. This was the very first British television view of the sport of kings. Those were the days when pioneers such as Norman Collins, Terence Macnamara, Tom Bridgwater and D. C. Birkinshaw were blazing technical trails at the BBC. The television pioneers mentioned above must have been looking at BBC-2's magnificent colour pictures of this year's Grand National, brilliantly produced as well as engineered, ending with a remarkable interview by David Coleman with the winning jockey Eddie Harty. This interview was surely quite a classic in this sports TV field, worth repeating for viewers and, on closed-circuit, in the many training colleges around the country, including the BBC's own staff educational facilities.

HISTORY REPEATING ITSELF

Communication by visual aids has progressed from smoke signals, semaphore, Wheatstone's electric telegraphs, Fox Talbot's photography, Marconi's wireless telegraphy, Edison's Kinetoscopes, Paul's animated pictures, Baird's mechanical television, etc. to colour on u.h.f. All these developments were milestones of progress, often remembered by their participation in important national events. In Britain the most popular have been concerned with the monarchy and the sport of kings—horse-racing. It was Robert Paul's exhibition at the London Alhambra (music hall) of the finish of the 1896 Derby which caused a sensation and initiated the motion-picture industry in England. The fact that the winning horse Persimmon belonged to the Prince of Wales (later Edward VII) was an important factor. From then on the Oxford and Cambridge Boat Race, the Cup Tie Final, Brooklands Motor Racing, the Royal Ascot Gold Cup and the Grand National were annual events with enormous visual public appeal for press and newsreel photographers.

PREPARATIONS FOR SPORTING EVENTS

Then as now preparations for visual and written reporting were as carefully planned as the training of the contestants. Will G. Barker, an Ealing film producer, specialised in photographing sporting events long before regular cinema newsreels existed. The Grand National was his most elaborate event. In the early morning at Aintree he took with him around the course 24 cameramen (six of them from his Ealing studio) with their heavy wooden handle-turned cinematograph cameras and tripods. He supervised the setting up of every camera himself, giving precise instructions on exposure, focusing, film-loading and unloading, etc. Later, as the crowds began to arrive, Bill Barker cycled around the course and double-checked everything. Then came the race, with cameras ready for rain or sunshine; lens apertures open from *f*3.5 (the widest aperture) to *f*8. Within minutes of leading-in the winner 24 wooden film magazines plus some extra magazines containing crowd, bookie and ring scenes were rushed in a (horse-drawn) cab to Liverpool Lime Street Station where a luggage-van fitted up as a film developing laboratory awaited on the rear of a London-bound train.

The negative was developed, edited and on occasions three prints made before arriving at Euston. Crowded audiences at the Alhambra, Pavilion and Hippodrome music halls cheered the achievement as it flashed on the screen. You could see all this from a gallery seat (early doors) for sevenpence, half-a-pint of beer for twopence, a programme for a penny and an evening paper with starting prices for a halfpenny. No taxes were added! Those were the days when cameramen and projectionists had to learn their jobs the hard way.

TECHNICAL TRAINING

Cleaning up film magazines, checking the cleanliness of the camera mechanism, removing dust or marks from the camera lens, fetching a cup of tea for the boss: all these were fundamental duties to be carried out by a would-be cameraman. And when the day's work was finished he would often help with the film development in a dark room, winding it on to wood frames or " pin " frames and rocking them in a tankful of pyro-soda solution before fixing, washing and drying. Pyro-soda dyed the hands and fingernails a dark amber, which was immediately noticed and appreciated by a would-be employer. This industrial tanning was a perquisite which often secured a job.

That was long before film (or television) schools or colleges existed. Apprenticeship was haphazard in film studios or in the newsreel field and any mistakes usually led to the sack. The position has changed in the past few years, with too many amateurish technical schools supplying too many students to too few film or television organisations. Some training colleges are first rate, such as those organised by the BBC; Granada; Plymouth Tech.; Polytechnic, London and the Royal College of Art. But the prospect of a big National Film School, amateurish in concept and enormously expensive to build and operate, fills engineers with apprehension. The Government White Paper working party which visited film schools in Warsaw, Lodz and Rome did not include a single engineer or technologist. They did not bother to visit the Thomson Foundation College near Glasgow, which has a very logical syllabus.

MATCHING COLOUR FILM & VIDEOTAPE

"Film Technical and Training Manager, Film Operations and Services, BBC", is an elaborate description of a complicated job which accurately describes the office occupied by D. J. Corbett whose 225-page book on *Motion-Picture and Television Film—Image Control and Processing Techniques* admirably sets out in detail many of the points he made recently in his splendid B.K.S.T.S. lecture *Matching Colour Film to the TV Studio.* The BBC have developed a high-speed method of shooting the interiors of staged colour plays and features on videotape and shooting the associated exterior shots on 16mm. or 35mm. film. There were many snags, but the BBC seem to have coped very well indeed. Mr. Corbett was particularly preoccupied with fundamental errors to be avoided by lighting men, art directors, wardrobe, make-up and the rest of the team. He listed the following errors to avoid:

(1) *Deep* reds.
(2) A saturated *cyan.*
(3) High saturation *combined with high luminance* on any colour.
(4) High saturation combined with low luminance *—especially if camera tube(s) are noisy.*
(5) Zoom lens operated at a *large* aperture with 16mm. film camera, colour.
(6) *Shooting into the light* (TV or film)—except for special effects shots.
(7) *Contrast* lighting.

The European Broadcasting Union has issued a valuable (but less interesting) booklet entitled *Colour Motion-Picture Film Materials Especially Suited to Presentation by Colour Television.* It is a document covering "the requirements of television broadcasting authorities for complete systems of motion-picture photography in colour, especially suited to give optimum results when the material is presented by colour television rather than by optical projection. It does not preclude the use of existing film materials should they prove to be satisfactory, but is primarily intended as a guide to desirable characteristics to be aimed at in designing new products specially for the purpose."

Having seen extremely good colour results from colour tape or film reproduced in my own home, at the BBC studios on closed circuit or on a cinema screen projected from film, it is obvious that the BBC is tackling these problems successfully. There is still however a tendency towards too great contrast, particularly with whiter-than-white colours such as white collars, tablecloths and papers. This is an old trap that TV lighting men should avoid; film studio lighting men insist on "off-white", "broken white" or even a faint cream colour to paper which, for the sound point of view, should not crackle when handled!

Film for TV: head close-ups at 500 ft. distance. A 1000 mm. lens on an Arriflex (Techniscope) film camera in the centre of the Mexico Olympiad Sports Arena.

PHOTOGENIC FACES

Television colour cameras are very revealing in close-ups, even more so than motion-picture cameras. Film studio type make-up and powder on men often looks terrible on television. But most men's faces look even worse without some kind of make-up treatment. Sometimes the face merely requires a wash, shave, astringent lotion and the removal of unattractive blackheads. Yes! Revelations of the human face on modern colour receivers can be very cruel. Sooner or later the old film studio lighting tricks for flattering the female features will arrive: diffusion discs and/or gauzes in front of the camera lens, plenty of soft filler light, "kicker" light used with great discretion, elimination of nose shadows and eye shadows—these are the secrets of lighting cosmetry.

Iconos

TESTING TELEVISION RECEIVERS

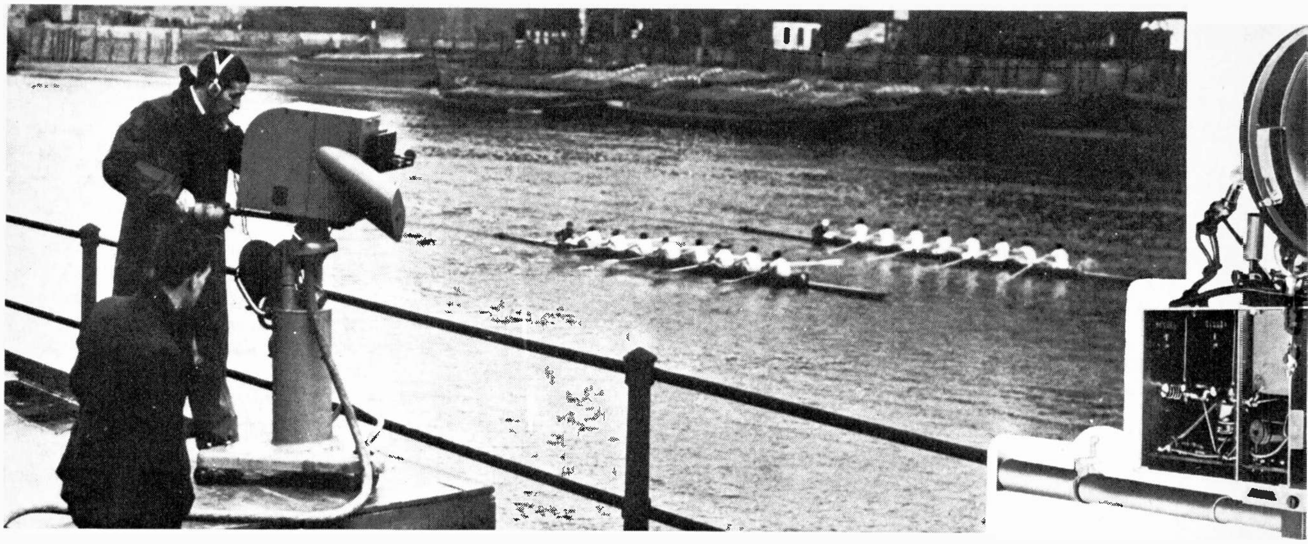
—continued from page 399

biasing due for instance to a change in the value of a cathode resistor.

Black-after-White & Ringing

Black-after-white and ringing are other symptoms that can result from video valve trouble, changes in the values of circuit elements and open-circuit capacitors, especially those in the cathode, screen grid and anode circuits. An electrolytic going low in value will tend to produce degenerative feedback at low video frequencies; while the lower video frequencies are emphasised, giving streaking symptoms, if a video compensating component fails or changes in value. The sync performance can also be severely affected by video stage trouble.

NEW G. J. KING SERIES STARTS NEXT MONTH: COLOUR TELEVISION WAVEFORMS



Early TV Camera Tubes

THE system of television used all over the world today, as distinct from the side-track trodden by Baird, is entirely dependent on two types of cathode-ray tube, the receiver c.r.t. and the type of c.r.t. used in transmitting the picture and known as a camera tube. The pioneers of all-electronic television, as we might call it, seem to have realised three essentials: (1) The building up of the picture at the receiver must be simultaneous with the breaking down at the transmitter (in modern language, transmitter and receiver must be synchronised). (2) The receiver and transmitter systems must use cathode rays to scan the pictures (such rays are easily deflected and shifted, unlike mechanical scanners). (3) For high sensitivity, the signal from the camera at any moment should depend on the total light which has fallen on the camera tube *between* scans (i.e. there must be signal storage).

Campbell-Swinton's outline scheme of 1908 (described in *Nature,* 1908, Vol. 78, p. 151) certainly fulfilled the first two essentials, and his later attempts in 1911 and 1926, when he used a camera tube whose sensitive surface was made up of small spots of the photosensitive material selenium, show that he realised the importance of the third requirement. In this sense, there seems little doubt that Campbell-Swinton should be regarded as the inventor of television as we now know it.

To show how the design of camera tubes developed to make maximum use of the principle of storage, so greatly increasing their sensitivity, and also developed in complexity as the technical demands of television increased, we shall trace the history and working principles of four types of camera tubes each of which represented an important advance in the technology of television. These were the Image Dissector, the Emitron, the Super-Emitron (Iconoscope and Super-Iconoscope in USA) and the C.P.S. Emitron. The last named tube was in use until quite recently in some applications.

The Image Dissector

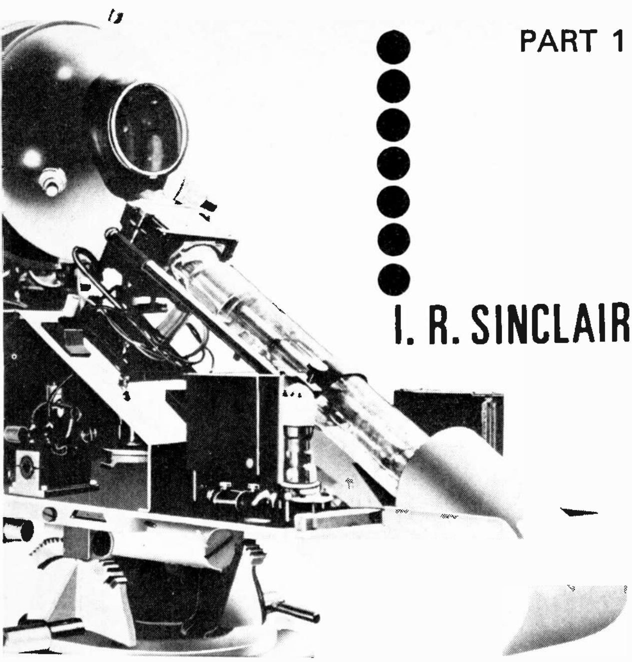
The image dissector does not use an electron gun and obtains the scanning beam directly from the photocathode. All the electron beams in the image dissector originate either by photoemission or by secondary emission, and since these processes are widely used in other camera tubes it would be as well to look at them more closely.

Light is a form of energy and the shorter its wavelength the more energy it carries. Ultraviolet light carries a large amount of energy and this energy is sufficient to dislodge some electrons from many materials when struck by u-v light. The speed at which the electrons come off enables them to travel to an electrode slightly *negative* to the material losing electrons and the voltage required just to stop current is called the "stopping potential". Electrons coming from an illuminated surface, called a photocathode, will travel to any surface which is more positive than the stopping potential relative to the photocathode.

There is another way of removing electrons from a surface. If any substance is struck by a beam of electrons the effects produced depend on the energy of the beam which in turn depends on the accelerating voltage. If an electron beam accelerated by up to 35V (low speed electrons) hits a surface most of the electrons simply land.

At between 50V and about 5kV each electron landing knocks off some others so that more are *removed* than land, and above 5kV or so electrons hitting the surface penetrate so deeply that few can be displaced. The emission of electrons from a surface struck by an electron beam is called *secondary emission*: the electrons of the beam causing it are called primary electrons and the electrons released secondary electrons (see Fig. 1). The speed of secondary electrons is much lower than the speed of primary electrons and can be found from the stopping potential which would have to be

Our heading photographs show on the right an Emitron tube in place in a camera and on the left televising the "Head of the River" race from Harrods on March 26th, 1938.



PART 1

I. R. SINCLAIR

applied to stop current flowing to a third electrode, the collector, which has to be present to avoid the secondary electrons simply returning to the surface from which they were emitted.

If either photoemission or secondary emission occurs from an *insulated* piece of material then the voltage of that material must change. When electrons are being *lost*, the voltage will rise positively (since electrons are *negative*) until the voltage exceeds its surroundings by the amount of the stopping potential, after which the voltage remains constant. When electrons are gained, as when slow electrons strike an object, the voltage becomes more *negative* until it equals the potential of the source of electrons (usually a cathode) less the stopping potential (usually about one volt).

The principle of the image dissector is shown in Fig. 2. It consists of a transparent photocathode deposited on the glass endplate of a tube, a small aperture, and a set of metal electrodes (dynodes) which are coated with a material of high secondary emission (see *Photomultipliers*, PRACTICAL TV December 1967 and January 1968). The whole tube is surrounded by focus and deflector coils.

When a pattern of light and shade is focused on to the photocathode a beam of electrons focused to the same diameter as the photocathode is obtained, closely grouped where they originate in a well-lit portion of photocathode and sparse where they originate in a dark area. This whole beam is scanned so as to be deflected past the small aperture which selects a small portion of the beam. This small portion was collected at an anode in early image dissectors and formed the output current. The output was, however, extremely low, a tiny fraction of a microampere, and in later versions this signal current was noiselessly amplified in a multiplier section. The multiplier consisted of a set of metal electrodes having high secondary emission so that about four electrons were given off for each electron striking. Given sufficient stages a gain of 500,000 could be obtained by this means.

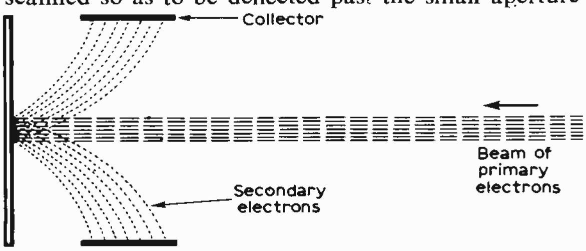


Fig. 1: Secondary emission from a surface.

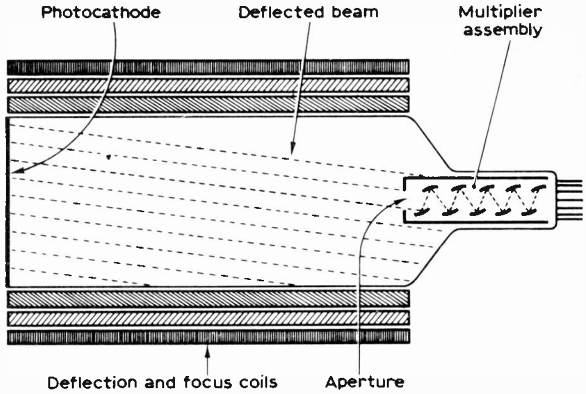


Fig. 2: The image dissector.

The image dissector was invented by Phil Farnsworth in the USA in 1924 and was for many years the only all-electronic device available for use in a TV camera. Even with the multiplier stages included the sensitivity was too low for anything but exceptionally well-lit shots or for stills from slides (for which purpose image dissectors are still made and used) because of the lack of *storage*. Lack of storage means that the electrons which reach the multiplier at any time are only those leaving one small spot of the photocathode at that time, so that the effective exposure of each element of the picture (the size of the aperture) is extremely small. If a line is scanned in 10μsec and there is 500 line resolution, the smallest element of picture is exposed by 10/500 or 1/50μsec not the sort of exposure with which a photographer would be happy. The aim of storage is to make all the electrons released by the photocathode *between* scans (1/25 of a second) contribute to the output current with the effect of raising the sensitivity immensely.

It is interesting to note that the company founded by Farnsworth to make image dissectors is still in existence. Apart from a few image dissectors it makes large quantities of specialised cathode-ray tubes.

The Emitron

The Emitron was developed in the laboratories of EMI Ltd. in the years around 1932. At the same time in the USA a similar tube was being developed under the name of the Iconoscope. Both tubes use a light-sensitive surface which consists of small dots of photoemissive material (which releases electrons when struck by light) on an insulating surface; this *mosaic*, as it was called, appears to have been invented in the Radio Corporation of America research laboratories by Vladimir Zworykin, one of the most notable pioneers of television in the USA.

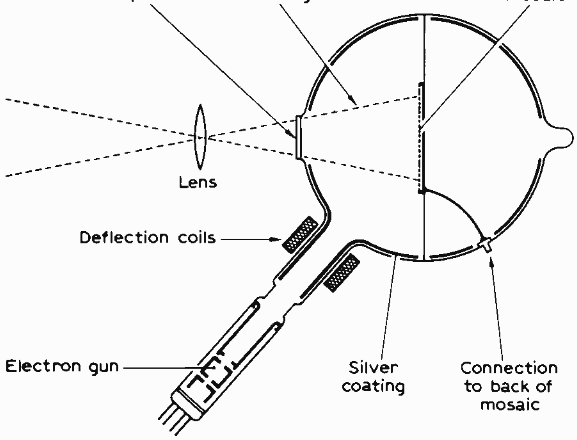


Fig. 3: Construction of the Emitron tube.

The development of the two tubes appears to have been on parallel lines and this article will refer to the developments in the USA only when important differences of technique are involved. The work on the Emitron was carried out by a team of brilliant research workers which included J. D. McGee (now Professor of Applied Physics at Imperial College, London), Jedham, Lubszynski, Rodda, Keyston, Blumlein (possibly in his short life the most important and prolific inventor in electronics) and others all under the direction of Sir Isaac Shoenberg. There is a strange parallel with the work of Marconi in that what was being attempted was thought theoretically impossible, and the way in which the Emitron worked was not fully understood until much later when tubes were already being used in television broadcasting. Cameras using the original type of Emitron were in use at the London transmitter from the time of its opening in August, 1936.

Constructionally the Emitron appeared as shown in Fig. 3. The bulb was of $7\frac{1}{2}$ in. diameter and of Pyrex glass. The long neck contained an electron gun which produced an electron beam which could be magnetically deflected and focused on to the mosaic. Near the gun neck was a polished flat glass window sealed into the bulb so that an image could be projected on to the mosaic by a lens outside the tube. The projection shown in the bulb behind the mosaic was the remainder (after sealing off) of the tube through which the Emitron was evacuated of air. A coating of silver was applied to the inside of the bulb excluding, of course, the window, so as to provide a final anode for gun electrons and also to shield the tube from electrostatic fields.

The Mosaic

The mosaic was the most critical portion of the Emitron, and it was in the construction of the mosaic that the Emitron differed most from the Iconoscope. A mosaic began as a sheet of mica selected for uniform transparency and lack of blemishes; the type known as ruby mica was most suitable. Mica consists of flat sheets, and it is possible to separate very thin sheets by piercing the edge with a fine needle, dropping water between the separated sheets and then running the needle between the sheets to make the separation complete. Very thin sheets can be separated in this way (the author has split mica sheets down to 0·0003 in. thick). Those selected for the Emitron were 0·001 in. thick and of size 4×5 in.

One side was silvered using a commercially available silver paint which left a silver coating when heated in a furnace; it had been developed for decorating china! The other side was coated with a very thin film of silver by vacuum evaporation. When the whole assembly was again heated in air to 200°C the thin silver film broke up into minute droplets, a process called aggregation or agglomeration. These droplets formed even at temperatures considerably less than the melting point of silver and were completely insulated from each other electrically since they were deposited on the insulating sheet of mica. Each island of silver was in effect one plate of a small capacitor, the other plate being the continuous film of silver (too thick to form into droplets) on the other side of the insulating mica.

This mosaic assembly was then fastened to another thicker piece of mica which served as a support and was mounted inside the tube. Initially some trouble was experienced with microphony (video signals caused by vibration of the tube) which was traced to the movement of the mosaic sheet against the insulating backing sheet, causing the backing sheet to become charged. This was cured by silvering the backing sheet also and clamping the two securely together.

The whole target assembly of mosaic and backplate was flexible enough to be rolled up and inserted into the tube through the gun tube, using specially designed tongs to manipulate the mosaic into place on its mounts. At the same time the connection was made to the output lead which contacted the back plate.

During the pumping of the tube each island of silver was made photoemissive by reacting the silver with the vapour of the metal caesium. The caesium, which cannot exist in the presence of oxygen or water had, when required, to be prepared within the tube by electrically heating a perforated tube of nickel filled with a mixture of silicon and caesium chromate. The caesium vapour migrates to the coolest portions of the tube and will react with any silver to form a photocathode surface. Reaction with the silver used as a tube coating must be discouraged by keeping the tube warmed in the regions where it is silver coated.

The Gun

A cross-sectional diagram of the gun is shown in Fig. 4. One major gun problem was that the gun did not face the mosaic directly but at an angle, so that the distance from gun to mosaic varied as the beam scanned down the mosaic. One way of avoiding defocusing was to apply part of the field scan to the focus electrode (A1) so that the gun was automatically kept in focus during scanning (a

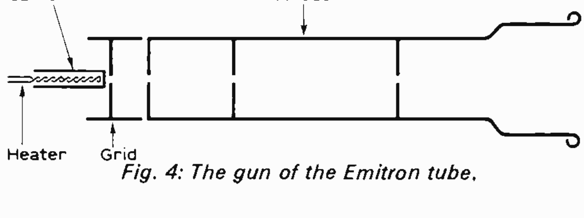


Fig. 4: The gun of the Emitron tube.

process now known as Keyston correction, after the inventor). After some experiments, however, it was realised that this would be unnecessary if the beam spot were made so small that even the change of focus from the top to the bottom of the field would not cause two scanned lines to overlap in width. The cathode of the gun is run at about 1,000V negative to the mosaic so that by secondary emission the mosaic is tending to charge *positively* since more electrons are displaced than land.

The Action of the Tube

From what has been said of secondary emission so far it would appear that the tube would be an unworkable proposition. The photoelectrons leaving the mosaic should charge it slightly positive, the beam should charge it more positive, and the potential of each element of the mosaic should then stay fixed at slightly above earth potential with no further change. To understand why the tube does work two further conditions must be made clear. The first is that the faster secondary electrons leave a surface the more positive that surface can be relative to the collector without attracting the electrons back. The second is that electrons are attracted not only by the electric field caused by distant electrodes but also by areas to the side, so that electrons may leave one mosaic element to travel to the one next door if it is at a higher potential. This latter effect is called Coplanar Grid Effect.

The average potential of each element of the mosaic is 1·5V more positive than the collector. In this condition photoelectrons are not released from the mosaic as there is no surface to which they can travel. The voltage difference which photoelectrons can overcome is called the *stopping potential* and it increases with the frequency of the light (going up from infra-red to ultra-violet).

When the mosaic is scanned, however, it is being struck by high-velocity electrons, and the secondary electrons are emitted with fairly high velocities so that they have a higher stopping potential. In the area hit by the beam, the potential of the silver islands rises to 4V above the collector potential, and when this happens current flows in the output terminal which is the other plate of the capacitor formed by the silver islands and the mica.

Now imagine the situation at an instant in time when one island has just been struck by the beam (Fig. 5). The potential on that island is 4V; the potential on the next in line is 1·5V. If light is falling on the next island photoemission will now take place because the voltage between the two islands is 4V−1·5V=2·5V, enough for coplanar grid effect to take place and ensure photoemission. When the beam strikes the next island it will also be charged up to 4V and the current which flows in the output terminal measures the difference between the photoelectric potential and the 4V potential caused by the beam.

This method of operation has several distinctive features. First, the signal current is maximum when the light is minimum (in the black areas) since the potential of stress of mosaic elements which are dark is 1·5V and this changes to 4V when the beam strikes giving 2·5V of signal to be converted into output current. In white areas, however, the potential of mosaic elements has risen to nearer 4V so that the

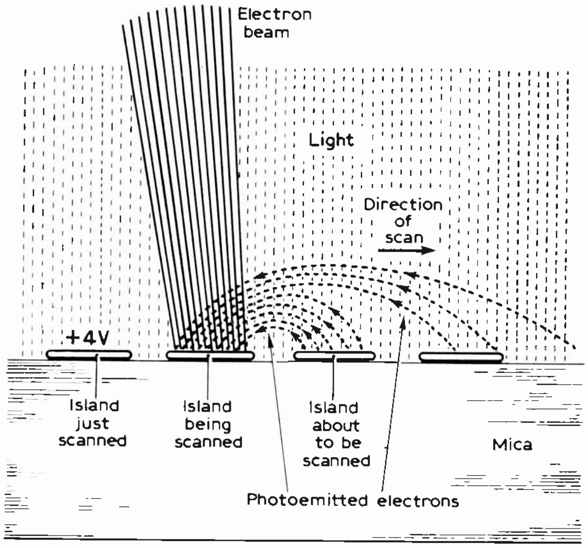


Fig. 5: The action of the Emitron target.

output signal is smaller. The video signal is therefore *negatively modulated*, like that of the image orthicon (PRACTICAL TV, July 1967) and unlike that of the vidicon (PRACTICAL TV, August 1968).

Secondly, since photoemission can only take place from a mosaic element when the beam is very close, the camera permits exposure only during that time and storage time is short. If the camera is focused on an object moving rapidly down the field the output is a series of perfectly sharp pictures because there has been little storage. The Emitron behaves like a film camera with a very short exposure and is therefore not very sensitive.

Disadvantages of the Emitron

The efficiency of the Emitron in converting visual signals into electrical signals is only 5% of the theoretical maximum, mainly because so little advantage can be taken of storage, the mosaic being photosensitive only when the beam is near. In addition to this not all the secondary electrons released by the beam have high speeds and land on the collector. Some return to the mosaic and neutralise stored charges.

Because the beam from the gun lands on the mosaic at an angle the secondaries come off at an angle and tend to land back on the mosaic at the side farthest from the gun causing signal d.c. level to be darker in this region. This effect is called tilt and it can be compensated by adding a sawtooth signal to the video signal.

The random *spurious signals* caused by the landing of slow secondaries cannot, however, be so easily compensated.

An experimental model of the Emitron used a gun whose cathode operated at −7·5kV. At this voltage the electrons from the gun charged the mosaic *negatively*, opposing the charging direction caused by the photoemission. Tilt and spurious signal interference seemed to be improved, but development was not continued.

TO FOLLOW: THE SUPER-EMITRON AND C.P.S. EMITRON

INSTALLING and SERVICING COLOUR RECEIVERS

PART 9

P. G. ALFRED

In our account of colour fault-finding we avoided detailed description of how to find a particular dud component causing an impressive and obscure fault. What we have been trying to do is to establish the right kind of mental approach to the problem coupled with a sensible checking procedure which, used in combination, help to cut the corners and isolate the fault to a particular circuit stage with the minimum of time and effort wasted on blind alleys. This is the art that experienced service engineers develop instinctively to a high degree after working for many years on a wide variety of television problems. But this ability can be acquired much more quickly if a conscious effort is made all the time to analyse each problem, to decide how best to tackle it, and then to store the experience gained so that good use can be made of it next time.

Checking Individual Stages

At this point it would be easy to duck any further problems and say simply that once a fault has been isolated to an individual circuit it can be checked through by the same well-established techniques that are used in monochrome receivers. This is perfectly true of course but the systematic approach applied to say a decoder as a whole can be applied just as profitably in modified form to an ident amplifier, a bistable circuit, or any other piece of colour circuitry. Although the process is well known to most of us, it may be worthwhile to take a simple example and see how much we can deduce from a few straightforward standardised tests. It should also have the added advantage of showing how much useful information can be missed by haphazard prodding about with a meter or scope as a substitute for a spot of real thinking.

Nearly all electronic circuits fit into one or other of two general categories. One consists of various forms of amplifier handling either small signals such as i.f. or chrominance subcarriers or the large-signal stages which provide a big voltage swing accompanied by a considerable amount of power dissipation such as the luminance, sound, and field output circuits. The other category comprises the pulsed circuits such as sync separators, clippers, clamps, bistables etc. We make this distinction because the two types of circuits tend to have different d.c. operating conditions, and this is an important point to bear in mind when fault-finding in unfamiliar equipment.

When tackling a faulty circuit the first point to check is whether you know exactly what the circuit consists of and what its functions are in terms of inputs and outputs. If you have any doubts study the circuit diagram and try to get a clear idea of what currents and voltages you should expect to find at the key points. The next job is to locate the components involved taking care to identify anode/collector loads, cathode/emitter bias resistors, input/output coupling capacitors and so on. In the process of doing this you will have checked automatically for any signs of overheating such as discoloured paint or components or brown patches on the printed board. You have now reached the stage where you know what results to expect from your measurements and where to apply your instrument probes in order to get them.

Valve Amplifier Stage

By way of example let us take a simple valve a.f. amplifier of the completely general type shown in Fig. 27 and assume that it is giving no significant output but that the previous stage is in order. Obviously there are many different measurements that we can make, but where do we begin? The first item to check is the h.t. line. Is the voltage correct? If it is low we suspect either the h.t. supply or that the faulty circuit is drawing too much current. Filing away this item of information we carry out the fundamental fault-finding operation which must be applied to all active circuits. *Are the d.c. operating conditions correct?* If so the valve is working properly and the fault lies in the external circuit, such as a coupling capacitor going open-circuit and interrupting the input or output.

If the d.c. conditions are wrong the fault must lie either in the feeds to the various electrodes or in the valve itself. The first case is checked by measurement and deduction, and this should also indicate whether the valve is at fault. If it does not, check by substitution.

When checking the d.c. operating conditions the first point to establish is the cathode voltage with respect to chassis using an ordinary multirange meter or a d.c. coupled oscilloscope. If we know

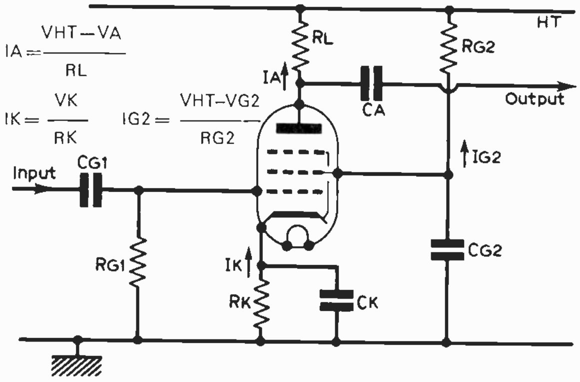


Fig. 27: A simple pentode valve amplifier stage, illustrating d.c. operating conditions.

Table 8: Checking valve d.c. operating conditions. (See Fig. 27)

Possible faults considered:
Open-circuit *R*g1, *R*L, *R*g2, *R*k
Short-circuit *C*g1, *C*k, *C*g2
Low-emission cathode or faulty heater.
All voltage measurements made between the appropriate electrode and chassis.

(1) Valve wholly or partly cut off

(a) Anode voltage Va high

*V*g2 and *V*k low, *V*g1 O.K.	*C*g2 s/c or *R*g2 o/c
*V*g2 high, *V*k low, *V*g1 O.K.	Low-emission cathode, *R*g1 or *R*k o/c or faulty heater
*V*g2 high, *V*k low, *V*g1 positive but hard to measure accurately	*R*g1 o/c

(b) Anode voltage Va low

*V*g2 low, *V*k low, *V*g1 O.K.	*R*L o/c

(2) Valve conducting too heavily

Anode voltage Va will be low

*V*g2 low, *V*k high *V*g1 positive	*C*g1 s/c or leaky or screen to grid valve leak
*V*g2 and *V*k low, *V*g1 O.K.	*C*k s/c

Screen to grid or cathode short-circuits will cause catastrophic failure and overheating. Associated components and h.t. feeds will usually be damaged.

the type of valve we shall also know what bias voltage to expect, either by experience or from valve data. Since in our example the control grid voltage is 0V (d.c.) then the cathode voltage will usually be in the range +1 to +4V.

The cathode current ($Ik = Ia + Ig2$) is equal to Vk/Rk and any serious fault will cause this to be obviously too high or equally obviously too low. If the cathode bias and hence the cathode circuit (assuming that the cathode bias resistor is in order) are correct then it is probable that the rest of the circuit conditions are also correct. However, to guard against the coincidence of the anode and screen currents both being wrong but approximately correct in total check the control, screen grid and anode voltages.

Table 8 shows various combinations of incorrect electrode voltages and the likely faults that we can deduce from them. This is not a hard and fast classification—a pocket cribsheet—because a valve is seldom completely cut off or conducting to the point of saturation. Consequently the electrode voltages may not have the clear cut divergencies from their normal levels which will permit an immediate and confident diagnosis.

What we are trying to do here is to illustrate a principle once again. Earlier in this series we showed that faults in a decoder can quite easily be isolated to a single circuit stage by using a common-sense systematic approach. Having done this we can apply the same technique to the faulty stage and by a few quick measurements isolate the fault to just one or two components which can easily be checked on a multirange meter. Method is all important, and when allied to the fruits of experience results in an efficiency and speed of working which must seem little short of miraculous to the complete beginner.

Transistor Amplifier Stage

A transistor and its associated circuitry carries out the same function as a valve: i.e. it can be used to provide either voltage or current amplification, or both together. However it has certain important differences. In the first place a transistor normally has only three electrodes, and so fewer measurements are needed to assess its performance. This is the superficial aspect. Of more basic importance is the fact that it is base *current* that controls the amount of current flowing between collector and emitter as opposed to negative grid-cathode *voltage* bias controlling the anode to cathode current of a valve. This means that if a transistor is conducting the base-emitter voltage will always be about +0·6 to 0·7V for a low-power npn silicon type and about —0·2V for a pnp germanium type. Note that the base-emitter voltage of high-power silicon transistors can be considerably more than 0·7V—in some cases up to 1·5V.

Once again we have to emphasise the importance of checking the d.c. operating conditions before all else. A single voltage measurement across the emitter resistor tells you whether the transistor is conducting, and if so how much. $Ie = Ve/Re$. The collector voltage should also be measured and will be l.t.—$Ie \times Rc$ to a close approximation, where Rc is the total resistance between l.t. and the collector. Both these calculations assume that the collector and emitter resistances are correct. Any discrepancy indicates a faulty measurement or a dud component.

A word of warning however. When measuring the emitter to chassis voltage across the emitter resistor with a multirange meter first *check the meter setting*. If it is accidentally switched to a current range the low impedance presented by the meter will shunt the emitter resistor and may cause such a large collector current to flow that the transistor will be overloaded and the junction destroyed. This will happen almost instantly and without any pop or smoke to indicate the enormity of your clanger! For the same reason always take the greatest care if you find it necessary to poke about with a screw-driver. If in doubt—*don't*.

Checking a Transistor

Having established the d.c. operating conditions by emitter, base, and collector voltage measurements, plus a spot of mental arithmetic, the fault-finding procedure is much the same as for any equivalent valve circuit. The only exception is when you want to test a transistor to find out whether it is faulty. Whereas a valve will die a slow death, a transistor is normally a go/no-go device. In other words it either performs properly or not at all. Failing a proper test set-up the best procedure is to measure the impedances between each pair of electrodes. Bearing in mind that a three terminal transistor looks like a pair of diodes back to back,

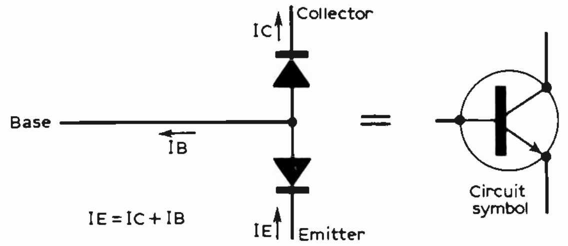


Fig. 28: A transistor looks like a pair of diodes connected back-to-back. For low-power silicon npn transistors Vc cannot be less than Ve + 0·1 volts approximately because of the clamping action of the cb junction. Similarly Vb cannot exceed Ve + 0·6 volts approximately.

as in Fig. 28, it is useful to measure the following resistances: b-e, e-b, b-c, c-b, c-e, e-c. Don't forget that when measuring resistances on a multirange meter current is flowing *into* the transistor from the negative (black) lead.

It is useful to measure these resistances on a good transistor of the same type as the suspect and then to compare the results with those obtained on the suspect removed from the equipment. Differences of the order of 2:1 normally indicate a definite fault although it is difficult to give accurate guidance on this point.

Transistor DC operating Conditions

Figure 29 shows a simple transistor amplifier stage equivalent to the valve version we discussed earlier. Three voltage measurements, emitter, base-emitter and collector will establish whether the d.c. operating conditions are correct and hence whether the stage is basically all right. If it is then the input or output coupling networks must be faulty. For example the succeeding stage might have a base-emitter short-circuit thus effectively removing the a.c. output of the stage being tested. Alternatively one coupling capacitor might be open-circuit.

A major d.c. fault may cause the transistor to be bottomed, i.e. the collector will be at virtually the same voltage as the emitter (it cannot be appreciably lower because of the clamping action of the base-collector diode shown in Fig. 28) due to an excess current flowing. This means either that the emitter resistor is short-circuited in some way or that an extra d.c. voltage has found its way on to the base.

If the collector voltage is high—up at l.t.—the transistor is cut off and a measurement of the base-

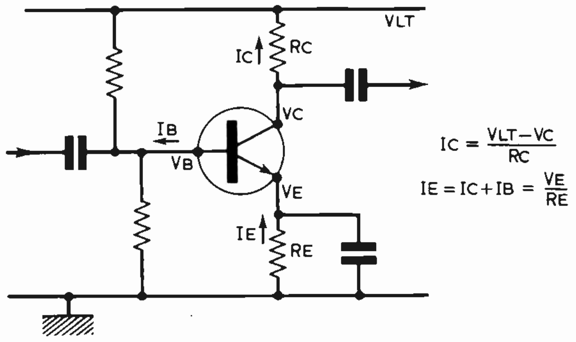


Fig. 29: A simple npn transistor amplifier stage, illustrating the d.c. operating conditions.

Table 9: Checking transistor d.c. operating conditions. (See Fig. 29)

(1) Measure the base-emitter voltage: $Vbe = Vb - Ve$ (voltages measured with respect to chassis).

Vbe 0·6-0·7 V approximately, transistor conducting, but you do not know how much.
Vbe Less than 0·6 V, transistor cut off.
Vbe Appreciably greater than 0·7 V, transistor faulty or emitter o/c.

Above voltages apply to low-power silicon transistors. Vbe for low-power germanium transistors should be −0·2 V. High power transistors may have Vbe as high as 1·5 V.

(2) If Vbe is correct the transistor is conducting and any fault present is more likely to be in the external circuit than in the transistor itself. To check the current measure Vc.

$$Ic = \frac{Vl.t. - Vc}{Rc}$$

Alternatively measure Ve: $Ie = Ve/Re$.
Ic is approximately equal to Ie.

(3) A measurement of Vc tells you immediately whether the circuit d.c. conditions are correct unless the collector load is faulty. To cover all eventualities check Vc, Ic and Ie. Excessive current can only be caused by a fault in the base or emitter circuits.

emitter voltage will show it to be less than 0·6V (silicon). Here we would expect either a faulty d.c. feed to the base or an open-circuit emitter resistor.

The logic in all this is of exactly the same variety as one uses in valve circuits but the process is simpler because there are fewer electrodes and so the operation of the circuit is more down to earth.

Table 9 shows some of the standard checks for normal d.c. operating conditions and the diagnosis that can be made about the cause of the fault. Note that if a d.c. coupled oscilloscope is used for measuring the voltages it will also indicate the presence or absence of inputs and outputs if these are large enough to register on the display. In the case of pulsed operation any fault in the input or output network will usually cause the shape of the pulse to be distorted—not only in its amplitude—and here is a useful clue.

Pulsed Circuits

Circuits which are used to amplify or shape pulses often present special problems. From their very nature such stages tend to be either fully conducting or else switched off for most of the time, changing their state as soon as a pulse arrives and then reverting to normal again when the pulse has passed. A check on the d.c. operating conditions is useful in a general sort of way but many faults can occur which will upset the working of the stage without significantly affecting the d.c. working point.

Undoubtedly the best tool once again is the d.c. coupled oscilloscope. Measurements at grid and anode or base and collector will soon establish whether inputs and outputs are present, whether the pulses are distorted, and whether the stage is bottoming or cutting-off correctly.

When the shapes, amplitudes, and d.c. levels of inputs and outputs are known it is usually not too difficult to isolate the fault to a very small area by deduction. We keep on placing the onus on the process of deduction, but there is a point beyond which generalised guidance can go no further and the successful and speedy outcome of the fault-finding operation depends upon the willingness of the engineer to think for himself.

Repairing the Fault

Repairing the fault is the prosaic end of the business, seldom interesting and nearly always tiresome. Components are hard to get at, difficult to see clearly inside a wooden box and you are often asked to unsolder anything up to eight or ten joints simultaneously. Even an octopus would feel short handed on occasions! Still, most engineers have learnt to do the impossible quite easily and for the benefit of newcomers to the sport here are some hints worth remembering.

With conventional hand-wired assemblies it is best to cut out the faulty component and solder the replacement to the stumps of the old one. Any attempt to unwrap joints usually results in things becoming loose or damaged by overheating. The job takes longer and is really no better providing you know how to solder properly.

Most problems centre around printed boards. Let us take simple resistors and capacitors first. The chief danger to guard against is lifting the copper because this will involve a tricky repair which at best is only a botch and an untidy one at that. The thing to avoid above all else is *pushing* the component while applying heat to the soldered joint. Even levering the component upward with a screwdriver can cause trouble because whilst one end is coming up the other may go down. On the whole the best technique is to cut out the body of the component with a pair of sidecutters and then pull out each stump in turn with a pair of long-nosed pliers. If a steady pull is maintained, starting before you apply the iron, you will never have any loose copper waving about underneath the board. It goes without saying that you need a small, hot, clean and well-tinned iron.

Soldering

When replacing a component always tin the leads first with a thin film of solder. You may have to scrape the leads first. If necessary lightly and quickly tin the copper as well. Then when you make the final joint a single quick jab with the iron will produce a perfect connection without any difficulty or damage. Always apply the iron to the lead alone, feed on a small quantity of solder, and allow it to run down on to the copper. The result should be a smooth glossy fillet of solder looking better than the original.

Transistors and diodes need special care. *Do not* solder too close to the body and if possible always hold the lead between the body and the joint in a pair of long-nose pliers to act as a heatsink. Be careful of course not to stress the seal where the lead goes into the transistor or diode. In a few cases the leads must be kept short in i.f. circuits

—*continued on page 425*

VIDEOSCOPE MV3

PART 3

MARTIN L. MICHAELIS, M.A.

LAST month we described the deflection amplifiers and preamplifiers as well as the c.r.t. circuitry of the Videoscope MV3. We will now complete the circuit description by considering the timebase and intensity modulation sections. Next month we shall conclude with the alignment instructions for the finished instrument.

THE TIMEBASE

This is a low-amplitude oscillator known as a *cathode sanatron* now gaining popularity in preference to the high-amplitude Miller transitron circuit used in the former videoscopes and many other oscilloscopes. The Miller transitron has the advantage of being able to drive a c.r.t. directly with its single-ended signal without any amplifier, but it has a number of disadvantages. First it requires two banks of matched capacitors and thus a double switch. Since it employs the Miller effect of virtual capacitance multiplication it is difficult to maintain accurate waveforms at high speeds on account of stray capacitance multiplication. The cathode sanatron does not make use of the Miller effect because it uses no capacitors in a timing bank connected between the anode and grid of a valve. A single set of capacitors suffices, but a twin triode is needed to obtain the multivibrator function for flyback which the Miller transitron establishes by using the screen and suppressor grids of a single pentode valve. A further trouble with a high-amplitude timebase oscillator when used to drive a push-pull deflection amplifier as in the former videoscopes was the critical design of the necessary voltage divider in order to maintain linearity and freedom from hum.

The operation of the cathode sanatron is as follows. Since grid pin 7 is connected to anode pin 1 and then to h.t.+ via the anode resistors the triode section pins, 6, 7 and 8 of V4 immediately draws heavy current upon switch-on so that the timing capacitor selected by S3 is rapidly charged up to a positive potential. Whilst charging current is flowing there is a corresponding negative voltage pulse at anode pin 6 on account of the voltage drop across the anode load VR9, R56. This negative pulse is coupled via C19, C18 and R53 to the grid of the other triode section, so that this is definitely held cut off by cumulative multivabrator trip action as long as charging current is flowing in the other triode section.

Very soon the timing capacitor has been charged up to such an extent that current through that triode must drop because there is too little voltage difference remaining between anode pin 6 and cathode pin 8. As soon as anode current drops for this reason at a sufficient rate, a positive-going flank of adequate slope appears at anode pin 6 for the start of the reverse multivibrator trip cutting the other triode hard on at grid pin 2 and thus immediately cutting the first triode off at grid pin 7 by virtue of the drop of anode pin 1 potential when anode current flows here. This condition persists until the charged timing capacitor has discharged through R57 and VR10 to such an extent that cathode pin 8 has dropped within the grid base again in relation to the lower potential of pin 7 prevailing when anode pin 1 is conducting. As soon as the cathode pin 8 potential has come within the grid base, anode pin 6 can start to conduct again and feed a negative-going flank to grid pin 2 which reduces anode current at pin 1 and feeds a positive-going flank to grid pin 7.

The action is cumulative and produces the multivibrator retrip once again cutting pin 6 anode current hard on to recharge the timing capacitor and cutting anode current at pin 1 off. The complete cycle of events now repeats; the recharge of the timing capacitor represents the rapid flyback whilst the subsequent slower discharge through R57 and VR10 until the cathode potential re-enters the grid base is the forward timebase stroke.

An important condition for proper functioning of this oscillator is that it must be starved of h.t. current, hence the very large value of the common smoothing resistors R43 and VR8 in relation to the working anode loads R52, R56 and VR9. The low resulting h.t. voltage is stored in C20. The voltage across C20 is normally insufficient to make the zener diode D5 conduct. The sole purpose of this diode is to permit the use of a low-voltage electrolytic since otherwise the voltage across C20 would rise to about 500 volts immediately after switch-on before the valve draws any current. A low-voltage electrolytic and zener diode are together smaller and cheaper than a 500V electrolytic. VR8 serves as amplitude preset control by way of adjusting the actual working h.t. voltage established across C20.

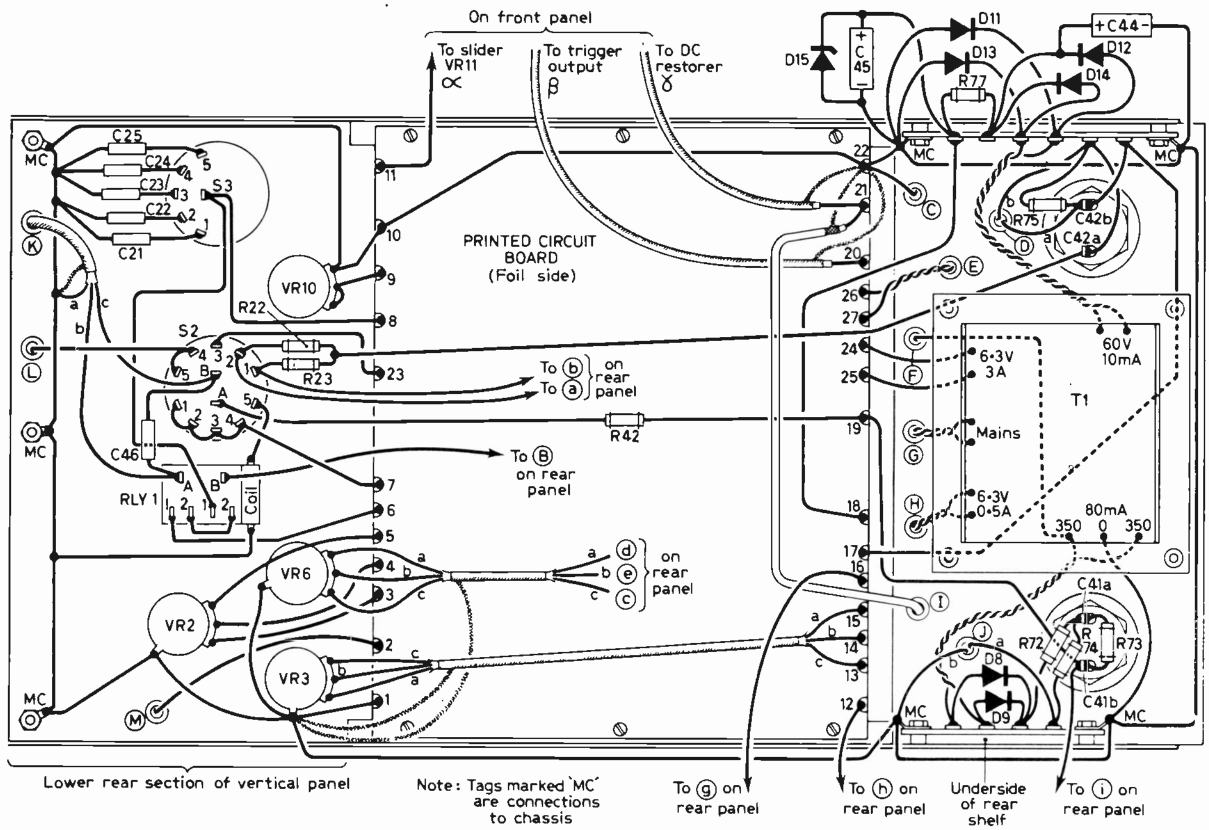


Fig. 5: Underside wiring diagram.

No timebase oscillator produces a strictly linear forward stroke since this is always a section of an exponential charging or discharging process. The linearity is the better the greater the ratio of the aiming voltage to the actual excursion. The actual excursion at the valve control grid is equal to the grid base, which is a few volts, for both the Miller transitron and the present cathode sanatron, but in the former the aiming voltage is the full h.t. line voltage of several hundred volts whereas in the cathode sanatron it is only the lower mean cathode potential of some 70V at pin 8 of V4. The linearity of the low-amplitude cathode sanatron is thus inherently poorer than that of a high-level Miller transitron or any other circuit based on the Miller integrator. Nevertheless the linearity is very acceptable if a high slope valve with a really short grid base, such as a starved ECC85 as specified for V4,. is employed.

It is important to use a timebase which is acceptably linear, i.e. which moves the spot on the c.r.t. so that equal distances represent equal intervals of time. Only then is it possible to read-off timing information regarding the displayed waveforms to sufficient accuracy for normal servicing and experimenting. For more accurate work it is preferable to feed sharp pulses from a suitable signal generator to the intensity-modulation amplifier input in order to mark equal intervals of time by spotting corresponding narrow dark segments on the trace. This permits highly accurate time read-off from the displayed waveforms, regardless of the degree of linearity of the timebase.

TIME CALIBRATION

Steps have been taken to provide a simple time calibration of adequate accuracy for normal servicing and experiments. Formerly it was customary to calibrate timebases in terms of their repetition frequency, but this can be most misleading for assessing the timing of displayed waveforms if the stroke to flyback ratio is unknown or variable since it is obviously a poor approximation to take the stroke length as being equal to the repetition period.

It is more useful to calibrate all timebases in terms of time per centimeter of deflection. The five capacitors selected by S3 are related to the settings of S3 marked 1 to 5 such that the *complete* duration of the 5cm. timebase is respectively $10^1 \ldots 10^5 \mu$sec. The control range of VR10 is such that these figures apply in the slowest setting (maximum trace time, right-hand stop), and are divided more or less linearly in maximum ratio 25:1 as the left-hand stop is approached. This simple arrangement permits interpolation of adequate accuracy and gives a complete range of timebase speeds such that a 1 to 2 MHz sinewave can appear with one cycle over the entire width of the screen at one extreme, or several cycles of the mains frequency across the width of the screen at the other extreme.

SYNC AMPLIFIER

A great advantage of the low-amplitude cathode sanatron timebase is the extreme ease with which it can be synchronised. Since its own excursions are so small it is clear that tiny signal voltages suffice to produce sync lock. Thus far from needing an

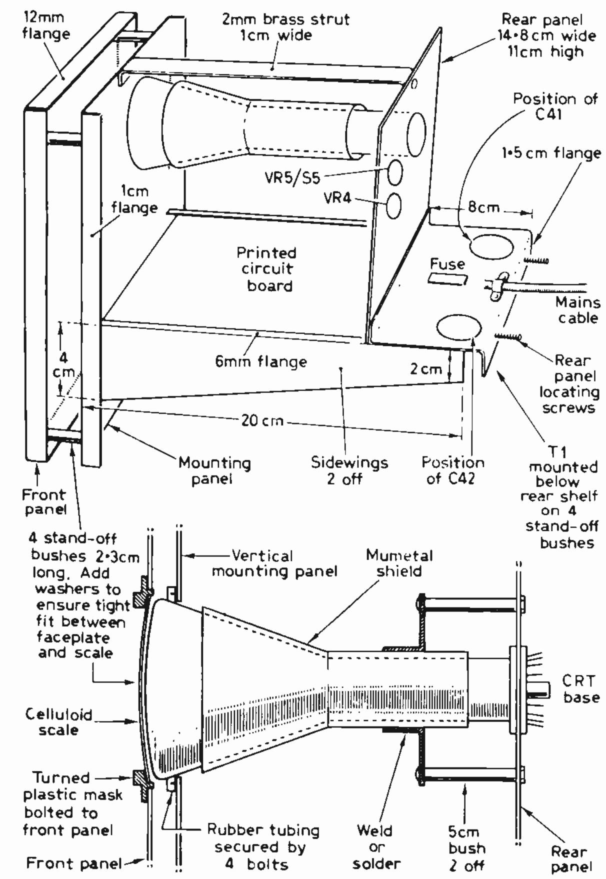


Fig. 6: Mechanical assembly.

amplifier one would suppose that an attenuator should be more appropriate when feeding the sync signal from a high-level source such as a late stage of the Y-amplifier. This is true, and we have indeed incorporated an attenuator in the form of the very small values of the sync-extraction resistors R22, R23 in relation to the anode load resistors R21 and R24 in V3 anode circuit. This at the same time obviates all distortion or bandwidth restriction imposed on the Y-signal path by the sync-extraction process.

The purpose of the sync amplifier Tr1 to Tr3 is to produce even sync action dependent only upon signal amplitude and not upon signal frequency within the entire bandwidth from a few Hz right up to many MHz. This is achieved by giving Tr1 to Tr3 a gain which drops to unity at the highest wanted frequency and has a value of ten at much lower frequencies. This gain of ten is cancelled again by the resistive attenuator R51, R55 which is effective at low and medium frequencies. At higher frequencies C16 increasingly shunts R51 so that the attenuation factor decreases with the falling gain of the amplifier and the signal trânsferred to R55 remains constant independent of frequency. The amplifier thus operates in conjunction with the attenuators in order to cancel all variations of sync intensity with frequency, including the effects of the stray capacitance of the necessary switching between positive and negative flank internal sync, external sync and mains sync from the heater line.

The cathode sanatron synchronises extremely readily even to sinewaves of very low or very high frequency. However if more than a few millivolts are applied to V4 as sync signal the latter captures control and results in transition to straightforward amplifier operation instead of sawtooth oscillation. This leads to timebase amplitude and linearity distortion so severe that even doubling-back is obtained. It is therefore important to keep to the specified component values which definitely avoid such troubles for any settings of the manual controls.

It is important not to advance VR7 farther than necessary to obtain rigid lock to the desired signal because inevitably microvolts of hum will compete as soon as the sync control VR7 is advanced too far. Although definitely insufficient to distort the timebase this produces jitter at mains frequency. The display is then still locked and undistorted but is smeared in the horizontal coordinate.

USE OF VALVES AND TRANSISTORS

Although suggested by modern advances in the semiconductor field it is inappropriate to transistorise an oscilloscope using a c.r.t. designed for valve stages. This is because it requires deflection voltages of one or several hundred volts which can be obtained only with valves or special expensive transistors not yet readily and cheaply available. Special c.r.t.s with unusually high deflection sensitivities are required for economical transistorised oscilloscopes. Of course these considerations do not preclude the use of transistors in the preamplifier and low-level timebase stages, and this is indeed found in many current hybrid oscilloscope designs. However, we come up against further problems with the input stage, since this often has to run at high level if the signal to be scoped is large. It is definitely more difficult and more expensive to design a transistorised input circuit which will safely handle large signals whilst maintaining adequate bandwidth than to use an ordinary valve in a cathode-follower circuit.

So what are we left with? It is evidently quite inappropriate to employ extensive transistorisation in an oscilloscope design which aims to be as inexpensive and simple as possible, which is to be free of obscure components, and which is to use an ordinary c.r.t. such as the DG7-32. It appeared sensible to use transistors only for the sync amplifier, since this is a low-level amplifier and the necessary distortion for flank selection without resorting to overdrive is elegantly obtained by making use of the silicon threshold voltage at the base of an emitter-follower.

Tr1 and Tr2 form a Darlington pair which contains two silicon threshold barriers, whilst bias is obtained with the three forward-biased diodes D2 to D4 and R49. Thus the transistors are held *just* cut on irrespective of temperature changes because the diode and transistor threshold voltages possess the same temperature coefficients. Only positive-going flanks at Tr1 base are amplified; negative-going ones cut the amplifier off and are thus rejected. But we require a negative sync flank at V4 grid pin 2 because the function of the sync flank is to stop a stroke and start the flyback prematurely which is effected by cutting grid pin 2 off. Hence Tr2 provides the necessary inversion as well as gain at the collector. Tr3 is a simple emitter-follower as buffer. D1 is a most important safety device since it prevents the appearance of excessive cut-off potentials at Tr1 base which would otherwise cause breakdown of this transistor. D1 also improves the sync flank rectification.

HORIZONTAL MODE SWITCHING

S2 provides five modes of operation for the horizontal deflection system. Four of these operate the internal timebase with various modes of synchronisation through the same sync amplifier whilst the fifth mode disconnects the sync amplifier, switches off the timebase and connects the horizontal input socket via the horizontal gain control VR7 to the horizontal deflection amplifier V6. The switching is effected with a 2-pole 5-way rotary switch and a relay to change over the signal routeing. The latter can be effected by two additional 5-way wafers on the switch instead of a relay although there is a danger of trouble from cross-capacitances if unsuitable switch types are used.

For all four synchronised timebase modes S2A feeds h.t. to the timebase and not to the relay coil. The relay remains unenergised and its resting contacts route the signal from the slider of the horizontal gain control, now functioning as sync control, to the sync amplifier, and the output of the timebase to the input of the horizontal amplifier V6. The other wafer S2B selects the signal fed to the track of VR7. This signal is derived from the two Y-signal polarities, from the heater line or from an external input fed to P2.

HORIZONTAL GAIN CONTROL

In the fifth position of S2 the wafer S2A mutes the timebase by disconnecting its h.t. supply, now applying h.t. via a suitable resistor to the relay coil. The relay contacts change over and now connect the slider of the horizontal gain control VR7 straight through to the horizontal amplifier V6 whilst the second switch wafer S2B still connects the input socket P2 to the track of VR7.

C46 gives approximate frequency compensation for VR7 in that it is selected so that exact compensation is obtained somewhere between the quarter and half-way setting of VR7. Without this correction the bandwidth for an external input at P2 is over 1 MHz with VR7 at maximum but drops abruptly to about 30 kHz as soon as VR7 is turned down slightly. The introduction of C46 makes the bandwidth first of all increase and peak as VR7 is turned down, then become correct again, and gradually drop only at very low settings. The value of C46 is chosen to effect an acceptable compromise at all settings. If minimum waveform distortion for frequencies in the video band beyond the audio range is essential for any application of external horizontal input, use VR7 always set to maximum. The sensitivity is then about 1V/cm., calling for an input signal of some 5V peak-to-peak for full screen excursion.

INTENSITY-MODULATION AMPLIFIER

The intensity-modulation amplifier uses an ECC81 as V5. The design bandwidth was determined from the requirements of flyback blanking and small TV picture display, whilst the design sensitivity was determined in relation to the standard 1V positive-going video signal used in CCTV equipment and

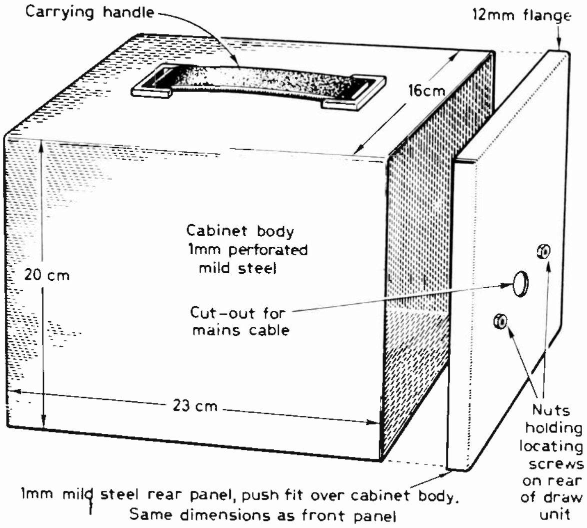


Fig. 7: Details of the case.

also obtainable from the video detector or video amplifier of ordinary TV receivers. The spot size in relation to the small screen does not permit resolution of more than some 1·0 to 1·5 MHz picture detail. This nevertheless gives pictures with a sharp appearance because the visual resolution of the human eye is not much better anyway for such small pictures at ordinary bench viewing distances. Such pictures have little or no entertainment value but they serve very efficiently for technical purposes such as viewfinding with a CCTV camera and of course as a general monitor to check that the camera is producing a proper picture.

The flyback blanking pulse possesses a duration of about 1μsec in the fastest timebase setting and this is handled adequately without undue trace loss if the bandwidth of the intensity-modulation amplifier extends to 1·0-1·5 MHz. The flyback pulse is obtained from V4 anode pin 6 as a result of the recharge current pulses for the timing capacitor selected by S3.

A suitable fraction of the flyback pulse amplitude is selected at VR9 slider and fed to the input grid pin 2 of the intensity-modulation amplifier. R59, C26 and C27 (selected during alignment) provide some over-peaking for this input only in order to improve the blanking timing at the highest timebase speeds. This does not affect the video or time-spotting input via P3. VR11 is the gain control for the external intensity-modulation signal input. In this mode C47 is selected during final alignment to effect approximate frequency compensation for VR11 in the same manner as described for VR7.

The amplifier V5 is a straightforward two-stage *RC*-coupled circuit whose large bandwidth is obtained by using small-value anode load resistors and judicious reduction of negative feedback at high frequencies with the help of C32 and C34 selected during final alignment. The output from V5 is not only fed to the c.r.t. grid via the d.c. restorer network but also to an output socket P4. When the synchronised timebase is operating the amplified negative flyback pulses are available at P4 for external use, e.g. for triggering wobbulator equipment or other experimental circuits.

TO BE CONTINUED

SERVICING television receivers

L. LAWRY-JOHNS

BUSH/MURPHY TV125/V849 SERIES

THIS series of receivers includes the Bush TV123, TV125 and TV128 and Murphy models V849, V873 and V879. The tuner units are of the usual Bush push-button type, the u.h.f. unit employing valves PC88 and PC86 and the v.h.f. one a PCF86 and a PCC89. The output of the u.h.f. unit is not taken to the v.h.f. mixer for extra amplification as is usual: it is taken direct to the i.f. panel at the socket PS10. Each unit has its own power plug and i.f. socket which makes for easier servicing.

The u.h.f. unit is fairly trouble-free, servicing normally being confined to valve replacement as the gain drops off or excessive drift is experienced. A grainy BBC-2 picture for example can usually be improved by fitting a new PC88 or PC86. the latter valve more often causing tuning drift.

In cases of no BBC-2 signal and where the valves are not at fault it is rewarding to check the h.t. voltage and the i.f. plug before removing the tuner for closer examination Where the tuner itself is at fault the writer has often found the connection to pin 2 of the PC88 valve base sprung off. If the soldered connections are not well made the long thick wire tends to spring away

VHF Tuner Unit

Apart from the necessity to change the valves as these wear, the PCC89 normally causing lack of gain, there are two main troubles which will be encountered with the v.h.f. tuner unit. One is fairly obvious, poor electrical contact on the slider switch. This necessitates only removing the bottom cover and applying a small amount of good quality switch cleaner to the contacts and operating the buttons so as to work it in.

The other trouble is a little more awkward because it necessitates replacing the plastic tuning wand in the coil former; but even this operation need only take a few minutes. The fact that the wand is broken is evidenced by the sudden inability of the buttons to select a desired channel. The white end of the wand may be seen protruding from the hole in the rear of the tuner, not moving as it should do when the buttons are operated.

When this fault is encountered, remove the two plugs from the i.f. deck and the large screw which retains the tuner bracket. Ease the unit off the left-side lugs and remove completely. Check the selector knobs and replace if the keyway is worn (which in itself will prevent proper tuning). Remove the bottom cover and undo the side screws. These are of the PK type but there is one BA screw under the centre section which must also be removed before the tuner proper can be separated from the mechanism. With this done the brass head of the wand can be seen. Free this from its return spring and fit the spring on the new wand (which of course you will have had handy, having been warned that this was

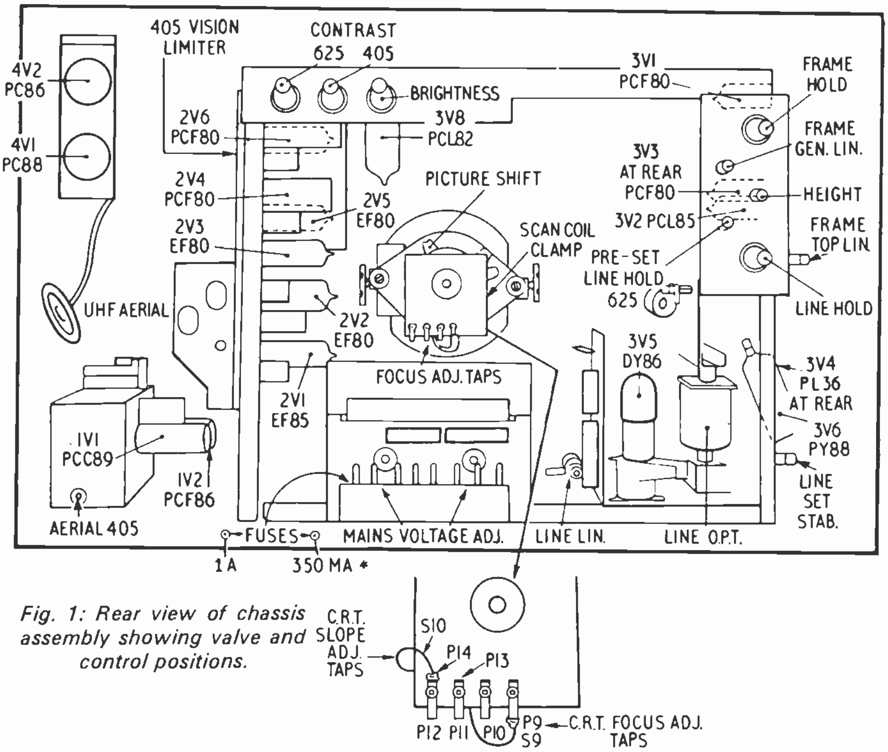
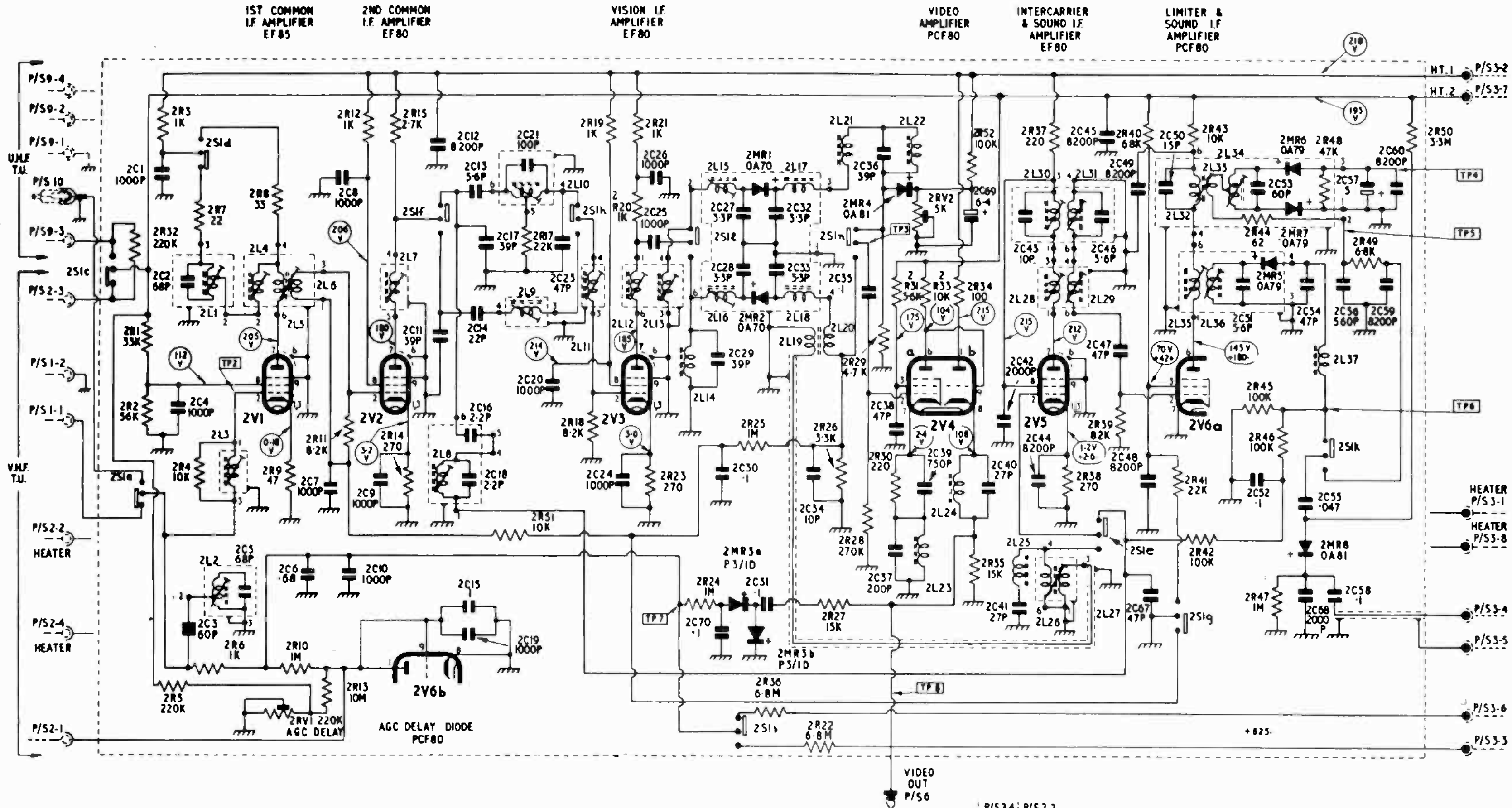
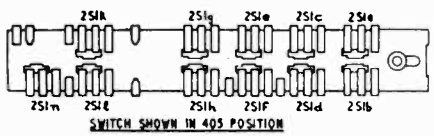


Fig. 1: Rear view of chassis assembly showing valve and control positions.





405/625 System switch (Receiver unit A348)

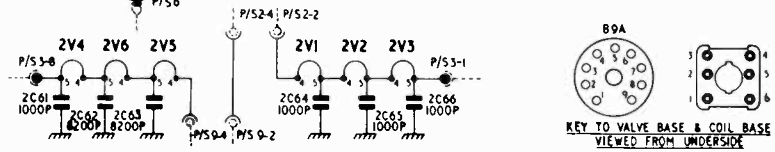


Fig. 2: Circuit diagram of receiver unit Type A348 used in the Bush/Murphy TV123/V849 series.

Modifications: 2C68 2000pF was connected between 2L37 and 2S1k; 2C36 was 33pF; 2R53 1kΩ added between 2C35 and 2V4 pin 2; 2R54 22Ω added between 2V5 pin 2 and 2S1e; 2R15 may be connected to the junction of 2R12 and 2C8 instead of to h.t.; 2C31 now 0·001μF; 2R56 22kΩ added in parallel with 2L32; the connection from the junction 2R51 and 2R25 to 2S1g taken instead via 2R55 1MΩ to the junction of 2R42 and 2R46; 2R22 changed to 2·7MΩ; 2R36 changed to 3·9MΩ; 2R35 changed to 9·1kΩ; 2R32 position changed to being between the centre pole and the u.h.f. pole of 2S1c; Type A436 receiver unit used on later models—this is electrically identical to the A348.

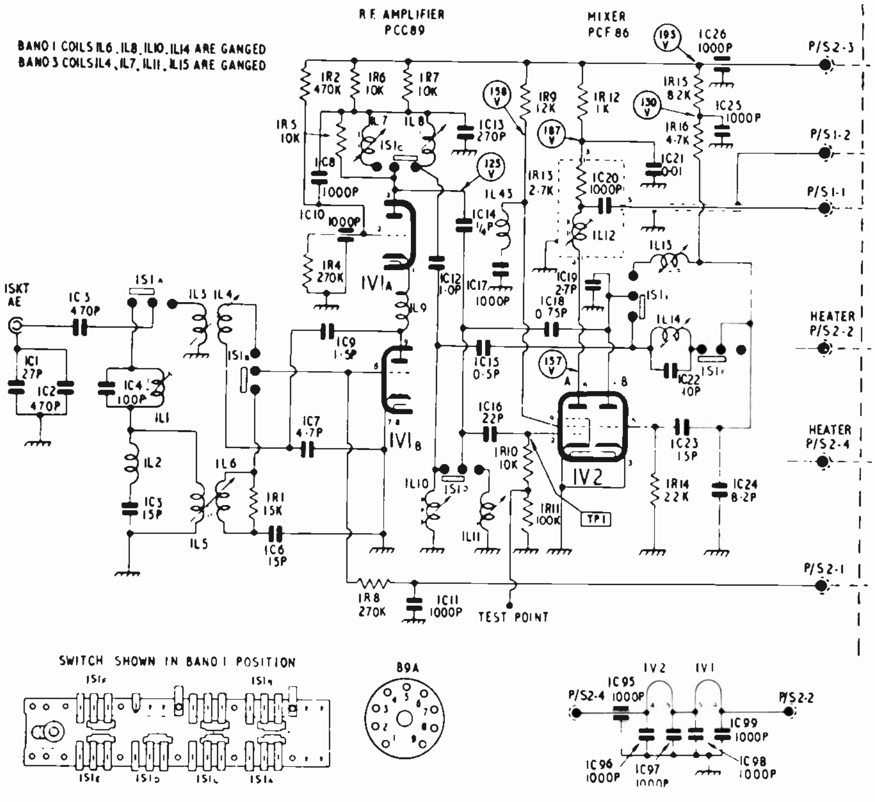


Fig. 3: V.H.F. tuner circuit and interconnections.

going to happen). The new wand should move freely in the coil former. Lightly greasing the wand may prevent it binding.

Apart from the poor switch contacts and broken tuning core, trouble may be experienced with the aerial socket and the two isolating 470pF capacitors in the aerial circuit, leading to intermittent reception, and also with one or two resistors associated with the valve bases. The 470kΩ (1R2) resistor to pin 2 of the PCC89 tends to go high as does the 12kΩ (1R9) one to pin 9 of the PCF86, both resulting in very weak reception.

Receiver Unit

The receiver unit is the left-side panel which carries the sound i.f. and detector stages and the vision stages up to the video output. It is in the video stage that trouble will be experienced and this will take two main forms.

First excess brightness with poor contrast; the brilliance may not black out the raster at its lowest setting. The cause is invariably due to the 10kΩ anode resistor of the video amplifier changing value. This is 2R33, to pin 6 of the PCF80 (2V4) on the upper left side. The original colours of brown-black-orange may not be discernible. Cut it out and fit a 10kΩ 2W type for more reliable operation.

The second symptom is burnt out resistors on the upper left side associated with pins 3 and 7 of the PCF80 valve base. The cause is an internal short in the PCF80 between its screen and control grids. This causes an excess current flow which burns out 2R31 (5·6kΩ) and 2R30 (220Ω). Mercifully the presence of 2C35 in the grid circuit saves the detector diodes. Replace the PCF80 and the resistors, which are a little awkward to get at. This fault can cause the HT2 feed resistor to fail (3R57 on the main deck), also the 1A fuse (3F2). If the complaint is no h.t. and the fuse is found blown and/or 3R57 (330Ω) is overheating, check the video stage first.

Excessive Contrast

Excessive contrast may show as an intermittent fault accompanied by vision buzzing on the sound, sometimes reverting to normal reception. Check to see that 2RV1 (a.g.c. delay) is properly set and check the controlled valves PCC89 and EF85. If there is no improvement check the PCF80 (2V6) and 2C6 (0.68μF) before suspecting the a.g.c. diodes 2MR3. Check other a.g.c. capacitors if necessary.

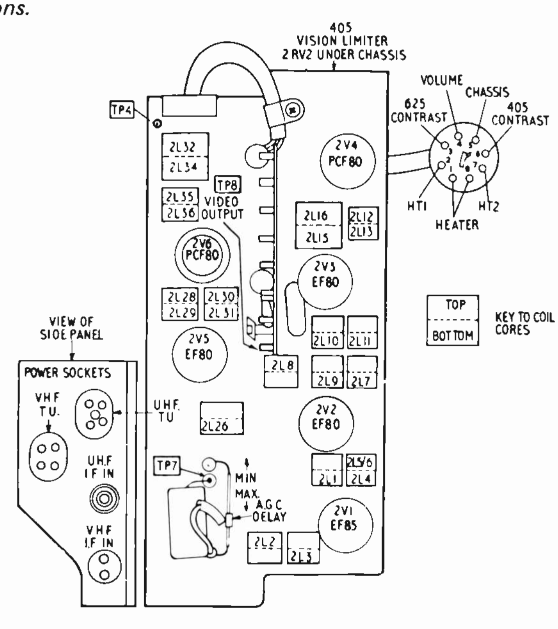
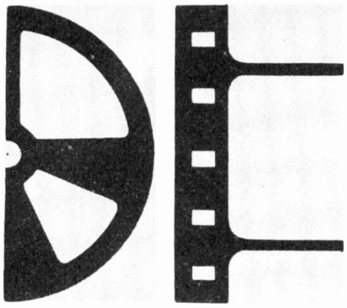


Fig. 4: Above chassis view of the receiver unit.

This fault should not be confused with intermittent fading which is often due to poor contacts on the system switching. This can usually be cleared by running switch cleaner down the left side contacts, at the same time operating the 405-625 buttons.

The function of the valves and diodes on the i.f. or receiver unit is worth close study.

CONTINUED NEXT MONTH



VIDTRONICS

BAYNHAM HONRI

A CONSIDERABLE number of technical ventures have been launched at various times during the past eight years, particularly in electronics. Some have turned out to be flops, but a few are becoming trumps. Last year revealed in particular those concerned with films: films for television; television tapes for films; and other combinations of processes which enable transfers to be made from one medium to another. Even 8mm. film or helical-scan videotape with ½in. or 1in. width tape has been brought into the tape-transfer arena.

The USA, Japan, Canada and several South American countries have electrical mains supplies on 60Hz (with 525 lines for TV) while Britain and Europe's electricity supply is on 50Hz (with 405 and 625 lines). This limits the interchange of taped programmes unless transfers can be made from 525-line videotape (NTSC system) to 625-line videotape (PAL or SECAM system). However there are now over 130 countries with television in operation, mainly black-and-white at present, but with a growing number installing or planning colour TV—and still more are just starting up on monochrome only.

World Videotape Standards

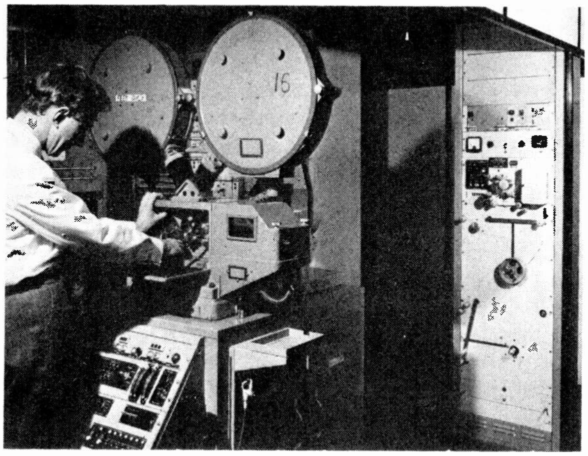
Every television network or station throughout the world possesses 16mm. telecine for running monochrome films. Some of them can even display 16mm. colour films. A lesser number of stations have 35mm. film telecine equipment and still less can boast both monochrome and colour 35mm. telecine. Fortunately the professional television organisations have determined interchangeable standards for videotape in the 525- and 625-line areas. Thanks to the magnificent line-standard converters developed by the BBC, all countries can now carry out the Reith Savoy Hill concept in 1924 that "*Nation Shall Speak Peace Unto Nation*". The world standard for universal and complete interchange of programmes however is by film on the standard gauges of 35mm. (devised by Edison in 1893 for his peepshow Kinetoscope) and 16mm. (introduced by Kodak in the twenties for amateur cine film users, long before it came into professional use). In comparison lack of agreement by educational authorities, particularly in Great Britain, has led to a chaotic number of differing videotape standards for which the Ministry of Education and Science must accept the blame: when will educational experts take advice and learn from professional TV engineers and producers?

Early Kinescope Snags

For a long time it has been obvious that the world market could not be fully provided with TV programme material on videotape, even by using 525/625 (or vice versa) line-standards converters when necessary. But there have been many technical snags in the transfer of pictures (and sound) from tape to 35mm. film without considerable loss of quality. The BBC and American networks regularly "kinescoped" such material with motion-picture cameras, pointing them at high-quality monochrome monitors and usually photographing only one half of the displayed interlace. This was because the intermittent film pull-down claws normally take quite an appreciable time to operate, during which period the camera shutter interrupts the rays of the picture image reaching the moving film. This method was often called the "suppressed frame" system. Improvements were made when transferring from tape to 16mm. film by fitting the camera with a special fast pull-down claw movement, which was able to photograph almost all the interlaced lines, aided by the use of slow decay time phosphor on the monochrome monitor display screen. Acceptable results on monochrome were achieved, though the accuracy of perforations was sometimes in doubt and horizontal steadiness had to rely on a guided edge of the 16mm. film.

The Vidtronics System

With the advent of colour television, kinescoping colour-monitor pictures on three-colour motion-picture negatives proved unsatisfactory on both 16mm. and 35mm. film, the degradation being such that it was rarely acceptable for television programmes other than newsreel items. For some considerable time the Technicolor company has been carrying out research at its laboratories in Los Angeles and Harmondsworth, near London Airport, in the development of a process they have called "Vidtronics". This system has been evolved for transferring picture and sound from the Ampex 2000 colour videotape machine (which can be adjusted for 625 lines, 50 fields or 525 lines, 60 fields) to 35mm. film, a process which has to be carried out three times, once each for the respective colour



Interior film recording camera with control panel below and two 35mm. magnetic recording machines.

separations of the red, green and blue components of the v.t.r. picture.

The filtering for each colour into these components is carried out electronically and a delay system ensures the exposure of full interlace—or almost full. The 35mm. film is used in a fast pull-down Moy camera running at 25 frames per second, steadied with register pins to ensure accurate registration. The pair of register pins always enter the lower perforations of each frame in the camera, corresponding with the same relative positions in the Mitchell and other motion-picture cameras. For years such accuracy has been essential for optical and trick work in film making; also for dissolves, wipes, double exposures, superimposed titles, etc. Without such rigid precautions the overlay titles, for instance, will appear to "float", "ride" or "weave" on top of the background picture.

Results

Technicolor have wisely decided upon 35mm. film colour separations not only because of the necessity for registration accuracy for three-colour separation film negatives but because this fits in so well with the original brilliant concept of a dye-transfer system. This calls for a photographic image in relief, which with great delicacy and accuracy imprints in turn the yellow, cyan and magenta with three separate dye-transfer "facilities". The process has always seemed to me to be a miraculous one, using three such "rubber stampers" automatically. These colour-separation facilities are prepared from the new Technicolor kinescope separation negatives on optical prints, which are also used for optically printing the three-colour separation facilities for 16mm. colour film prints. The yellow, cyan and magenta separations are, of course, required for the subtractive method of colour photography: the familiar red, green and blue combinations arise from processes based on additive colour mixing.

My opinions of the Vidtronics system as displayed at the International Broadcasting Convention in London over six months ago were favourable, with slight reservations on the results on low-key scenes which were subject to a red cast on the black parts of a scene. This criticism no longer applies. I have recently seen 35mm. and 16mm. prints of part of the very latest vintage transfers from colour tape to film and can only say that they were faultless, limited only by the quality of the original colour television signal. The tape was colour recorded at an ITV studio and transferred at the Technicolor Labs, Harmondsworth, and was better than a very good print of another subject taped in the USA and transferred by Technicolor, Los Angeles.

John Mulliner, a leading electronic engineer in ITV for some years, is Head of the Vidtronics Division of Technicolor Ltd. Much credit is due to him for his contribution to the amazing refinements recently introduced, with the confident support of Frank C. Littlejohns, Managing Director of Technicolor's London laboratory. ■

SERVICING COLOUR RECEIVERS

—continued from page 415

but in general it is better to allow a little extra to reduce the risk of damage by heat or stress.

The most difficult job of all for the first-timer is to remove an eight-pin coil assembly. It makes an intriguing picture watching some poor chap scampering round like mad from pin to pin with his iron in a desperate attempt to keep eight blobs of solder soft whilst he attempts to remove the coil can out of the board! Haven't we all tried this at least once. It can be done, but it is hardly the best way. Far better to use a brush to remove surplus solder from each joint in turn. Incidentally beware of those slivers of solder that unobtrusively trickle down the board and cause an unseen short-circuit in a dark corner.

A better technique still is to use an air-operated solder pump that sucks the solder off the joint clearly and overcomes these problems. Every workshop should have one. Finally a good quality 60/40 solder with a high tin content is not the cheapest you can buy but it makes much better joints much more easily: it has better wetting properties and does not go through that long plastic stage which so often causes hidden dry-joints.

Conclusion

We have covered a lot of ground in this series of articles. All of it has been about the sort of activities that a large army of service engineers are doing every day up and down the country. In a sense we have been paying tribute to the skills and efforts that enable about fourteen million households to enjoy television programmes in all their variety whether in monochrome or colour. We have been talking mostly about colour because this is a whole new field of endeavour that is going to become the main preoccupation of more and more engineers as time goes on. It is upon their skill and conscientious care that the possibility of realising the full potentialities of colour broadcasting depends. ■

Workshop HINTS

by VIVIAN CAPEL

VALVEHOLDERS can give rise to numerous headaches for the service engineer. This month we will give hints in connection with this necessary component.

Cleaning Valveholders

Many intermittent faults can be traced to dirty valveholders so that just a slight movement of the valve in its holder results in noise on the sound or disturbance of the vision or timebase functions depending on the circuit with which the valve is associated. Often the only trouble is that the valve pin or holder contacts are slightly tarnished and a cure can be obtained by merely rocking the valve in its holder vigorously with a circular motion: friction between valve pin and socket cleans off the affected area. When rocking however do not displace the valve too far from the vertical position otherwise the holder contacts may be forced apart making matters worse.

If this does not do the trick a slight smear of silicone grease on the valve pins and a further rocking should prove effective.

Spare Valveholder Sockets

Sometimes it is found that any amount of cleaning has no effect, the reason being that the individual sockets in the valveholder are not making good contact with the valve pins. This may be because they have been bent or forced apart or often because one part of the socket is actually broken off. A close visual examination of the top of the valveholder will usually reveal broken sockets. Those that are just bent apart can often be squeezed together by using a very fine-bladed screwdriver such as the watchmaker's screwdriver to lever the affected part over.

Sometimes the metal of the valveholder sockets has become fatigued to the extent that any attempt to squeeze them together results in the socket or part of it breaking off. With many valveholders it is possible to remove individual sockets and replace them without discarding the whole valveholder with all the work and effort that this entails. It is usually necessary to disconnect the wiring to the base of the particular valveholder socket, clean off all excess solder and straighten out the solder tag if necessary after which it can be pushed upward so that the socket emerges from the top of the valveholder.

Having done this the question remains as to where a replacement can be obtained. It is not always necessary to obtain a new valveholder and rob it of one or more sockets. It is anyway possible that the replacement will be of different design so that it cannot be fitted to the old socket. Often however a replacement can be found in the set. There are a number of valves on which the pins are not all used. The corresponding sockets on the valveholders can therefore be removed and used as replacements. This is true for example in h.t. rectifiers which have several unused pins, and also the boost rectifier although in some cases the boost diode valveholder is of a different type to those used in the rest of the set so that its spare sockets cannot be used. Even if the receiver does not possess valve rectifiers more likely than not spare pin sockets will be found somewhere.

Splaying Valve Pins

In some cases it will be found that valveholder sockets are not removable or that so many are defective that not enough replacements can be found. In such a case the whole valveholder needs replacing. This entails a fair amount of work and the receiver may be an ancient one that is not really worth spending much time or money on.

In such a case an improvement may be obtained by splaying the valve pins out a little. To do this the body of the valve must be gripped firmly in one hand and each pin bent outward using a small pointed-nose pair of pliers. The amount by which the pins are bent is only very slight as otherwise they will not engage in the holder at all. All pins on the valves are treated in the same way and of course care must be taken not to break the glass valve envelope itself.

The general result will be a more positive grip and good contact between the valve pins and the outside section of the valveholder sockets, even though they may be broken or have lost their grip due to metal fatigue. The method should only be adopted however in cases where it would be uneconomic to replace the holder. All future valves fitted to the holder will have to be treated in the same way and any removed from it for test will have to have their pins straightened before they can be inserted in a valve tester without damage to the tester valveholder.

Valve Plug-holder

Taking voltage measurements is one of the main operations when diagnosing faults. Sometimes it is necessary to make a few quick checks, for example on an outside service call in order to determine whether the receiver should be brought into the workshop or not. Difficulty arises when it is not possible to gain access easily to the underside of the valveholders. There may perhaps be no

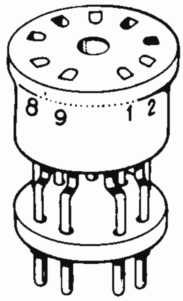


Fig. 1: Valve adaptor

inspection covers, and dismantling the chassis or panel may require a lot of work. Sometimes it is possible to pull the valve partly out of its holder and take measurements from the pins. This is rather chancy however as the valve may be pulled out too far and contact lost, affecting the reading, or the test prod may short to the metal chassis. A very useful device which can be used in these circumstances is the valve plug-holder.

This consists simply of a standard 9-pin valveholder and a 9-pin valve plug (see Fig. 1); the tags of the holder are simply soldered directly to the tags of the plug thereby forming a single unit which can be plugged into the valveholder of the receiver and into which the valve itself can be plugged. The exposed soldered tags around the side then make voltage checks quite easy. It is a good idea to scratch the pin numbers on the holder adjacent to each pin so that the pins can be quickly identified when the adaptor is in position.

There is one limitation to the use of this device and that is in r.f. or i.f. circuits. The increased capacitance between the pins will usually detune the associated circuits or may cause instability. In any case the proximity of coil cans around the holder would make taking voltages rather difficult. In other circuits however the device is very useful when taking measurements where access to the underside cannot easily be obtained. Current measurements can also be taken by unsoldering the appropriate socket on the holder. Even if access to the receiver valveholder is available use of the adaptor is usually easier than unsoldering wires that have been wrapped around the holder in the set.

Valve Swapping

Sometimes valves fall below the standard required for a particular circuit although they still work. Thus for example a field output valve may give insufficient scan with some cramping. In such cases it is often possible to change the valve for one of the same type in the same set but in a less critical circuit. Often the field output and sound output valves are the same so that if the sound output valve is up to standard it can be used in the field circuit and the field valve in the sound output circuit. In older sets valves of the ECL80 type were liberally used and it is often possible to improve performance by a change about. So too with the i.f. valves in the vision and sound strip. Vision sensitivity may be less than desired due to two or more i.f. valves being below par. These generally will have little effect on the sound and so a changeover can be made.

TO BE CONTINUED

TV HEARING-AID

—*continued from page 392*

To assist constructors with box drilling detailed drawings are given in Fig. 3.

Working from the circuit and Veroboard layout in Figs. 2 and 4 the construction of the circuit board itself should not present many problems. A fair amount of room exists on the board to cater for $\frac{1}{4}$W resistors if these happen to be at hand; but the electrolytics must be of the miniature variety and connected in circuit with heed to the correct polarity. Note that the main power supply electrolytic C6 and the emitter resistors of Tr2 and Tr3 (R7 and R10) are mounted on the metal conductor side of the board.

Before fitting the circuit board into the box it is best to connect the on/off switch and the jack socket to their appropriate wires, which should have previously been cut to length. The whole assembly can then be lowered into the box together, after which the microphone insert can be fitted into the hole on the side of the box and the wires connected inside making sure that the "earthy" wire is connected to the tag which is in contact with the metal case. The other tag is insulated by a ceramic bush.

Correctly working the circuit takes betweeen 3·5-4mA from the 9V battery and the gain should be such that a feedback whistle occurs when the earpiece is brought within about an inch from the front of the microphone. If it is required to fit a manual gain control, this may be done by making R2 variable, a value of up to about 25kΩ being suitable.

Alternative Front-end

I.C.s are recent devices and their supply is currently focused more towards the manufacturer than the enthusiast amateur. In fact the home-constructors' market is unlikely to be fully satisfied until manufacturers themselves have had ample opportunity to fully appraise such devices in commercial equipment designs. To enable those constructors who may encounter difficulty in obtaining the TAA320 or who may prefer to use conventional components to make the deaf-aid, the alternative previously mentioned bootstrapped front-end is shown in Fig. 5. This can be employed easily enough to take the place of the TAA320. ■

FAULT FINDING FOCUS

—*continued from page 405*

completely rule out the possibility of locating the fault for it always pays to check that the preset sliders have not become forced off their control tracks due to an oversize screwdriver, that diodes have a good forward-reverse ratio and that chassis inspection shows no dry-joints.

When checking for intermittent faults be extremely careful when probing or applying pressure for it is very easy to break off a lead which requires nothing less than soldering gymnastics to replace without having to remove the entire panel. This particularly applies to transistors and if you do happen to pull a transistor lead from its panel connection it is often more convenient to solder a short length of wire to the printed circuit and then solder this to the transistor lead rather than to try to reconnect it directly.

TO BE CONTINUED

YOUR PROBLEMS SOLVED

Whilst we are always pleased to assist readers with their technical difficulties, we regret that we are unable to supply service data or provide instructions for modifying equipment. We cannot supply alternative details for constructional articles which appear in these pages. WE CANNOT UNDERTAKE TO ANSWER QUERIES OVER THE TELEPHONE. The coupon from page 429 must be attached to all Queries, and a stamped and addressed envelope must be enclosed.

MURPHY V759

When switched on from cold the picture appears slowly with 2in. of black at each side. The picture fills out to full size after about 2 minutes but then a 1in. black band appears at 5 second intervals at the bottom.

Could this be a voltage drop at the mains or in the set? It always narrows in the early evening which could be a peak-viewing time. Two hours before the stations close down the picture fills out to full size.—P. McLinley (Northern Ireland).

The lack of width may be due to a lazy 30P19 line output valve and the bottom compression to a weak 30PL13 field output valve.

PYE 11U

The original trouble with this receiver was a dark edge on the left side of the picture and some short white lines breaking from the bottom upwards. These increased on turning up the brightness. I changed the PL36 which removed the dark band but the white lines persist. I also notice that the lead from the transformer to the DY87 seems to be overheating.—D. Talboys (Oxford).

We feel that the overheating of the DY87 lead may be misleading since it normally carries little current. Your bright lines fault could be due to a defective PCL85 field output valve on the lower half of the chassis.

BUSH TUG68

When I switched to Channel 1 (BBC) ITV sound breaks through on Channnel 1 sound and even by tuning the interference cannot be entirely eliminated. There is no interference on the picture when this occurs and Channel 9 is good on sound and vision.

There is a beat oscillation on the sound of Channel 1 which drifts through as the set warms up. Fine tuning will get rid of this until it drifts through again. Sometimes the sound interference is so bad that only ITV sound can be heard with the BBC-1 picture.—R. Simmonds (Buckinghamshire).

It would appear that the tuner contacts are not making and breaking properly. You will observe on inspection that the slider travel is controlled by a spring-loaded screw and nut on the front. The dome nut has a leaf spring over its end. Adjust the nut to make the contacts work properly. The tuner cover is secured by four 6BA nuts.

STELLA 2049A

I am receiving a fairly good BBC-2 picture but it is necessary to have the volume control turned up almost full before a reasonable level of sound is reached. Sound on BBC-1 and ITV is more than adequate.—K. Russ (Kent).

The trouble can usually be located under one of the 625 sound i.f. coil cans where a poor connection or dry joint causes loss of gain. Quite often moving the cans will reveal which requires attention.

FERGUSON 508T

The sound does not come on till the set has been on for quite a time. When it does appear it comes on with a "click".—J. Dolman (Liverpool, 25).

The fault is most probably in the PCL82 audio output valve or stage. Check this and the EF80 sound i.f. amplifier decoupling.

THORN 900 CHASSIS

There is no e.h.t. The sound on both 625- and 405-lines is good. I have replaced the line output transformer which is a jelly-pot type, renewed the PL500, PY801 and PCF808. In addition I have replaced the 0·22μF boost capacitor.

There is a negative drive voltage of about 20V at the grid of the line output valve and this voltage can be varied by adjusting the 405-line hold control. The whistle on 405 is just about audible but cannot be heard on 625.

The anode of the PL500 does not get hot as sometimes happens and taking off the top cap of the PY801 makes no difference. The screen feed resistor to the PL500 is the correct value but the main h.t. rail seems to be a little down.—A Bailey (Manchester, 10).

It seems that you have line drive, but it is possible that its amplitude is abnormally low. This could delete the e.h.t. supply. Such trouble could be caused by a fault in the line oscillator or in the coupling to the output stage. On the other hand normal drive to the ouput valve should lead to exhaustive tests of the associated components, including the width and linearity circuits as trouble with these would heavily damp the stage and prevent it working correctly. Also if necessary ensure that the replacement line output transformer is in good order and wired correctly.

KB KV003

Please can you advise on how to adjust the picture height which is controlled internally on this set.—S. Scott (Doncaster).

The height control is a small slider adjustment inside the rear of the receiver. To remove the case, remove the side 625 tuner knob. Remove the rear socket and aerials, both top front screws and lift off the cabinet.

FERRANTI T1002/1

Both the picture and sound are of excellent quality but there is a series of white dots and streaks on the screen which vary with the picture content. This fault is more noticable on BBC-1 than on ITV. Could it be possible that this is caused by a faulty receiver nearby or is this a fault in the set itself?—P. Webb (Somerset).

You should examine the condition of the perspex top of the line output transformer at the heater end of the U25, also the e.h.t. connection to the tube. The e.h.t. metrosil could also be faulty. The trouble is most likely a discharge of e.h.t.

GEC 2029 COLOUR RECEIVER

This set appears to have a fault which is more noticeable when viewing monochrome pictures. The left-hand side of the screen appears shaded towards magenta, although purity adjustments have been carried out and appear satisfactory (the set has also been degaussed with degaussing coil).

The magenta shading—not caused by flyback—diminishes towards the right-hand side of the screen. By advancing the green screen control the effect can obviously be lessened but this interferes with correct grey scale at the centre of the screen.—C. Topham (Lancashire).

This fault is generally due to residual magnetism, indicating the need for thorough degaussing. However if this has been tried without success the fault could be caused by trouble in the grey-scale tracking or as the result of the tracking being affected by a spurious signal modulating the line. It is possible that the line blanking circuit is picking up a spurious signal (hum?) and manifesting this as change in conductivity of the colour-difference amplifiers from line start to line finish. This would be a good start for investigations. It might well be that a capacitor or resistor feeding the line pulses to the blanking and clamping circuits has altered in value somewhat or that hum signal is gaining admittance at this vulnerable point—as the result of an open-circuit capacitor, for example.

FERGUSON 508T

The vertical lock is at the end of its travel and will not lock until the height control is reduced to give about 2/3 picture height. The result is fold-over at the bottom of the screen. I have changed the PCL82 but this has made no difference.—A. C. Street (London, S.E.6).

Check the 22kΩ resistor to pin 1 of the ECC82. Also check the 2·2MΩ resistor to pin 1 of the PCL82. Check C97 (0·01μF) capacitor behind the linearity control.

QUERIES COUPON

This coupon is available until June 20, 1969, and must accompany all Queries sent in accordance with the notice on page 428.

PRACTICAL TELEVISION, JUNE 1969

TEST CASE

79

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

? *THE symptom on a Cossor Model 1972A was lack of total operation of the brightness control. The control would turn down the brightness a little, but even in the fully retarded setting of the control, screen illumination was still present with the aerial removed and the contrast control turned right back. This made it virtually impossible to secure the correct contrast (black/white) ratio in the picture with the set working otherwise normally.*

Thinking that the picture tube was at fault the experimenter replaced this, but the trouble remained. He then commenced to test in and around the video amplifier stage and the feed from this to the tube cathode, but with no luck.

What could have been causing this trouble and what part of the vision channel did the experimenter overlook? See next month's PRACTICAL TELEVISION *for the solution and for another item in the Test Case series.*

SOLUTION TO TEST CASE 78

Page 380 (last month)

In the Thorn 950 Mk II chassis a 100μF section of the main smoothing capacitor is concerned with smoothing the supply to the field timebase. Actually it tends to hold this circuit at very low impedance to avoid field breakthrough into other parts of the set.

It not uncommonly happens that this section of the capacitor goes open-circuit or intermittent, giving the symptoms described in last month's Test Case. Owing to both the reduced vertical scan amplitude and the distortion, the symptom usually gives the impression of having its origin well in the field timebase circuits. However replacing the capacitor—or, less desirable, disconnecting the 100μF section and fitting a separate single 100μF unit—cures the trouble.

Published on or about the 22nd of each month by IPC MAGAZINES LIMITED, Tower House, Southampton Street, London, W.C.2, at the recommended maximum price shown on the cover. Printed in England by Fleetway Printers, 17 Sumner Street, London, S.E.1. Sole Agents for Australia and New Zealand: Gordon & Gotch (A/sia) Ltd. Subscription rate including postage for one year: To any part of the World £2 1s.

Practical Television Classified Advertisements

The pre-paid rate for classified advertisements is 4/- per line (minimum order 12/-), box number 1/- extra. Semi-display setting £2 10s. 0d. per single column inch. All cheques, postal orders, etc., to be made payable to PRACTICAL TELEVISION and crossed "Lloyds Bank Ltd." Treasury notes should always be sent *registered post*. Advertisements, together with remittance, should be sent to the Classified Advertisement Manager, PRACTICAL TELEVISION IPC Magazines Ltd., Fleetway House, Farringdon Street, London, EC4, for insertion in the next available issue.

TECHNICAL TRAINING

CITY & GUILDS (electrical, etc.) on "Satisfaction or Refund of Fee" terms. Thousands of passes. For details of modern courses in all branches of electrical engineering, electronics, radio, TV, automation, etc., send for 132-page handbook—FREE. B.I.E.T. (Dept. 173K), Aldermaston Court, Aldermaston, Berks.

EDUCATIONAL

CORRESPONDENCE & PRACTICAL COLOUR TELEVISION COURSES by Electronic & Colour Television Training Limited. Recommended by leading manufacturers and approved by Training Board. For full details write or phone 45, Walton Road, East Molesey, Surrey. 01-979 5553.

BECOME "Technically Qualified" in your spare time, guaranteed diploma and exam. Home-study courses in radio, TV servicing and maintenance. T.T.E.B. City and Guilds, etc., highly informative 120-page Guide—FREE. CHAMBERS COLLEGE (Dept. 858K), 148 Holborn, London, E.C.1

TV and RADIO, A.M.I.E.R.E., City & Guilds, R.T.E.B., Certs., etc. on "Satisfaction or Refund of Fee" terms. Thousands of passes. For full details of exams and home training courses (including practical equipment) in all branches of Radio, TV, Electronics, etc., write for 132-page Handbook—FREE. Please state subject. BRITISH INSTITUTE OF ENGINEERING TECHNOLOGY (Dept. 172K), Aldermaston Court, Aldermaston, Berks.

TRAIN FOR SUCCESS WITH ICS

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

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

ICS, INTERTEXT HOUSE, STEWARTS ROAD, LONDON, SW8.

SITUATIONS VACANT

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

SITUATIONS VACANT

(continued)

T.V. ENGINEER requires private instruction in use of sophisticated instruments, Oscilloscopes, Wobbulators, etc. Box No. 76.

ENGINEERS. A TECHNICAL CERTIFICATE or qualification will bring you security and much better pay. Elem. and adv. private postal courses for C. Eng., A.M.I.E.R.E., A.M.S.E. (Mech. & Elec.), City & Guilds, A.M.I.M.I., A.I.O.B., and G.C.E. Exams. Diploma courses in all branches of Engineering—Mech., Elec., Auto, Electronics, Radio, Computers, Draughts, Buildings, etc. For full details write for FREE 132 page guide: BRITISH INSTITUTE OF ENGINEERING TECHNOLOGY, (Dept. 171K), Aldermaston Court, Aldermaston, Berks.

SERVICE SHEETS

SERVICE SHEETS, Radio, T.V., 5,000 models. List 1/6 S.A.E. enquiries. TELRAY, 11 Maudland Bank, Preston.

BY 100s, 3/9 each; 3 for 10/-, with Free Surge Resistors, Lesmar, 15 Conholt Road, Andover, Hants.

SERVICE SHEETS (1925-1969) for Televisions, Radios, Transistors, Tape Recorders, Record Players, etc., by return post, with Free Fault-Finding Guide. Prices from 1/-. Over 8,000 models available. Please send S.A.E. with all orders/enquiries. Hamilton Radio, 54 London Road, Bexhill, Sussex.

LARGE SUPPLIER

OF

SERVICE SHEETS

(T.V., RADIO, TAPE RECORDERS, RECORD PLAYERS, TRANSISTORS, STEREOGRAMS, RADIOGRAMS)

Only 5/- each, plus large S.A.E.

(Uncrossed P.O.s please, returned if service sheets not available.)

C. CARANNA

71 BEAUFORT PARK LONDON, N.W.11

We have the largest supplies of Service Sheets (strictly by return of post). Please state make and model number/alternative.

Mail order only.

SERVICE SHEETS

(continued)

RADIO, TELEVISION over 3,000 models. JOHN GILBERT TELEVISION, 1b Shepherds Bush Road, London W.6. SHE 8441.

SERVICE SHEETS with Free Fault Finding Chart, 4/6d. S.A.E. Lesmar, 15 Conholt Rd., Andover, Hants. (Mail only.)

MISCELLANEOUS

UFO DETECTOR CIRCUITS, data, 10s. (refundable). Paraphysical Laboratory (UFO Observatory), Downton, Wilts.

D.I.Y. TELEREPAIRS. Forward your fault query for an immediate analysis by our team of experts. Make and Model No. with full description of fault together with P.O. or cheque for 10/-, to 48 Armson Avenue, Kirby Muxloe, Leics.

FOR SALE

NEWNES RADIO & T.V. Servicing, Volumes 1 to 5 for sale at £7 10 0, others available. Also various T.V. spares. Marchant, 27 Long Street, Tetbury, Glos.

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

TOP TRADE DISCOUNTS FOR ALL

COMPONENTS
VALVES
TUBES
TRANSISTORS
L.O.P.T's

Free Trade Catalogue
Engineers & Service Dealers Only

WILLOW VALE,
THE SERVICE DEPT.
WHOLESALERS,
4 The Broadway, Hanwell,
London, W.7
01-567 5400/2971

AERIALS

TV AERIALS

Band I. H. Mast Fitting	£2	0	0
Band III. 5 Ele Mast Fitting	£1	12	0
Band I/III. S/D and 4-Array	£1	17	6
Band IV. 10 Ele Array	£1	12	6
Band IV. 18 Ele Array	£2	18	6

Lashing Kits from 10/-; Poles, Co-ax 10d., Grade "A" 1/6. Plugs 9d.

P. & P. 7/6. C.W.O., S.A.E. for list.

TELEINDUSTRIES LTD.

BREAKSPEAR ROAD, RUISLIP, Middx.

WANTED

DAMAGED AVO Meters, Models 7 and 8. Also damaged Meggers, any quantity, send for packing instructions. HUGGETTS Ltd. 2/4 Pawsons Road, West Croydon.

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

WANTED—Popular Brand New Valves—R.H.S., Stamford House, 538 Great Horton Road, Bradford 7.

BULK SURPLUS STOCK WANTED, Valves, tubes, all television comp. also 19"/23" TV's working or not. 71.36512.

NEW VALVES WANTED. Popular TV and Radio types. Best cash price by return. DURHAM SUPPLIES, 367A Kensington Street, Bradford 8, Yorkshire.

WANTED new valves, television, radiograms, transistors, etc. STAN WILLETTS 37 High Street, West Bromwich, Staffs. Tel: WES 0186.

WANTED Newnes R/T.V. Servicing 1959/60 onwards. Details Booker, 8 Holly Court, Knaresborough. Tel. 3891.

WANTED Newnes Radio & T.V. Servicing Manuals; service sheets and back numbers of Practical Television, also service equipment, details to Box 75.

WANTED. Manufacturer Manual for T128 CU Bush Television. A. H. Clark, 20, Millfield Road, Luton.

NEW TELEVISION VALVES

ANY QUANTITY *BEST PRICES*

Also slim 17"/19" T.V.S. (non-workers accepted).
Collections arranged.

Taylor Electronic Supplies Ltd.,
535, Millbrook Road, Southampton
Tel.: Soton 74828

SETS & COMPONENTS

NEW BVA VALVES! Huge range by return postal service well known to the trade. Brief list of television types herewith, full list s.a.e.

DY86/7	8/-	PCF80	10/3	PL504	17/-	6BW7	13/9	30PL13	18/6
EB91	5/-	PCF86	12/3	PY81	8/3	6CD6G	28/-	30PL14	18/6
ECC82	8/6	PCF801/2	12/3	PY82	7/-	6F23	15/6	etc., etc.	
ECL80	8/-	PCF805	13/-	PY800/1	8/3	20L1	19/6	SPECIAL BARGAINS	
EF80	8/-	PCF808	13/6	R19	13/-	20P4	20/-	(mostly imported)	
EF85	8/3	PCL82	10/3	U25	15/-	30C15	13/9	ECC82	5/-
EF183/4	11/3	PCL83	12/3	U26	15/-	30C17	15/9	EF80	5/-
EH90	10/3	PCL84	10/3	U37	15/-	30F5	16/6	EY86	7/-
EY51	7/6	PCL85	10/6	U191	14/6	30FL1	12/9	PCC84	6/6
EY86/7	7/9	PCL86	10/3	U193	8/3	30L15	15/3	PCC89	9/6
PC86/8	10/3	PL36/8	12/9	U251	17/3	30L17	14/6	PCF80	6/6
PC97	8/3	PL81	10/3	U301	17/-	30P12	15/6	PCL82	6/9
PC900	10/3	PL83	10/3	U801	24/-	30PL1	12/9	PY81	5/9
PCC84	9/3	PL84	8/3	6/30L2	15/6	30P4MR	20/-	PY800	7/6
PCC89	12/3	PL500	16/6	6AT6	9/9	30P19	12/9	PY801	6/3

POST FREE OVER £3—LATEST ENCAPSULATED BY 100 & 33 ohm res, 4/-!

SEE SEPARATE TUBE LIST etc.

PHILIP H. BEARMAN

CALLERS WELCOME

Tel. 449/1934 & 7873 (Robophone)

(Suppliers to HM Govt. etc.)
6 Potters Road, New Barnet, Herts.

Closed Thursday & Saturday afternoons

SETS & COMPONENTS
(continued)

BARGAIN PARCELS

ANY 1—2/-, 5—9/-, 10—14/- 100—110/-

FROM THE LIST BELOW

EBF80, EBF89, EB91, ECC82, ECC83, EF80, EF85, EF183, EF184, EY86, ECL80, PCC84, PCF80, PCF82, PCL82, PCL83, PCL84, PL36, PL81, PL82, PL83, PY32, PY33, PY81, PY82, PY800, U26, U191, 6F23, 6-30L2, 30F5, 30L15, 30FL1, 30P12, 30P4.

MANY OTHER TYPES IN STOCK

P. & P. 1/-

BY100 TYPE RECTIFIERS WITH SURGE RESISTORS ON TAG STRIPS 2/6 ea.

VELCO ELECTRONICS

62 Bridge St., Ramsbottom, via Bury, Lancs.

R & R RADIO

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

VALVES BOXED, TESTED & GUARANTEED

EBC41	4/6	PCC84	3/–	PY82	3/–
EBF80	3/–	PCF80	3/–	U191	4/6
EBF89	3/6	PCF82	3/6	6F23	5/–
ECC82	3/–	PCL82	4/–	30F5	2/6
ECC83	4/–	PCL83	4/–	30L15	5/–
ECL80	3/–	PCL84	5/–	30P12	4/6
EF80	1/6	PL36	5/–	30C15	5/–
EF85	3/–	PL81	4/–	50CD6	7/6
EF183	3/6	PL82	4/6		
EY86	4/–	PL83	4/–		
EL41	5/–	PY33	5/–		
EZ40	4/6	PY81	3/6		
		PY800	3/6		

POST ONE VALVE 9d. TWO TO SIX 6d.
OVER SIX POST PAID.

150 NEW ASSORTED Capacitors, Resistors, Silvered Mica, Ceramic, etc. Carbon, Hystab, Vitreous ½-20 watt, 12/6. Post Free. WHITSAM ELECTRICAL, 33 Drayton Green Road, West Ealing, London, W.13.

SETS & COMPONENTS
(continued)

TELEVISION TUBE SHOP

ALL THE LATEST NEW TUBES AT REDUCED PRICES

A28-14W	**£11. 0.0**
A47-11W	**£19.19.6**
A47-13W	**£11.15.0**
A47-14W	**£7.12.6**
A59-11W	**£12.19.6**
A59-13W	**£14.15.0**
A59-15W	**£9.10.0**
A59-16W	**£14.15.0**
AW21-11	**£10.10.0**
AW36-20, 21	**£5.12.6**
AW36-80	**£5. 7.6**
AW43-80	**£6. 7.6**
AW43-88, 43-89	**£6.12.6**
AW47-90, 91	**£7.10.0**
AW53-80	**£8.12.6**
AW53-88, 53-89	**£8. 5.0**
AW59-90, 59-91	**£8.15.0**
C17BM, FM, HM	**£6. 7.6**
C17LM, PM, SM	**£6.12.6**
C21HM, SM, TM	**£7.17.6**
CME 1201	**£12.10.0**
CME1601	**£10. 5.0**
CME1702, 1703	**£6.12.6**
CME1705	**£7. 7.0**
CME1901, 1903	**£7.10.0**
CME2101, 2104	**£8. 5.0**
CME2301, 2302	**£8.15.0**
CME2306	**£14.15.0**
CRM93	**£5.10.0**
CRM124	**£5.10.0**
CRM141, 2, 3, 4	**£5. 2.6**
CRM171, 2, 3	**£6. 7.6**
CRM211, 212	**£8.17.6**
MW36-24, 44	**£5. 2.6**
MW43-64, 69	**£6. 7.6**
MW43-80	**£6. 7.6**
MW53-20	**£8.17.6**
MW53-80	**£8.17.6**
7405A	**£6.12.6**
TSD217, 282	**£11.10.0**

All tubes tested before despatch and guaranteed for 12 months.

Re-processed tubes also available at reduced prices.

CARRIAGE 10/-, via B.R.S. or 15/- via passenger train. Add 2/6 for Comprehensive insurance.

Midland Stockists:—
Amateur Electronics,
518/520 Alum Rock Road,
Birmingham 8

TELEVISION TUBE SHOP

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

WE GIVE GREEN SHIELD STAMPS

TELEVISION TUBES

Large stocks of television tubes, London's leading wholesale suppliers, all tubes complete with guarantee card. By return despatch. Terms: Cash with order, s.a.e. all enquiries.

14in. types. AW36/20, AW36/21, AW36/80, MW36/24, CRM141, CRM144, CME1402 etc.	£4 17 6
17in. types. MW43/80, AW43/80, CRM173, CME1702, MW43/69, CRM172, AW43/88, AW43/89, CME1703, CME1705 etc.	£4 17 6
19in. types. AW47/90, AW47/91, CME1901, CME1903, CME1902, C19AH	£4 19 6
21in. types. AW53/88, AW53/89, CME2101, CME2303	£6 12 0
MW53/80, AW53/80, MW53/20, CRM211/2	£8 18 10
23in. types. AW59/90, AW59/91, CME2301, CME2303	£6 12 0
23in. Twin Panel. CME2306, A59-16W	£13 1 0
23in. Panorama. A59/11W etc.	£12 0 0
19in. Twin Panel. A47-13W, CME1906 etc.	£10 1 0
19in. Panorama. A47/11W etc.	£9 0 0

We stock all types of tubes. **Carriage and Packing** 12/6d. per British Road Services. Large stocks of valves, transistors, components, L.O.P.T's. Electrolube, Servisol switch cleaner, Multicore solder. Service Tools.

WILLOW VALE ELECTRONICS LTD.

The Service Dept. Wholesalers, 4, The Broadway, Hanwell, London, W.7. Tel: 01-567 2971/5400

FREE CATALOGUE—TRADE ONLY. S.A.E. Please.

EX N.E.V. C.C.T.V. Camera and Monitor Circuits. S.A.E. for list. LOWE, 35 Hensley Point, Hackney, London, E.9.

TOWERBY LTD

For Line Outputs and Deflector Coils

We have the Country's largest stock of Manufacturer's Original (or Authorised Replacement) Line Output Transformers for many "difficult" makes, including **Ambassador, Baird, Cossor, Decca, Dynatron, Ekco, Ferguson, G.E.C., H.M.V., K.B., Masteradio, Peto-Scott, Philips, Regentone, RGD, Sobell, Ultra,** etc. Also deflector coils output and oscillator transformers, inc. **Alba, Bush, Murphy.** Examples, L.O.P.T. **Murphy** 310/350/410/540/659/759, 117/-; **Bush** TV80 117/-. TV22 & 24, 78/6; **Cossor** 950 77/6; **Ferguson** 306/308 79/6; **Philips** 1768U L.O.P.T. assembly 122/6; **Ultra** 1984-200c 101/3.

Rewind most L.O.P.T. 90/-.

SPECIAL OFFER

Ekco improved type for Models T221, 231, 310 all at 45/-; **Ferranti** 14T4 series inserts 25/-; **Philco** 1019/1021 52/6. Terms: C.W.O. or C.O.D. (3/6) post/packing 6/-; 2 or more L.O.P.T.s post/packing free.

All enquiries answered but regret no lists available. Same day delivery on most types.

TOWERBY LTD

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

70 STREATHAM HILL, LONDON, SW2.

Tel: 01-674 2185.

BY 100 TYPE 6 for 10/-

RECTIFIERS

SUPER SILICON

TV etc., 1200 PIV, 800 MA 5/- or complete with instructions, resistor, condenser 6/6, 400 PIV. HW 6 amp 6/-, 200 PIV.HW 6 amp 6/-. **CONTACT COOLED,** 14RA1282/FC101 7/6, EC1 12/6, EC2 12/6, 30v. 250mA FW 7/6, 250v. 100mA FW Grundig 12/6, FC116 7/6 **FIN TYPES.**

Equivs. for RM4 7/6, 14A97 13/6, 14A86 7/6, 14A100 10/6, RM3 3/-. **CHARGER RECT.** FW 12 volt 1A 5/-, 2A 7/-, 4 amp 10/6. **CHARGER TRANSFORMER** 4 amp 12/6/2 volt 21/6. Plus 3/- P. & P.

LINE O.P. TRANS: All 30/- each. Cossor 948, KB Queen, Peto Scott 1920, 1726, 1729, 1730, Murphy V350 and V230, Philips 1446U/45 and 1746U/45 with EY51. **MULTIMETERS** from 32/-.

Stamped envelope for full latest selection and bargain offers in **CHEAP METERS, RADIOS, BABY ALARMS, INTERCOMS, WALKIE-TALKIES, SINCLAIR & EAGLE.** Under £1 P. & P. 6d., £1 to £3 1/6d. C.O.D. 3/6d. extra.

MAIL ORDER ONLY

DURHAM SUPPLIES

367 KENSINGTON ST., BRADFORD 8, YORKS.

LOOK! Nearly every type in stock now!!

NEW TELEVISION TUBES!

TWO YEAR FULL REPLACEMENT GUARANTEE

SEE THE DIFFERENCE A NEW TUBE CAN MAKE TO YOUR VIEWING—LATEST SCREENING TECHNIQUES INCLUDING TINTED SCREENS ON 19″ & 23″ TYPES

Large stocks by Cathodeon & other leading manufacturers so why buy ordinary rebuilds? Some Colour tubes available!

12″ £2 10 0 (not 110°) 14″ to 16″ (not 110°) £4 15 0

17″ £5 15 6 19″ 1901 & 19AH £7 10 0

Other 19″ mono tubes—all £6 17 6. Carriage all 12/-. All 21″ mono tubes—£7 15 0, 23″ mono tubes £9 10 0. Carriage 15/-.

RIMBALDS, 19″ £8 10 0; 23″ £11 10 0

TWIN PANELS, 19″ £9 17 6; 23″ £12 10 0

Carriage 20/-

Bulk enquiries welcomed, special terms.

PHILIP H. BEARMAN

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

6 POTTERS ROAD, NEW BARNET, HERTS.

Closed Thurs & Sat afternoons TEL. 449/1934 & 7873 (Robophone)

EXPORT T.V. BARGAIN

T.Vs. unused and boxed 625 line V.H.F. 110 Volts or 240 Volts A.C. 50 C.S. Made in U.K. by famous maker complete in working order. Ideal for D X work.

19″ Models only **£39** each

23″ Models only **£45** each

K. W. LOGAN,

26, Bucklersbury, Hitchin, Herts.

Phone: 4744

BOB'S BARGAINS. 10 assorted your choice 14/6. 100 assorted £5-10-0. PC F80 PCC84 PL81 PL36 PY81 PCL82 PCL83 EF85 U191 U301 30F5 30P12 PY33 PY32 PY82 EB91 ECL80 ECC82 EBF80 EBF89 6BW7. The following valves only at 12/6 per doz. EF80 EY86. All valves tested. 3 BY100 type rec. with surge res. 9/- p. & p. 6d. New 25k ohm w.w. controls 2/- p. & p. 6d. EKCO U25 type plastic l.o.p.t. housings 12/6 p. & p. 2/-. Mail Order Only. 2 St. James St., Rawtenstall, Rossendale, Lancs.

BAKER & BAINES

for Television and F.M. Aerials

Examples of prices: F.M. dipole 21/-, H 38/-, BBC dipole 30/-, X 38/-, H 42/-, 3 ele 89/-, ITA 3 ele 26/-, 5 ele 34/-, 8 ele 47/6, 11 ele 57/6, combined BBC/ITA 1 + 5 45/-, H + 5 69/-, X + 5 75/-, BBC2 8 ele 29/-, 14 ele 37/-, 18 ele 54/-, 22 ele 63/-. All types generally available including accessories—prices include mounting clamps and postage.

11 DALE CRESCENT, NEW TUPTON, CHESTERFIELD.

WITWORTH TRANSFORMERS LTD.

Dept. P.T., 26 All Saints Road, North Kensington, W.11

Telephone: 01-229 9071. 9 a.m. till 5 p. m

TELEVISION LINE OUTPUT TRANSFORMERS

PRACTICALLY ANY MAKE OR MODEL SUPPLIED OR REWOUND

EKCO, FERRANTI, DYNATRON Replacement cases **16/-** each, please state model.

S.A.E. for return of post quotation.
TERMS: Cash with order or C.O.D., please add **4s.** for postage.

C.O.D. orders will be charged **6s.**
Transformers fully guaranteed. (98