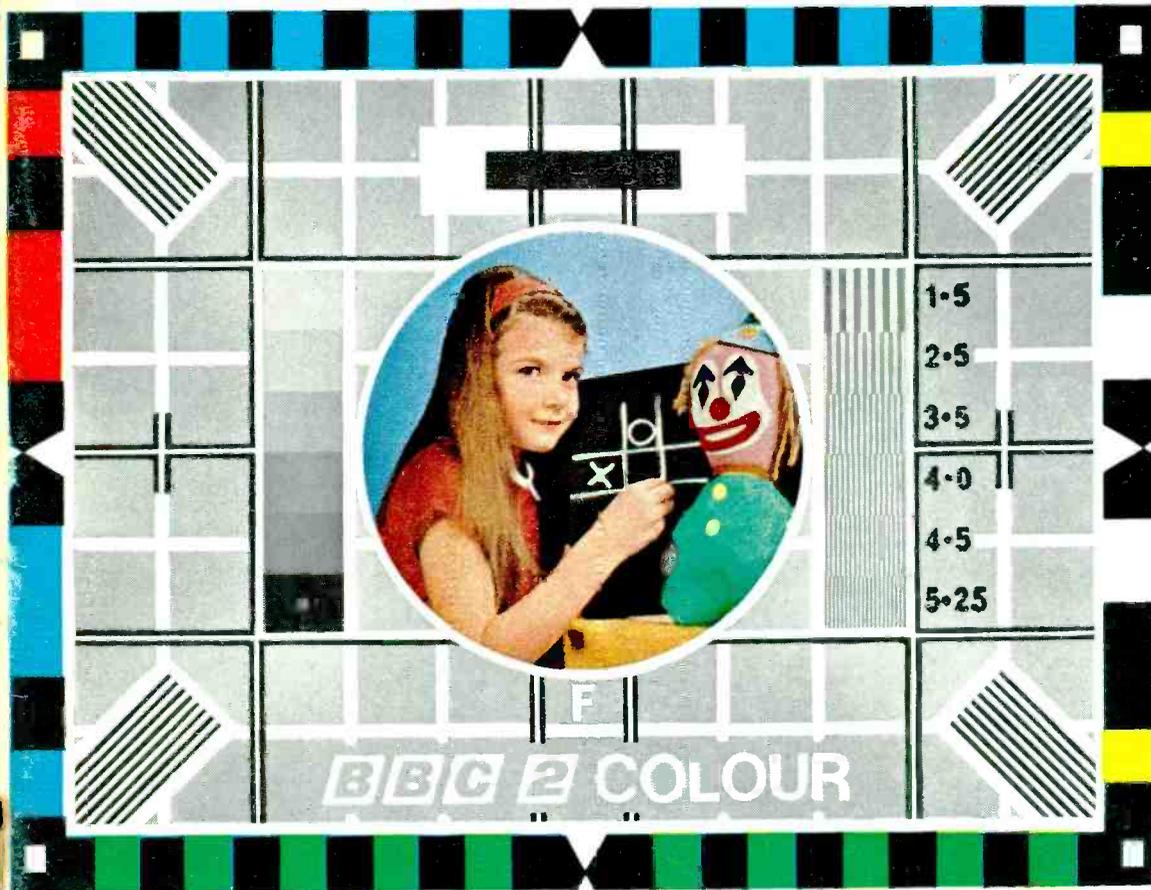


COLOUR COLOUR COLOUR

Practical TELEVISION

DECEMBER 1967

2/-



COLOUR IS HERE!
STARTS ON DEC. 2

This is the latest list of Line Output Transformers and inserts from D & B Television

NOW UNDER NEW MANAGEMENT

ALBA Prices on request.
BUSH TV53, TV56, TV57, TUG58, TUG59, M59, TV63, TV66, TV67, Inserts **27/6**.
EKCO TC208, TC209, TC209/1, T221 to 331, Complete L.O.P.T. **40/-**, TMB272 **48/6**, T344, T344F, T348, T348F, T356, TC312, T313, T313F, T335 **58/6**, TP347, TP373 new **70/-**.
EMERSON E700, E701, E704, E707, E708, E709, E710, E711, Portarama, Inserts **35/-**, 306, 308 **40/-**, 204 to 246, Inserts **30/-**, 1472 to 1475, 17K3 to 17SK4, Inserts **35/-**, T1001, T1002, T1002/1, T1004, T1005, T1021, T1011 **40/-**, T1012, T1023, T1034, T1022 **58/6**.
K.B. PV40, MV100/1, OF100, PV100, NV40, NF70, OV30, QV10, QV30, Inserts only **45/-** pair.
PETO SCOTT TV1416, TV1419, TV1716, TV1719, TV1720, TV1722, TV1725, TV1418, TV1726 Inserts only **32/6**.
PHILCO 1029-1030, 1035-1036 new at **82/6**
PYE V4, V7, VT4, VT7, CTM4, CTM7, Insert only **40/-**, V200, V400, V210 **55/-**. Other types prices on request.
REGENTONE T14, 10-6, 10-4, 10-17, 10-21, Inserts only **30/-**, T176, 191, 192, T21FM, Inscr's only **45/-**, Deep 17, THE17, T21, 600, 590, Inserts only **35/-**.
SOBELL T25, T280, 193, SC24, SC34, SC370, T279, TPS186, Rewinds only **70/-**.
 All the above L.O.P.T. can be rewound at **70/-**.

ULTRA 1984, 1984C, 200C, new **82/6**, 1980C, 1984C **82/6**, 2380-2384 **82/6**.

1967 REVISED VALVE LIST

DAF91	4/3	EL84	4/2	PL84	6/6
DAF96	6/3	EM81	6/9	PL500	13/6
DF91	3/-	EY51	6/10	PY33	8/6
DF92	3/-	EY86	6/3	PY81	6/-
DF96	6/11	EZ81	4/11	PY82	5/6
DK92	7/9	PC86	10/9	PY800	6/-
DK96	6/9	PC88	10/9	PY801	6/-
DL94	5/9	PC97	7/3	UABC80	5/3
DY87	6/3	PCC84	6/2	UCH81	6/3
EABC80	6/3	PCC89	10/-	UCL82	7/-
EB91	3/-	PC189	10/10	U25	12/3
EBC90	4/3	PCF80	6/2	U26	12/3
EBF89	6/6	PCF82	7/7		
ECC82	4/9	PCF86	7/9	30C15	11/3
ECH42	9/3	PCL82	7/-	30F5	9/9
ECH81	5/-	PCL83	8/6	30FL1	13/9
ECL80	6/9	PCL84	7/6	30L15	14/9
ECL82	6/3	PCL85	8/11	30P12	8/11
EF80	4/9	PFL200	13/6	30P19	12/9
EF85	6/3	PL36	10/6	30PL1	14/9
EF183	6/-	PL81	7/6	30PL13	14/9
EF184	6/3	PL83	6/6	30C18	10/-

Large selection of Slimline T.V. Sets for Sale at Bargain Prices. Fully Guaranteed. For Callers Only.

All Line Output Transformers, Inserts and Valves are new and are fully guaranteed for 3 months. C.O.D. 5/- extra. Return of Post service. S.A.E. all enquiries. Post and packing 4/6.

D. & B. TELEVISION (Wimbledon) LTD
 131 KINGSTON ROAD, WIMBLEDON,
 01 540 3513 S.W.19 01 540 3955

TRADER SERVICE SHEETS

4/- each plus postage

We can supply Trader Service Sheets and Manufacturer's Manuals for most makes and types of Radios and Televisions.

Please complete order form below for your Service Sheet to be sent by return. To:

OAKFIELD ENTERPRISES

LIMITED

30 CRAVEN STREET, STRAND, LONDON WC2

Make	Model	Radio/TV

1967 List available at 2/- plus postage

If list is required indicate with X

From
 Address

I enclose remittance of
 (and a stamped addressed envelope)
 s.a.c. with enquiries please.

MAIL ORDER ONLY (Dec P.T.)



"SABRINA"
 STILL WELL IN FRONT

COMPLETELY REBUILT C.R. TUBES ALL TYPES

12" now	£5. 0.0	} For Single Tubes
14" to 17" now	.. ..	£5.10.0
19" now	.. ..	£6.15.0
21" now	.. ..	£8. 0.0

ALL C.W.O.—TRADE SUPPLIED

Special Bonus Scheme for Service Engineers—Reducing to:

12"—**87/6**; 14"/17"—**97/6**; 21"—**147/6**

FREE Pass. transit & Ins. anywhere in British Isles or N. Ireland (12 months' guarantee).

ALSO FULL RANGE OF VALVES
 (Guaranteed 12 months)

SABRINA C.R. TUBE CO.
 Electron Works, 50 North Bar
 BANBURY, OXON
 Telephone 2390

turn on, tune in, & hold it !

...at least until you've read
this book from Pitman

Principles of Television Reception

W. Wharton & D. Howorth 40s net

The introduction of 625-line ultra-high-frequency transmissions, the advent of colour television, and the impact of transistors are all fully incorporated in this timely book which offers an explanation of the fundamental physical principles of high-definition television together with a clear account of the circuits, and techniques and systems involved.

The value of this book lies in its suitability for electrical technicians of all grades and indeed any student (at degree, national certificate or diploma level) whose basic knowledge of electrical and electronics is sound and who wishes to understand his subject in depth.

Contents: High-Definition Television; Circuit and Modulation Theory; Principles of Monochrome Television; Introduction to Monochrome Receivers; R.F. and I.F. Amplifiers, Detectors and Audio Stages for Monochrome Receivers; Video Amplifiers, Synchronizing-pulse and A.G.C. Systems; Picture-tube Scanning Circuits; Principles of Colour Television; Colour Display Tubes; Practical Performance of Colour Television Systems; Introduction to Colour Television Receivers; Video Circuits for Colour Receivers; Propagation and Reception of Television Receivers; Colorimetry; Receiving Aerials and Feeders.

Sir Isaac Pitman & Sons Ltd. 39 Parker Street London WC2

REBUILT TUBES!

*You're safe when you buy from
RE-VIEW!*

- ★ Each tube is rebuilt with a completely new gun assembly and the correct voltage heater.
- ★ Each tube comes to you with a guarantee card covering it for two years against all but breakage.
- ★ Each tube is delivered free anywhere in the U.K. and insured on the journey.
- ★ Each tube is rebuilt with experience and know-how. We were amongst the very first to pioneer the technique of rebuilding television tubes.



**HERE IS WHAT YOU
PAY:**

12in. . .	.. £4.15.0
14in. . .	.. £5. 0.0
15in. . .	.. £5. 5.0
17in. . .	.. £5. 5.0
19in. . .	.. £5.15.0
21in. . .	.. £7. 5.0

*Cash or cheque with
order, or cash on delivery*

Discount for Trade

Old Tubes Purchased

RE-VIEW ELECTRONIC TUBES

237 LONDON ROAD, WEST CROYDON,
SURREY. Tel. THOrnton Heath 7735

VALVES SAME DAY SERVICE NEW! TESTED! GUARANTEED!

SETS 1R5, 1R5, 1T4, 3V4, DAF91, DF91, DK91, DL92, DL94.
Set of 4 for 16/9. DAF90, DF90, DK90, DL90, 4 for 24/8

1 70F	7/8787	7/-B36	4/9 ECH42	9/-PC86	8/-PY801	6/-
1030F	7/3705	12/-B729	12/6 ECH81	5/8 PC88	8/-R19	7/-
1N30F	7/9706	6/9 CCH35	9/-ECH84	6/6 PC97	5/8 R20	12/9
1R7	5/87H7	5/8 DAC32	7/3 PCL80	6/-PC900	7/8 U25	11/6
1R4	4/97Y4	6/6 DAF91	3/9 PCL82	6/9 PC934	5/8 U26	11/6
1R7	4/9 10F1	9/9 DAF90	6/-ECL86	7/9 PC939	6/9 U47	13/6
1T4	2/9 10P13	10/6 DF90	7/-EF89	3/9 PCC189	8/6 U49	13/6
1A7	7/-12AT7	3/9 DF93	7/9 EF41	9/6 PCF80	6/6 U52	4/6
1A7	5/8 12AU6	4/9 DF91	8/9 EF80	4/9 PCF82	6/-U78	3/6
1A7	4/9 12AU7	4/9 DF90	9/-EF85	5/-PCF88	9/-U181	11/-
8V1	5/6 12AX7	4/9 DH77	4/-EF86	6/9 PCF800	11/8 U301	13/-
5V10	4/6 12KSGT	7/6 DH81	12/6 EF89	5/-PCF801	7/9 U801	18/-
5V10	7/9 20P2	10/6 DK32	7/9 EF91	3/6 PCF802	9/6 UABC80	5/9
6V10T	5/-30L1	14/0 DK91	5/6 EF92	8/8 PCF805	11/9 UAF42	7/9
5V10	7/6 30P1	9/-DK92	3/-EF97	7/8 PCF806	11/8 UB41	6/6
6V12	11/9 30P3	14/9 ECK95	6/6 EF183	6/6 PCF808	12/6 UB41	6/9
CA45	2/3 20P4	17/-D133	6/9 EF184	5/9 PCL82	6/9 UBF80	6/-
CA45	3/6 2514GT	11/6 DL35	5/-EH90	6/9 PCL83	8/6 UBF89	5/9
6V10	4/9 30C1	6/8 DL92	4/9 EL33	6/8 PCL84	7/-UBL21	9/-
6V10	4/-40C15	11/8 DL94	9/6 EL41	8/8 PCL85	8/8 UC92	5/-
6V10	4/6 30C17	6/8 EH91	2/8 EL84	4/9 PCL86	8/8 UCC84	7/9
6V10	4/3 30C18	11/9 DY86	5/8 EL90	5/-PEN84	6/9 UCC85	8/8
6V10	15/-30C15	12/-DY87	5/8 EL95	5/-PEN86C16	6/8 UCF80	8/8
6V10	6/9 30P11	13/9 EABC80	6/-EM80	5/9 PFL200	18/-UCH42	8/9
6V10	7/9 30P14	12/6 EAF42	3/8 EM31	6/9 PL36	9/-UCH81	8/-
6V10	6/8 30L1	5/8 EB91	2/8 EM84	6/8 PL81	6/9 UCL82	7/-
6V11	7/9 30L15	12/-ERC33	7/-EM87	6/8 PL82	6/9 UCL85	8/9
6V12	3/6 30L17	13/-EB41	8/-EY61	6/8 PL88	8/8 UP41	8/9
6V14	9/-30P4	12/-EBF80	6/-EY80	6/-PL84	6/8 UP80	7/-
6V14	12/6 30P12	11/-EBF89	5/8 EZ40	6/9 PL000	18/-UP89	5/9
6V14	1/6 30P19	12/-ECV81	3/8 EZ41	6/9 PX35	7/8 UL41	8/9
6V10	4/8 30P11	14/6 ECK82	4/8 EZ40	4/6 PY32	8/6 UL44	20/-
6V10T	7/6 30P13	14/6 ECK83	7/-EZ31	4/6 PY33	8/6 UL84	6/-
6V10	4/7 30P14	14/6 ECC84	6/8 EZ82	9/-PY80	6/8 UY41	6/6
6V10	3/6 3510GT	7/8 ECC85	5/8 KT61	6/8 PY81	5/3 UY85	4/9
6V10T	6/8 35M4	4/8 ECF80	7/-KT81	12/-PY82	5/-VP4B	10/6
6V10	3/6 35Z4T	4/8 ECF82	6/8 N18	3/8 PY83	5/9 VP1321	21/-
6V10T	5/9 60C3	12/6 ECF86	9/-N78	14/9 PY88	7/8 W77	8/6
7B6	10/9 AZ31	9/-ECH35	6/-N108	14/6 PY800	6/-Z77	8/6

READERS RADIO

85 TORQUAY GARDENS, REDBRIDGE
ILFORD, ESSEX. Tel. 01-550 7441

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.

COLOUR TELEVISION SCHOOL

**DAYLIN ELECTRONICS ANNOUNCE A
CORRESPONDENCE COURSE IN THE THEORY
AND PRACTICE OF COLOUR TELEVISION**

A series of 10 lessons dealing in detail with:—

Colour mixing, the PAL colour system, colour receivers, decoders IF circuits, time-bases, convergence waveforms, set-up procedures, test equipment, fault finding, typical circuits. This course is designed for engineers who will be called upon to service colour television receivers within the next four months. Expert guidance throughout the course. Test questions with each lesson. Model answers supplied. Terms available. Certificates awarded.

Fee for the complete course 10 guineas.

To: DAYLIN ELECTRONICS LIMITED
32 PARKSTONE DRIVE
SOUTHEND-ON-SEA, ESSEX

Please send, without obligation, details of your colour television course.

NAME

ADDRESS

Practical Television

DECEMBER 1967
VOL. 18 No. 3
issue 207

INDUSTRY IN DANGER

AFTER so many years of false starts, disappointments, conferences and controversy, it is hard to believe that the seemingly unattainable colour TV service is at last a fact of life. The wonder of it all is that we have a TV industry left at all!

For a decade or more, it has taken quite a hammering from Governments of the day, no matter what their political hues. As one example, in the last ten years there have been no less than 23 changes in the field of purchase tax and HP requirements with the result that makers, retailers and the public have all been confused or frustrated.

Last month we spoke of the dwindling number of manufacturers; during the same period a very large number of independent retailers have had to draw the shutters or sell out to one or other of the big chains. The industry has contracted in the interests of self-preservation.

It has come to the point where it is valid to question whether or not the Government wants the industry to survive at all. Already importations of foreign merchandise have cost us a large proportion of the transistor radio market, and tape recorders are following the trend. How long before *all* such products are imported?

Unless action is taken, the situation will deteriorate still further. Within two years we should see the phasing out of 405 v.h.f. television outlets, with duplication of programmes on 625 u.h.f. This will enable manufacturers to produce a simpler single standard receiver but will provide further hazards.

Until now, it has not been worthwhile for foreign makers to consider the U.K. TV market, but when we share a common technical standard the flood gates could open.

Unless something is done not only to ensure that our home-based industry is spared the frustrations of the past but is positively encouraged to become stronger, we could well end up importing not only transistor radios and tape recorders but our TV sets as well.

W. N. STEVENS—*Editor*.

THIS MONTH

Teletopics	100
Colour is Coming!—Part VII <i>by A. G. Priestley</i>	102
Colour is Here!	108
Video Circuit Experiments <i>by G. R. Wilding</i>	110
Letters to the Editor	114
Iconos Reports on the International Broadcasting Convention 1967	115
Video Tape Recording—Part III <i>by H. W. Hellyer</i>	117
Photomultipliers <i>by K. T. Wilson</i>	120
Servicing Television Receivers —Thorn 980 Chassis <i>by L. Lawry-Johns</i>	123
Stockholm's Telecommunica- tion Tower <i>by E. P. Young</i>	126
DX-TV <i>by Charles Rafarel</i>	128
Servicing with a Neon Tester <i>by V. D. Capel</i>	129
A Look at Transistor TV Circuits —Part IV <i>by S. George</i>	131
Underneath the Dipole <i>by Iconos</i>	135
Your Problems Solved	138
Test Case—61	140

THE NEXT ISSUE DATED JANUARY WILL
BE PUBLISHED ON DECEMBER 22

TELETOPICS

PTV at the exhibition



AT THE International Radio Engineering and Communications Exhibition at the Royal Horticultural New Hall, Westminster, London, S.W.1, on September 27-30, 1967, the central feature was the Radio and Space Research display by the Science Research Council. This exhibit demonstrated studies of the atmosphere in relation to radio communications; the effect of the lower atmosphere was illustrated by a working model of a microwave refractometer. There was also a model of the new 25-metre diameter steerable aerial recently commissioned at Chilbolton in Hampshire which is being used to study radio propagation of radio waves through space and the earth's atmosphere.

Dr. J. A. Saxton, Director of the Radio and Space Research Station, opened the Exhibition at 12 noon on Wednesday, September 27th, together with other Government and Armed Services officers who also supported the exhibition.

The General Post Office, Royal Signals, Royal Navy and Royal Air Force displayed their latest equipment and working test equipment for today's services.

Colour television was displayed by Bush Radio.

Manufacturers of communication short-wave receivers and transmitters from several countries showed the latest models with s.s.b. and v.h.f. and a wide range of aeriels, components and test gear.

Demonstrations of transmitting and receiving television and experimental equipment, a Radio Teletypewriter station, and mobile equipment were working daily.

Picture shows a view of the Practical Wireless and PRACTICAL TELEVISION stand.

COLOUR TV GROUP AT MILAN FAIR

TWO senior engineers of the Plessey Components Group's Wound Components Division at Titchfield, Hampshire, have been in Milan attending the Fifth Technical Convention on Electronic Components recently (September 12 to 14, 1967)—the most important gathering of colour TV experts yet arranged.

Mr. Arthur W. Lee, presented a paper on "Advances in line output stage techniques", and Mr. Peter H. Phillips, gave a paper on "Considerations in the development of a deflection coil for 90° shadow mask colour cathode ray tubes". The convention was attended by leading figures in colour television from all the major industrial countries of the world.

Look your best on colour TV

THE first colour television in Europe was launched on BBC-2 on July 1. Kenneth Adam, Director of BBC Television, outlining some of the BBC's plans, in the course of an address to Britain's Radio Industries Club, quoted from the notes given to guests on "How to look your best on Colour Television". "For men, tweed suits are excellent. Avoid pronounced striped or checks, or bright shirts, or ties of rainbow hue. Shave shortly before coming to the studio, colour picks up 'five-o'clock shadow'. You will probably have to have lipstick in order that you shan't appear to have made-up lips. And lastly — avoid that booster drink immediately before transmission. You will be noticeably flushed." "Advice for women", Mr. Adam added, "is rather more complicated, but includes no guidance on the length of skirts. Colour television will undoubtedly have its effect on clothes, but the BBC has no intention of setting up as a fashion house."

EEV Tubes to see in the dark

ENGLISH Electric Valve Company is developing two Isocon television camera tubes and samples are available for experimental evaluation.

The P850 is a 4½in. Image Isocon designed for viewing low intensity X-ray fluoroscopic screens. It has a curved faceplate for use with standard mirror optical systems; if a corrector plate is interposed, a refractive optical system may be used. This tube is used extensively in the Image Intensifier equipment manufactured by Marconi Instruments of St. Albans.

The P880 is a 3in. Image Isocon designed for special television purposes at very low scene illuminations. It can produce good pictures when the photocathode illumination is only 10⁻⁴ foot-candles: even if the photocathode illumination falls as low as 10⁻⁶ foot-candles, acceptable pictures can still be produced.

Weather recording instruments on Belmont TV mast



BRITISH Insulated Callender's Construction Company Limited is completing an order from **EMI Electronics Ltd.** for the supply and installation of **BICC** cables, glands, junction boxes and the erection of weather recording instruments for use by the **Central Electricity Research Laboratories** on the **ITA's** 1,265ft. cylindrical television mast at Belmont, Lincs., which came into service in May 1966.

"Munro" wind speed and direction indicators are supported on external maintenance platforms at 1,252ft. and 680ft. The topmost indicator is mounted on two 10ft. **BICC** light unit radio mast sections bolted to the floor of the external platform enabling the instrument to be mounted at a height of 1,227ft.—the highest recording instrument supported by a permanent structure in Europe.

COLOUR TV TRANSMISSIONS FROM DOVER

THE Dover BBC-2 transmitter now radiates the colour programmes, which now amount to some 10 hours per week.

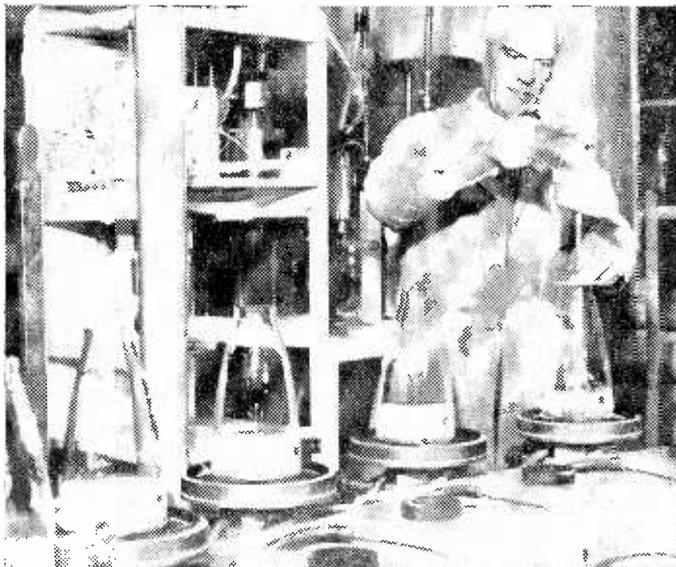
The BBC-2 trade test transmissions, on Mondays to Saturdays inclusive, are now mostly in colour and Dover will radiate these also. These trade transmissions are, however, subject to interruptions during the next week or so because of essential engineering work at Crystal Palace, the signal from which is used for the BBC-2 programme feed to Dover.

TV STANDARDS CONVERSION —A LECTURE

ON Thursday 7th December 1967 at the Royal Television Society, 70 Brompton Rd., S.W.3 at 7 p.m. there will be a lecture entitled "Electronic Conversion between European and North American TV Standards" by E. R. Rout, C. Eng., M.I.E.E.

Synopsis: Image transfer standards conversion between 525/60 and 625/50 television signals degrades picture quality, demands skilled operation and offers little hope of satisfactory performance with colour signals. Electronic conversion using assemblies of fused quartz delays for storage can overcome these problems and this lecture describes the principles employed in the current BBC developments in this field. The first stage of development has produced a relatively simple converter that offers an early but fundamentally limited solution to the problem. A second stage of development, already well advanced, will result in a more complex converter free of such limitations.

M-O V win c.r.t. order for French Oscilloscopes



CONSTRUCTIONS Radioelectriques et Electroniques du Centre of St. Etienne is the latest French oscilloscope manufacturer to place a production order for **M-O Valve Co. Ltd.** cathode ray tubes.

The order is for **M-O V's** 1800H Series, 18cm double-gun helical p.d.a. c.r.t.'s—pictured in production at the Company's **Hammer-smith** factory. The 1800H gives **CRC's** OCT749 oscilloscope a maximum sensitivity of 100 μ V/division over the band 0-700kc/s. **CRC's** OCT749 is a sophisticated oscilloscope which displays two independent signals on a common timebase.

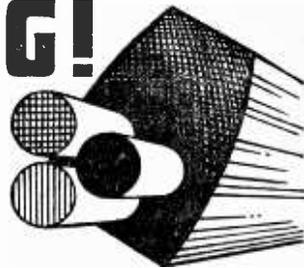
M-O V's display of industrial c.r.t.'s at the **Paris Component Show** aroused keen interest amongst French oscilloscope manufacturers.

We regret it has become necessary to increase the cover price of **PRACTICAL TELEVISION** from 2s. to 2s. 6d. if the standard of the magazine is to be maintained. We feel sure that our readers will prefer to pay this small increase rather than that the authority and quality of the magazine should be impaired in any way. This will take effect with the January issue. The new annual subscription rate will be 35s., but existing subscriptions will run on at the existing rate until expiry.

COLOUR IS COMING!

A SHORT BASIC COURSE ON COLOUR TV FOR
THE TECHNICIAN AND AMATEUR ENTHUSIAST

by A. G. PRIESTLEY



PART 7 — PURITY, CONVERGENCE AND GREY-SCALE TRACKING

THE title of this article does not imply a group of miscellaneous features being used as a convenient way of rounding off this series about colour television. They are vital features of a receiver if good pictures are to be obtained—whether in black-and-white or colour. However carefully the receiver has been designed, manufactured, aligned and tested by the factory the picture can be marred or even completely spoilt by bad adjustment of purity, convergence or grey-scale tracking during subsequent servicing operations. It is, therefore, no exaggeration to say that it is the duty of every colour service engineer to understand the need for these adjustments and to learn how to carry them out so that every receiver he handles produces a picture that does justice to the quality designed into it by the setmaker.

There is no mystic art involved, and the key to success lies in a little knowledge, a certain amount of practice, and conscientious care. Every service engineer is capable of mastering these routine adjustments, and it will be a pretty hard-boiled character who fails to experience a small glow of satisfaction every time he produces a good colour picture. It becomes a matter of personal pride always to leave a receiver in a good state of adjustment.

PURITY

In our description of the shadow mask tube we saw that the beam of electrons from each of the three guns has to pass through the holes in the shadow mask and land on the appropriate colour phosphor dots. In other words, electrons from the red gun have to come from such an angle that they can only land on dots of red phosphor and do not spill over on to the neighbouring green and blue dots of each triad of phosphor dots. Electrons from the other guns have to come from different directions so that they, too, land only on the correct dots (see Figs. 14—16, part 4, PRACTICAL TV, September 1967). Obviously the whole art of achieving correct purity is to ensure that all three beams come from the right directions. This enables a completely even colour to be obtained over the entire surface of a blank raster, with no localised areas tinged with a spurious hue.

This is a very simple and basic requirement, but there are a number of factors which complicate the

situation. In the first place the three electron guns have to be very accurately located in the neck of the tube relative to each other, and also in relation to the tube axis. If the shadow mask has been properly positioned in front of the phosphor dot triads it is possible to achieve perfect purity provided that means are available for compensating for the small tolerances inevitable in any mechanical assembly. To this end a pair of purity rings, radially magnetised, are fitted round the tube neck behind the deflection coil and convergence yoke assembly. If one ring is rotated relative to the other the magnetic fields can be arranged either to add or cancel. The resultant field inside the tube neck can, therefore, be varied in intensity. If both rings are rotated together the direction of the field can be altered as well. We thus have a means of moving all three electron beams bodily in any desired direction by a controllable amount in order to achieve the appropriate angle of approach to the shadow mask.

Another controlling influence is provided by the deflection coils. These generate the magnetic fields that deflect the electron beams so that they scan the screen of the c.r.t. In doing so the deflection coils make each beam appear to originate from a single point in space inside the deflection field. The coils must therefore be positioned on the tube neck so that the apparent point of origin of each beam coincides with the location which was assumed during the manufacture of the tube when positioning the shadow mask and laying down the pattern of phosphor dot triads. Deflection coil assemblies normally incorporate a simple means of obtaining axial movement (fore and aft) before being clamped securely to the tube neck. This constitutes the primary adjustment for obtaining good purity. It is used in conjunction with the purity rings.

Obviously any spurious or extra magnetic fields which can affect the electron beams will also affect purity. If the shadow mask itself becomes slightly magnetised the beam landings will be upset, so that it is necessary to degauss (demagnetise) the mask when the receiver is installed. This is done either by degaussing coils built-in to the receiver which operate for a short time on every occasion the receiver is switched on, or else by an external coil wielded by the service engineer. Note that if the c.r.t. is fitted with an implosion-safe band round the periphery of the screen this will need degaussing as well. Static convergence magnets can also affect purity, but of this more later.

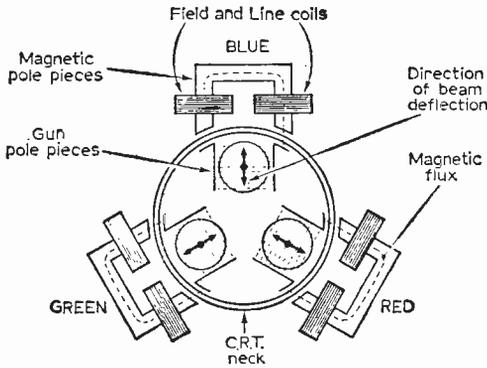


Fig. 31: The convergence yoke assembly on the c.r.t. neck, shown diagrammatically. The three pole piece assemblies are mounted in a single rigid structure and incorporate the static convergence magnets, which are not shown here.

CONVERGENCE

When near-purity has been obtained the next job is to achieve good convergence. Good, because perfect convergence is an ideal that can seldom be realised in practice although in a well-designed and adjusted receiver the errors are small enough not to be significant.

The three guns in the c.r.t. produce three separate coloured images, and the function of convergence is to make sure that they are correctly superimposed over the whole area of the screen. The colour at any given point on the picture is then the sum of the light output from the three phosphors at that particular point, and the detail in all areas of the picture is clear. If the convergence is poor so that the three images are not in correct registration, the result is colour fringing on outlines and loss of fine detail. This is particularly noticeable on monochrome reception, but is also detrimental to colour displays.

STATIC CONVERGENCE

The process of obtaining good convergence can be divided into two separate functions, static and dynamic. Static convergence refers to the correct registration of the three beams at the centre of the screen where they are not deflected by the scanning fields, i.e. the position they would occupy if the scanning currents were zero.

Although the electron guns are very carefully aligned during manufacture, external adjustments

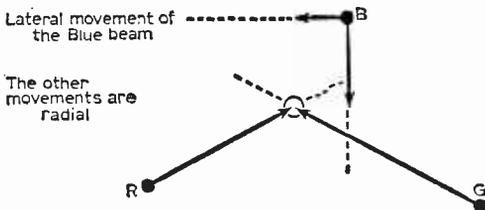


Fig. 32: Showing how static convergence is obtained at the centre of the c.r.t. screen, viewed from the front.

have to be provided to cater for the inevitable small tolerances, and these take the form of adjustable permanent magnets built-in to a convergence yoke assembly, which is illustrated diagrammatically in Fig. 31. Coils are mounted on the pole pieces to provide the dynamic correction that we shall be discussing in the next section. Pole pieces are also built-in to each gun structure to direct the magnetic field so that it flows perpendicularly to a line drawn from the centre of the tube neck to each gun. This causes the electron beam to be deflected radially, as shown. So, since the guns are arranged at angles of 120° to each other, with the blue gun at the top, the R and G beams can be made to move diagonally on the picture, and the B beam vertically up and down. However, these three controls are not enough on their own to ensure correct convergence, and so an extra magnet and coil assembly is added behind the convergence yoke to provide lateral movement of the B beam as well. These processes are shown in Fig. 32.

Our first operation, therefore, when setting up convergence is to obtain perfect registration of the three images at the centre of the screen by adjusting the four static convergence magnets. Since any magnetic field in the tube neck is liable to affect the purity, it is then a wise precaution to check this before proceeding further. Similarly any subsequent adjustment of purity will have an effect on the static convergence. However, this is a simple adjustment to carry out.

DYNAMIC CONVERGENCE

Dynamic convergence is the process of centralising the relative positions of the R, G and B beams in varying degrees over the whole area of the picture having first obtained correct registration at the centre, as we have just discussed. This variable, or "dynamic", control is achieved by passing currents at line and field frequency with the appropriate waveforms through the coils on the pole pieces of the convergence yoke.

The need for this dynamic control arises primarily from matters of pure three-dimensional geometry, but also to counteract the effect of any asymmetrical magnetic fields in the deflection coils. Taking first the geometry, if you project a beam of electrons from a single gun at the axis of the c.r.t. so that it scans the whole of a more or less flat screen you will get a pincushion-shaped raster. This is because for a given angle of deflection the beam has to travel further in the corners than it does on the centre lines of the screen. This effect is well known in monochrome television and is corrected by external permanent magnets. In a shadow mask c.r.t. these extra magnetic fields are not permissible.

Matters are further complicated by the fact that the three guns are not in the axis of the c.r.t., but are inclined slightly towards it. You therefore get three separate pincushions of different shape. This leads to the kind of misconvergence shown in Fig. 33. The misconvergence can extend to several millimetres, and so correction is obviously essential.

Now there are many kinds of convergence circuit techniques which can be used, so let us stick to

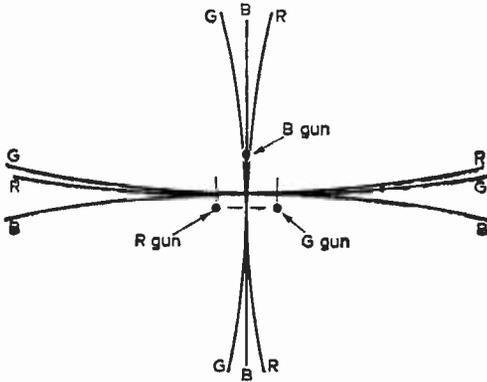


Fig. 33: Illustrating misconvergence due to c.r.t. geometry. Further errors are caused by gun alignment tolerances.

our policy of discussing basic principles. This will avoid confusing the issues with a mass of detail which is hard to digest at this stage.

Before discussing correction methods in general we should perhaps enlarge a little on Fig. 33. This shows the inherent misconvergence which will occur on a shadow mask c.r.t. However, due to tolerances in gun alignment and other factors that we will enlarge on later the horizontal R and G lines at the top and bottom of the picture will seldom coincide. Similarly the vertical blue lines at the beginning and end of the horizontal scan will not often be symmetrically disposed between the R and G lines. The actual misconvergences encountered in practice are, therefore, not so tidily arranged as the errors shown in Fig. 33, which are based solely on considerations of tube geometry.

CORRECTION CURRENTS

The curved scanning lines in Fig. 33 are all basically parabolic in shape, and so we need to pass currents with parabolic waveforms of the opposite sense through the coils on the convergence yoke in order to converge the three separate lines into a single one. You will notice that the zero points of the R and G lines in the horizontal direction are spaced apart, and so clearly the R and G parabolas will also have to be tilted a little in order to obtain the appropriate correction. The term *tilt* is commonly used in convergence circuitry, but



Fig. 34 Tiltting a parabola by adding a sawtooth component.

what it actually refers to is the effect of adding a small sawtooth current. If a small sawtooth component is added to a parabolic waveform, the latter is tilted in a direction governed by the polarity of the sawtooth. This is illustrated in Fig. 34.

APPLYING CORRECTION

To illustrate the process of correcting misconvergence let us consider the problem of the curved green and red vertical lines of Fig. 33. Supposing we feed a parabolic current of the appropriate amplitude at field frequency to the green convergence coil. The green line will be pulled straight by the magnetic field until it is superimposed over the straight blue line, but all points will tend to be displaced downwards and to the right (see Fig. 35) by an amount depending upon the amplitude of the correction needed. Similarly if the green line is tilted this can be corrected by a sawtooth current, but the upper portion of the line will be displaced upwards and to the left, and the lower portion downwards and to the right; or vice versa depending upon the direction of tilt. The upwards and downwards movements are due to the fact that the convergence pole pieces are inclined at an angle to the line we are trying to correct. The process is illustrated in Fig. 35. The same operation can be repeated for the red line by means of the appropriate currents in the red gun convergence yoke.

Figure 35 shows that as we adjust the red and green verticals to lie over the blue, horizontal R and G lines at the top and bottom of the picture will move up or down and this may, or may not, be a good thing. In other words, the controls interact because of the diagonal movement of the

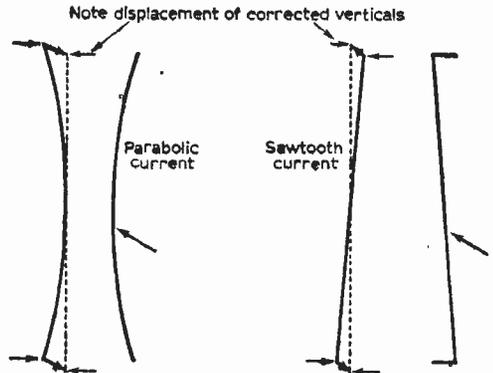


Fig. 35: Undesirable displacement of lines in addition to the required correction.

R and G beams. Blue moves vertically up and down of course, and a parabolic current will cause the horizontal blue lines at the top and bottom of the picture to move upwards or downwards, whilst a sawtooth current will cause them to move in opposite directions: outwards or inwards.

The control of blue vertical convergence, therefore, presents no undue difficulties. The real problem lies in trying to get converged R/G verticals simultaneously with converged R/G horizontals at the top and bottom of the picture since the beams move diagonally, as we have seen. Readers who have tried to converge early designs of colour receivers will have encountered this difficulty, and of course the same problem arises in connection with centre line horizontals, and vertical lines at the ends of scan. These of course are controlled in basically the same way, but with parabolic and sawtooth currents at line frequency.

MATRIXED CONVERGENCE

The practical difficulties mentioned above in connection with R/G convergence have been largely overcome in all modern receivers by the use of matrixed networks. The basic technique is shown in Fig. 36. If you consider a small area of the picture where R and G beams are separated, and apply equal convergence currents the beams will move together, and in addition will move upwards by the same amount. Conversely if *equal but opposite* currents are applied the beams will retain their same relative horizontal position, but will move towards each other in a vertical direction. By reversing the phase of these currents the beams can be made to move in the opposite direction. This is necessary if tube tolerances are such that the position of the R and G beams are interchanged compared with the more normal case illustrated in Fig. 33.

Thus an R/G parabola amplitude control applies equal currents to the R and G yoke coils and converges the mid-line verticals, whilst an R/G parabola balance control applies equal and opposite currents and converges horizontals at the top and bottom of the mid-line. Similarly a tilt amplitude control provides tilt correction to R/G verticals, and a tilt balance control gives differential correction of horizontals between the top and bottom of the picture.

The line convergence controls operate on the same principle with the R/G parabola control providing convergence of verticals at the end of scan and the parabola balance control converging the mid-line horizontals. The R/G horizontal tilt and tilt balance controls act in a similar way.

It should be pointed out that the fundamental interaction of the controls has not been completely avoided, but because the primary movement occurs in either the horizontal or vertical directions the adjustments can be carried out much more quickly, easily and logically.

HORIZONTAL BLUE CONVERGENCE

Voltages applied to the blue convergence yoke cause vertical movement of the horizontal lines and so the provision of line frequency parabolic and

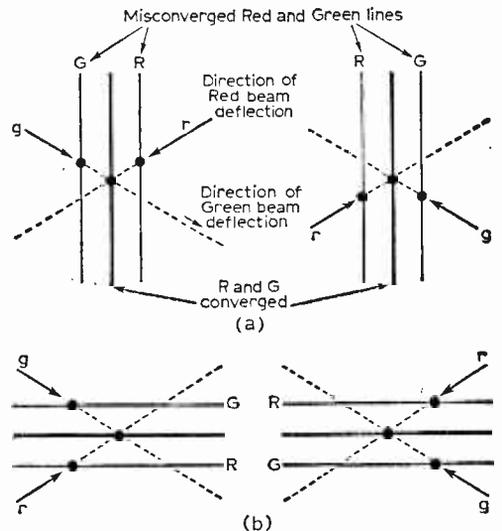


Fig. 36: (a) Converging vertical green and red lines by applying equal currents to both R and G convergence yokes. (b) Converging horizontal R and G lines by applying equal but opposite currents.

sawtooth currents enables horizontal lines to be straightened quite easily except for a tendency to droop at the ends of scan. Special shaping circuits can be added to provide extra correction if needed.

BLUE LATERAL CONVERGENCE

In practice the blue verticals at the end of the scan can be either inside, outside, or in-between the red and green lines if no correction is applied. A coil is, therefore, added to the blue lateral magnet assembly, and parabolic and sawtooth currents at line frequency enable the blue verticals to be converged on the red/green.

DERIVING CORRECTION CURRENTS

The parabolic and sawtooth currents are obtained from the field and line timebases. Field currents are usually obtained by shaping the anode or cathode circuit currents of the output stage. Line frequency correction currents can be produced by using large amplitude voltages obtained from the primary of the line transformer and passing these through shaping circuits. Alternatively the sawtooth scan current itself can be used, with less shaping, applied to convergence yoke coils of lower impedance. Because of the different shaping requirements of the two systems there is likely to be a difference in the number and function of the controls provided. The important points of course are the quality and stability achieved, rather than the details of the controls needed to obtain convergence.

DUAL-STANDARD CONVERGENCE

The field convergence should remain unchanged

on 405 and 625 line operation, but line convergence will have to be switched to some degree. In order to maintain the same static convergence on both systems it is customary to add diode clamps across the red, green and blue convergence coils so that all correction currents are at the same d.c. level in the middle of scan, and hence the static convergence is unchanged whether convergence correction currents are applied or not. This makes convergence much easier to achieve, and avoids extensive switching or the addition of extra circuits.

GREY-SCALE TRACKING

Let us begin by describing what we mean by grey-scale tracking. It is really quite simple. If we feed a monochrome signal to a colour receiver a normal monochrome drive waveform will appear on the three cathodes, but no colour difference drive voltages will appear on the control grids: only the normal d.c. operating voltages. This is because no colour information is being transmitted. Naturally we expect to see a normal black-and-white picture with neutral grey tones, and highlight areas of the correct shade of white. This constitutes perfect grey-scale tracking.

If we had a perfect c.r.t. with three guns of exactly identical characteristics, and three sets of phosphors of exactly the right sensitivity, matters would be easy. We would simply operate all three control grids at the same d.c. voltage; all three screen grids at an equal (but higher) d.c. voltage, and feed the monochrome drive voltage equally to all three cathodes. We would then get a correct black-and-white picture—i.e. perfect grey-scale tracking.

GUN TOLERANCES AND PHOSPHOR CHARACTERISTICS

In practice of course things are different. The characteristics of the three guns in the c.r.t. are carefully matched by the manufacturers so that the *shape* of the I_a/V_g characteristics is nearly the same. However, due to normal tolerance problems the curves are liable to be displaced relative to each other, see Fig. 37. Added to this the three phosphors are not equally sensitive, and in any case have tolerances. Two important effects result from these discrepancies.

If you operate all three guns appropriately under exactly the same d.c. conditions so that one beam is just cut-off, the chances are that another gun will be beyond cut-off, i.e. "blacker than black", and the third will give an appreciable light output. The black areas of the picture will, therefore, have a marked colour bias. To overcome this the three screen grids must be operated at different d.c. potentials so that the three guns are just at cut-off when the picture signal is at black level. The effect of varying the screen grid potential is shown in Fig. 37, and it is usual to find three potentiometers in a colour receiver for this purpose. They should be adjusted so that dark grey tones are of a neutral hue, because the eye is particularly sensitive to colour distortions in this part of the tonal range on monochrome pictures.

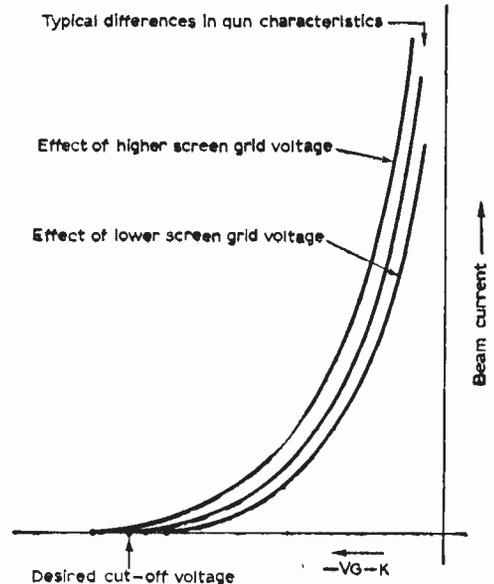


Fig. 37: Showing how each of the three guns in the c.r.t. can be set to the same cut-off voltage by adjusting the screen grid voltages. This overcomes normal tolerances between the three guns.

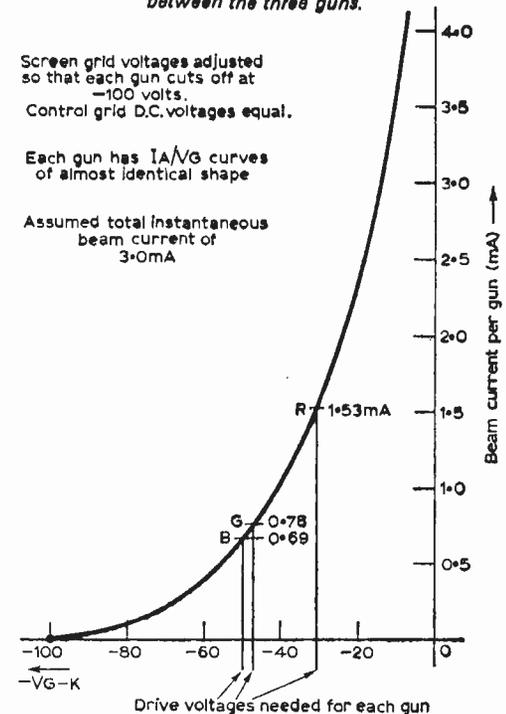


Fig. 38: Cathode drive voltages needed by each gun to obtain illuminant C on a typical c.r.t. Preset controls are incorporated to adjust the overall levels of the drive voltages.

The other problem concerns the white highlights. If we want our highlights to match the hue of illuminant C, as specified in the transmission system, the beam currents from each gun are not going to be equal, and there is quite a wide tolerance involved. In a typical c.r.t. the red beam current is normally the largest, and the ratio of I_r/I_g is of the order of 2.0 and I_r/I_b about 2.2. So on a bright monochrome picture area with a total beam current of 3.0mA you might have $I_r=1.53\text{mA}$, $I_g=0.78\text{mA}$ and $I_b=0.69\text{mA}$. Furthermore there is a tolerance in these beam current ratios of about ± 25 to 30 per cent to cover manufacturing spreads for all c.r.t.s.

One way to obtain different beam currents from each gun is to feed each of the three cathodes with a monochrome drive voltage of a different amplitude. It is common practice to supply the whole luminance drive to the red gun cathode, and reduce drives to the cathodes of the green and blue guns by means of potentiometers. The correct highlight colour, normally illuminant C, can then be preset on each receiver. These drive ratios are illustrated in Fig. 38.

There are of course other ways of controlling the c.r.t. operating conditions but the technique described above is likely to be the one most commonly encountered in practice. In passing, it should be noted that the means of achieving brightness control must not alter the c.r.t. electrode potentials in a manner which upsets the grey-scale tracking. It should also be borne in mind that the a.c. colour-difference drive voltages on the control grids of the c.r.t. have to be preset in similar ratios to the cathode drives in order to obtain correct colour performance.

CONCLUSION

We have now come to the end of this series of articles on colour television. It has been concerned almost exclusively with the principles of operation of the system, and the functions of each of the more important parts of the receiver circuitry. We have of necessity omitted all sorts of interesting side issues and description of individual circuits. This policy has been adopted partly for reasons of space limitations, but also because there is little point in considering the detailed effects of phase and matrix errors in a decoder, or the exact mode of operation of a bistable circuit, until the functions of these circuits are clearly understood.

The author feels strongly that newcomers to the art of colour television are best advised to try and think in simple terms, and to progress with a series of ever more detailed block diagrams. Once these have been absorbed the individual circuits will not present undue problems. There are in fact only a small number of key points which have to be understood before colour television begins to fall into place.

To more experienced readers it is perhaps worth commenting that this block diagram approach is capable of yielding a surprising number of important clues in the art of fault-finding. It is, for example, an interesting and profitable exercise to draw up a flow-diagram checking procedure for a PAL decoder. It can yield many short-cuts. Good luck!

NEXT MONTH IN

Practical TELEVISION

WIDE RANGE PULSE GENERATOR

A precision wide range pulse generator when utilised with an oscilloscope for Tv circuit and response testing is particularly useful. It has important applications in the fields of CCTV and colour TV.

It permits advance triggering of an oscilloscope. This is essential for systematic television design. The basic circuit comprises a variable oscillator (20c/s-20kc/s) using potentiometer tuning, pulse width selection from 10 μ S to 11mS. Operation of the unit is extremely simple. It is an all semiconductor design and built on a printed circuit board.

CAPACITANCE DIODE TUNING

Junction diodes, when operated in the reverse conduction mode, act as capacitors. Their use as variable capacitances is wide—especially for automatic frequency control (a.f.c.), and use is also made of their function in tuning v.h.f. and u.h.f. channels with a potentiometer.

The reasons why junction diodes act as variable capacitors is explained and the elementary principles of semiconductor diodes are looked at.

THE PROFESSIONAL SERVICE ENGINEER

The servicing and repair of television is a fascinating hobby.

Many amateurs eager to enter the profession, can earn high wages, often give up their job and plunge headlong into the service trade. What are the prospects, opportunities and qualifications required in this field? Service procedure and general workshop procedure are also fully covered.

PLUS ALL THE REGULAR FEATURES

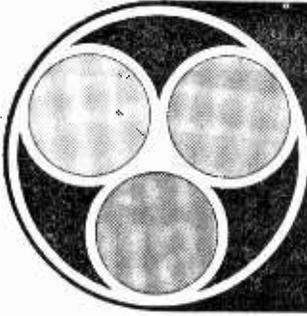
ORDER YOUR COPY ON THE FORM BELOW

TO.....
(Name of Newsagent)

Please reserve/deliver the JANUARY issue
of PRACTICAL TELEVISION 2s. 6d., on sale
December 22nd and continue every month until
further notice.

NAME

ADDRESS.....



COLOUR IS HERE! STARTS ON DEC.2

ON December 2nd, the BBC—using its u.h.f. outlet BBC-2—makes history by launching its full colour TV service. A good deal of emphasis will be placed on light entertainment and this will include *The Black and White Minstrel Show* (no comment!), a new Dick Emery series, a new Charlie Drake series, a 13-week series with Julie Felix, Kenneth Williams' International Cabaret, a new series by *Three of a Kind*, the panel game *Call my Bluff* and *Crossword on 2*.

Films will be prominent and will include the *World Cinema* series of top foreign films, the established *Midnight Movie* series and also a new series of colour spectacles from the '40s and '50s (*The Hollywood Musical*). Sport will also be featured: following the successful try-out at Wimbledon, the All Blacks tour is scheduled for coverage, as is a series of twelve top golf matches. A big criticism, however, is that no plans seem to have been made to cover top soccer matches and

we hope the BBC will remedy this before long.

Music will be represented by a special programme about Benjamin Britten, the first-ever opera in colour (*Madame Butterfly*) and a monthly magazine programme *Music International*. Documentaries and special features will include a 12-week series on Australia, *Release* (weekly feature on the arts), *Chronicle* (monthly programme on history and archaeology), *Wheelbase* for the motor-ing enthusiasts, *Horizon* for covering natural sciences and technology.

Vanity Fair is scheduled as the first colour production of the BBC classic serials, *Whicker's World* and *Man Alive* will now be in colour—as will *Late Night Line-up* which was the first actual programme ever to be transmitted by the BBC in colour. There will also be a series of *Late Night Horror* which the producer promises will lend plenty of scope for exploitation of colour.

TEST CARD "F"

Test Card "F", shown this month on the cover, was designed jointly by the BBC, BREMA, the EEA and the ITA. It provides tests for the various functions of colour and monochrome receivers. The following material is taken from the BBC Information Sheet 4306(1) with additional notes (printed in italics) provided by BREMA. Copies of the BBC sheet, including a full-colour print of the test card, may be obtained at 5s. for 6 copies, or 70s. for 100 copies, from M. G. Foster, Engineering Information Department, BBC, Broadcasting House, London, W.1.

(1) DECODER PERFORMANCE

The top castellations start four lines after the end of the field-blanking period. The first four lines of each field scan are the standard electronic colour bar signal of 100% amplitude and 95% saturation. The position chosen permits the signal to be viewed easily on an oscilloscope triggered from the field scan.

Faults or adjustment errors in a receiver show up as changes in shape, asymmetry of the waveform, or a difference in amplitude from line to line on the waveform of the red, green, and blue components of these colour bars as seen at the output of the decoder. In addition, if the colour bars are observed on the face of the tube, an assessment of the decoder performance can be obtained by switching off individual guns of the tube.

The colour bars in the first four lines after the

end of the field blanking period will not normally be visible on the displayed picture, but are useful for making waveform checks in the workshop when an oscilloscope is available.

(2) REFERENCE GENERATOR

The top border castellations (cyan, which has a high luminance component) shows up decoder errors effectively. Their location also enables the recovery of the reference generator after the field-sync period, when the reference bursts are absent, to be seen as variation in the saturation of the castellations. The bottom castellations (green) provide a means of assessing the reference generator performance at the end of the field as compared with the start.

The red and blue castellations on the left-hand side will give rise to the greatest disturbance of the regenerated colour picture if the gating circuits permit picture information to pass to the reference generator. Thus, if this fault is present in the receiver, bands of saturation changes or "Venetian Blinds" will be visible on coloured areas across the picture depending on the decoding circuits employed.

(3) SYNC SEPARATOR

The right-hand castellations (yellow and white) provide a check on sync-separator performance in the presence and absence of the sub-carrier. Any malfunctioning of the sync-separator circuits will appear as variations in the position of the picture content on the extreme right. The spacing of the left- and right-hand castellations

has been staggered to make it clear from which side any disturbance arises, and to give the maximum possibility of phase change resulting from a gating error.

(4) RESOLUTION

The bars in the frequency gratings are of square-wave form. Allowance is made to control the modulation depth, to avoid over-modulation resulting from the parameters of the system.

These gratings are only available on one side of the centre circle. Due to astigmatic effects the use of these gratings on their own for focus adjustments may not give the best overall result, and should be used in conjunction with other features, e.g. the accentuated lines of the background grid and the corner stripes.

Colour patterning on some of the frequency gratings is inevitable, since the frequencies of some of these gratings fall within the passband of the colour sub-carrier circuits, and this should not be regarded as a malfunction of the equipment.

(5) CONVERGENCE

Certain lines in the grid have been outlined in black to assist in checking display tube convergence. Others have no outlining in order to avoid the confusion which might otherwise result from the low-frequency ringing seen when certain types of quadrature distortion are present in a receiver. The blackboard and white cross also provide a check on static convergence, allowing this to be set correctly in the central area of the screen.

For convergence adjustments a grid pattern generator should be used; the test card is useful for checking performance. Perfect convergence over the whole screen is unattainable, particularly in the corners, but errors should not be visible at viewing distances over about six feet.

(6) COLOUR PICTURE

The colour picture in the centre circle contains areas of flesh tones and of bright colours to facilitate overall picture quality assessment and the correct setting of saturation. The blackboard and white cross provide a check of static convergence. The circle containing the colour picture is outlined in white to avoid any "optical illusion" effects which might occur if the coloured areas abutted directly on to the background grey and white grid. Test Card "F" is intended primarily for technical purposes and is only secondarily a demonstration picture. It is not intended that the colour test card should be regarded as a substitute for the grid-pattern generator when setting convergence.

(7) ASPECT RATIO

The central white ring should appear truly circular when the width and height of the picture are adjusted to the standard aspect ratio of 4:3.

(8) PICTURE SIZE

The transmitted picture is slightly smaller than the test card, its limits are indicated by the points of the opposing arrowheads in the border. As most receivers have a display area with an aspect ratio of about 5:4, it is usual to adjust the receiver

so that the top and bottom edges of the display area coincide with the arrowheads and the side castellations of the test card just appear in the display area of the receiver.

The positioning of the display picture may differ between different makes of receiver.

(9) CONTRAST

To the left of the centre circle of the test card is a column of six rectangles with a contrast range of about 30:1 between the top and bottom squares. The difference in brightness between adjacent rectangles should be constant on a correctly adjusted receiver. Within the top and bottom rectangles are small lighter spots; white or black crushing is shown by the merging of the top or bottom spot into its surrounding area.

The step wedges can be used for setting the grey-scale of the receiver with the colour control set at zero or with the colour otherwise killed.

(10) RESOLUTION AND BANDWIDTH

At the right of the centre picture are six gratings each consisting of vertical stripes corresponding to the following fundamental frequencies: 1.5, 2.5, 3.5, 4.0, 4.5, 5.25Mc/s.

The gratings are equivalent to square-wave signals, and on a correctly adjusted receiver will appear to extend in value from white to black, with their surrounding area white.

(11) SCANNING LINEARITY

The white lines in the background should enclose equal squares and the central white ring should appear truly circular.

(12) LINE SYNCHRONISATION

The border of the test card is a pattern of alternate rectangles in black and colours with a higher luminance value. On black and white receivers these rectangles appear in tones from black, grey to white. The right side of this border serves as a test signal to check the line sync. Faulty line sync shows as horizontal displacement of those parts of the picture on the same level as the lighter toned rectangles in this side; it will also give the central ring the appearance of a "cog-wheel".

(13) LOW-FREQUENCY RESPONSE

Low-frequency response can be checked by means of the black rectangle within the white rectangle at the top centre of the test card. Poor l.f. response shows as streaking at the right-hand edges of these areas and also of the border castellations.

(14) REFLECTIONS

Reflections of the TV signal, from hills or large buildings, may result in displaced "ghost" images. This effect will be most readily seen as displaced images of the white or black vertical lines, particularly where these are adjacent.

(15) UNIFORMITY OF FOCUS

In each corner of the test card there is a diagonally-disposed area of black and white stripes; the focus of these areas and of the central area of the test card should be uniform.

VIDEO CIRCUIT EXPERIMENTS

G. R. WILDING

Most of the components associated with the video output valve have an effect on the frequency response of the stage. This gives the experimenter the chance to vary the characteristics of the stage to achieve different results

THE view is sometimes expressed that television offers fewer opportunities for experiment than does radio, however there undoubtedly remains much room for interesting and purposeful experiment in the video, sync separator and a.g.c. stages of the average receiver. In the video stage particularly, nothing gives so clear an insight into circuit functioning, the nature of the video signal and the problems facing the designer as when vital component values are changed or the circuit altered from one type to another.

Those readers who have attended technical colleges and worked on "Philco Trainers" and similar demonstration equipment will appreciate how instructive such work can be, and by using an older wired-circuit 405 receiver, this practical self instruction can be duplicated. The video stage really extends from the vision detector to the tube cathode, and therefore includes the detector load resistor and associated i.f. decoupling capacitors.

Video amplifier load

First—let us turn to the video amplifier valve itself, often a pentode directly coupled to the c.r.t.

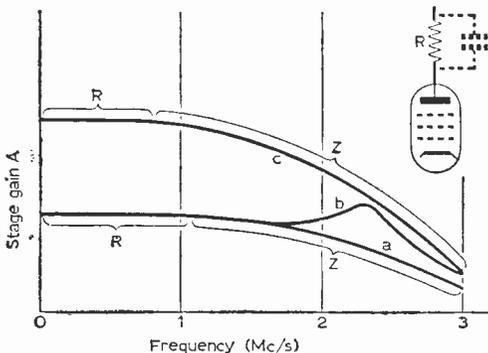


Fig. 1: Typical video amplifier frequency response curves on 405. (a) With purely resistive load. (b) With peaking coil to boost the response at about 2.25 Mc/s. (c) Purely resistive load twice that of (a). At low video frequencies pentode stage gain $A = gm \times Ra$ where Ra equals the value of the anode load resistor, but at higher frequencies where the shunting of the total stray capacitance becomes effective Ra equals Z or $(R \times Xc) / \sqrt{R^2 + Xc^2}$.

cathode. In order to accommodate the positive going video signal, the video amplifier is biased well back to prevent running into grid current on peak high-lights. In receivers employing only a resistor as an anode load, it will be found to be around 4.7kΩ. If this is replaced by one of 10-15kΩ there will be a significant increase in contrast, gain being directly related to anode impedance, i.e., $A = gm \times Ra$. However this will only be really noticeable in the lower frequency Test Card gratings. Fig. 1 shows the effect on stage gain of varying the anode load.

At first the impression could be formed that the h.f. video response had actually been reduced—but this is not so. At low and medium video frequencies when the valve anode impedance is virtually that of the anode resistor, gain will be dependent on that component's value, but at higher video frequencies when the reactance of the stray shunting capacitance is comparable or less than the ohmage of this resistor, its value becomes of small significance. On bringing contrast to the correct level for best viewing at low frequencies, the high video frequencies, which produce fine detail, will have insufficient amplitude to fully modulate the tube and the picture will have weak and hazy definition. If contrast is increased to bring h.f. resolution to the required level, the low frequency video signals will be excessive and produce mainly "soot and whitewash" tonal gradation.

Oppositely, if pre-detector gain is sufficiently high to permit a reduction in video anode load, the correct contrast setting for the lower frequencies will be more closely approached than for the higher frequencies since there will be less amplitude disparity between them and a well balanced picture will result. To take full advantage of video anode load reduction, the value of the detector load resistor should be reduced proportionately.

So, experiment 1—vary the value of load resistor, and also temporarily connect a small picofarad capacitor across the load resistor, or from video anode to chassis, to accentuate the effect of the stray circuit capacitance on picture definition.

Peaking coils

In many receivers, designers have endeavoured quite successfully to linearise the overall frequency response by including a small "peaking" coil in series or parallel with the load resistor to resonate

with this stray capacitance at about 1 to 2Mc/s and thus lift or compensate for the fall-off in amplification that usually becomes evident just before 1Mc/s. If the receiver does not incorporate such a coil, it then becomes a most interesting and informative exercise to connect such a small coil in series with the load resistor and note the effect produced. Suitable coils of from 40 to 50μH can be easily wound on miniature formers or taken from scrap receivers—some detector circuit filter chokes prove quite effective, and should be mounted well clear of the chassis to prevent adding further capacitance to the stage.

Almost certainly the result will be undue accentuation or "ringing" at one frequency rather than a slow overall rise to offset the sag in h.f. response since the inductance of such coils must be correct to a few micro-henries for optimum levelling of frequency response with the particular load resistor involved. Generally, the higher the value of load resistor, the more "peaky" will the h.f. response be since increasing R_a decreases the damping imposed on the LC combination. However, by trying various types of coils and simultaneously varying the value of anode load resistor it may be possible to produce a high gain with well maintained top end response. In any event it will prove highly instructive and really show how ringing can be instigated in the video circuit.

Cathode circuit

After such experiments with anode load components, it might be well then to turn to the video cathode circuit. In general, video cathode components fulfil three main functions:

1. The resistors determine the degree of bias.
2. The capacitors determine the amount and frequency range of negative feedback developed across the resistors.
3. On 405, a rejector tuned circuit eliminates the 3.5Mc/s "dot" beat signal.

The degree of bias is most important and, as mentioned earlier, is in excess of the usual Class A position since to fully modulate the tube from black to peak white requires a fairly high input to the video pentode (due to low stage gain occasioned by low anode loads) so that bias must be fairly heavy to ensure that the grid does not actually go positive with respect to cathode. Secondly, as the video signal is directly coupled from the detector, the output is constantly positive so there is no advantage in biasing above the commencement of the linear section of the valve's I_a/V_g curve.

If now the value of the cathode resistor or resistors is increased, three effects will become apparent:

1. Tonal gradation will deteriorate making it even more difficult than usual to clearly separate the two darkest squares on the Test Card.
2. Sync lock will deteriorate.
3. In extreme cases, the reduced amplitude sync pulses caused by the excess bias will produce a reduced negative bias at the sync separator grid to give an insufficient a.g.c. voltage leading to ineffectual contrast control and overloading on strong signals.

These major effects are due to the excessive bias causing the low amplitude portion of the video

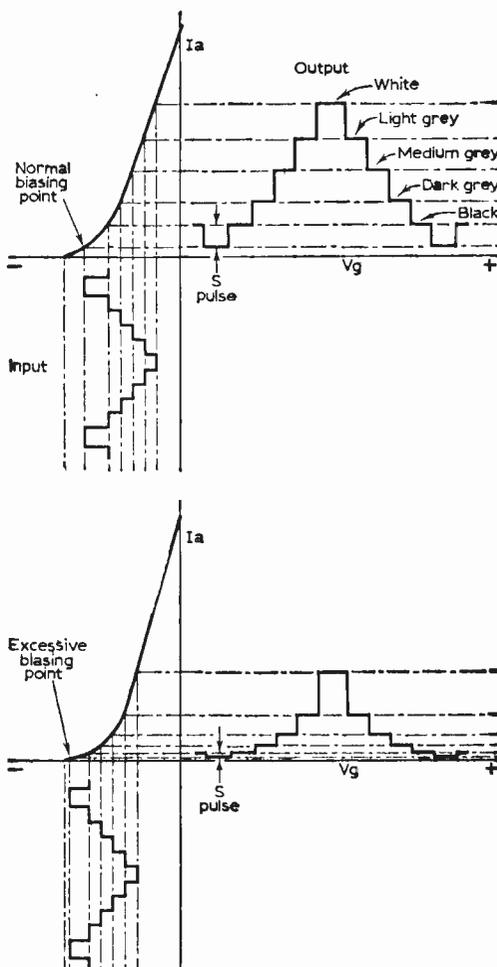


Fig. 2: Showing effects of excessive bias on the video amplifier. Normal operation is shown at the top. The lower diagram illustrates the reduction in sync pulse amplitude, impairment of tonal gradation and overall reduction in the video signal waveform that occurs with excessive bias applied to the stage.

input waveform, i.e., the sync pulses and dark picture areas, to be handled by the flattest part of the valve's characteristic and given reduced amplification compared to that afforded to the light picture areas. This is illustrated in Fig. 2.

On the other hand, if grid bias is reduced below specification, while sensibly equal amplification will be given to both low and high amplitude inputs, the permissible maximum input level must be restricted to prevent the grid going positive. The instantaneous video input must never rise in excess of the applied bias or the picture highlights will suffer. Varying video bias one way or the other is most instructive and gives greater insight into valve operation than could be gleaned from many a textbook.

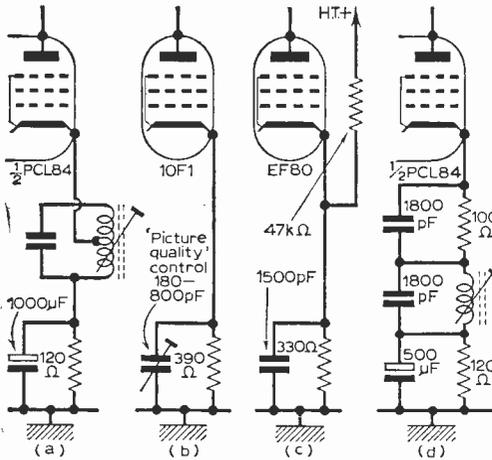


Fig. 3: Four different video amplifier cathode circuits. (a) Full cathode decoupling with 3.5 Mc/s rejector (Sobell). (b) Adjustable selective negative feedback (Murphy). (c) Selective feedback and bias stabilising resistor (47kΩ) used on some Alba models. (d) Selective feedback and 3.5 Mc/s rejection (Invicta).

Not all receivers simply have one or two series connected resistors in the cathode lead. Often a "bleeder" resistor is connected from the h.t. rail to the cathode of the valve so that bias is determined by the current taken by this component in addition to that passed by the valve, see Fig. 3(c). The function of this resistor is mainly to stabilise valve bias by keeping cathode resistor current within narrower limits than those created by the valve alone, but it also permits the use of a lower value resistor in the cathode lead for the same bias voltage. Reduction in its value will therefore increase valve bias. To fit a "bleeder" resistor in this manner and keep bias at its original figure, it would be necessary to reduce the value of the cathode resistor to compensate for the additional current.

Cathode decoupling

Many thousands of words could and have been written on the factors that govern the choice of the decoupling capacitors shunted across the cathode bias resistors. In a nutshell the main aim is to assist in the linearizing of the video frequency response curve while at the same time maintaining gain at an adequate level. To this end, dual combinations of cathode resistor and capacitor are frequently employed, often with a large electrolytic decoupling one resistor while the other may be shunted by a picofarad type of precise value. In this way while virtually zero negative feedback is developed across the resistor shunted by the large value electrolytic, the desired degree of feedback over the desired frequency range is developed over the other. In this way the attenuation in h.f. video response is compensated for to some considerable extent by increasing negative feedback towards

zero frequency and from the point where the top end fall-off commences.

The same effect could not be obtained by shunting one cathode resistor with a capacitor whose value lay somewhere between the two types mentioned. Also, not only does choice of capacitor and resistor values determine the frequency selective nature of the feedback, but also modifies the signal handling capacity and input/output impedances of the valve. A great deal can be learned by changing capacitor values, but in those models that use a picofarad type either solely or in conjunction with a large electrolytic, it is always worthwhile replacing the former by a compression type trimmer with a maximum capacitance well in excess of the pF value so that the precise amount of capacitance for optimum resolution can be determined by direct observation.

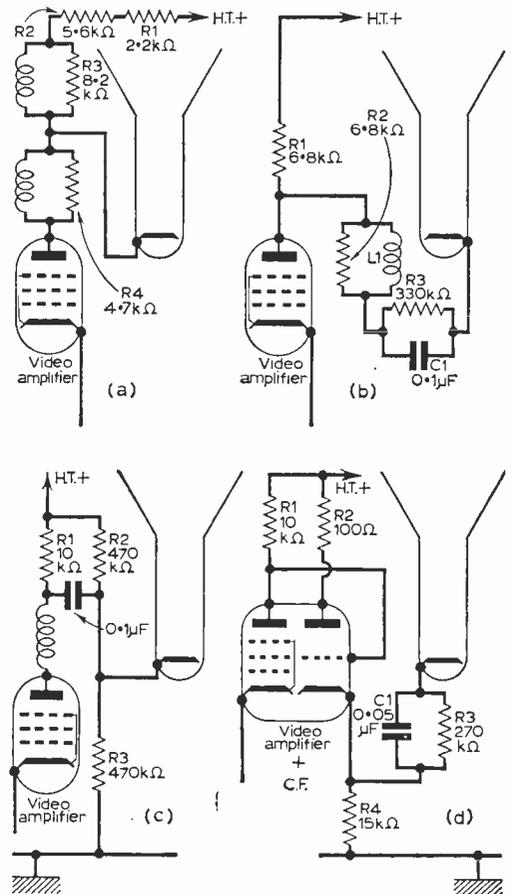


Fig. 4: Four different picture tube drive systems. (a) Direct coupling to picture tube cathode (Philips). (b) Direct coupling with h.f. boost by R2, L1 and i.f. attenuation by R3, C1 (Regentone). (c) A.C. coupling to picture tube cathode (Murphy). (d) Cathode follower with i.f. attenuation by R3, C1 (Bush).

Picture quality controls

Such capacitors connected across the cathode resistor were quite common in early receivers—often labelled “picture definition” or “picture quality” controls—and enabled the set to be adjusted for maximum definition with possibly the merest trace of overshoot to sharpen the h.f. response.

Where the video cathode circuit uses two resistors in series with one shunted by a high value electrolytic and one by the picofarad type of capacitor, the designer’s aim is to reduce the low frequency amplification, and temporarily disconnecting or varying their values will provide a real insight into the negative feedback characteristics of such “dual” cathode circuits. In some Pye models this can be done by means of a switch or preset link.

Fig. 3 shows various video amplifier cathode arrangements.

Picture tube drive systems

Equally as important as the cathode circuitry is the video feed to the tube from the video anode, and an inspection of commercial designs will show that additional to their main purpose, they can perform four other functions as follows:

1. Attenuate lower picture frequencies by a frequency selective potential divider or series RC combination.
2. Reduce signal d.c. component level and thereby reduce “aircraft flutter”.
3. Boost h.f. response with series “peaking” coils.
4. Electrically isolate the tube from the video valve to provide purely a.c. signal coupling.

Examples of several tube feed supply systems are shown in Fig. 4. Note that to attenuate the lower video frequencies the same principle is used as was employed in the video cathode circuit, that is, the shunting of series feed resistors by a capacitor which offers negligible reactance to high frequencies but high reactance to low frequencies. Whereas in the cathode circuit such frequency selective capacitors were of picofarad value as the cathode resistors were limited to only a few hundred ohms, in the c.r.t. feed circuit the capacitors average about 0.05 to 0.1μF, while the

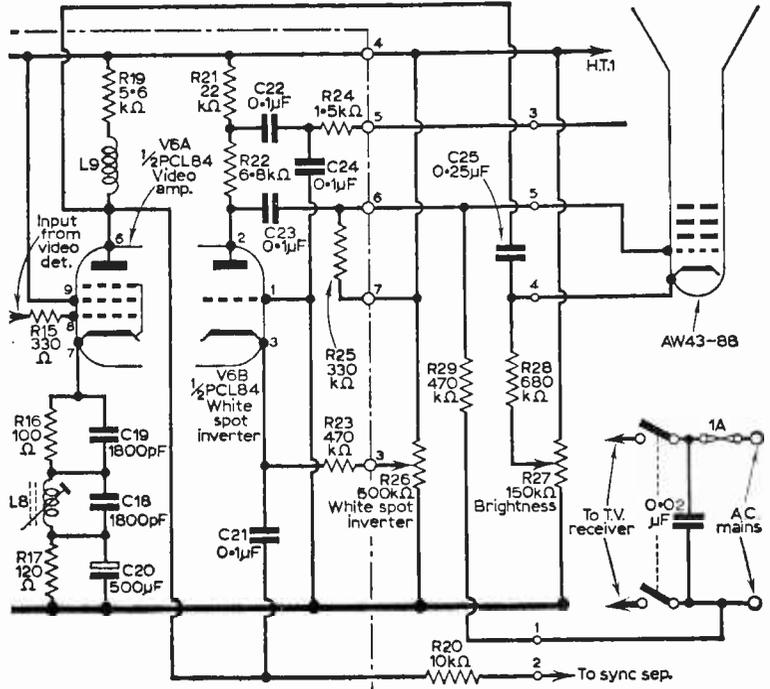


Fig. 5: Video amp'lifier and interference inverter stages used in many Pye and Invicta receivers. The video output is a.c. coupled to the picture tube cathode by C25, brightness control being effected by varying the d.c. cathode potential while the grid voltage is held constant by the potential divider network R25, R29.

associated resistors are around 300kΩ.

The principle involved however is precisely the same. A.C. video coupling from valve to c.r.t. is often regarded as something originated by dual-standard design, but the a.c. feed system shown in Fig. 4(c) was used by Murphy in many 405-only receivers while Pye/Invicta similarly employed an a.c. feed system in many 17in. models in conjunction with their black spot interference inverter circuit.

White spot inverters

This latter circuit is shown in Fig. 5 and was particularly beneficial for viewers situated close to main roads by reducing the objectional big white interference “blobs” to much less obtrusive black spots.

A triode is used in the Pye/Invicta circuit to invert the interference pulses, conducting heavily, and momentarily blanking out the beam trace by instantaneously lowering the tube G1 voltage. To stabilise G1 voltage it is tied to the h.t. rail via a 330kΩ resistor while the cathode is taken to the slider of the 150kΩ brightness control by a 680kΩ “stand-off” resistor.

These circuits offer much opportunity for experiment to determine best values of component for optimum interference inversion with minimum clipping of “highlights” for each particular receiver and c.r.t.



LETTERS TO THE EDITOR

SPECIAL NOTE: Will readers please note that we are unable to supply Service Sheets or Circuits of ex-Government apparatus, or of proprietary makes of commercial receivers. We regret that we are also unable to publish letters from readers seeking a source of supply of such apparatus.

The Editor does not necessarily agree with the opinions expressed by his correspondents.

DID BRITAIN INVENT TELEVISION?

SIR,—With reference PRACTICAL TELEVISION, October 1967, the following are extracts from two different Encyclopaedias.

In April 1925, John Logie Baird first demonstrated from room to room, but the foundation of television goes back to 1817, to the discovery by Berzelius of the element selenium. Only 56 years later it was accidentally discovered at the Valencia Cable Station that some selenium rods used as resistances altered in value under strong sunlight and this led to the discovery that the resistance of selenium became lower when it was exposed to a bright light. This opened up the possibility of converting light-waves into electric impulses, Nipkow in 1884 invented his famous scanning disc, meanwhile Faraday in 1845 and Kerr in 1877 had demonstrated the effect of a magnetic field on polarised light, but television was still not possible, as no means existed of amplifying the extremely small currents available. From *The New World Library—1965—volume thirteen*, published by the Caxton Publishing Co. Ltd. London.

The first television machine was invented in theory in 1884 by the Russian engineer Paul Nipkow. From *The Universal World Reference Encyclopaedia*, Consolidated Book Publishers, Chicago, Illinois.—V. YOME (Gibraltar).

FRAME SHIFT INTERLACE & FRAME WOBBLE

SIR,—If you will bear with me, I would like to defend my stand on the question of Frame Shift Interlace, Mr. A. O. Hopkins' "Frame Wobble".

It seems that both Mr. Gerzon and Mr. Hopkins have fallen into the pitfall of applying these new techniques to display-tubes optimised for the present two-field system. I am indebted to Mr. Gerzon for his interesting point about the Kell factor. But is this not also a function of fluorescent decay-time?

I notice I did elicit a small concession from Mr. Hopkins, who is in the enviable position of being able to try these things first-hand. He states that it was "... better than the present crude separation . . .", but the "Overlap wastes bandwidth". Surely, with a very linear short-neck tube with good interlace, it should be quite easy to position the "shifted" frame between the lines of the previous one, and adjust spot-focus to avoid overlapping lines.

Such a system would only work with tubes capable of reasonable resolution, and timcbases delivering a good interlace stability. It would be optimised by careful choice of phosphor half-life,

which would be a little longer than at present. Only experience can tell.

Surely Mr. Hopkins, in his September letter, does not mean that the system does not support "Kinetic Image Linkage", for even with two-field systems and live performances, the fields are in fact successive FRAMES, in that they are taken successively in time. Storage-tubes for low-level lighting use a system of true frame-speed integration, but cine experience tells me that this would slightly enhance the fluidity of movement, within reasonable limits.

Nothing short of wide-band 625 transmission would qualify the v.h.f. bands for compatibility with the rest. My idea is not to patch up the v.h.f. network, but to suggest a way of improving even the 625 channels at minimal cost.

Screens will get bigger. This is inevitable. And even 625 is not enough for wall-to-wall TV in the second millennium. With f.s.i., one almost gets something for nothing—we agree that 25 f.p.s. is too fast for economy of bandwidth, and no one has clearly shown me that 12.5 is too slow for satisfactory image continuity. Again, we seem to be agreed that screen coverage is improved, and that luminance definition is better, if not quite doubled. And if the "Overlap wastes bandwidth" on unsuitable receivers, then at least a little quality gained is better than none. Let us not look the gift-horse in the mouth.

My main claim is for the compatibility. The running of a test-card for experimenters and professional engineers to try it for a while, and make their own minds up would at least give us a stake in something which may prove profitable. We have tried NTSC and PAL experiments, and neither system was home-brewed.

Unmodified receivers would display a picture with image-content shift on a 25in. screen of only 1/40in. for 405, and 1/60in. for 625. I can't see anyone complaining, or even noticing. On smaller screens it would be even more trivial.

The only cloud in the sky seems to be that chrominance is not improved on delay-line receivers. This is because at present colour-mixing is carried between successive lines-of-field, and therefore across a line-of-frame. With Mr. Hopkins' three-field system, mixing is carried out across TWO lines-of-frame, and with mine across THREE. However, the colour definition is already only one quarter of the luminance laterally, and I cannot see why it should be better vertically. Certainly, no multiple-interlace system would degrade the chrominance. It just would not improve in step with the luminance, except on Economy-PAL (VolksPAL).

—continued on page 116

ICONOS REPORTS ON THE INTERNATIONAL BROADCASTING CONVENTION 1967



CONVENTION, conference, colloquium, conversazione; powwow, palaver, debate; look, listen and absorb. All were part and parcel of the three days of concentrated attention of five-hundred or more registered delegates to the Convention from all parts of the world. The Royal Television Society, the Electronic Engineering Association and the Institute of Electrical and Electronics Engineers (United Kingdom and Republic of Ireland section) jointly planned an ambitious programme of lectures, demonstrations, exhibitions and social events which will long be remembered by the participants.

Thirty-nine papers were read by lecturers from all parts of Europe, USA, Japan, Singapore; in addition to wide representation of various sections of BBC, ITV and equipment manufacturers, many of them aided with films and slides.

After the Convention had been opened by the Rt. Hon. Lord Hill of Luton the Conference started off with an explanation of the methods of line conversion between European and North American television standards by E. R. Rout of the BBC. It is only about three years ago that we all marvelled at the apparent miraculous transfers from 525 lines 60 fields to 405 lines 50 fields in black-and-white television by direct electronic methods instead of re-photographing from the screen of a monitor on one line standard to the camera tube of another line standard. Progress with such transfers with colour signals is still full of snags, but the use of fused quartz delays for storage is likely to overcome these fundamental difficulties. This development is now in hand.

Colour TV—Mobile Units

Next came a series of illustrated lectures on colour television mobile units by speakers from NBC and CBS networks (USA) and ABC and ATV in England, covering colour vision-mixing facilities, camera equipment, communication methods, vehicle and coachwork requirements and weight distribution.

The planning was tackled by each company in different ways, though the equipment was basically equivalent; comprising six colour cameras, vision-mixing and sound to match. The ABC Television approach was radically different in concept, the vision-mixing compartments being set-up sideways, with director and technicians looking across the vehicle instead of in the forward- or backward-looking position.

Each of the mobile colour camera units required a total of from four to six vehicles to cope with

from four to six cameras. This included ancillary "stage" technical props, such as rostrums, camera cable drums and other bulky and heavy impedimenta. Each speaker presented slides or films, showing the circus-like collection of vehicles.

The American plan had to include separate provision for advertising sponsors to view the colour monitors separately; the CBS vehicles included extendable walls at one side, giving more working space in some of the compartments. ATV's four-colour camera unit provided technical facilities for making colour programmes on 525 lines, NTSC standard, for export.

Unusual developments of television in far-away places were described in A. T. B. Borden's paper on the *Development and Operation of a Complete Wired Television System in Hong Kong*. This service covers the functions of origination, distribution and delivery by wire to the viewers, together with the maintenance of viewers' TV sets. While some of these papers were being read in the Richmond Room, the transmitter side of medium and u.h.f. broadcasting, television and sound, was dealt with by several British manufacturers in the Clarence Room. The first strenuous day ended with a general get-together.

Electronic cam

The Arriflex Electronic Cam system is based upon small television cameras being attached to motion picture cameras, to enable a picture director to view each camera set-up on television monitors. Vision-mixing from camera to camera sequences, he is able to photograph sequences on film in much the same way as normal television is recorded on to magnetic tape. This gives greater scope for film editing and, with 35 or 16mm. film, prints can be readily circulated to the world market, unrestricted by differences in line standards.

American technicians told us that 80% of their "staged" television programmes were on film, as this gave them a world market. Some of the ITV companies are well aware of this.

Dr A. M. Spooner (Rediffusion) described improvements resulting from the adoption of the Plumbicon camera as a view-finder for the 35mm. Arriflex film camera, which gives accurate reproduction on TV monitors of the pictures photographed, both as to exposure, picture registration and lack of parallax trouble. Demonstration test films of the Arriflex Electronic Cam system were shown.

Film was also dealt with in papers dealing with flying spot film scanners by representatives of

Fernseh G.m.b.H. and of Rank Cintel. On flying spot telecine apparatus, the film is transported continuously, instead of by the intermittent motion of film projector-type telecine equipment. For black-and-white television, flying spot is considered superior to the projector type, but it is much more expensive.

For colour television, however, there is little difference in the costs of multi-vidicon cameras, projector type telecine or the flying spot type, hence the large number of flying spot equipment orders that have been placed with both Rank Cintel and Fernseh flying spot machines.

Automation

There were several papers on the automation of individual programme switching to a hundred or so TV stations on an American network or a hundred separate sources to one TV station, manually or time-controlled. These included a paper by H. Mirzinski of Marconi who traced the development of Post Office television switching centres from the original simplicity of patch panels to a complexity requiring automation, to which is added the complication of colour.

The GPO have now installed automatic equipment in the London Post Office Tower and three provincial towns for storing the switching required for the patterns of connections between sources and destinations, together with their corresponding times. This is a case where the actual switching is under the control of a clock system driven by pulses from the speaking clock TIM. The stored information can be changed at any time and the clock overridden when the inevitable last-minute changes occur.

Q File

Automation was covered in several papers read on the Friday. The new Thorn system for the control of stage and studio lighting was described by R. E. Jones and demonstrated at the E.M.I. studio stage. Dimmer-lighting plots could be memorised during rehearsal and can be recalled as quickly as 2 cues per second. Provision is made for easy adding or subtraction to any cues, with cross-fades or cuts, as required. Compute or not to compute, that is the question!

This is an advanced development which frightens many TV lighting men. However, it is a piece of equipment that they will master in due course.

A very practical paper on *Operational Experience with a Four Tube Colour Camera* was presented by N. Parker-Smith (Marconi), in which he discussed the characteristics of the photo-conductive Plum-bicon camera tube as compared with the Image Orthicon. Valuable points on the operational control and maintenance of optimum colour balance were made. I. P. James of E.M.I. dealt in an interesting manner with the controversy concerning the relative advantages of the three-tube and the four-tube colour cameras, favouring the latter.

The last paper in the Convention was an educational and entertaining address by E. Carlton Winckler, supported by films showing how—and how not—to design colour in scenery, clothes, décor, facial make-up—that will give the best results for colour or black-and-white reproduction.

LETTERS—continued from page 114

Incidentally, I used to live in Streatham, very close to the Crystal Palace transmitters. Without an aerial, BBC-1 came through beautifully, and ITV was acceptable. However, BBC-2 could not be received even with a set-top aerial, and very careful alignment of a loft-6 had to be carried out for several hours to avoid ghosts, snow, loss of sync and weak image. That's progress?

I would like to thank Mr. Hopkins for giving us so much food for thought. With his superior experimental experience he has raised many controversial points, but I hope he will take my point that without attention being paid to phosphor characteristics, accurate interlace and fine spot-focus, particularly on very large screens of the type that viewers will inevitably demand, such a COMPATIBLE system of frame-shift cannot be, and for cold financial reasons should not be judged too lightly.—C. WEHNER (London, S.W.6).

ANOTHER VIEW ON TELEVISION

SIR.—May I express the opinion that a simple answer (a single name) can only be given if we distinguish between early theory and practical demonstration of television (Teletopics, October 1967 issue of PRACTICAL TELEVISION).

If the question means: "Who first tried to trace a TV picture (by selenium stylus) and later was one of several inventors who made mosaics of elements (copying the eye's retina)?" the answer: Senlacq in 1879.

If it means: "Who invented methodical scanning (by apertured disc), but was unable to make it work without efficient p.-e. cells and amplification?" the answer: Nipkow in 1883.

If it means: "Who invented methodical scan-TV system, and a few years later gave an exact description, showing how to use c.r. tubes at transmitter and receiver?" the answer is Campbell Swinton in 1908 and 1911 respectively. (Rosing tried to use a c.r. tube for reception only in 1907.)

If it means: "Who first obtained outlines and silhouettes (using a lens-wheel assembly similar to that on the stamp)?" the answer is Baird in 1924; he transmitted them in 1925. He "televised" recognisable faces and figures (including smoke from a cigarette) in 1926. Dr. Jenkins in the United States of America achieved similar results some months later.

Braun invented a c.r. tube in 1897, Ryan put an electro-magnet coil around the neck in 1902, Wehnelt added a "hot cathode" in 1905 and later a control cylinder (grid). We must not forget the potassium photo-electric cell of Elster and Geitel in 1912, and the caesium-on-oxidised-silver cell of Ives in 1924. The cathode ray tubes were first used in oscilloscopes, and the photo-electric cells to reproduce sound for cine films.

If the Post Office wanted to commemorate the man who got television started, transmitted pictures to the USA in 1928, demonstrated colour TV and stereoscopic TV in 1928, transmitted regularly from "2LO" from '29, and invented the system broadcast by the BBC from 1932 to 1936, they could safely have printed BAIRD on their stamp.—A. O. HOPKINS (Worthing, Sussex).



PART 3

H.W.HELLYER

AS one of the leading world electronic manufacturing concerns it is only to be expected that Philips would waste little time in putting a competitively-priced domestic video tape recorder on the market.

The word "domestic" can be misleading: we have already had correspondence on the subject! Who wants to buy a machine to play with that does little more than a cine camera and costs more than a colour TV, one reader complained. Putting aside the couple of questions he has left begging, we can say that the people who want to buy these machines, which are now slipping in price beneath the £500 mark with many accessories, or less than £350 for the basic machine, occupy many walks of life. There are some surprising uses for video tape recorders, and the potential market expands daily.

Costs

Another question often raised is that of operating costs. Head wear is a bogey that frightens many people, visualising the terrible friction problems at a virtual speed of 900in./sec. What they overlook is that the quality of the heads used in current VTRs is a vast improvement on the ordinary recording head used in our home audio tape recorders, and the tapes used for video recording are also a cut above those used for audio purposes. Even so, the makers need to state a figure for head wear, and Philips have spent a large proportion of their research budget in reducing head wear so that they can safely guarantee a minimum of 500 hours for a simply replaced £25 head in their Peto Scott ET2610 range. As the head is self-aligning and can be fitted in seconds, the running cost works out to something like one shilling an hour.

The lin. tape used for these machines costs something like £30 for a 3,000ft. reel, giving about an hour's recording—and, of course, like ordinary sound tape, it can be used over and over by simple erasure. The life of the tape runs to hundreds of playings and storage problems are no greater than with ordinary sound recording tapes, and certainly no more stringent than film.

The Peto Scott ET2610 has been mentioned, and before delving more deeply into Philips' general video tape recording techniques, it may be as well to give a few brief details about this machine, which retails at less than a thousand pounds.

Its prime advantage when it first entered the market was "compatibility". This is one of those awkward terms that means different things to different people. To the VTR engineer it means that any tape made on one machine can be replayed

on another machine of the same type. If we recall the first article of this series in which some of the difficulties of video tape recording were outlined, we begin to realise that this, in itself, is no mean achievement.

This is a single video head recorder, the head rotating 50 times per second (3,000r.p.m.) and the lin. tape passing the head drum at 10in./sec. Helical scan is employed and the tracks, occupying a diagonal length of about 500mm., take up nearly one complete field, sync pulses occurring during the period between the video head leaving one track and beginning the next.

Audio signals are recorded on one edge of the tape and sync pulses on the other edge by a separate, stationary head. There are four motors, a pair for video head transport, one for tape transport and the fourth for the spools. Servo control of the video head motors is effected by means of a photo-resistor and lamp (see Fig. 8 later), a disc with slits being coupled to the motor, which receives its power from a control unit the output of which is governed by phase differences between pulses created by the lamp and disc arrangement and the recorded video field-frequency pulses. The latter occur along with the video output signal on playback.

Tape transport is controlled in much the same way and an eddy-current brake assembly is used. We shall consider the general principle of these servo systems and brake operations in a later article when we dissect the Sony VTR in closer detail.

Head drive

The interesting and quite unique feature about the Philips design is the head transport arrangement. Two asynchronous motors are used, their direction of rotation being the same, clockwise in plan, with a coupling belt between them engaging the spindle of the disc on which the head is mounted so as to drive it in the opposite direction, i.e. anticlockwise.

As the tape is passing from left to right around the back of the head drum set to the rear of the tape spools (see Fig. 2, Part 1), this causes the head to track the downward moving tape (angled by its helical path) so that the actual length of each video track is around 465mm. The diameter of the drum, measured at the head length position, is actually 150mm., but a small amount of the total circumference is lost between the points where the tape contacts and finally leaves the drum, the head traversing this gap before re-entering at the top of the tape for its next adjacent track. Field pulses are recorded by the separate stationary head during the period when the tape is not in contact with the

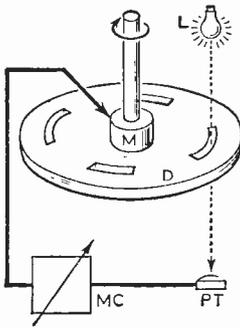


Fig. 7: Servo-control of tape transport motor. Lamp shines on phototransistor PT through slotted disc D. Resultant pulse output controls bistable circuit MC which switches the polarity of the current through the stator coils of d.c. motor M.

rotating video head. Thus, one field is recorded for each head revolution, and the interlaced picture comprising two fields occupies two tracks, each $150\mu\text{m}$. in width, with a $30\mu\text{m}$. spacing between them, i.e. the spacing between adjacent track centre-lines is $180\mu\text{m}$.

The coupling of the head circuit to the amplifiers etc. is done by making the disc carry one winding of a transformer, with the coupling winding fixed beneath it, effecting a transfer without any engagement of moving parts.

Tape drive

Regular speed of tape drive is most important with video recording, and where separate motors are used for different functions some quite sophisticated methods of control are needed. The main tape drive spindle of the Philips' system, which has two pressure rollers engaging it to equalise the thrust, is the spindle of a d.c. motor, but without the drawbacks usually associated with these devices. Instead of brushes or other forms of mechanical current collectors, an optical collector is employed. A disc (see Fig. 7) with four slits cut in it is fixed to the motor spindle and a lamp above the disc shines through each slit as it passes, energising a phototransistor. This is thus switched on and off at regular intervals and controls a flip-flop circuit which reverses the flow of current in the motor's stator coils at the appropriate moment.

Another lamp and a photoresistor (see Fig. 8) perform the control for speed regularity. As the correct tape speed is obtained when the driving disc rotates at $6\frac{1}{2}\text{rev./sec.}$, eight holes are cut in the plate. Then if the motor is at the right speed $8 \times 6\frac{1}{2} = 50$ pulses per second are passed back along the control path from the photoresistor. These are applied to the control circuit C2. Also applied to this circuit are 50c/s pulses derived from the sync separator stage SS, which is similar to that in a television receiver. This is, of course, during the recording of a video signal. On replay, mains-derived pulses are used instead, the constancy of the mains ensuring regular pulses. From C2 a control d.c. voltage is obtained, amplified and used to regulate the tape drive motor circuit. This control system is switched out during fast wind and rewind, the speed of the motor then increasing to about 75rev./sec.

On replay, as shown in Fig. 9, the pick-up coil P scans the recorded field pulses and these are compared with the mains pulses derived from the phase regulator FR. This regulator is controllable, so that the operator can change the relative phase

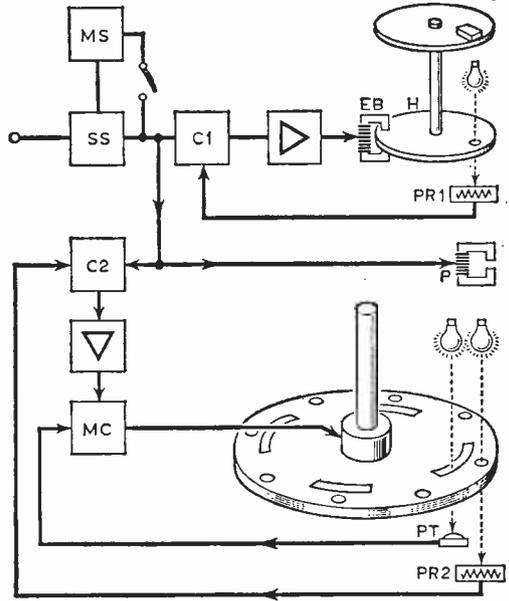
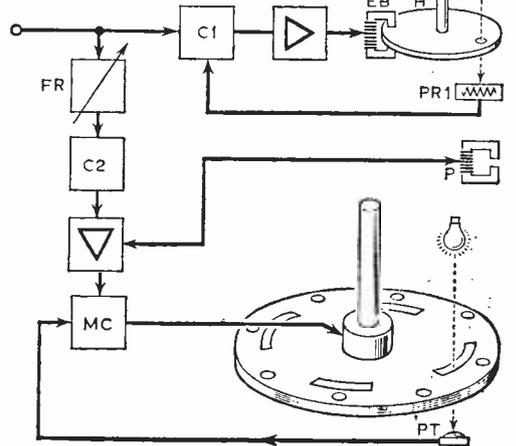


Fig. 8: Control of tape transport and head disc motors is by pulse comparison. Speed control of head disc H is by eddy-current braking, strength of which is determined by pulse comparison. Both head and tape transport discs have lamp and photoresistor control. Record arrangement shown, with sync pulses fed to control head P.

of the mains pulses and reduce the characteristic moiré pattern which occurs if the phasing is wrong. It will be noted that the photoregulator of the video head disc H is in action on both record and replay.

Fig. 9: Tape and head transport control arrangements during playback. Pulses from sync head P are compared with pulses from adjustable phase regulator FR to give tape speed control.



Video drive regulator

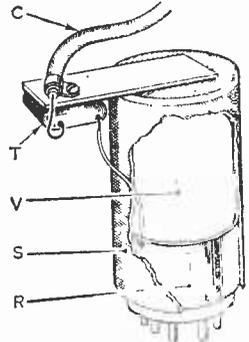
The action of this circuit is rather different. The disc H has a single hole and again this gives a 50c/s pulse train for the regulator arrangement when the disc is rotating at the correct speed. These pulses are applied to the control circuit C1 where they are compared with incoming field pulses from the sync separator, SS, Fig. 8. The phase or frequency difference between these two sets of pulses is taken off as a d.c. potential to control an eddy-current brake. The reason for using this technique rather than direct motor control is that simpler circuits can be used and less power is needed from the control circuit. By this means, the exact position of the video head relative to the signal is maintained.

One snag may have been noticed: these control circuits depend on the presence of incoming field pulses so that in their absence the phase sampling circuits would react strongly and tend to brake the machinery! Switching channels or suffering a temporary transmission breakdown could have drastic results unless some safeguard were employed. The circuit MS does this job. If sync pulses are absent this circuit opens and allows mains pulses to take their place until sync pulses are resumed. It is thus in circuit during record only.

Record circuits

As with the previous models discussed in this series the video signal is not recorded directly but is used to modulate an f.m. carrier. The reason for this is that the lower video frequencies present particular recording problems, and biasing the signal in the manner used for a.f. recording is especially difficult because of the wide video frequency range, zero to 2.5Mc/s in this case. In addition, any irregularity in contact between head and tape produces a signal amplitude variation. By using frequency modulation, the signal can be tailored to avoid this kind of interference—and indeed other forms of noise interference which show as amplitude variations. Limiting can be very carefully arranged during playback to provide the frequency detector with as clean a signal as we could wish.

Fig. 11: Signal pickup is by ring electrode R round common i.f. valve V, with outer screen S (shown partly cut away). Signals are fed via transformer T and coax cable C to recorder.



The recording circuit is shown in block form in Fig. 10, the vital part being the modulator. This uses a multivibrator whose frequency can be varied from 3 to 4.3Mc/s, the lower frequency corresponding to the peaks of the sync pulses and the upper to the white level. To stabilise the multivibrator, part of the output from amplifier A is fed back via a discriminator D which has an impedance/frequency characteristic with a steep slope at 3Mc/s. After rectification and d.c. amplification the signal from this stabiliser arrangement is applied to the modulator keeping the lower frequency exactly at 3Mc/s to counteract the effects of variations in temperature and mains voltage fluctuations.

The basic video signal is also taken off prior to the modulator to give visual level indication and to feed the sync circuits.

Playback is fairly straightforward, except for the a.m. limiting mentioned previously. There are two approaches to this technique. Some makers use a number of successive amplifier/limiter stages in a "passive" arrangement. Philips prefer an "active" limiter, which consists of a multivibrator with a constant output voltage. The principal reason is that passive limiters give no output when signals are briefly interrupted, whereas the active type continues to oscillate at its natural frequency even in the absence of triggering signals. If this frequency is arranged to lie in the middle of the band covered by the f.m. signal, instead of white streaks on the picture, a grey signal is reproduced, giving less visual annoyance.

Signal pickup

Another point of special interest is the Philips' method of signal pickup from a television receiver. No direct connection is needed. Instead, capacitive coupling to an intermediate frequency stage handling the sound and vision signals is made by a ring (see Fig. 11) which encircles the valve. Further i.f. amplification and separation of the sound and vision signals, with detection and video amplification, is carried out in the VTR circuitry.

On playback, the signals from the tape are modulated on to carriers in the Band I spectrum for direct application to the aerial socket of a television receiver. R.F. modulators are a particular problem, as we shall see in later articles. Curiously enough, more liberties can be taken with design at radio frequencies than at video or audio frequencies—but this is another subject which must be left to a later article.

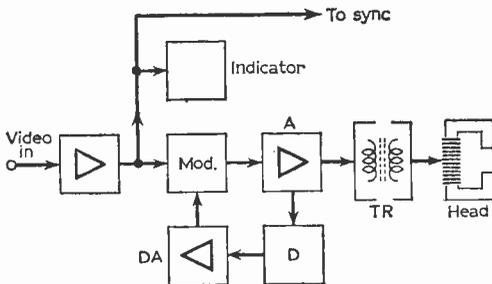
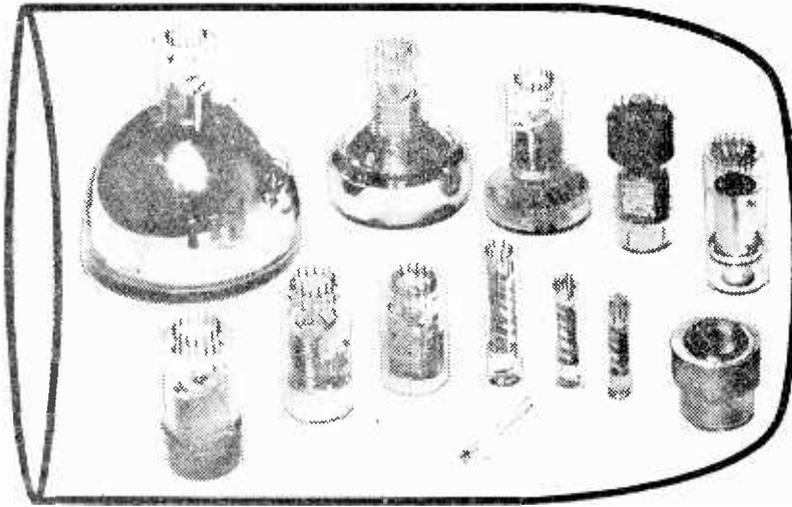


Fig. 10: Basic recording circuit. Video signals are fed to the f.m. modulator, amplified and applied to rotary transformer TR to be applied to recording head. A sample of the f.m. signal is taken off at A and applied to a discriminator D. The output of this is fed back via d.c. amplifier DA, to control the modulator frequency. A portion of the video signal before modulation is taken to the visual indicator and to the sync circuits.

To be continued



PHOTOMULTIPLIERS are devices that convert radiant energy, which may be visible light, infra-red, ultra-violet, X-ray or gamma rays, into electrical energy. What distinguishes photomultipliers from the simple photocells which also perform this function is that the electrical signal is greatly amplified by factors of 100 to 100,000 times by a process which, unlike any other method of amplification, does not introduce any noise into the electrical signal.

Both photocells and photomultipliers are vacuum devices, and like any valve require high voltages for their operation and are physically large. On these counts, there are several applications where semiconductor light detectors such as photo-transistors, photoresistors (such as cadmium sulphide) and photovoltaic cells (selenium cells) are more convenient. There are, however, many applications where a small light signal must be noiselessly amplified, where changing temperatures must not affect the operation of the photodetector, and where it must respond to very rapid changes in light level. Photomultipliers are used industrially

in "light gates" where the interruption of a light beam can open doors or prevent the operation of a piece of machinery; here the insensitivity to temperature change is important. When infra-red signals, light from a distant star, or scattered X-rays must be measured, the small power of the incoming radiation means that considerable amplification of the incoming electrical signal is necessary, and the signal may be very much smaller than the noise produced by an amplifier. In such cases the noiseless amplification feature of the photomultiplier is vital.

Flying-spot scanner

Another extremely important use of the photomultiplier is in the television transmission of pictures by a flying-spot scanner. Such scanners are an extremely useful method of producing TV still (or, with some extra ingenuity, moving) signals with a minimum of expense, and the conversion of the light signal to a TV signal requires a device

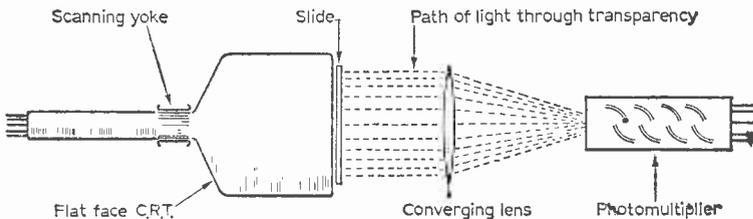
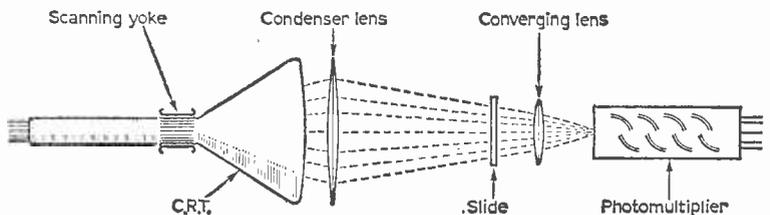


Fig. 1 (left): Simple flying-spot scanner arrangement using a flat-faced c.r.t.

Fig. 2 (right): A more efficient flying-spot scanner arrangement in which a more complex optical system is used.



PHOTOMULTIPLIERS

which can perform the conversion at video frequencies (up to 3Mc/s). This the photomultiplier can do easily.

The flying-spot scanner is, in fact, an example of the use of each of the desirable features of the photomultiplier: rapid response, noiseless amplification of small signals, and insensitivity to temperature.

Principle

In its simplest form the flying-spot scanner (Fig. 1) uses a cathode-ray tube on the face of which appears a raster of constant brilliance. A photographic transparency is placed in contact with the face of the tube, and the light passing through the transparency is focused by the converging lens on to the sensitive area of the photomultiplier. At the position of the c.r.t. scanning spot the light from the c.r.t. passes through the transparency, the amount of light emerging depending on how transparent the transparency is at that point. As the spot scans the face of the c.r.t. the transparency is also scanned, and the light focused on the photomultiplier generates an electrical signal which is the video signal corresponding to the transparency used. Since the video amplifier can invert this signal if necessary, either a positive or a negative transparency may be used. The simple technique requires a c.r.t. the same size as the transparency, but a more complex optical system enables us to use any size of c.r.t. or transparency (Fig. 2) or even an opaque photograph, print, drawing, or object (Fig. 3). It is also possible to

split up the light so as to feed three photomultipliers, using a colour filter in front of each to obtain separate colour video signals.

Basic photoemissive cell

To understand the photomultiplier, we must first understand the idea of photoemission. Historically, the discovery of photoemission was a turning point in physics, as it stimulated the discovery of the electron, the development of quantum theory and an entirely new outlook on our ideas of light. In 1888, an experimenter called Hallwachs found that a zinc plate suspended from a non-conducting thread and charged up from a high voltage lost its charge if it was exposed to ultra-violet light. Even before this, it was known that sparks were more easily obtained from an induction coil in daylight than in darkness. Later, in 1902, Lenard found that electrons were set free from several materials when they were struck by ultra-violet radiation, and that the same materials liberated electrons when struck by visible light. The speed of the electrons depended only on the wavelength of the light and not on its intensity, which controlled only the number of electrons. These results could not be explained by the theories of physics then existing, and they were accounted for only when Planck and Einstein applied the (then)

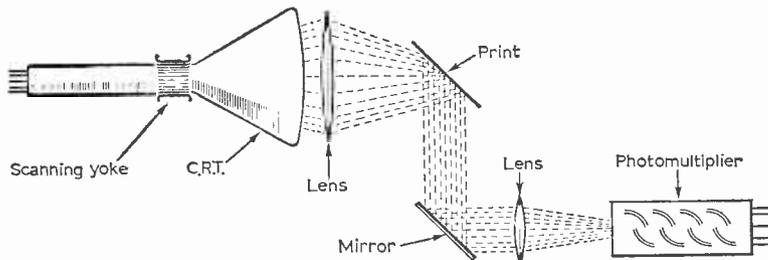
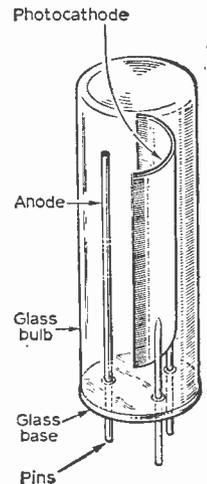


Fig. 3 (above): Flying-spot scanner for prints.
Fig. 4 (right): Basic vacuum photoemissive cell.



new quantum theory to the photoelectric effect, as it was called.

We know now that most pure metal surfaces emit electrons readily when they are bombarded by radiation (a thin film of gold is an excellent detector of ultra-violet), but not many respond to visible light. Moreover, if we graph the electron output from a metal against the wavelength of the light we have a different shape of curve for each metal; in this way it is possible to make photocells which respond strongly only to certain colours of light.

To make a useful practical photocell we must have some way of measuring the electron stream driven off by the light, a means of directing the light on to the electron emitting material, and a material which gives a high electron current for a given light input. These requirements are fulfilled in the vacuum photocell shown in Fig. 4. The emitting material is deposited on a curved metal plate known as the photocathode. A metal pin is placed centrally in the tube and is insulated from the photocathode. It is run at a voltage positive to the photocathode and is thus the anode. The assembly is inside a glass bulb, so that light can reach the photocathode, and the whole bulb is evacuated so that electrons may travel easily from photocathode to anode.

In use the cell is wired up with a positive supply to the anode in series with a detector of current (microammeter or amplifier), and a negative supply to the photocathode, the light source being directed on to the photocathode. The standard unit of light measurement used is the lumen, a unit which indicates light power. Unfortunately, the relation between lumens of light and watts of electrical energy is not straightforward, as the power of light varies with its colour, but for green light approximately 620 lumens equal one watt. It should be noted that the inefficiency of lamps and the colour restriction means that a one-watt lamp emits rather less than one lumen of green light, and the actual amount depends on the temperature of the filament as well.

There are, however, methods of measuring the luminous output from a lamp, and the electrical current from the photocell for one lumen can be calculated. The actual value depends on the photocathode material used but is usually about $30\mu\text{A}$ per lumen. When we consider that the light produced on a photocell by a flying-spot scanner may be about 0.001 to 0.00001 lumens, the need for the noise-free amplification provided by the photo-multiplier can be understood.

Photosensitive surface

The essential part of both photocells and photo-multipliers is the photocathode. In photocathodes used for visible light a single metal is never used, and the precise technique used for preparing the photocathode surface has an enormous effect on the sensitivity of that surface. No two photocathodes are identical, and photocathodes made from the same materials in the same way by different people can be quite dissimilar. In spite of this, there is some degree of standardisation of photocathodes in terms of the ratio of current at a particular light colour to maximum current, and

photocathodes are allocated S numbers (S—1; S—10; S—20) according to their colour response and maximum sensitivity.

Practically all the commonly found photocathodes are based on the alloy of the metal-like material antimony and the alkali metal caesium, or on the silver and caesium alloy. All the alkali metals—sodium, potassium, caesium, rubidium and lithium—are photoemissive, but the compound with antimony is very much more photoemissive than any metal alone. Exposure to air, however, instantly oxidises the alkali metals so that photocathodes must be made in a vacuum and kept in a vacuum. The easiest way of doing this is to form the photocathode while the tube is being pumped, the method employed depending on the type of photocathode being prepared. The silver-caesium photocathode starts as a coating of silver plate on a nickel cathode of the shape shown in Fig. 4. The cathode and anode pins are assembled on to the tube base along with a metal pellet which contains a mixture of caesium chromate and silicon. When air has been evacuated from the tube, a very small amount of oxygen is introduced, and a high voltage is applied between the anode and cathode. The gas discharge which ensues oxidises the surface of the silver slightly, and greatly enhances the sensitivity of the photocathode. The oxygen is then pumped away, and a sensitive microammeter connected in series with the anode. A light is directed on to the cathode, and the metal pellet is heated by induction from outside the tube. The effect of the heat on the chemicals inside the pellet is to release caesium vapour which lands on the silver oxide surface and reacts chemically with it. When this happens at the correct temperature photo-emissive current can be read on the microammeter, and the caesium vapour is released until the current has reached a maximum and dropped again. When the caesium generation has stopped, the photocurrent can be seen to rise again as the tube cools. The tube is then sealed and taken off the pump.

Simple photocathodes of this type give sensitivities of 5—15 μA per lumen; to reach the very high levels of sensitivity of modern photocells a multi-alkali photocathode must be used. Such a photocathode is usually deposited on glass, the glass forming the end window of the tube. A film of antimony is evaporated from a hot wire with the tube cool. Potassium is liberated from one pellet with the tube hot, until a certain sensitivity is reached, and more antimony is added. Then sodium is released from a second pellet with the tube at a higher temperature, followed by more antimony. The temperature is then lowered again, and successive additions of caesium (from a third pellet) and antimony are made until no higher sensitivity can be obtained. Again, the process is stopped only when the sensitivity has passed a maximum, and the sensitivity increases as the tube cools. Photocathodes of this type can be made to give sensitivities of more than $100\mu\text{A}$ per lumen, and a sensitivity of 200 has been achieved. They have the added advantage that their response to colour is very similar to that of the human eye; also, by thickening the antimony layer, the red response can be boosted for use in the red detector in a colour network.

PART 2 NEXT MONTH



Servicing TELEVISION Receivers

No. 140 - THORN 980 CHASSIS

by L. Lawry-Johns

RECEIVERS using this chassis are the Ferguson "Junior 12", H.M.V. "Imp", Ultra "Cub" and Marconiphone Model 4618. These receivers are intended as "second" sets being very light (15 lb.) and easily carried from room to room. There is no provision for u.h.f. reception and therefore the circuitry is simplified for 405 line (Band I—III) standard only. Another limitation is that there is no mains adjustment and the sets should only be used on normal a.c. mains supplies, 220—240V. The tube is a 12in. Mazda CME1201 "Rimband" with no implosion screen.

Unboxing

To obtain access to the chassis, the rear section or shell of the cabinet is removed. This is secured by four screws at the front. First remove the two top front screws and then lay the receiver face down on a soft surface. Remove the two screws from the front underside. Ensure the telescopic aerial is removed from the coaxial socket. Lift off the shell, feeding the mains lead in as far as required. Care is required when the shell is replaced as the two hold controls can easily be bent and damaged if their slender knobs do not accurately pass through their respective holes. Also the mains lead should be withdrawn as the shell is replaced to avoid excess cable inside pushing valves, etc., out of position.

All the circuitry is on a single printed panel. The tube, loudspeaker and tuner unit are separately mounted on the front panel. To separate the front panel and tube from the tuner and printed board, first remove the knobs of the tuner, unsolder the two inner leads from the tag board of the sound output transformer and the earth lead of the tube strap from the copper of the printed board (this is underneath). Then remove the screws marked A on the general rear view diagram (Fig. 2). Remove the c.h.t. cap from the side of the tube and unplug the c.r.t. base connector. Slacken the screw of the deflection coils assembly clamp. Remove the printed panel from the clips on the front and withdraw the tuner unit and the printed panel together with the deflection coils assembly. Alternative fixing bosses are provided in case the original fixings are damaged. There are three for the c.r.t. mounting brackets, also for the front-to-back stay and tuner front-bracket.

Circuit features

It has already been mentioned that there is no provision for mains adjustment. A BY101 silicon diode (W9) is used to supply the heater line. For a full explanation of this system readers are referred to page 27 of the October 1967 issue (Bush TV135

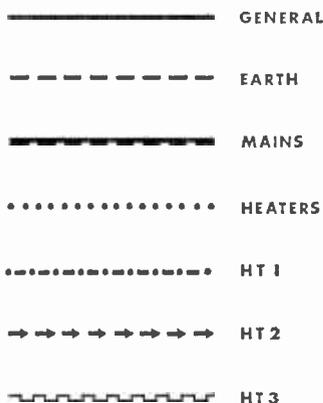


Fig. 1: Coding used on the printed circuit board.

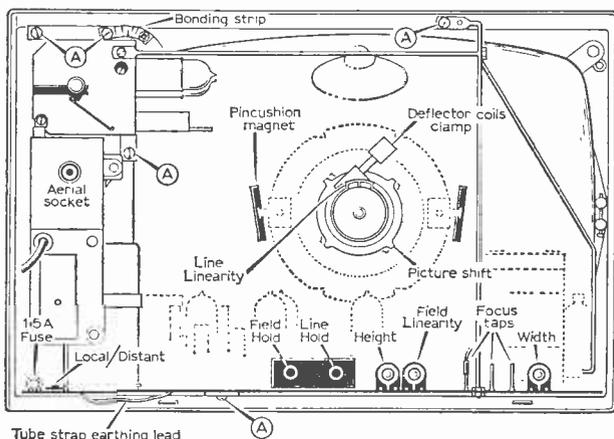


Fig. 2: Rear view to show presets and dismantling points.

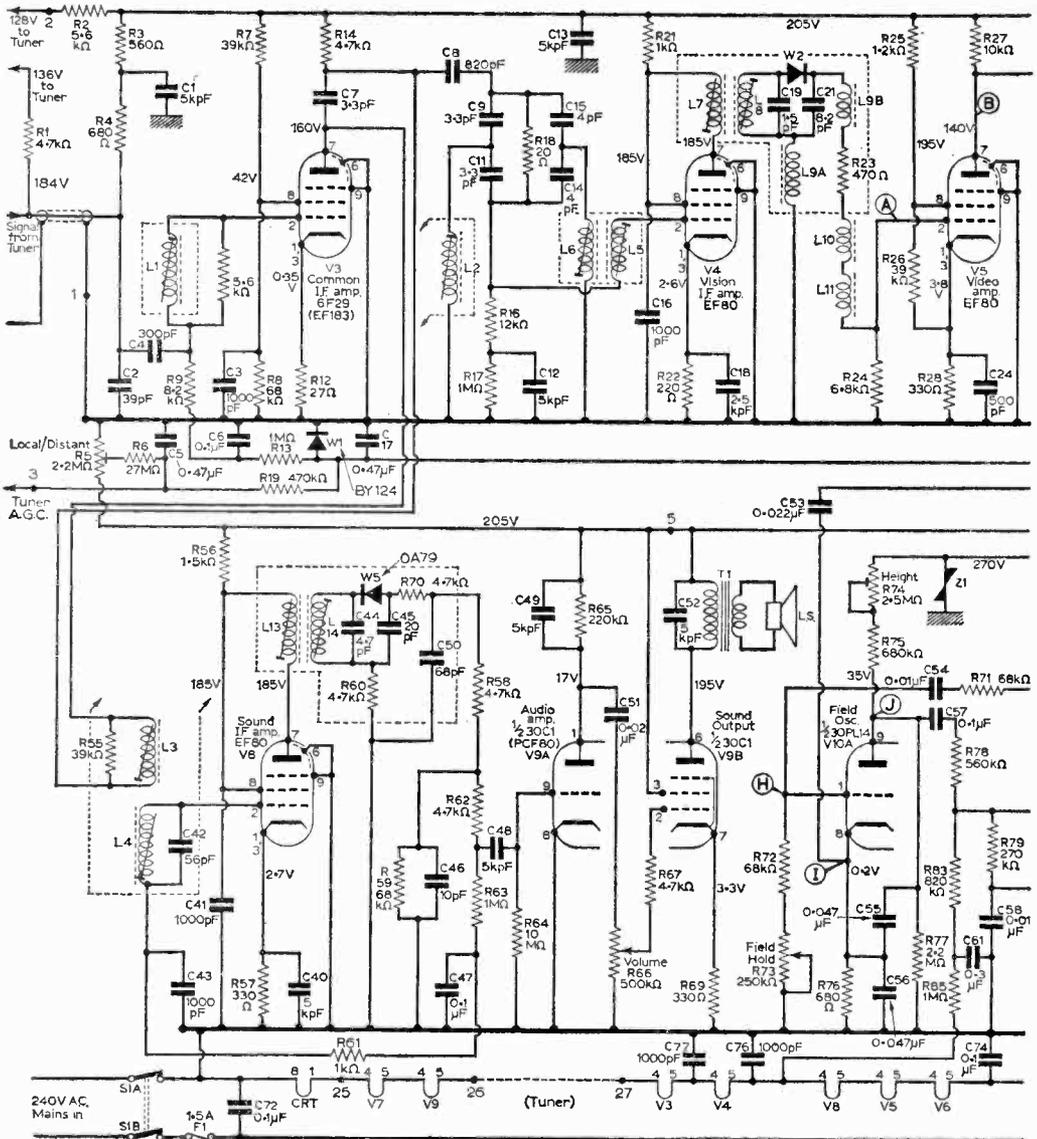


Fig. 3. Circuit diagram of the

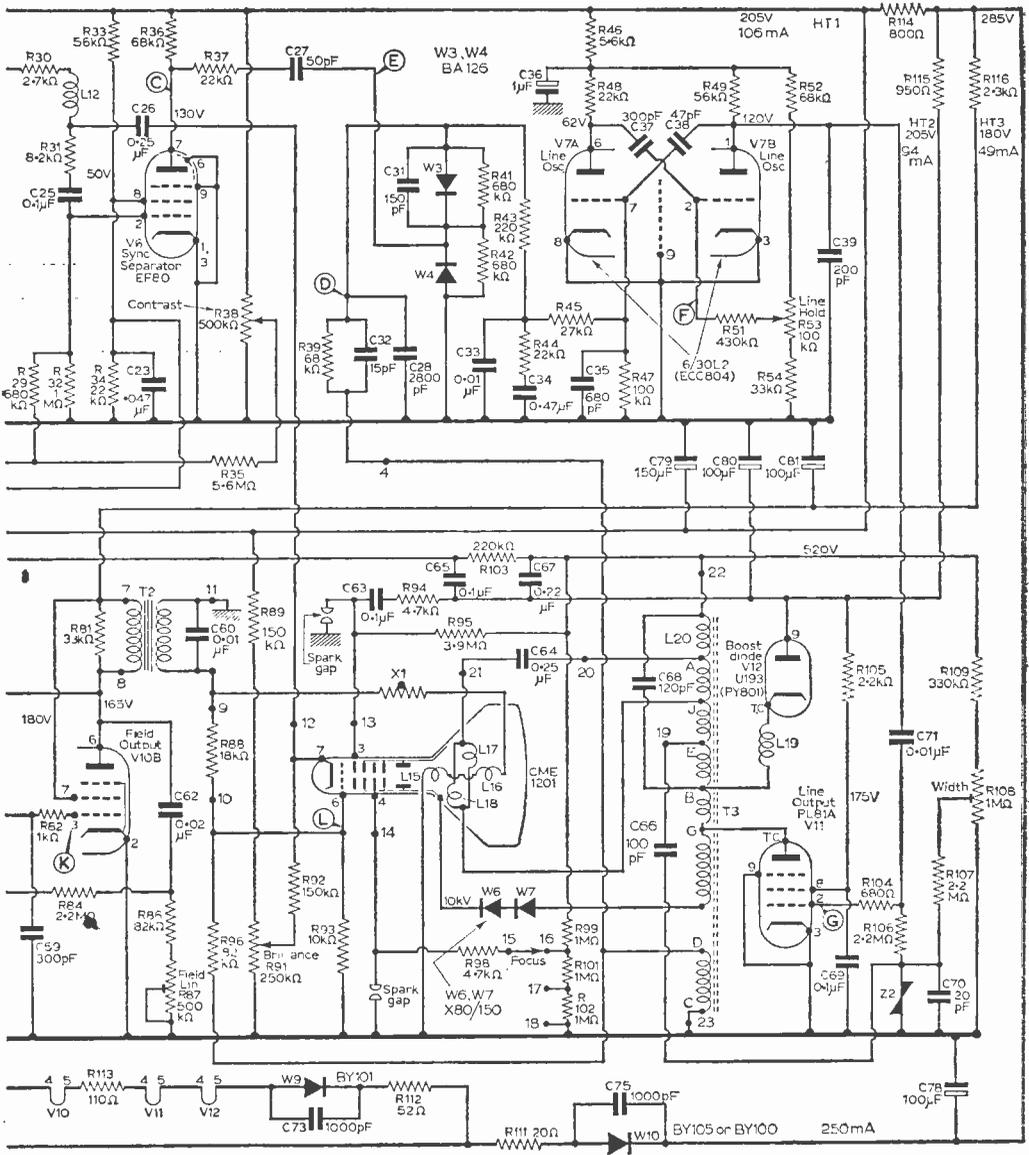
series). In this case the warning indication of trouble in the heater line is in the bias to the field output stage (R85 connection to V8 heater), not to the sync separator as in the Bush receivers. There are two resistors in the heater circuit, R112 (52Ω) and R113 (110Ω). These should be checked when the heater chain is dead.

The h.t. rectifier (W10) is a BY105 or BY100 in series with a 20Ω surge resistor R111. All the main smoothing electrolytics are in a single can (C78, 79, 80 and 81). Apart from C36 over on the front centre (1μF) there are no other electrolytics. The

field output does not use cathode bias and the audio output is unbypassed for current feedback.

E.H.T. rectifier

The rectifier used (W6, W7) is a scaled down version of the multi-pencil type box used in the larger Thorn chassis, as only 10kV is required. For those not acquainted with this method of e.h.t. supply it follows the voltage doubling and tripling system used in some earlier receivers mainly of the projection type. This basic idea is to avoid



main chassis, Thorn 980 series.

a very high voltage overwind on the line output transformer. Projection receivers used three EY51 in a tripler circuit to provide some 25kV. The Thorn system is to use a small plastic box, which is easily removable, containing whatever number of pencil rectifiers is necessary. This is a very nice system but the smell produced when they break down would turn any chemistry class school-boy green with envy! So when the customer says his set contains stink bombs as well as producing no picture, go straight for the c.h.t. box. The rectifiers used are of the X80/150 type.

Voltage and current measurements

The readings given on the circuit diagram (Fig. 3) were measured with 240V a.c. mains input, no signal, and all controls set for normal operation using, except for c.h.t., an Avo Model 8 (20,000 ohms/volt). Due to the silicon rectifier in the heater supply line a moving-iron or hot-wire meter should be used to obtain accurate voltage and current measurements in the heater chain: an Avo meter will read approximately 0.2A d.c. and 4V d.c. across a 6.3V heater.

To be continued

STOCKHOLM'S TELECOMMUNICATION TOWER

by E. P. Young

tower and a surrounding three-level ground structure, which is also in the form of a square. The sides of the tower are 10 metres. At the height of 80—100 metres there are four balconies, placed diagonally, where radio-relay aeri-als are located, while, at 120—130 metres above the ground, there are four levels shaped as eight-pointed stars and intended for the general public. Here, the windows are tinted blue which helps to keep the heat out, as in Sweden the temperature of 100°F is not uncommon in summer. There are two high-speed lifts, said to be the fastest lifts at present in use in Europe, for transportation to the upper levels. Each of these lifts can take 13 persons at a time.

In the entrance lobby of the ground structure, which visitors pass through on their way to the lifts, two walls are covered by a very futuristic work of art called "Playroom Futurum" produced by Walter Bengtsson, a renowned Swedish sculptor. The material he used is nickel-plated and partially enamelled copper. The exterior of the tower is also adorned with relief designs which refer to television techniques. Also here, visitors may take part in a competition to find a name for the new tower, the winner receiving a prize of 5,000 Swedish Crowns.

The telecommunication tower is designed to serve as a switching centre of the Telecommunications Administration of Sweden's country-wide network for the distribution of sound-broadcasting and television programmes. The tower contains radio-relay equipment for television, sound-broadcasting and multi-channel telephony as well as equipment for power supply, ventilation etc.

In the ground structure is located the Stockholm-broadcast control centre; the central operation point of contact between the Telecommunications Administration and the Swedish Broadcasting Corporation. Here are performed the switching and supervision of the programme circuits covering the whole country. In addition, this ground structure houses the remote control centre for the technical operation and control of the communication circuits and the transmitter stations in large parts of eastern Sweden.

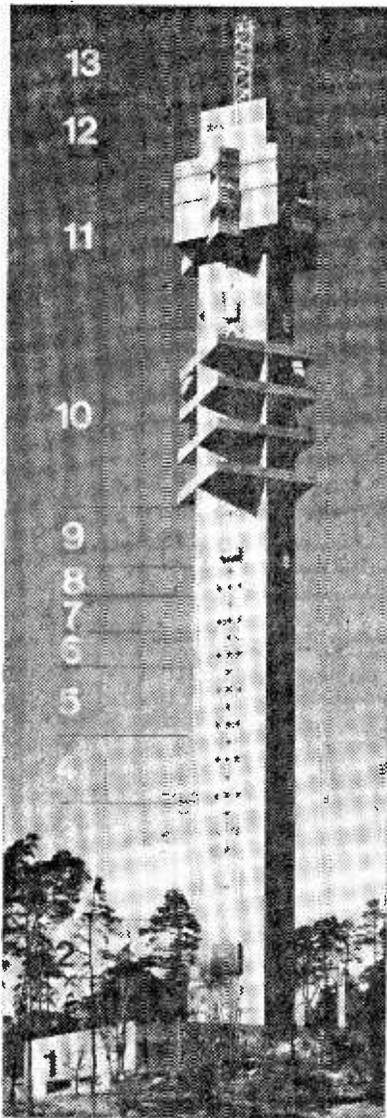
The tower has also, from the outset, been provided with equipment for a possible future distribution of colour television and stereophonic sound. Put to use on a partial basis in 1966 for the relaying of television programmes destined for the North of Sweden inter alia, the tower will be ready for full operational service by the turn of the year 1967/68. By then it will take over activities so far carried out by other broadcasting centres in Stockholm at 8 Kungsgatan and 117 Valhallavägen.

There are approximately 70 people stationed in the Telecommunication Administration's section of the tower building and they have to work by shifts because 24-hour supervision is essential at the control desks.

The cost of the whole tower—including the technical equipment—has been estimated at about 30 million Swedish Crowns (1 crown = 1s. 5d.), and the city of Stockholm has contributed towards the costs and is also in charge of the restaurant and the belvedere galleries. It is estimated that over 200,000 persons visited the tower in the first two months of its inauguration.

There are thirteen sections of the Stockholm tower and these are indicated by numbers on the photograph as follows:—

1. The ground structure houses the offices and operational



A NEW ATTRACTION for tourists in Stockholm is the telecommunication tower at Kaknäs. Construction started in the autumn of 1963 and the official opening was May 12, 1967. As can be seen from the first picture there are certain similarities with our own Post Office Tower in London. The slender concrete structure is, perhaps, rather less elegant than the GPO Tower and is certainly not as high, being 455ft. (as against 580ft.) for the main structure, plus a 52.5ft. (as against 40ft.) trellis mast, bringing the total to 507.5ft. (compared with 620ft.)

The new edifice consists of a 140 metre high, square shaped radio-relay

premises of the Swedish Telecommunications Administration's Broadcast Control of the Stockholm region. Here are performed the selection, switching and supervision of sound and television broadcasting circuits between the studios of the Swedish Broadcasting Corporation and transmitter stations located in various parts of Sweden, of circuits used by the Corporation for the gathering and recording of programme components, and of circuits used in the international exchange of broadcasting transmissions. It contains also remote-control equipment for the technical operation of a large number of transmitter and radio relay stations in Sweden.

In a basement beneath it, where the entrance to the lifts is, there is a diesel-powered emergency power plant which comes into operation automatically about 20 seconds after a failure of the mains power supply.

2. On this level are located the installations for air-conditioning, which includes the moistening of the air to the correct humidity required for the proper functioning of the telecommunications equipment located on the ground floor.

3. Here is the power supply control plant, including voltage stabilisers. If the mains supply should fail, the batteries of this plant supply the power required until the emergency generator (in the basement) starts working. Here is also the power supply apparatus for the battery-fed telecommunications equipment.

4. Spare parts store.

5. Offices and archives.

6. Store-rooms.

7. Premises for testing and repairing radio-relay equipment.

8. Sundry radio equipment.

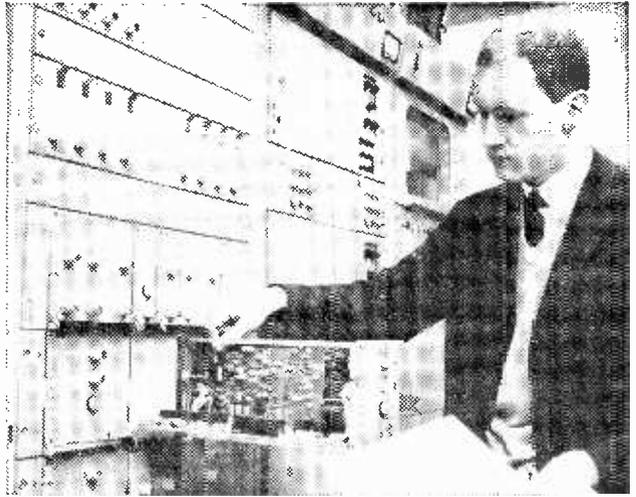
9. Equipment for ventilation of the radio-relay rooms.

10. Five levels here house radio-relay equipment for sound and television broadcasting, as well as for multi-channel telephony. On four of these levels there are balconies where large parabolic aerials for radio-relay links are mounted.

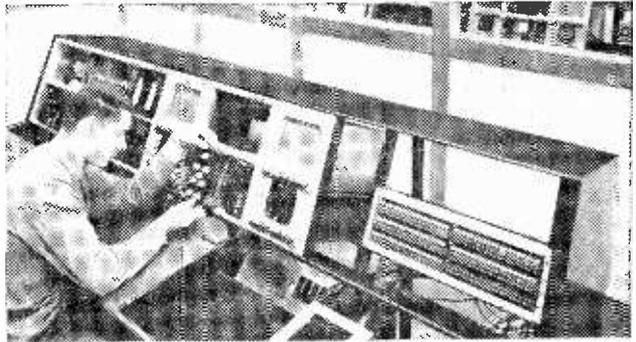
11. Eight levels here house a restaurant (for 200) and its appurtenant premises, on two of which there are observation galleries, one open, the other glazed.

12. This level, which accommodates the ventilating plant and the lift engines, serves as a base for the trellis mast at the top of the tower.

13. The steel trellis mast on top of the tower, 52ft. 5in. in height, is for carrying such aerials as have to be mounted higher than the balconies at 10. It is provided with fixed and rotating flight warning lights.



An engineer checks a rack containing a generator for measuring signals over the television network.



A telecommunications worker assembling one of the nine broadcasting control desks. From these desks is controlled the quality of radio and television transmissions. All desks have equipment prepared for the transmission of stereophonic sound and colour television.



Here, an engineer tests a colour television monitor.

DX-TV

A MONTHLY FEATURE
FOR DX ENTHUSIASTS

by Charles Rafarel

NOT much to report this time, but as I write these lines there is at least a small batch of Sporadic E openings of recent date to note, and this is quite late in the season.

10/9/67. E3 and E4 Sweden, E2 Norway.

11/9/67. E4 Norway, E4 Spain, and E4 Switzerland.

12/9/67. E4 Sweden, IB Italy.

20/9/67. R1 and R2 USSR, E2 Spain.

22/9/67. R2 Czechoslovakia, E2a Austria.

29/9/67. E2, E3 and E4 Sweden.

6/10/67. R1 Czechoslovakia, E2a Austria, and E3 W. Germany.

7/10/67. R1 Czechoslovakia, E2 W. Germany.

10/10/67. R1 USSR.

15/10/67. R1 and R2 Czechoslovakia, R1 Hungary, E3 and E4 Yugoslavia, plus a number of unidentified programmes.

Even though this is the worst period of the year, this time it seems to be the duller spell that I can remember. However, I feel pretty certain that by the time you read these lines we shall be "in business" again, at least as far as the "Trops" are concerned.

The best days for the Trops would seem to have been the 9th and the 11th October, when the French Band III and u.h.f. stations came rolling in down here. News from DX friends:

(1) I have heard news indirectly from an old DX friend (Frank Smales, of Pontefract) who heard a New Zealand ham on short waves telling his English counterpart that he had received TV Band I from both BBC-1 and ORTF-1 in New Zealand during July last (F2 openings, of course) during the NZ winter, so there is hope for us later on in January, February and March, 1968.

(2) Our old friend R. Bunnev reports the opening of the following new stations and alterations to existing ones:

Denmark. Copenhagen Ch.31 1,000kW Hor.

France. Bourges-Neuvy Ch.26 1,000kW Hor.

Le Mans-Mayer Ch.27 1,000kW Hor.

Strasbourg Ch.56 1,000kW Hor.

There are also a number of new ORTF/u.h.f. stations that I feel are too far south to be possible here, and these are omitted.

France. Rouen Ch.33 power up to 500kW (I have already noted improved reception of this, and now we know why). Metz-Luttanges Ch.34 new mast 235 metres high, was 30 metres (the same applies here).

W. Germany. Minden Ch.26 500kW, was 250kW. Osnabrück Ch.50 250kW, was 12.5kW.

E. Germany. News that there is now a proposed second chain. Details to follow.

(3) Back to the old problem of the Polish-Hungarian test cards, we are still in trouble here as far as I can see!

As mentioned last month, my wife and I have been in Czechoslovakia and Hungary, and I intended to call on M.T. when I was in Budapest but, like all capital cities, Budapest has its parking problems and after some two hours' delay in crossing the Czech-Hungarian frontier I did not in fact have enough time to locate the M.T. office to make inquiries.

What I did see, however, was the M.T. test-card in Siofok on Lake Balaton where we stayed. The transmitter was Kabhegy Ch.R12, just across the lake, but the hotel TV set was just awful and the picture weak and "smeared" badly, but the figures that we have written about recently were *white* as far as one could see!

There are two possible interpretations of this. Firstly, Hungary has white figures, and I feel that this is probably correct, or secondly, there is the possibility that M.T. use two types of card and this would explain the conflicting reports in the past. So it looks as if we will, after all, have to try and clear this up by correspondence with Budapest.

We welcome a comparative beginner, J. W. Harrower, of Falkirk. After only six weeks DX-ing, his log includes Spain, Switzerland, Italy, France, USSR, Poland, Czechoslovakia, Hungary, Austria, W. Germany, Sweden, Finland, Norway, Portugal and Yugoslavia. Total: 36 stations in 15 countries. Excellent! His address is 6 Wolf Road, Falkirk, Stirlingshire, and he would welcome contact with other DXers in his area.

D. Kelly, of Castlewellan, NI, has been getting most of the usual stations, but a new one for him is E. Germanv Cottbus (rare now). He has had Finland not only on E2 and E3 but E4 as well. This is most interesting as no station is listed as vet for E4. I feel from his DX-TV experience that he is not likely to be mistaken, so there may be a new one about!

A. Papaefvtchiou, of Cyprus, again reports F2 activity and the reception of African stations in his area, most activity on E3 and E4 rather than E2. He notes that E2 Enugu, E. Nigeria is "missing" but I would feel that there are other explanations than poor conditions for this. It would seem that politics can harm DX too! He says that with the decrease of S.P.E. activity F2 is much easier to identify, so that is good news.

D. Bowers, of Saltash, reports that the relief map of the Canary Islands appears as a background to their news reader, so that should help us in identification. He also quotes the R.S.G.B. on coming sunspot activity with figures as follows: Nov. 1967=96. Dec. 1967=98, Jan. 1968=100, i.e., good DX via F2 to all of us!

servicing with a **NEON TESTER**

V. D. CAPEL

IT may happen that one is called upon to service a television receiver unexpectedly when there is no meter or other test equipment available. A pocket tester that can always be carried, however, is the neon screwdriver. Its use in diagnosing faults is limited, but it is surprising how numerous are the tests possible with it. Many professional field engineers find it so quick and convenient to use that they always conduct the preliminary examination of a defective receiver with its use. Some skill is necessary in interpreting the results obtained but this can be attained with practice.

The neon lamp has no d.c. path through it as is the case with a filament lamp. It consists of a pair of electrodes mounted in a glass envelope filled with neon gas. A potential applied across the electrodes causes a current to flow and the gas becomes ionised resulting in the emission of a pale red glow. The lamp is a high-impedance device as only very minute currents flow. This being the case, quite high series resistances can be introduced in the circuit without greatly affecting performance.

Such a resistance is offered by the body of the operator. When one side of the neon lamp is connected to a live point and the operator is in contact with the other side, current will flow through the lamp and through the operator's body to earth. This current is so small that the operator is not aware of it, but for safety purposes a further series resistance is included in the tester in order to limit the flow of current. The path taken by the current is shown in Fig. 1. Neon testers are normally made in the convenient form of a screwdriver where the screwdriver blade forms the probe and a metal clip at the back the other electrode connection with which the operator's hand must be in contact. The indicator lamp is viewed through the clear handle of the screwdriver. An obvious advantage of this device is that only one connection needs to be made to the circuit under test and no connecting leads are required.

In the case of a "dead" receiver in which the valves are not alight the neon tester can be of great help. First, test the mains plug and lead. A common mains input arrangement is shown in Fig. 2. Place the neon tester on the fuses, one of which should show live. The other conductor of the mains lead can then be tested by reversing the mains plug in its socket whereupon the other mains fuse should show live. Where a 3-pin plug is fitted this may be inconvenient, and so an alternative test can be applied. This, in the arrangement shown, entails simply turning the mains switch of the receiver on and then checking again at the two fuses (note that in many receivers the switch comes before the fuse, and in most modern sets only one fuse is used, on the live side). Only one should show alive. If both are alive this shows that

the neutral lead to the mains plug is open-circuit. The reason for this is clear from Fig. 2, where it can be seen that the neutral fuse is connected to the live side of the mains by means of the internal circuit through the receiver. Tests should of course be made at both sides of the fuses as one of them could be the cause of the trouble—this will quickly be shown up by the neon tester. If one side only shows live the fault is in the internal circuitry; if both fuses or neither light up then the fault is in the mains lead or plug.

Should the indication reveal a fault in the internal circuitry there are four possible causes; the switch, the mains dropper or thermistor, a valve heater, or an open-circuit connecting lead. The latter is unlikely except perhaps in the case of interconnecting leads between panels or chassis. The most accessible of these points is normally the mains dropper which is positioned to achieve adequate ventilation. A quick touch on all the tags of the mains dropper with the neon tester will reveal whether all these are live. If one is not there is likely to be an open-circuit in the dropper between this tag and the one preceding it. Care should be taken not to be misled here though as sometimes separate resistors, such as the h.t. surge limiters, are wound on the same former as the heater circuit resistors. Before checking the mains dropper be sure that the mains plug is correctly connected so that the live side does in fact go to the top end of the heater chain rather than the chassis. This incidentally is another use for the neon tester, to check that the chassis connection is correct for safety before working on it with conventional test equipment.

If the dropper appears to be in order the next

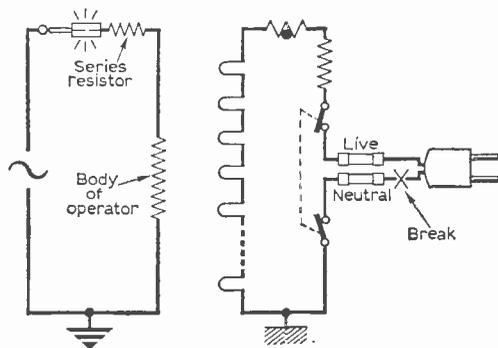


Fig. 1 (left): The current path through the body when using a neon tester. Fig. 2 (right): A break in the neutral conductor of the mains lead makes both mains fuses live.

step is to check through the heater chain. This is often a tedious and time-consuming operation, especially if a circuit diagram is not available. It helps to remember that the rectifiers, h.t. and boost, are at the "hot" end of the chain, generally followed by output valves, the line output first, while at the "earthy" end are the c.r.t. heater, the tuner and the sound detector stages. Time can often be saved by starting half-way down the chain and then working in whichever direction the fault appears from there. A live indication will show that the fault is below the selected point whereas no indication will show that the fault is above it. The defective heater is reached when a live indication is found on one side but not on the other.

Many field engineers go straight for the tube heater as this is the easiest to reach, and in order to set the owner's mind at rest at the beginning. Double-diodes of the EB91 type are frequent offenders with open-circuit heaters. It often pays to check these first, saving unnecessary checking through the rest of the heater chain.

While electrode connections to the pins of various valve types are not standard fortunately heater connections largely are, and this is a help when checking through the chain. The heaters of most 8-pin valves (B8A and B8G bases) are pins 1 and 8; those of 7-pin (B7G) valves 3 and 4; and those of 9-pin (B9A) valves 4 and 5. In the case of double-triodes using the 9-pin base such as the ECC82 etc. a centre tap is provided at pin 9. These types are usually connected so that pins 4 and 5 are strapped together and the other lead connected to pin 9, thereby putting both halves of the heater in parallel.

Where the heater chain is intact and the valves are alight the majority of faults can be detected by making h.t. measurements. Accurate readings are obviously only possible with a meter but the neon tester can be used to determine whether h.t. is present at a point or not and can thus aid in the diagnosis of numerous faults.

Neon lamps will work equally as well on d.c. or a.c. and are thus suitable for making h.t. tests. A difference in the illumination with d.c. will be noticed because the glow will be centred around one electrode instead of around both as is the case with a.c. Surge limiters and smoothing resistors as well as feeds to remote points such as the tuner unit can therefore be checked by using the neon tester.

The presence of h.t. on valve electrodes can also be checked, although care must be taken with the miniature pins on present valve bases not to short one to an adjacent pin with the flat blade of the screwdriver neon tester. Such valve base checks enable tests to be made of the primaries of output transformers, screen grid resistors and so on. Open-circuit cathode resistors can also be checked by connecting the neon to the cathode pin of the valve holder. The low cathode potential will be insufficient to cause the neon to strike, but if the resistor is open-circuit then h.t. potential will be found here through valve conduction, and the neon will glow. The principle is illustrated in Fig. 3.

In cases where there is no brilliance on the screen the neon tester can be used to quickly determine whether the line-output stage is functioning. All that is necessary is to hold the screw-

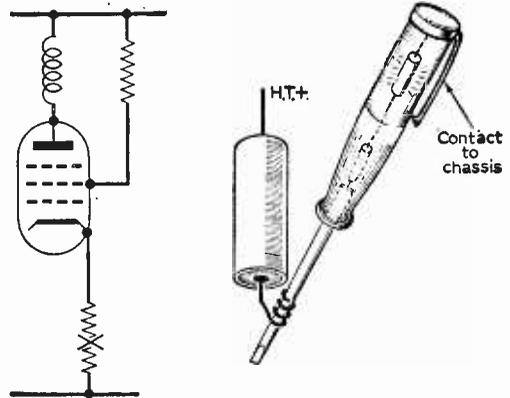


Fig. 3 (left): When the cathode resistor is o.c. valve conduction makes the cathode live. Fig. 4 (right): Testing a capacitor with the neon tester.

driver blade somewhere near the line-output transformer. The field surrounding this component is such that when it is functioning correctly the neon will be illuminated. The tester should *not* be used to contact a high-voltage source or to draw an arc from the top cap of the line-output valve, boost diode or e.h.t. rectifier.

Capacitors of the non-electrolytic type can also be tested with the neon tester. They must be taken out of circuit for the purposes of the test unless one end goes to an h.t. point, in which case this can be left. If the capacitor is not already connected at one end to h.t., one end of the capacitor is taken to a suitable h.t. point. The free end is then connected to the blade of the neon tester and the metal clip on the handle which is normally held in the hand is contacted to chassis. The effect will depend upon the value of the capacitor. High values such as $0.1\mu\text{F}$ and over will cause the neon to light brightly and then gradually die out, the operation taking a few seconds. Lower capacitors will die out much quicker, and in the case of $0.001\mu\text{F}$, about the lowest value which can be checked in this way, the neon will just give a quick flash. With practice it is possible to estimate the value of the capacitor under test. No flash at all indicates that the capacitor is open-circuit, whereas if the neon stays alight, even if only faintly, this points to an internal leak. Quite high resistance leaks can be discovered by this means.

When making normal tests with the neon tester held in the hand it is as well to remember that the current flow, and hence the amount of illumination, depends upon the total resistance to earth. If the user is standing on thick carpeting or if he is wearing rubber-soled shoes the illumination may be only very faint. In such cases the indication can be improved if the free hand touches a wall or some other part of the building structure. When testing for h.t., matters can be improved by resting the back of the free hand gently against the chassis. The chassis should never be gripped, as if the hand holding the tester accidentally touches a high potential point then a bad shock can result. Care must always be taken if the chassis is touched with the free hand. ■

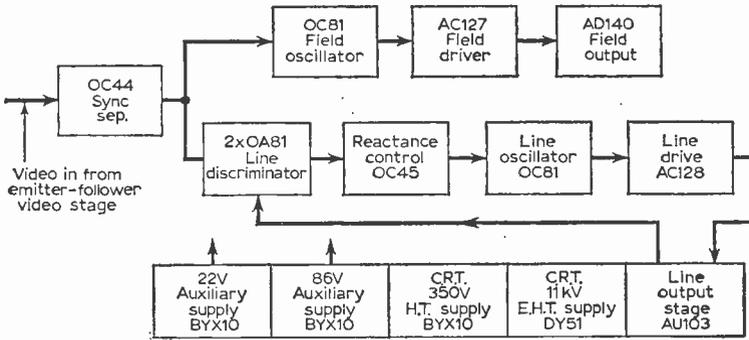


Fig. 11: Block diagram of the Philips T-Vette timebase circuits.

Valves arranged to operate as a varying reactance have been used for many years and the basic principle is easily applied to transistors. The basic idea is that a valve or transistor loads a tuned circuit, passing a current at 90° phase displacement to the applied voltage so that it functions as a capacitor or inductor, according to whether the current leads or lags the voltage. To the tuned circuit, therefore, the valve or transistor current

represents the most convenient point to do this. Of course the actual power drain is slight, otherwise a separate h.t. generator would be needed.

The block diagram (Fig. 11) shows the transistor line-up and usage while Fig. 12 shows most of the line timebase circuitry. The actual line output transformer has not been included since it generally follows conventional practice as used in valved receivers, with 405/625 switching, S-correction capacitors, and low-impedance scan coils fed from a tapping via series width and linearity coils. To prevent any surges on system change damaging the output transistor, the 405/625 switch first removes the power supply from the stage, then makes the necessary component changes before reconnecting the supply. A somewhat similar procedure is used in some valved dual-standard receivers to eliminate possible transient surges on system change but this is usually accomplished by holding off the line output pentode's screen feed resistor during switchover.

is purely capacitive or inductive, and if it varies so does the resonant frequency of the circuit.

In this circuit, coil L1 on 405, plus the parallel connection of coil L2 on 625, mainly determine the frequency at which the sinewave line oscillator Tr2 oscillates. Capacitor Ctun in series with resistor Rtun have values such that a near quadrature voltage is developed across the resistor, and this is fed to Tr1 emitter via the 1µF electrolytic capacitor. If the line speed alters, therefore, so will the phasing of the two pulses (sync and feedback) at the discriminator, producing a change in d.c. output to alter Tr1 base bias and thus restore the original conditions in the oscillator tuned circuit.

The output from Tr2 is coupled via T1 to the driver transistor Tr3, whose output in turn is coupled via transformer T2 to the high power line output transistor Tr4. The 180Ω/22kpf series network shunted across the primary of T2 is to limit collector current to a safe value.

Incidentally, the driver transistor operates in the

LINE SYNC

As can be seen (Fig. 12) a quite conventional two-diode discriminator (D1, D2) circuit, whose d.c. output voltage depends on the degree of synchronism between the incoming sync pulses and feedback pulses tapped from the line output transformer, is used.

This d.c. control potential is also compared with the voltage tapped across the 500Ω line hold control potentiometer, which is shunted across the chassis and h.t.2 rail between two limiting resistors (2.7kΩ and 150Ω). The resulting p.d. applied to Tr1, the reactance transistor, as base bias controls its conductivity.

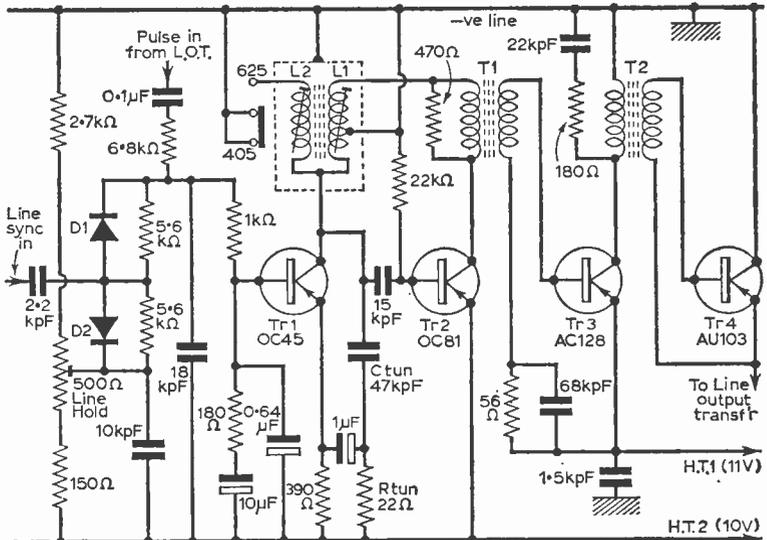


Fig. 12: Line timebase circuits, Philips T-Vette.

is again capacitively coupled to the npn output stage. An interesting point in this circuit is that the collector load of the output transistor is a choke with the field scan coils directly connected between the output transistor collector and the driver transistor emitter. As these transistors are of opposite type, these two points are both positive and, in this circuit, of almost equal voltage.

The basically simple line drive and line output stage of this receiver is shown in Fig. 14. The driver transformer T1 in the collector lead of Tr1 is tuned to the line frequencies, the resonant frequency being lowered on 405 by switching in the additional 0.15 μ F primary shunting capacitor. The 1-18 Ω resistor is in circuit only on 625 to reduce the driver transistor's collector current (the value is chosen between 1 and 18 Ω to maintain collector current at 85mA \pm 5mA).

The actual output stage uses three rectifiers in a voltage tripling arrangement to give 10kV e.h.t. from only a relatively small transformer secondary winding. The three filaments load the transformer somewhat, but serve to linearise its output. As with the Philips T-Vette, the line output stage provides an auxiliary h.t. feed (from rectifier D4) for other parts of the receiver and the c.r.t. first anode.

Diode D3 damps the line output transformer to prevent it ringing during that section of the line scan when the output transistor is cut-off. Diode D5 with its associated resistor and capacitor injects a negative flyback pulse from a tertiary winding on the output transformer to the grid of the c.r.t. to achieve line flyback blanking. Diodes D1 and D2 function as boost rectifiers charging up the 200 μ F boost capacitor to augment the output transistor collector voltage.

FLASHOVER PROTECTION

Many valved television receivers now incorporate miniature spark-gaps to act as low-resistance paths to surges produced by high voltage flashovers in the c.r.t. In most Thorn models, for example, both the c.r.t. first anode and focus electrodes are connected to such miniature spark-gaps. In solid state receivers this and other forms of protection are even more necessary in order to protect the transistors, especially the high power output types, from damage. In the Sony receiver, a spark-gap is connected from the c.r.t. cathode to chassis. In the Philips model there is a comprehensive system to eliminate transistor damage from this cause. This consists first of two 47kF capacitors (C1 and C2, see Fig. 15) connected from the c.r.t. focus and first anode electrodes to absorb any transient surges, while two spark-gaps protect the control grid and cathode. Then to assist a rapid build-up of voltage across the cathode spark-gap the cathode lead includes a 1.5k Ω resistor to hold-off the video circuit capacitance. Finally, the earth side of the capacitors, the c.r.t. aquadag coating and the earth connections of all the printed circuit panels are returned to one chassis point.

SERVICING

In general it must be admitted that servicing transistor television receivers is rather more involved, intricate and time-consuming than servicing valved models. For one thing, most valve

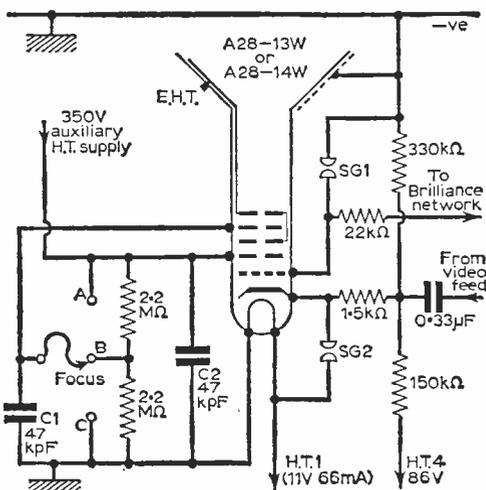


Fig. 15: Flashover protection circuitry, Philips T-Vette.

circuits are fairly conventional, the stages and valve functions easily identifiable, and components more accessible than in the necessarily confined transistor portable cabinets.

To clear most faults with speed, the maker's service manual will be found a great help. Transistor voltages need to be accurately measured, and probes or signal injectors will be found to be particularly valuable.

Possibly the most important point to remember is that while valves can withstand considerable overloads for a short time transistors, though more rugged in many ways, can instantaneously be damaged by a momentary overload or circuit surge. To this end arcs must not be drawn from e.h.t. points, electrolytics bridged while the set is working, or points earthed while making tests.

Soldering-irons must be of low wattage and earthed, while all probes must have an isolating capacitor to prevent changing transistor d.c. biasing conditions. If an r.f. or a.f. signal generator is applied to the circuit, always connect the earth lead first to ensure that none of the transistors are overloaded. When making resistance tests, use a meter that passes only a small current from a low voltage source; and remember that due to the low input and output impedance of transistors when the test current is the right way round (i.e. forward biases the junctions) in-circuit component tests can easily give misleading indications. To show up transistor effects on the reading, simply reverse the meter leads, but when in doubt about the value of any component it is best to isolate it at one end.

Finally, capacitors, transformers, shorting blobs on printed circuit panels and bad soldered joints account for most faults in these types of receiver. Always, before beginning any dismantling, thoroughly check the operation and effect of all controls and carefully note all symptoms. Very often a full observation of all symptoms allied to an understanding of how the circuit functions will immediately whittle down the probable causes of the fault and save much actual service work. ■

TIMES change. Fashions change. And so do the meanings of words and their legal and/or logical interpretations. This applies to the show business, including television, films and the theatre, to the customs and excise authorities and to the tax collectors generally. One and all are sympathetic towards any product which can be exported to earn dollars or any other currency. Rules and regulations however are not made to be broken.

Film manufacturers of sixty years ago

Sixty years or so ago, when large numbers of silent films were being made in England and exported to all parts of the world (especially to USA), the film makers were known as "film manufacturers"; indeed, one of the most important British film producers, Cecil M. Hepworth, named his company the Hepworth Manufacturing Company, whose studios were at Walton-on-Thames. This is the studio where the first *Robin Hood* TV series was made about forty years later. Several of the other film producers, such as Williamson, Kinemacolor, Friese Greene, Geo. A. Smith, together with Alfred Darling (the instrument maker who became a motion picture camera manufacturer), had their rather primitive glass-house studios in Brighton. This was in about 1908, before Hollywood, California, became the film-making centre of the world, the "Brighton of USA!" During the same period the British film exports to USA were almost strangled by high USA import duties and patent litigation by a combination of syndicates called the "Edison Trust". This ancient history may well be once more repeating itself in various ways, as it has done with phonographic cylinders, gramophone discs, sound-on-film recording, colour photography, colour television and colour video tape. Quite apart from the tough bargaining on royalties of a complicated character, which is now going on, the producer of programme material on tape or film is subjected to selective employment tax, as he is no longer considered to be a "manufacturer". Only the people who develop and print the film or make the film-stock itself are placed in that category, entitling them to a rebate on "this discouraging tax".

UNDER NEATH



THE DIPOLE

Television production exports

Fortunately, there are a few larger-than-life characters in the production side of films and television who take these things in their stride—in particular Mr. Lew Grade, of ATV and of the ITC, the latter company specialising in film series for television all over the world. When you count up the number of lengthy ITC television series now being shown in hundreds of American TV stations, it makes you think. Titles include *The Saint* (with Roger Moore), *Danger Man* and *The Prisoner* (with Patrick McGeehan), *The Champion*, *Captain Scarlett* (puppet series) and *Man in a Suitcase* (Richard Bradford). This represents millions of dollars currency coming back to Britain, in addition to many valuable 625 line video tape exports, such as the Morecambe and Wise

series. Physically, each valuable episode takes very little space on a 'plane to USA and, with cinema film negative or prints, can avoid the uncertainties of shipping hold-ups at the docks.

The acquired taste

The enormous success of the Grade—ITC film series in America has had an interesting and valuable result; it has given the American public a taste for the style of British production for the cinema as well as for the television series. When I was in New York for the Society of Motion Picture and Television Engineers Conference, I noted from the newspapers that over 200 cinemas in greater New York were showing British films. What do you know! It now looks as though British films for cinemas or television can be *themselves* and not try to look like a mid-Atlantic mixture.

Coincidences

You can't expect BBC and the ITV companies to organise their programmes to coincide or to differ in the subjects they present. From the viewers' point of view, it would be nice to be able to switch over from, say, high-brow surrealistic music on one channel to, say, a music hall comic on the other—or vice versa. Yet it is surprising how often the same type of subject matter turns up on both.

Arm twisters

Take, for instance, the BBC's series *The White Rabbit*, in which Kenneth More gives a magnificent performance of an RAF officer who acts as a liaison with the French resistance movement—and gets caught by the German counter-espionage. Of course, interrogation of a somewhat horrific type ensues. A few minutes later, turning over my set to ITV, I saw the start of *Man in a Suitcase*, a new series with a new star, Richard Bradford, who himself initiates a new off-beat fashion of not caring what people think, but as an ex-undercover, ex-security, ex-secret service man provides a new set of reactions to the "brain washing" and other strong-arm methods of scientific persuasion by a foreign country.

LAWSON BRAND NEW CATHODE RAY TUBES



The rapidly increasing demand for a complete range of new tubes of the very highest quality is now being met by the new Lawson "CENTURY 99" range of television tubes.

SPECIFICATION:

The new "Century 99" range of C.R.T.s is the product of Britain's premier C.R.T. manufacturers. All types are exact replacements, manufactured to the original specification but incorporating the very latest design improvements to give superb performance, coupled with maximum reliability and very long life.

"Century 99" C.R.T.s, available as direct replacements for the following makes and types

MULLARD		MAZDA		BRIMAR		EMISCOPE & EMITRON	GEC & COSSOR also ENGLISH ELECTRIC
MW43/69	AW36-80	CRM121	CME1901	C12FM	C17SM	4/14	141K
MW43/64	AW36-21	CRM123	CME1902	C14M	C197A	4/15	171K
MW36/24		CRM122	CME1903	C14GM	C1916A	4/15G	172K
MW31/74		CRM124	CME2101	C14HM	C1910AD	5/2	173K
MW31/16	Twin Panel Types	CRM141	CME2104	C14JM	C19AH	5/2T	212K
MW43/80	A47-13W	CRM142	CME2301	C14PM	C19AK	5/3	2102A
MW36/44	A59-15W	CRM143	CME2302	C17A	C211A	5/3T	7201A
MW53/80	A59-13W	CRM153	CME2303	C17A	C21AA	14KP4	7203A
MW53/20		CRM171	Twin Panel Types	C17A	C21HM	17ARP4	7204A
MW43/43		CRM172		C17A	C21KM	17ASP4	7204A
AW59-91		CRM173		C17AF	C21SM	21AYP4	7401A
AW59-90		CRM211	CME1906	C17BM	C21YM	17CJP4	7405A
AW53-28		CRM212	CME2306	C17GM	C23-TA	SE14/70	7406A
AW53-80		CME141		C17HM	C23-7A	SE17/70	7501A
AW47-91		CME1402		C17JM	C23AK		7502A
AW47-90		CRM1702		C17LM			7503A
AW43-89		CME1703		C17M			7504A
AW43-88		CME1705		C17PM			7601A
AW43-80		CME1706					7701A

12" ..	£4.10.0
14" ..	£5.10.0
18" ..	£5.19.0
19" ..	£6.19.0
21" ..	£7.15.0

Terms:
C.W.O.
Carr. and
Ins. 10/-

2 YEARS' FULL REPLACEMENT GUARANTEE

Complete fitting instructions supplied

LAWSON TUBES
STATION ESTATE, MALVERN.
Offices
18 CHURCHDOWN ROAD,
MALVERN, WORCS. MALVERN 2100

NEW VALVES

Guaranteed Set Tested 24-HOUR SERVICE

1R5	4/6	ECC83	4/3	PCL84	7/-
1S5	3/9	ECC85	4/9	PCL85	8/3
1T1	2/9	ECH35	5/9	PFL200	12/6
3S4	4/3	ECH42	8/9	PL36	9/-
3V1	5/6	ECH81	5/3	PL81	6/6
6A45	4/6	ECH84	6/3	PL82	5/19
6F1	6/3	ECL80	5/9	PL83	5/11
6L18	6/-	ECL82	6/-	PL84	6/-
10F1	9/6	ECL86	7/6	PL500	12/6
10P13	10/3	EP39	3/6	PY32	8/6
12K8GT	7/-	EP80	4/9	PY33	8/6
20P2	9/-	EP85	5/-	PY81	5/-
20P1	7/6	EP86	6/-	PY82	4/9
30P4	11/-	EP89	4/9	PY83	5/3
30P19	11/-	EP183	6/-	PY800	5/11
CH35	8/9	EP184	5/6	RY801	5/11
DAC32	8/9	EL33	6/3	R19	6/6
DAF91	3/9	EL41	8/-	U25	10/9
DAF96	5/11	EL84	4/6	U26	10/9
DF33	7/6	EY51	5/3	U91	10/6
DF91	2/9	EY86	5/6	UAF42	6/11
DF36	5/11	EZ40	6/6	UBA80	5/-
DK32	7/-	EZ80	3/9	UBC41	6/6
DK91	4/6	EZ81	4/-	UBF89	5/9
DK96	6/3	KT61	6/3	UCB44	7/9
DL33	6/6	N78	14/6	UCF85	6/-
DL35	4/9	PC86	7/9	UCG90	8/-
DL92	4/3	PC89	7/9	UCH42	8/6
DL94	5/6	PC97	5/3	UCH81	5/9
DL96	5/11	PC900	7/6	UCL82	6/9
DY86	5/6	PCC84	5/3	UCL83	8/6
DY87	5/6	PCC88	9/9	UF41	8/9
EABC80	5/6	PCC189	5/-	UF89	5/6
EBD1	7/6	PCF80	6/3	UL41	8/6
EBF80	5/9	PCF82	5/9	UL84	6/6
EBF89	5/9	PCF801	7/9	UY41	5/3
ECC81	3/9	PCL82	6/3	UY85	4/9
ECC82	4/3	PCL83	8/6		

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

NEW RANGE BBC 2 AERIALS

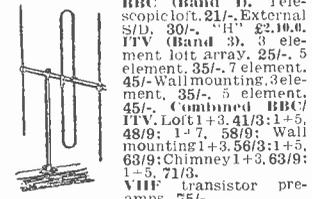
All U.H.F. aerials now fitted with tilting bracket and 4 element grid reflectors.

Loft Mounting Arrays: 7 element, 35/-, 11 element, 42/6, 14 element, 50/-, 18 element, 57/6. **Wall Mounting with Cranked Arm:** 7 element, 60/-, 11 element, 67/-, 14 element, 75/-, 18 element, 82/6. **Mast Mounting with 2in clamp:** 7 element, 42/6, 11 element, 55/-, 14 element, 62/-, 18 element, 70/-.

Chimney Mounting Arrays - Complete: 7 element, 72/6, 11 element, 80/-, 14 element, 87/6, 18 element, 95/-.

Complete assembly instructions with every unit. **Low Loss Cable:** 1/6 yd. U.H.F. Premium from 75/- State clearly channel number required on all orders.

BBC - ITV AERIALS



BBC (Band D, Telescopio): 21/-, External S/D, 30/-, "H" £2.10.0.

ITV (Band 3), 3 element: 21/6, 25/-, 5 element, 35/-, 7 element, 45/-, Wall mounting, 3 element, 35/-, 5 element, 45/-, Combined BBC/ITV, Loft 1+3, 41/3; 1+5, 48/9; 1+7, 58/9; Wall mounting 1+3, 56/3; 1+5, 63/9; Chimney 1+3, 63/9; 1+5, 71/3.

VHF transistor preamps: 75/-

COMBINED BBC - ITV - BBC AERIALS: 1+3+9, 70/-, 1+5+9, 80/-, 1+5+14, 90/-, 1+7+14, 100/-, Special leaflet available.

F.M. (Band 2), Loft S/D: 12/6, "H", 30/-, 3 element, 52/6. External units available, Co-ax cable, 8d. yd. Co-ax, plugs, 1/3. Outlet boxes, 4/6. Diplexer Crossover Boxes, 12/6. C.W.O. or C.O.D. P. & P. 5/-. Send 6d. stamps for illustrated lists.

Callers welcomed - open all day Saturday
K.V.A. ELECTRONICS (Dept. P.T.)
27 Central Parade, New Addington
Surrey (CR0-0J8) LODGE HILLS 366

FIRST-CLASS RADIO AND T/V COURSES... GET A CERTIFICATE!

After brief, intensely interesting study — undertaken at home in your spare time — YOU can secure a recognised qualification or extend your knowledge of Radio and TV. Let us show you how.

FREE GUIDE

The New Free Guide contains 120 pages of information of the greatest importance to both the amateur and the man employed in the radio industry. Chambers College provides first rate postal courses for Radio Amateurs' Exam., R.T.E.B. Servicing Cert., C. & C. Technicians, A.M.I.E.R.E. Guide also gives details of range of diploma courses in Radio/TV Servicing, Electronics and other branches of engineering, together with particulars of our remarkable terms of

Satisfaction or refund of fee

Write now for your copy of this invaluable publication. It may well prove to be the turning point in your career.

FOUNDED 1885—OVER 150,000 SUCCESSSES

CHAMBERS COLLEGE
(Incorp. National Inst. of Engineering)
(Dept. 884V), 148 HOLBORN
LONDON, E.C.1

Cutting and editing

What is the difference between cutting and editing, as applied to film picture and/or sound and video tape picture and sound? Technically they are wide fields apart, but the aims and objects are much the same. The *editing* of film; comedy, drama, documentary or news is an overall practical operation, principally concerned with strategy. The *cutting* of the same material involves the practical use of scissors to achieve the precision timing which is the objective of producer, director and supervising editor.

Both 35mm. and 16mm. picture films are used for television these days in a most sophisticated way, with ingenious sound counterpoints, dissolves, music and effects. Sound and picture are handled on separate films in the editing stage though, of course, a magnetic sound strip is often applied to 16mm. negative for newsreel use, which makes cutting difficult as the sound is not opposite the associated synchronised picture, but 28 frames behind it. This is "commag" sound, whereas with "sepmag" sound, the editor can manipulate the separate sound film in a multitude of ways. Precision cutting and timing from shot to shot can be carried out exactly to a single frame of motion pic-

ture, whereas the reflexes of a vision mixer have to be remarkably swift to average a precision closer than six frames.

Nevertheless, remarkable achievements have been made in high-speed vision mixing of sporting events. More difficult are the re-cutting, re-transferring and even standards conversion problems of tape. It is said that 80% of the "staged" material on American television is on film—and the main reasons for this preference are the fluidity of film editing, suitable for export to any country and with no line standard complications.

The hatchet men

Many viewers saw the TV newsreel films of the fracas outside the Chinese Embassy and events of a similar kind at London Airport. BBC, ITV and Chinese film cameramen were busy "covering" the exchanges of blows, the flourishing of weapons and the hullabaloo. It did rather look as though some of the participants were "staging" the scenes specially for their own cameramen. Be that as it may, there is no doubt that any first-class film editor could have cut and edited any arrangement of shots to give impressions of (a) that the Chinese were being cruelly mis-

were doing their utmost to create a dramatic scene, (c) that the police were exceeding their duties and (d) that the police were not exceeding their duties. Add a few appropriate sounds from the Mellotron effects machine plus some dramatic "hurry" music of Dick Barton type and you've made a Melodrama out of a Molehill! Add some close-ups of banana skins and custard pies and you've changed the situation into a Keystone comedy.

Responsibility

There is no doubt that the director can influence the editor's shape of a film for television just as much as the director of a "staged" live or taped television play can (and does) control the script writer and the vision mixer. The combined impact of TV sight and sound is enormous, whether used by advertising sponsors, dramatists, politicians or news editors. Somehow, they manage to bear their heavy responsibilities with great equanimity and fortitude.

Icons

SPRING INTO ACTION!

The December issue of P.E. includes:

- ★ SPRING LINE REVERBERATION UNIT
- ★ ANTI-DAZZLE DRIVING MIRROR
and the FIRST of a new series for beginners on
- ★ SEMICONDUCTOR BASICS
with a full page display of
- ★ CIRCUIT SYMBOLS

PRACTICAL ELECTRONICS — On Sale Now!

TUNEABLE U.H.F. PREAMPLIFIER

It is regretted that the above-mentioned article has been withdrawn from the current issue. The main suppliers of the basic u.h.f. converter utilised in this conversion informed us—prior to publication—that no further units were available. Despite exhaustive enquiries, no other source of supply could be located. As a result of this we have decided to withhold its publication.

Practical Wireless — January 1968

Easy-to-build 5-stage receiver

The "Clubman", suitable for 160 and 80 metre amateur bands, is simple to construct and has the facility that extra stages and refinements may be added.

Intermittent fault locator

This unit is designed to find those hard-to-trace faults. It is self-contained with its own power supply.

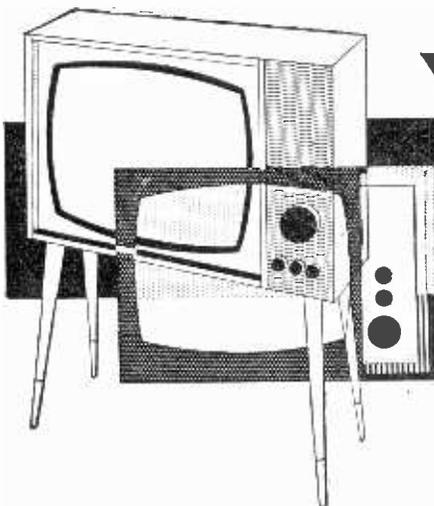
Learning Morse

This article gives instructions on learning the Morse code and gives a design for a simple Morse oscillator.

Simple crystal tuner

Ideal as a present for a youngster or as a project for the novice.

ON SALE DECEMBER 8th



Your

Problems Solved

Whilst we are always pleased to assist readers with their technical difficulties, we regret that we are unable to supply diagrams or provide instructions for modifying surplus equipment. We cannot supply alternative details for constructional articles which appear in these pages. WE CANNOT UNDERTAKE TO ANSWER QUERIES OVER THE TELEPHONE. The coupon from page 140 must be attached to all queries, and a stamped and addressed envelope must be enclosed.

EKCO T310

This set is all right on BBC (both picture and sound). On ITV, however, the sound is very weak and the picture is very sensitive to adjustment of the controls.—A. Walker (Brentwood, Essex).

We would suggest that you check the 30L1 valve in the tuner unit which may be weak. Check the 50 μ F electrolytic capacitor connected to pin 7 of the sound output 30PL1 by bridging with a known good capacitor.

RGD RV202

BBC 1 has become like a fringe station; the picture being very grainy and noisy. ITV and BBC 2 are satisfactory.

I have substituted the two v.h.f. tuner valves with no improvement.—L. Woodcock (Hounslow, Middlesex).

If the fault is in the tuner then it will certainly have to be removed for repair. Indeed, the nature of the symptom would require the tuner to be returned to the makers for checking on their special alignment jig.

However, since Band III is okay, we would suggest first that you look into the Band I aerial and its coupling to the feeder, for a weak signal to the set on Band I only may well be responsible.

EKCO T345

This set is now 8 years old and in pictures there is a greyish colour in place of black. Whites are blurred and blend so much in the background that they are hard to see.

The contrast control has no effect except to cut the picture off suddenly.—J. Petch (Rothwell, Leeds).

The symptoms you describe are typical of a failing tube. We would advise you to check the video amplifier and if this is in order, then the tube is most probably at fault.

FERGUSON 406T

This set has developed a fault on sound. When switching the set on from cold, the sound and the picture are excellent but after a few minutes there is a slight "pop" and the sound goes. Only by turning the volume control fully up can it be heard at all.

During this time the picture remains perfect.—A. Pleece (Surrey).

The trouble is most probably due to a faulty capacitor. Check from the detector diode onwards, i.e. the 0.01 μ F to the volume control and the 0.01 μ F associated with pin 1 and pins 3 and 9 of the PCL82. Check V10 (EF80) and 0.001 μ F pin 8 to chassis.

DEFIANT 9A51

After switching on, the picture and sound come on with heavy interference on the picture. This then disappears leaving only the raster and the sound of ITV coming through on the BBC. After the set had been on for about 40 minutes I touched a small screwdriver on the i.f. output (centre wire on tuner). The set then became active again and worked well for some hours.

After the set went wrong again, it would only work properly if the i.f. output was touched with a screwdriver.

The resistance R209 is also charred. I cannot find this in the service sheet and wonder if you could let me know its value for replacement.—F. Burnell (Bradford, Yorkshire).

It is likely that the resistor to which you are referring is valued at 1k Ω , brown body, black tip and red spot (centre band). This should be changed if necessary. However, it is likely that the fault causing the described symptom lies somewhere in the tuner. The electrical contact made by the screwdriver blade on the "test point" could generate an r.f. disturbance, and this can sometimes temporarily correct a fault in a capacitor or resistor in the tuner, or even reduce the r.f. resistance of a dry joint in the tuner or i.f. strip.

FERGUSON 306T

After about an hour, the picture creeps up until there is a two-inch black band across the bottom of the screen.

Also, is it possible to fit a finger-operated height control in place of the screwdriver-operated circular metal type (with a contact passing over curved carbon).—A. Hansell (Birmingham).

Check the top centre PCL83 by replacement, then check the 0.01 μ F capacitor in the linearity circuit.

A 1M Ω control with an extended spindle can be fitted if required to enable the height of the picture to be adjusted more easily.

MARCONIPHONE VT161

The sound on Channel 9 has suddenly gone weak and on the picture there is a fair amount of "mush" accompanied by ringing.

The resistor strapped across tag 3 on a small tag strip on the upper chassis and L31 is burnt out. Can you state the value of this resistor and say if this could be the cause of the fault? Channel 1 sound and vision are good.—W. Bates (Harlow, Essex).

We think that the resistor is 1k Ω $\frac{1}{2}$ W. However, your letter does not make its position in the circuit very clear. You will have to send us a circuit section, in which the resistor is included, for greater information or the fault. Check the capacitor connected from this resistor to chassis for low insulation resistance.

FERGUSON 406T

When first switched on, the raster covers the screen but it gradually climbs to about 3in. from the bottom, accompanied by severe patterning. After about 5—10 minutes, the patterning clears but it takes about half an hour before the screen is completely filled.

There is also a hazy line about 1in. wide approximately $\frac{1}{2}$ screen width from the left. This is influenced by the contrast control, but complete elimination is unobtainable.—J. Moore (London, N.W.2).

Check the 470 Ω bias resistor of the PCL82 (V12), the 100 μ F capacitor and C104 if necessary.

Check the electrolytic capacitors generally. Replace the PL36 valve and the 1.5k Ω resistor across the width control.

FERRANTI 17SK5

Usually the picture is most excellent on both channels. There is, however, one annoying feature; the picture will suddenly flash much brighter then go back to normal. The only component I have found at fault is the picture quality control which was burnt out. I have replaced this but it has not cured the fault.—A. Brown (Bolton, Lincolnshire).

This trouble could be either in the tube biasing circuits or in the video stages. Any disturbances altering the tube biasing will, of course, affect the picture brightness. Check the video amplifier valve. If the trouble persists, check whether the raster by itself (i.e., with the aerial disconnected and the

contrast turned to zero), turned up by the brightness control, alters in brightness. If it does, then the d.c. conditions are at fault and not the signal (vision) circuits.

ULTRA 6632

During a programme, the picture started to reduce in size going inwards until only a white line was showing vertical down the middle of the screen. Then all at once it went completely dead on sound and vision.

This set has additional protection provided by a fusible resistor link in the h.t. line, and a fusible resistor link in the main supply to the switch solenoid. Either link may be resoldered to make contact after eliminating any overload condition. On removing the back of the set the fusible resistor (h.t.) on the right-hand side of the set has become unsoldered, which appears that an overload has occurred.—S. G. Lester (Ilford, Essex).

The failure is in the line output/booster diode section. Check the associated valves and replace if low or faulty. It is possible that the line output transformer has developed shorting turns. In either case excessive h.t. current would flow and open the protective device.

DECCA DM45

The sound is good but the picture is very weak. I have changed all the valves except the video amp. and measured all the voltages which are correct. E.H.T. is present though I have not measured it.

The fault arose when the e.h.t. winding of the line output transformer burned out and I replaced the overwind with one from a Marconiphone (C. 1955) with tube MW 43/69—since this required 16kV as did the DM45, it would seem O. K.—R. Farish (Wigton, Cumberland).

This could well be due to low e.h.t. voltage due to a wrong overwind. We would have thought, however, that this would also give bad focusing. If, in fact, the focusing is poor, low e.h.t. voltage should be suspected. Otherwise, check the condition of the picture tube and its electrode potentials.

STELLA ST1017U—46

When switching on, the picture has a 4in. black line at the top and bottom. After the set has warmed up, the black line decreases until it is about 1in. wide top and bottom. The width is not affected and the height control is working normally.

The sound has also been very rough since the fault occurred and I have changed the sound output valve but the faults persist.—J. Huckle (Wirral, Cheshire).

The low vertical amplitude should first lead to a check of the PCL82 valve. If this is okay, check the 100 μ F electrolytic on its cathode. However, since sound is rough, it would be worth checking the feed from the boosted h.t. line. This goes from the tube first anode to both the sound a.f. amplifier and the field generator. Check the resistors and the 0.056 μ F capacitor on the tube first anode tag (tag 3).

BUSH M59

I have just fitted a new tube to this receiver, together with c.h.t. rectifier and line output valves. The trouble now is very poor contrast and when the brilliance control is advanced the picture disappears leaving only the raster. The contrast and limiter controls fail to correct this and the best picture I can receive is very grey.—C. Brent (Yeovil, Somerset).

We would advise you to check the first anode supply to pin 10 of the c.r.t. base if you are sure that the tube itself is good.

Check video amplifier and circuit.

FERGUSON 506

On switching on it is impossible to adjust the fine tuner to eliminate vision-on-sound and sound-on-vision. At the centre position of the tuner it is possible to get these two faults occurring together. Then, for about an hour afterwards the tuner must be adjusted every ten minutes to lose excessive vision-on-sound.—G. Cork (Birmingham, 21).

First of all, ensure that the rear local/distant control is turned to local.

Then check the tuner unit valves and then, if necessary, the a.g.c. line components for shorts.

SOBELL 1013DST

There is a buzzing noise on sound (BBC only). This varies from being very faint to very loud with every camera transmission.—A. Bird (Bristol, 3).

This is the symptom of vision breaking into the sound channel. If the effect persists the fine tuner is adjusted for maximum sound, the i.f. transformers of the sound i.f. strip should be carefully adjusted for maximum sound when the fine tuner is adjusted for maximum vision.

PHILCO 1000

The windings of the line output transformer are burnt. Can you state what has caused this and are there any components that I should replace before replacing the l.o.p.t.?—A. Bishop (Bristol, 5).

We can see no reason why a fault outside the transformer should burn it out. Normally such a condition is caused by faulty insulation on the transformer itself.

QUERIES COUPON

This coupon is available until DECEMBER 22nd, 1967, and must accompany all Queries sent in accordance with the notice on page 138.

PRACTICAL TELEVISION, DECEMBER, 1967

TEST CASE -61

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.

SOLUTION TO TEST CASE 60
Page 90 (last month)

? A Bush TV141 suffered from lack of height. At full setting of the height control the screen was underscanned by about $\frac{1}{2}$ in. top and bottom. Overall linearity was fair, but on Test Card D it was noticed that slight compression occurred at the bottom. The picture was otherwise quite reasonable in brightness and focus.

The PCL85 field timebase valve was first checked by substitution, without improvement. Check of the cathode voltage of the pentode gave the correct reading, also at the screen grid and anode. The h.t. rail voltage was correct and normal checks round the field circuits failed to reveal the trouble.

Eventually it was found that the triode anode voltage was low, but the height control and feed resistors were correct in value.

What could have been the cause of this trouble, and why was the technician possibly led away from the real cause by the symptoms? See next month's PRACTICAL TELEVISION for the solution to this problem and for a further item in the Test Case series.

It is not generally realised that the biasing of the video amplifier valve can affect the sync pulses while letting through the video signal without distortion. If the bias is too high, for example, the positive-going picture signal at the control grid will overcome this bias and the picture signal proper will tend to work on the linear part of the valve's characteristic curve. However, the sync pulses, which are relatively negative-going, will push the valve well towards anode current cut-off, with a consequent attenuation of the sync pulses at the anode.

Normally, under incorrect video valve biasing conditions, some sync pulses get through, but their amplitude is low and the timebases are only lightly locked. This was the cause of the trouble in Test Case 60, last month. The set in question employed a potential-divider across the h.t. supply, with the tap connected to the video valve cathode. This arrangement is sometimes featured to help stabilise the valve's working point. It was eventually discovered that both resistors had altered in value, and changing them cleared the fault.

PRACTICAL TELEVISION SPECIAL

OUR PRACTICAL CHRISTMAS OFFER TO YOU!

PRACTICAL TELEVISION presents the tried and trusted Swiss Kelek 18 ct. Gold-Plated Watch.



The KELEK DE LUXE

21-Jewel Lever, a watch of classic elegance with all the built-in qualities described below. Plus automatic self-winding.

Yours for only £10.10.0



The KELEK

17-Jewel Lever, beautifully designed, ultra-accurate and with all special features below.

Yours for only £7.7.0



HOW TO GET YOUR WATCH

Complete the coupon below and write your name and full address twice where shown. Send coupon with postal order or cheque crossed "& Co" and made payable to George Newnes, Ltd. Write your name and address on back of remittance.

Post to:

PRACTICAL TELEVISION Watch Offer (PT/W1)
136 LONG ACRE, LONDON W.C.99.

CHRISTMAS DELIVERY—Latest date for receipt of orders is December 6, 1967. If gift is for an address other than your own, please address the label section accordingly on coupon.

We regret that this offer is not available in Eire or overseas.

HERE'S the most practical present you can give to yourself—or to a friend—this Christmas . . . a superb quality watch. By special arrangement with a famous Swiss manufacturer of International repute, PRACTICAL TELEVISION has been able to obtain a supply of famous Kelek Wrist Watches, and present two for you to choose from—as your Christmas gift to yourself. The special price of each is most attractive, you will agree, and your choice will be sent to you in a presentation box post free. And what superb watches they are! Whichever you choose you'll have unflinching time-keeping.

15 SPECIAL FEATURES

JEWEL LEVER MOVEMENTS.

AUTOMATIC DATE CHANGE—Shows the date day by day, month by month.

PRESSURISED AND WATERPROOF TO 3 ATMOSPHERES—If you unfortunately went swimming in yours it would still keep perfect time.

RUSTPROOF STAINLESS STEEL BACK—Free from corrosion from dampness, rain, perspiration.

SHOCKPROOFED—Eliminates the risks of knocks and shock.

ELECTRONICALLY TIME-TESTED in different positions to ensure accuracy in day-to-day wear and movement.

TEMPERATURE-COMPENSATED HAIRSPRING—Adapts itself to changes in climate.

GOLD-PLATED · ANTI-MAGNETIC · UNBREAKABLE MAINSPRING · SWEEP SECOND HAND · DUSTPROOF · COMPLETE WITH LEATHER STRAP and PRESENTATION BOX. TWELVE MONTHS INTERNATIONAL GUARANTEE WITH EVERY WATCH.

ORDER ON THIS FORM

PRACTICAL TELEVISION WATCH OFFER

Please send me the KELEK Watch indicated here.

KELEK 17-Jewel Lever £7.7.0

Tick

KELEK DE LUXE 21-Jewel Lever £10.10.0.

One

Cheque/P.O. No. _____ Value £ _____ s. _____

Please check that coupon is complete with your name and address in two places, and that your remittance is correct.

NAME _____

ADDRESS _____

_____ (PT/W1)

(BLOCK LETTERS)

LABEL WRITE IN BLOCK LETTERS

NAME _____

ADDRESS _____

_____ (PT/W1)

If undelivered please return to:

PRACTICAL TELEVISION, 136 Long Acre, London, W.C.2

SETS & COMPONENTS

150 NEW ASSORTED Capacitors, Resistors, Silvered Mica, Ceramic, etc. Carbon, Hystab, Vitreous, 1-20 watt 12/6. Post Free. WHITSAM ELECTRICAL, 18 Woodrow Close, Pervale, Middlesex.

STOP

FULLY GUARANTEED L.O.P.T. REWINDING SERVICE

A few of the types are listed below:—

- BUSH TV 53-66.
- K.B.P.V.P.20, etc.
- PHILIPS 1768U, 177G100U, etc. All at 50/-

NEW FROM STOCK

- U25 Type EKCO, state model, PYE 200-400.
- FERGUSON 306-308 305-307 All at 45/-
- FERGUSON 406, 408, 416, 436, 438
- S.A.E. Enquiries P., & P. 4/-, C.O.D. 6/-

WITWORTH TRANSFORMERS Ltd.
26 All Saints Road, North Kensington
W.11 Telephone: 01-229-9071

TV SPARES, all makes, all sets. SAE/Quote. EKCO/Ferr. Plastic Housings 15/- each. Car/House Alarm Kits 25/- each. Transistor Car Radios with fittings kit £8.10 std. Push button £11.10 comp. Band Radar Detectors for car £13.10 comp. 8 x 10 Binoculars in hide case £7.10. 10/50 £10. Please add P.P. 5/- Open Sats. All new goods.
KING'S, 8 Cray Parade, Main Road, St. Paul's Cray, Kent. Tel: ORPINGTON 30566.

BARGAIN PARCELS

Any 10 Valves 14/-, Any 100, £6. PCF80, PCC84, PL81, PL36, PL82, PL83, PY81, PY800, PY32, PY32. PCL82, PCL83, EF80, EF85, EB91, ECL80, EY86, ECC82, 30FL1, 6-30L2, 20F1, 10F1, 20P4, U191, 30F5.

ALL VALVES SET TESTED. P. & P. 1/-
3-BY100 Type Rectifiers with Surge Resistors, 10/-
50 Television Fuses, 5/-

VELCO ELECTRONICS

49 Bridge St., via Bury, Lancs.

BOB'S BETTER BARGAINS. Any 10 valves 14/6 post paid. Refunded in full if not satisfactory. PCF80, PCC84, PL81, PY81, PL36, PCL83, EF80, U191, LY86, 30P1, 30F5, EF85, PY32, PY82, EB91, 30PL1, 30FL1, 30P4, ECL80, T.V. sets, set of four with plates, 5/-, post 3/6. Mail Order only. GREEN, 2 St. James Street, Rawtenstall, Rossendale, Lancs.

EX N.E.V. C.C.T.V. Camera and Monitor Circuits. S.A.E. for list. LOWE, 62 Brownswood Road, London, N.4.

MULLARD BY100 rectifiers. genuine new branded, not cheap rejects, 6/6 each or 70/- dozen. BARTLETT'S, 38 Clifton Road, Greenford, Middx.

COMPONENTS GALORE. CRT's Valves, Transistors, Tools, Electrolyte, all your service requirements at "Willow Vale. The Service Wholesalers", 69 Station Road, Hanwell, London, W.7. Free catalogue by return.

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

SETS & COMPONENTS
(continued)

NOTICE

TRADEX (BRADFORD)

BANKRUPTCY DISPOSAL SALE

Due to liquidation of a leading Electrical Service Department we have what we believe to be the Best Selection of Valves and Spares ever offered to the public.

Television Tuner Units (used) complete with valves.

(Good working order. Pushbutton type with 30L15 and 30C15. Suitable for Ultra, EGD, Regentone, Sobell, McMichael, Pilot, G.E.C., and others. Only £1 each. P.P. 5/-.

Fire-ball Tuners (used) working order with valves, PCF80 and PCC84 or PCC89. Only £1 each. P.P. 5/-.

Any Tuner Unit for any set, working with valves, Only 35/- each. P.P. 5/-.

Line Output Transformers and Scan Coils (used). Good. Any make if available. Only 35/-, P.P. 5/-.

Loudspeakers. Ex. TV. 6 x 4in. and 6in. round. 3/- each. P.P. 5/-.

Radio Chassis complete with valves, Only 35/- each. Post paid.

17in. 13 Channel TVs. Ex. rental working order. Carriage paid £8 each. Untested, carriage paid £3.10 each.

Salvage Valves. Boxed, ex. equipment. All good emission.

- EF80 1/- PY81 3/- PCF80 3/-
- EF14 5/- PL36 5/- 6BW7 4/-
- 30P4 6/- ECC82 4/- PY33 5/-
- EB91 1/- PL82 4/- PCC84 3/-
- EF85 4/- ECL80 4/- 30FL1 5/-
- 30P12 5/- 30F5 5/- ECC83 4/-

One doz. valves on choice 25/-, P.P. 5/-, postage on valves 6d. each, over 4 post free.

Free valve equivalent list every order.

Salvage components, taken from popular model TVs. You enquiries invited, s.a.c. please, reply by return. Terms of business: Cash with order or C.O.D. Crossed cheques and P.O.s payable to "TraDEX".

TRADEX (BRADFORD)

5 Toller Lane, Bradford 8, Yorks.

PHILIPS 625 UHF Conversion Kits, two complete IF and time-base panels. Escutcheon Kit and knobs, 22/6 each, post paid. BARTLETT'S, 38 Clifton Road, Greenford, Middx.

RESISTORS: 1/2 watt carbon film 5%. All preferred values in stock from 10 ohms to 10 megohms 2d. each. Send S.A.E. for free sample. CAPACITORS: Mullard Miniature Metallised Polyester PC Mounting all 250V D.C. working, 0-01mF, 0-022mF, 0-047mF, 0-1mF, 0-22mF, all at 6d. each. Hunts tubular 0-1mF 200V working at 3d. each. Send 6d. stamp for extensive list of low priced Electronic Components. Instruments and Equipment. Please include 1/- Postage & Packing on all orders under £1. Dept. P.T.1. BRENSAL ELECTRONICS LIMITED, Charles Street, Bristol 1.

TELEVISION TUBE SHOP

THE

NEW TUBE Specialists

- A47-13W£12.10.0
- A59-13W£15.10.0
- 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£7.12.6
- AW53-88, 53-89£7.17.6
- AW59-90, 59-91£9.10.0
- C14BM, FM£5.15.0
- C17BM, FM, HM£6. 7.6
- C17LM, PM, SM£6.12.6
- C21HM, SM, TM£7.17.6
- CME1402£5.17.6
- CME1702, 1703£6.12.6
- CME1705£7. 7.0
- CME1901, 1903£7.10.0
- CME2101, 2104£7.17.0
- CME2306£15.10.0
- CRM93£5.10.0
- CRM124£5.10.0
- CRM141, 2, 3, 4£5.17.6
- CRM152£5.10.0
- CRM153£3.19.6
- CRM171, 2, 3* £6. 7.6
- CRM211, 212£8.17.6
- MW31-16, 74£5.10.0
- 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
- 14KP4A, 141K£5.12.6
- 171K, 172K, 173K£6. 7.6
- 7201A, 7203A£5.12.6
- 7204A£5.10.0
- 7401A£6. 7.6
- 7405A£6.12.6

Manufacturers' Reprocessed Tubes available at £1 each less than the above prices.

All tubes tested before despatch and guaranteed for 12 months.

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

* Reprocessed tubes only of this type at present.

Midland Stockists:—

Amateur Electronics Co.,
240 Lichfield Road, Aston,
Birmingham.

TELEVISION TUBE SHOP

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

JUST SOUTH OF THE BRIDGE
OPEN SATURDAY UNTIL 4 p.m.

SETS & COMPONENTS (continued)

BRAND NEW TELEVISION TUBES — 2 YEAR GUARANTEE!

(CATHODEON AND OTHER LEADING MANUFACTURERS)

We hold large stocks of top quality tubes, why buy ordinary rebuilds? Some rebuilds available, 19in. upwards at 21/- off quoted prices. 12 months warranty. Colour, rimbands, etc. available. Lists, Rimband types, 19in. £8.10.0; 23in. £11.0.0.

CRM121, 2, 3 & 4; MW31-16, MW31-74; C12FM; 121K, C12/1, etc.	£3 0 0	
AW36-80; MW36-24, 36-44; CRM143, 4; CME1402; C14BM; C14FM, MW41/1, etc.	£4 0 0	
CRM143, CRM144; £4.0.0	CRM141, 2, 3; 15EP4 etc. C17BM, SE14/70, AW36-20, 36-21.	£4 15 0
AW43-80, 43-88, 43-89; MW43-64, 43-69; MW43-80; CRM171, 2, 3, 4; C17FM; CME1703, 5; C17AF; C17SM	AW47-90; AW47-91; CME1902; CME1903, etc.	£5 15 6
C19AH; CME1901; AW53-88, 9; CME2101, 4; AW53-80; MW53-20; MW53-80; CRM211, 2, etc.	19in. Twin Panels A47-13W; CME1906, £9.17.6	£6 17 6
	23in. Twin Panels A59-13W, CME2306.	£7 10 0
	(Carriage 15/-)	£12 10 0
	(Carriage 25/-)	

CARRIAGE AND INSURANCE. Up to 19in. 12/-, 21in. upwards 15/-. Twin Panels (see above). Lists, s.a.e. please.

SOME OLD TUBES WANTED, 17" UPWARDS

PHILIP H. BEARMAN, 6 Potters Road, New Barnet, Herts. Tel: BAR 1934/7873 (Robophone)

CLOSED Thursday & Saturday afternoons
LISTS BRITISH VALVES!

T.C.S. LTD.

FOR LINE OUTPUTS AND DEFLECTOR COILS

WE have the Country's largest stock of Manufacturers' Original (or Authorised Replacement) Line Output Transformers for many "difficult" makes, including Ambassador, Baird, Cossor, Ekco, GEC, HMV, KB Masteradio, Peto, Scott, Philips, Repentone, RGD, Sobell, Ultra, etc. Also deflector coils, output and oscillator transformers, Inc. Alba, Bush, Murphy Examples, L.O.P.T.s: Murphy 280, 89/8; 310/350/410/540/659/759, 99/8; Bush TV53, 79/8; 80, 95/-.

SPECIAL OFFER:

Ekco Improved type for Model T221 at 42/6, T231 at 45/-; T310 at 47/6.

Terms: C.W.O. or C.O.D. (3/6). Post/packing 5/-, 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.

T.C.S. LTD.

28 BROCKLEY CROSS, LONDON SE4

Tel. TIDeway 5394

R & R RADIO

51 Burnley Road, Rawtenstall

Rossendale, Lancs

Tel. Rossendale 3152

Boxed Valves		Fully Guaranteed
EF80 4/-	PC084 5/-	PY33 7/6
EC082 4/-	PEF90 5/3	30P19 7/6
KL250 6/-	PL81 5/-	30P4 7/6
EB91 2/-	PY41 6/-	L191 7/6
EF85 5/-	PY800 5/-	C301 7/6
EF86 5/6	PL36 7/6	PCL83 7/6

Postage: One valve 6d. extra. Two valves 6d. each extra. Three to Six valves 2d. each extra, over six post paid. Speakers ex T.V. 3 inch round 2/6, 6 x 4 8/8, Post 2/6, 8 inch round 6/8, post 3/6 for one or two.

Transistors

OC45 8/-, ACY27 4/-, ACY2R 4/-, ACY30 10/-, 2N697 10/-, 2N706 3/-, AC128 2/6, G.E.C. Rect-60 volt P.I.V. 1/-, Postage 6d. per order.

OLYMPIC II TV, S.A.E. for itemised price list. AJAX ELECTRONICS, 18a Rumbold Road, Fulham, S.W.6.

THIS MONTH'S SCOOP!

NEW BRIMAR C17AF BOXED

17" 110° 0-3A Short neck
Can replace AW43-88, CME1703 etc.

£3.0-6

Carriage & insurance 12/6

TELEVISION TUBE SHOP

48 BATTERSEA BRIDGE ROAD, SW11

15 VALVES 15/-

From the following: 30PL13, 30PL14, PCL82, EF80, ECL80, PCF80, PCC84, PL36, 30F5, EB91.

Valves Tested. P. & P. 2/-
S. ASHWORTH, 9 Mandeville Terrace, Hawkshaw, Bury, Lancs.

FOR SALE

RECTIFIERS

SILICON TV 6/- or complete with mstr., resistor components 7/6.

Rectifiers—Contact Cooled

14RA1282/FC101 13/6; 14RD2281/FC124FW 13/6; RC1 12/6; RC2 12/6; FC110 7/6; 14RA/1289 (FC31) see Silicon.

Rectifiers—Fin Types

Enquiries for RM4 9/6; RM5 17/6; 14A97 13/6; 14A86 10/6; EK2 17/6; EK9 17/6; 14A949 19/4; LW15 19/4; LW7 19/4; 14A100 19/4; 14A98 10/4; PW12V-1A 5/-, 2A 7/-; 4A 10/6.

MULTIMETERS from 32/-

Stamped envelope for full latest selection and bargain offers in cheap meters, Radios, Baby Alarms, Inter-coms and Walkie-Talkies.

Line O.P. Trans; all 30/- each

Murphy V350 and V230 Cossor 948, Philips 1440U45 and 1740U45 with EY31.
Under £1 P. & P. 6d. Over £1 Post free. NO C.O.D.

DURHAM SUPPLIES

175 DURHAM ROAD, BRAOFOOD 8, YORKS.

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

35mm SOUND CAMERA, suitable Video Tape recording, £60. K. ROSS, 58 St. John's Road, Manchester 16.

AMATEUR TV, G6LYF/T giving up. Complete Station for sale. Best offer over £80 secures, S.A.E. for details. JONES "Erehwon, Vicarage Rd., Stoke Gabriel, Totnes, Devon.

FOR SALE

(continued)

8 VOLUMES "Radio & Television Servicing", Vols. 1 to 58/59 £10. G. A. PEARSON 255 Oldfield Rd., Sheffield.

WANTED

NEW VALVES WANTED. Popular TV and Radio Types. Best cash price by return. DURHAM SUPPLIES, 175 Durham Road, Bradford 8, Yorkshire.

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

DAMAGED AVO METERS WANTED. Models 7 and 8. Any condition. Any quantity. HUGGETTS LTD., 2-4 Pawson's Road, West Croydon. Send for packing instructions.

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

WANTED Domestic Video Tape Recorder. Must be in good condition, state make and price. Box No. 55.

WORKING S/H Vidicon 405 line R.F. camera—home-built considered. DAVID, 23 Gloucester Road, London, N.17.

WANTED—Volumes of "Radio and TV Servicing", 1960-61, 1961-62, 1962-63, 1964-65. Write H. LYNCH, Clough Jordan, Co. Tipperary, Ireland.

SERVICE SHEETS

SERVICE SHEETS

For all makes of Radio, Television, Tape Recorders, 1925-1967. Prices from 1/-. Catalogue of 6,000 models, 2/6. Free fault-finding guide with all Service Sheets.

Please send Stamped Addressed Envelope with all orders and enquiries.

HAMILTON RADIO
54 London Road, Bexhill, Sussex

SERVICE SHEETS

(continued)

SERVICE SHEETS

4/- each, plus postage

We have the largest supply of Service Sheets for all makes and types of Radios and Televisions, etc. in the country (speedy service).

To obtain the Service Sheet you require please complete the attached coupon:

Name:

Address:

To: S.P. DISTRIBUTORS
35/36 Great Marlborough Street,
London, W.1

Please supply Service Sheets for the following:

Make:

Model No. Radio/TV

Make:

Model No. Radio/TV

Make:

Model No. Radio/TV

I also require new 1967 List of Service Sheets at 1/6 plus postage.

(please delete items not applicable)

I enclose remittance of
(which includes postage)

MAIL ORDERS ONLY (Dep. Pt.)

SERVICE SHEETS

(continued)

SERVICE SHEETS. Radio TV, 5,000 models. List 1/6. S.A.E. enquiries. TEL-RAY, 11 Maudland Bank, Preston.

SERVICE SHEETS with free fault finding chart 3/-. S.A.E. LESMAR, 17 New Street, Andover, Hants.

EDUCATIONAL

TV and Radio 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.

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

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.

AERIALS

TV AERIALS

Band I, H. Mast Fitting	£1 15 0
Band III, 5 Ele Mast Fitting	£1 10 0
Band III, S D and 4-Array	£1 15 0
Band IV, 9 Ele Array	£1 10 0
Band IV, 18 Ele Array	£2 18 6
Lashing Kits from 10/-; Poles, Co-ax Bd., Grade "A" 1/4. Plugs 6d.	

C.W.O., S.A.E. for list.
P. & P. 4/6.
TELEINDUSTRIES LTD.
BREAKSPEAR ROAD, RUISLIP, Middlesex

SITUATIONS VACANT

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

ALDERMASTON COURT POSTAL TRAINING for B.Sc. (Eng.) Part 1, A.M.I.E.R.E., A.M.S.E., City and Guilds, pay and security as Technician or Technologist. Thousands of Passes. For details of Exams and Courses in all branches of Engineering, Buildings, Electronics, etc. (including latest information on C.Eng.) write for 132-page Handbook—FREE. Please state interest. BRITISH INSTITUTE OF ENGINEERING TECHNOLOGY (Dept. 171K.), Aldermaston Court, Aldermaston, Berks.

EXCELLENT position vacant, very good prospects for experienced Radio, TV Engineer. Must have R.T.E.B. Certificates or equivalent. Exceptional accommodation facility available for successful applicant. Apply in confidence to Box No. 54.

PADGETTS RADIO STORE

OLD TOWN HALL, LIVERSEDE, YORKS.

Telephone: Cleeckheaton 2566

NEW 12in. Speakers with Built-in Tweeter, 28/6, post paid, 3 or 15 ohm Coil.

VALVE LIST

Ex Equipment, 3 months' guarantee

10F1, EF90, EB91, ECL80, EF50, PY82, PZ30, 20P3. All at 10/- per doz. Post paid. Single valves post 7d.

ARP12 1/6	EL36 5/-	PY82 1/6	U801 8/6	5U1G 4/-
EB91 9d.	EY86 5/-	PZ30 5/-	10C2 5/-	6B8 1/8
EBF90 3/-	KT36 5/-	U25 5/-	10P13 2/6	6K7 1/9
ECC81 3/-	PCC84 2/-	U191 5/-	165BT 8/6	6K2 5/-
ECC82 3/-	PCF80 2/-	U281 5/-	20P1 3/-	6P25 5/-
ECC83 4/-	PCL82 4/-	U282 5/-	20P1 5/-	6U4 5/-
ECL80 1/6	PL36 5/-	U301 5/-	20P1 5/-	6V6 1/9
EF50 1/-	PL81 4/-	U329 5/-	20P3 2/6	6P28 5/-
EF90 1/6	PY33 5/-	U251 5/-	20P4 8/6	EY51 2/6
EP91 9d.	PY81 1/6			

NEW VALVES EX UNITS

1T4, 2/-; 1L4, 2/-; 1A3, 2/6; 1S5, 2/5; 12AT7, 3/-; 3A4, 2/6; EF91, 2/-; EB91, 1/3; EL91, 2/-; U8, 4/-; 8SN7, 2/6; 10P13, 4/-; box of 50 ARP12 Valves, 22/-, post paid.

Untested Complete T.V. Sets, 13 Channels 17", 50/-; 14", 30/-; 12", 19/-, carriage on any set 15/-.

New T.V. Tubes with a slight glass fault. Most types. No 21" or 23" 50/- carriage 10/-, 12 months' guarantee.

Speakers EX T.V. Sets, 3 ohm P.M. 6 x 4 and 5" round 3/-, Post 2/9. Six for 22/-, Post paid. 7 x 4, 5/-, Post 2/9, 8" round 6/6, Post 4/-, 10 for £4.0.0. Carriage paid, ex column units.

Special offer. Regentone Big Deep 17" T.V. Set. All 13 channels. Good working order, good tube fitted. Cabinet in fair condition. Set and tube guaranteed 12 months if carriage paid both ways by customer £8.0.0. Carriage 15/-.

Display Unit, 2, SP7 tubes, 2 6H6 valves. Complete with case. Clean condition, 62/6, Carriage 10/-.

Reclaimed Tubes, SIX months' guarantee. AW3/80, 40/-; MW43/80, 30/-; MW3/89, 30/-; CRM172, 30/-; CRM142, 17/-; 12in. Tubes, 10/-; 17in. Tubes, perfect but without guarantee, 17/-; Carriage on any Tube in G.B., 10/-.

Ex Washing Machine Motors, Fully guaranteed. Single phase 1 h.p., 26/-; Sixth h.p., 15/-; Plus carriage 10/-.

Our new Walk Round Room is now open. Full of surplus Bargains. Also our Special Department, nothing over sixpence.

17in.—£11.10.0

3 Star Guarantee
★ Tube★ Valves
★ Components Carr. 30/-

TWO-YEAR GUARANTEE EX-RENTAL TELEVISIONS

FREE ILLUSTRATED LIST OF TELEVISIONS

17" - 19" - 21" - 23"

WIDE RANGE OF MODELS

SIZES AND PRICES

DEMONSTRATIONS DAILY

TWO-YEAR GUARANTEED TUBES 100% REGUNDED

14in.—£9/6 17in.—£9/6

21in. and all SLIMLINE TUBES 99/6

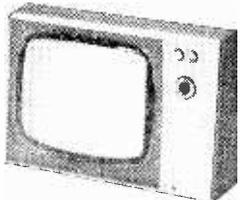
Exchanged Bulbs Carr. 10/6

EX MAINTENANCE

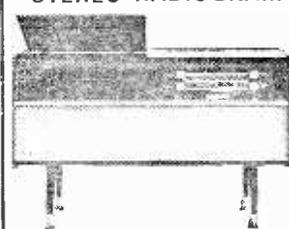
TESTED TUBES

17in.—35/-

Carr. 5/- (no. shuntline)



STEREO RADIOGRAM CABINETS £15



Superbly made and styled in Veneered English Walnut

LIFT UP LID TO CHANGE AND RECORD STORAGE COMPARTMENT

Position 8" x 5" Twin Speaker Dimensions: 45 x 15 1/2 x 15 1/2 Leads 1 gn. Carr. 30/- Other Models—Send for List

TAPE RECORDER CABINETS 49/6. Dia. 16" x 12" x 7 1/2". Red and Grey. Cut out for BSR deck. P. & P. 7/6.

TRANSISTOR CASES 19/6. Cloth covered many colours. Size 9 1/2" x 6 1/2" x 3 1/2". P. & P. 4/6. Similar cases in plastic 7/6.

SINGLE PLAYER CABINETS 19/6. P. & P. 7/6.

TV TURRET TUNERS, 2/6. New, less valves, Slim models 5/-, Press button models 19/6. P. & P. 4/6.

DUKE & CO. (LONDON) LTD.

621/3 Romford Road, E.12 0N-478, 6001 2-3

BENTLEY ACOUSTIC CORPORATION LTD.

38 CHALCOT ROAD, LONDON. N.W.1 Tel. Primrose 9090

Nearest Tube Chalk Farm SPECIALISTS IN NEW VALVES AND TRANSISTORS All goods advertised are in stock

0A2	5/	12AB6	9/	3525AT	5/6	6F08A	6/3	6F80	4/6	6Y30	3/	6F82	6/	8130	25/	1F42	4/8	ACU77	5/6	6F167	2/6	6C29	16/6
0B2	6/	12AD9	7/6	3016	6/3	6F80	9/9	6Z4	6/	6F84	1/4	6F84	8/	TY80P1110		1F80	6/8	AD140	8/	6F173	2/6	6C30	7/
0Z4CT	4/3	12AT6	4/6	2016CT	6/	6F88	7/	6F85	4/6	6Z41	6/	6F86	3/	110	9/	1F85	7/2	AD140	8/	6F174	2/	6C35	10/
1D6	9/6	12A1	6/8	4/2	7/2	6/6	6F88	5/9	6F86	6/3	6Z80	3/6	6F80	8/6	12114	7/6	1F86	9/	AF114	4/	6F170	5/	
1R5	4/9	12BA6	5/8	85A2	8/6	6F81	12/3	6F89	4/9	6Z81	4/3	6F80	9/6	116	15/	1F89	5/6	AF115	3/	6F171	4/6	6C38	11/6
1R5	3/3	12BA6	5/8	90C1	18/	6F83	10/6	6F91	3/3	6Z33	12/6	6F80	9/6	118	20/	6/8	1F41	9/8	AF116	3/	6F172	5/	
1R4	2/6	12B6	6/5	90C2	34/	6F70	4/9	6F92	2/6	6Z34	10/	6F80	11/6	119	40/	1F84	5/6	AF117	3/4	6F170	3/6		
2D21	5/6	12BH7	6/8	90C3	33/6	6F92	6/6	6F95	4/6	6Z35	14/6	6F84	9/	122	5/9	1F80	5/	AF118	3/	6F173	4/		
2N2	3/	12J2T	6/6	100C2	14/6	6F91	5/6	6F97	8/	6Z38	9/3	6F82	6/3	25	12/6	1F8	10/6	AF119	3/	6F178	4/		
3A5	8/	12K5	8/	807	11/9	6F93	3/6	6F98	9/	6Z39	26/6	6F83	3/6	26	11/	1F4N	10/3	AF120	3/6	6F172	5/		
3Q5CT	6/6	19A4Q5	5/5	5753	10/	6F94	3/6	6F183	6/3	6Z42	8/9	6F84	7/	131	6/3	1F21	9/	AF121	3/6	6F173	5/		
3R4	4/9	20D1	1/5	6090	6/	6F92	4/6	6F184	5/9	6Z43	8/9	6F85	8/3	133	13/6	1F41	5/6	AF173	10/	6F173	4/		
3V4	5/8	20D4	2/5	5475	2/6	6F93	4/6	6F90	2/5	6Z44	28/1	6F86	9/	135	16/6	1F85	4/8	AF180	9/6	6F174	4/		
5B4CY	8/9	20F2	11/6	ACDPEN	4/9	6F94	5/6	6F95	6/6	6Z45	19/6	6F87	7/	137	34/11	AF4	14/6	AF122	5/	6F174	7/6		
514C	4/9	20L1	15/6	1D2	19/6	6F95	5/	6L32	3/	6Z46	5/9	6F88	4/	145	15/6	VF4B	11/	BA115	2/8	6F175	4/6		
5V4C	8/	20P1	17/6	ADCPEN	4/9	6F95	7/	6L33	12/	6Z47	12/1	6F89	6/	146	14/6	VR105	5/	BA120	2/6	6F179	4/6		
5Y3CT	5/	20P3	17/	AZ41	7/9	6F91	3/	6L34	9/6	6Z48	4/	6L33	9/	191	12/	VR150	5/	BA120	2/6	6F179	4/6		
5Z3	7/6	20P4	17/6	AZ41	7/9	6F91	3/	6L35	9/6	6Z49	16/6	6L36	9/	251	12/6	VF11	6/	BA107	4/	6F178	6/		
5Z4A	7/6	20P5	17/	230	4/8	6F90	7/	6L41	8/	6Z50	27/6	6L38	18/8	282	12/3	W107	10/6	BA108	3/8	6F179	4/		
6A9G	7/6	25Y30	6/6	CL41	19/6	6F92	6/6	6L42	7/6	6Z51	4/3	6L39	6/8	301	12/6	W220	10/	BA109	4/6	6F187	4/6		
6A7	3/	25Z40	6/3	CL53	19/6	6F95	8/6	6L41	8/	6Z52	12/6	6L3A	6/8	404	6/	N41	10/	BA113	5/	6F188	4/6		
6A47	5/9	25Z6T	8/6	CY31	8/6	6F90	4/24	6L43	6/8	6Z53	4/	6L3B	5/9	401	18/	N66	7/6	BA115	3/	6F180	4/6		
6A45	4/9	30C15	12/	DA196	6/	6F90	12/6	6L44	4/6	6Z54	7/6	6L3C	6/	4020	6/	Y63	5/	BA116	5/	6F182	2/3		
6A7B	3/9	30C17	13/	DF96	15/	6F91	8/6	6L45	7/6	6Z55	12/6	6L3D	6/3	4AB08	5/3	Transistors	BA118	4/6	6F187	4/6			
6A113	5/8	30C18	14/	DF96	15/	6F93	6/	6L46	6/	6Z56	11/4	6L3E	6/3	4AF12	7/8	Transistors	BA135	5/	6F188	4/6			
6A9V	5/	30F5	11/6	DF97	10/	6F94	8/6	6L47	9/9	6Z57	19/6	6L3F	15/	4B41	10/6	2N404	6/	BA136	5/				
6BA6	4/3	30FL1	15/	DK40	10/6	6F91	5/	6L45	5/	N78	38/4	6L3G	14/	4B41	6/6	AA120	3/	BA137	5/				
6B6	4/3	30FL1	15/	DK92	7/6	6F93	7/	6L48	13/	N08	28/7	6L3H	9/3	4B41	6/6	AC107	3/6	BA138	5/				
6B36C	20/6	30FL1	15/	DK96	8/6	6F94	6/6	6M71	14/	PAB08	7/6	6L3I	6/6	4B41	6/6	AC113	5/	BA139	5/				
6B46	6/6	30FL1	14/	DF96	15/	6F90	5/9	6M10	5/9	6M1	2/6	6L3J	5/	4B41	6/6	AC126	2/	BA142	5/				
6B46	7/	30FL1	14/	DF96	15/	6F90	5/9	6M11	6/8	6M2	8/6	6L3K	5/	4B41	6/6	AC127	2/	BA143	5/				
6BQ2A	7/	30L17	13/	DM70	6/	6F91	6/	6M4	6/	6M8	8/6	6L3L	5/	4B41	6/6	AC128	2/	BA144	5/				
6B7	9/	30P4	11/6	DM71	9/9	6F94	12/	6M5	11/	6M9	6/9	6L3M	5/8	4B41	6/6	AC154	5/	BA138	5/				
6B8	8/	30P4M	11/6	DY87	5/9	6F95	11/	6M7	6/6	6M9	5/9	6L3N	7/3	4B41	6/6	AC156	4/	BA139	5/				
6B9	7/	30P12	11/	ES09	33/	6F96	7/9	6Y51	5/6	6P00	8/6	6L3O	6/	4B41	6/6	AC157	5/	BA119	9/				
6C9	10/9	30P19	14/	ES09	34/	6F98	6/	6Y81	7/	6P81	5/6	6L3P	9/	4B41	6/6	AC165	5/	BA151	5/				
6C9G	19/6	30P19	14/	ES09	34/	6F98	6/	6Y81	7/	6P81	5/6	6L3Q	9/	4B41	6/6	AC166	5/	BA150	5/				
6L19	19/	30FL13	15/	E180T	17/6	6F96	3/	6Y84	9/6	6P88	10/6	6L3R	10/	15/	11/	AC168	7/6	BA163	4/				
7B6	10/9	30FL14	15/	EAB08	5/9	6F97A	7/	6Y86	5/9	6P89	9/9	6L3S	17/	17/6	11/	AC168	7/6	BA163	4/				
7B7	12/8	30FL15	15/	EAF12	7/6	6F99	5/	6Y87	5/9	6P90	8/3	6L3T	18/9	18/	11/	AC168	7/6	BA163	4/				
10L110	13/	35L46T	8/6	E441	4/9	E440	8/9	6Y88	7/6	6P90	8/3	6L3U	19/9	19/	11/	AC168	7/6	BA163	4/				
10P13	14/6	35W4	8/6	E891	2/3	E841	4/9	6Y88	7/6	6P90	8/3	6L3V	19/9	19/	11/	AC168	7/6	BA163	4/				
12A14	15/6	35Z3	10/	E833	3/	E842	3/6																
12AC5	8/	35Z4CT	4/6	E834	7/3	E842	3/6																

We require for prompt cash settlement all types of valves, loose or boxed, but MUST be new. Offers made by return.

Terms of packing: Cash with order only. No C.O.D. Postage-Banking 6d. per item. Orders over £5 post free. Any parcel insured against damage in transit for only 6d. extra. All orders despatched on day except. Callers welcome to the shop, Mon. - Fri. 9 a.m. - 5.30 p.m. Sat. 9 a.m. - 1 p.m.

All goods are new first quality brands only and subject to makers' full guarantee. We do not handle manufacturers' seconds or rejects which are often described as "new and tested" but which have a limited and unreliable life. Complete catalogue of over 1000 valves actually in stock with resistors, condensers, transformers, microphones, speakers, metal rectifiers with terms of business, etc., sent free.

BBC2, TV, RADIO & TAPE REC. SPARES

UHF/625. Modify your set to BBC2. 1955 to 1963 models covered. Selection of new manufacturers conversion kits and tuners at reduced prices. List available by **SPECIAL OFFER: FERZUNO** 925 IF amp. chassis. NPL1, mod. 6 valves 45/- less valves, 17/6. **Gerrit and Hestor**, 3/6 p.p. 4. 5. **PHILIPS** 625 conversion kit includes tuner, I.F., switch, audio, circuits etc. less valves 39/6 p.p. 6. **GEC/SONELL** dual 405/625 IF amp. and output chassis, NEW 33/6, p.p. 4. 6.

UHF TUNERS. New with valves 30/-, less valves 12/6 p.p. 1/6.

TV SIGNAL BOOSTER UNITS. Sens. gain all stations. **PVE LAB/GEAR** transist. BB111A or C1111A. Best "plug in", 75/-, **UHF Mains** "plug in", 97/6. **UHF Mainboard 105/-**. Post free.

FIREBALL TUNERS. Salvaged 17/6 p.p. 4. 6.

PUSH BUTTON TUNERS. For Sobell 250, RGD 612, 619, REG 171S, 192. Salvaged 15/- p.p. 4/6.

TUNER TUNERS. New, Cylcon C. 38 Mc 20/-, KR 16 Mc's, KR MV F 38 Mc. 10/-, 4/6. Many others available. **Telex** 4. **Pye**, **For**, **Sobell**, **Philips**, **Stella**, **Gec**, **McMich**, etc. Large selection channel-coupler.

CRTs. Rebuilt, guar. 17m. 70/- 90 85/-; 17, 19m, 110, 105/-. Callers only.

LINE OUTPUT TRANSFORMERS. Popular types available. **brand new exact replacements** fully guar. A selection which can be supplied:-

PHILIPS 1758-1776, STELLA 6617 1017	93/6	LOPT Inserts p.p. 2 -	
EKO 221 to 311 (25 types)	42/6	Bush TV32 36, 43	45/
FERRANTI 1001 to 1011 (25 types)	42/6	Bush TV53 to 69	30/
EKO/FERRANTI (26 types) 70, 90	53/6	Cosor 930 to 950	35/
EKO 344, FERRANTI 1023 range	72/6	Emerson 700 range	35/
DECCA DM1, 2, 17; DM3C , DM11 (70)	73/6	Ferzuno 903 to 246	35/
FERG 305, 200, 205, 42/6; 405, 200 range	53/6	Ferranti 1475 to 1776	35/
FERG. HMV. MARCO 3000, 3000	59/6	Pye VTA 207, 209, PU40	42/6
2000, 4000, 6000 range	59/6	RGD D17, 590 to 619	35/
KBH 950 to MV60, 20/; QA 20, 1, RV 20 range	30/6	Res 10 to 10 17	35/
MARCONI V1157, 159, 160, 164	53/6	ULTRA 1770, 1780 range	35/
GEC 1252, 1748, 2745 range 53/6 later models	72/6		
HMV 1865, 1889, 42/6; 1870, 6/ 1880	54/6		
PVE V14, V17, 15/; 17, 21, 110 to 210	62/6		
PAM-INVICTA equip. LOPTs to above Pve	62/6		
SONELL TP8180, SC24, 34, 270, 370 ranges	65/6		
ULTRA 1980C, 1981C, 1000, 2000	65/		

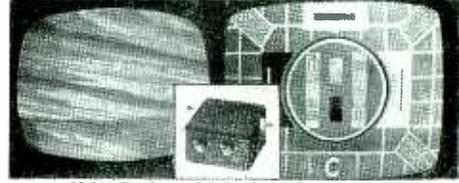
Also **ALBA**, **BUSH**, **COSSOR**, **McMICHAEL**, **MURPHY**, **DYNATRON**, etc. Postage and Packing for L.O.T.s 4.6. C.O.D. 3.6 extra.

SCAN COILS. Frame of frame core, transist., with linear coils, sound a p.p. 10/-, mains driven, control knobs, dual coil, control, line osc., transist., resistors, condensers, etc.

TAPE REC/CHANGER. Drive Belts, Dual Pinch Wheels, Idlers, Motors for most British (incl. **WALTER** and **Continental**).

SALVAGED COMPONENTS. Large selection for popular models, clean, serviceable condition. Tuners, Transformers, etc. **ENQUIRIES** invited, quotations given. C.O.D. despatch available.

THE KING TELEBOOSTER



FROM THIS - BY THIS - TO THIS

THE ORIGINAL VHF DUAL BAND TUNABLE PRE-AMPLIFIER

Still the best of its kind available. Latest low-noise transistor and printed circuit. Boosts Band I and III simultaneously without switching. Two amplifiers in one. Can produce good viewing out of almost nothing in fringe areas. Ideal for DX work.

Guaranteed gain: Minimum 18 dB Band I, 14 dB Band III, Channels: Red spot, Band 1, 2 and 3, all Band 3. Yellow spot, Band 1, 3, 4 and 5, all Band 3.

Power: Self-contained 9V PP4 battery, 11mA.

Plastic case 3 1/2 x 3 1/2 in., brown, with cork base.

Retail price, £3.15.6. complete with battery. OR self-contained mains version, retail price £5.17.6.

Specify channels, one Band I, one Band III.

THE KING UHF TELEBOOSTER FOR BBC2

Unique design, employing quarter-wave cavity resonator for 100% stability, printed circuit for reliability, with the very latest second generation low-noise transistor.

Channels: Blue spot 25-45, White spot 45-65, tunable.

Plastic case 3 1/2 x 3 1/2 in., brown, with cork base.

Retail price, £4.17.6. complete with battery. OR self-contained mains model, £6.15.0.

Sole manufacturers:
TRANSISTOR DEVICES LTD.
BRIDGE HOUSE, NEWTON ABBOT, Devon
Tel. 2457 *Send for literature*

31 Leo

VALUABLE NEW HANDBOOK **FREE** TO AMBITIOUS **ENGINEERS**

Have you had *your* copy of "Engineering Opportunities"?

The new edition of "ENGINEERING OPPORTUNITIES" is now available—without charge—to all who are anxious for a worthwhile post in Engineering. Frank, informative and completely up to date, the new "ENGINEERING OPPORTUNITIES" should be in the hands of every person engaged in any branch of the Engineering industry, irrespective of age, experience or training.

On 'SATISFACTION OR REFUND OF FEE' terms

This remarkable book gives details of examinations and courses in every branch of Engineering, Building, etc., outlines the openings available and describes our Special Appointments Department.

WHICH OF THESE IS YOUR PET SUBJECT?

TELEVISION ENG.
Advanced Television Eng.—Gen. Television Eng.—Television Servicing and Maintenance.

ELECTRONIC ENG.
Advanced Electronic Eng.—Gen. Electronic Eng.—Applied Electronics—Practical Electronics—Radar Tech—Frequency Modulation—Transistors.

MECHANICAL ENG.
Advanced Mechanical Eng.—Gen. Mechanical Eng.—Maintenance Eng.—Diesel Eng.—Press Tool Design—Sheet Metal Work—Welding—Eng. Pattern Making—Inspection—Draftsmanship—Metallurgy—Production Eng.

WE HAVE A WIDE RANGE OF COURSES IN OTHER SUBJECTS INCLUDING CHEMICAL ENG., AERO ENG., MANAGEMENT, INSTRUMENT TECHNOLOGY, WORK STUDY, MATHEMATICS, ETC.

WHICH QUALIFICATION WOULD INCREASE YOUR EARNING POWER?

A.M.I.E.R.E., A.M.I.Mech.E., A.M.S.E., A.M.I.C.E., B.Sc., A.M.I.P.E., A.M.I.M.I., A.R.I.B.A., A.I.O.B., A.M.I.Chem.E., A.R.I.C.S., M.R.S.H., A.M.I.E.D., A.M.I.Mun.E., C.ENG., CITY & GUILDS, GEN. CERT. OF EDUCATION, ETC.

BRITISH INSTITUTE OF ENGINEERING TECHNOLOGY

445A ALDERMASTON COURT, ALDERMASTON, Berks

RADIO ENG.
Advanced Radio—Gen. Radio—Radio Servicing—Telecommunications—Sound Recording—Automation—Practical Radio—Radio Amateurs' Exam.

ELECTRICAL ENG.
Advanced Electrical Eng.—Gen. Electrical Eng.—Installations—Draftsmanship—Illuminating Eng.—Refrigeration—Elem. Electrical Science—Electrical Supply—Mining Electrical Eng.

CIVIL ENG.
Advanced Civil Eng.—Municipal Eng.—Structural Eng.—Sanitary Eng.—Road Eng.—Hydraulics—Mining—Water Supply—Petrol Tech.

THIS BOOK TELLS YOU

- ★ HOW to get a better paid, more interesting job.
- ★ HOW to qualify for rapid promotion.
- ★ HOW to put some letters after your name and become a key man ... quickly and easily.
- ★ HOW to benefit from our free Advisory and Appointments Dept.
- ★ HOW you can take advantage of the chances you are now missing.
- ★ HOW, irrespective of your age, education or experience, YOU can succeed in any branch of Engineering.

132 PAGES OF EXPERT CAREER - GUIDANCE

PRACTICAL INCLUDING EQUIPMENT TOOLS

Basic Practical and Theoretic Courses for beginners in TV, Radio, Electronics, etc., A.M.I.E.R.E. City & Guilds, Radio Amateurs' Exam, R.T.E.B. Certificate, P.M.G. Certificate, Practical Radio, Television & Radio Servicing, Practical Electronics, Electronics, Engineering, Automation.

The Specialist Electronics Division of B.I.E.T.

NOW offers you a real laboratory training at home with practical equipment.

Ask for details

B.I.E.T.

You are bound to benefit from reading "ENGINEERING OPPORTUNITIES", send for your copy *now*—FREE and without obligation.



POST COUPON NOW!

To B.I.E.T., 445A Aldermaston Court Aldermaston, Berkshire *3d. stamp if posted in an unsealed envelope*

Please send me a FREE copy of "ENGINEERING OPPORTUNITIES". I am interested in (state subject, exam., or career).

NAME

ADDRESS

WRITE IF YOU PREFER NOT TO CUT THIS PAGE

THE B.I.E.T. IS THE LEADING INSTITUTE OF ITS KIND IN THE WORLD