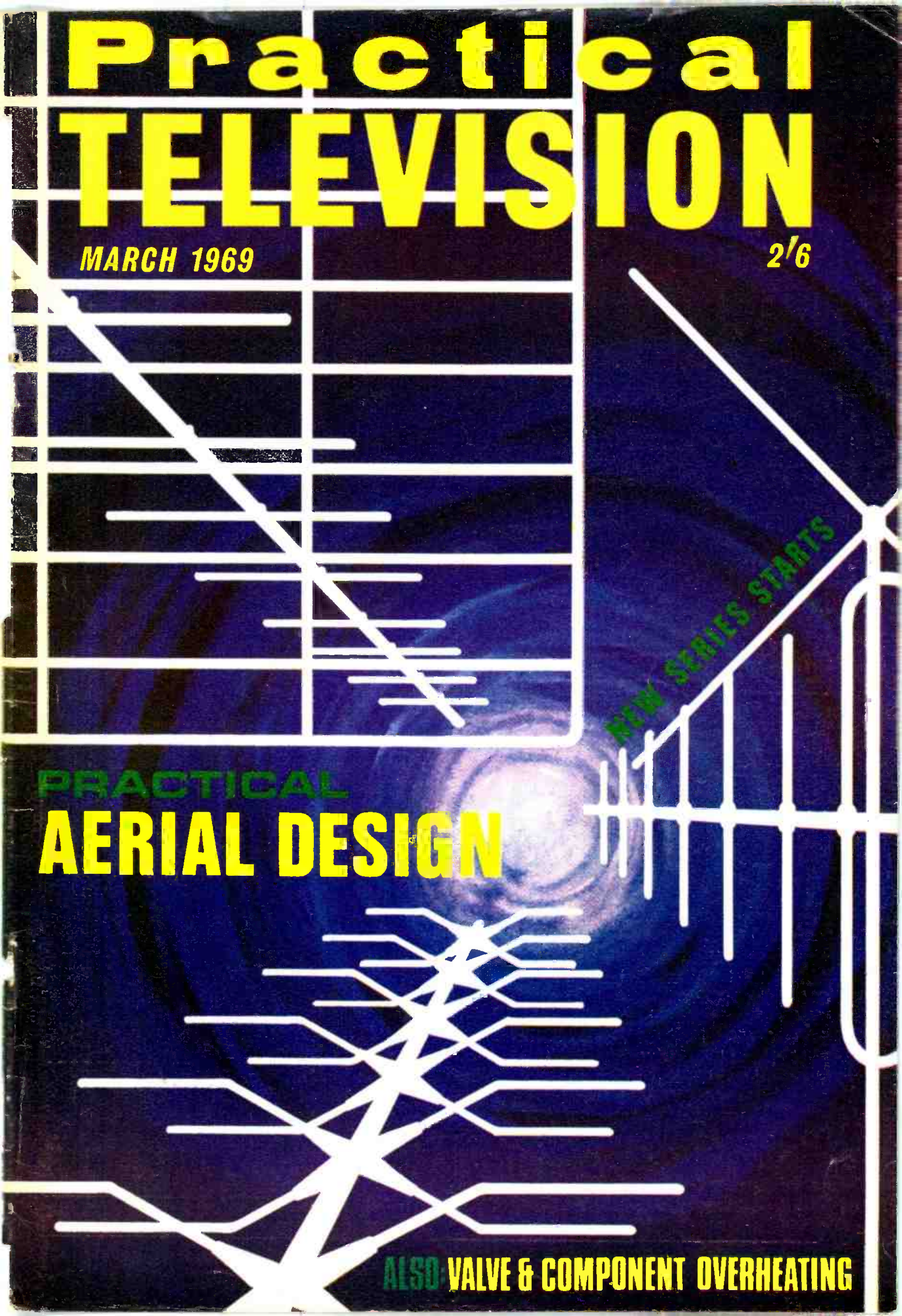
Practical TELEVISION

MARCH 1969

2/6



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20P5	18/-
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EBF89	6/3
EBL21	11/-
EC53	12/6
EC70	4/9
EC86	10/3
EC88	10/3
EC92	6/6
ECC31	15/6
ECC40	9/6
ECC81	3/9
ECC82	4/6
ECC83	4/6
ECC84	5/6
ECC85	5/-
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ECC91	3/-
ECC189	9/3
ECF80	6/6
ECF82	6/6
ECF86	9/-
ECF804	42/-
ECF805	12/6
ECH21	12/6
ECH35	5/9
ECH42	9/6
ECH81	5/3

ECH83	8/-
ECH84	7/-
ECL80	6/6
ECL82	6/-
ECL83	9/-
ECL84	12/-
ECL85	11/-
ECL86	8/-
ECLL800	30/-
EF22	12/6
EF36	3/6
EF37A	7/-
EF39	5/-
EF40	8/9
EF41	9/-
EF42	3/6
EF50	2/6
EF80	4/6
EF83	9/6
EF85	5/3
EF86	6/-
EF89	4/9
EF91	3/3
EF92	2/6
EF95	4/6
EF97	10/-
EF98	10/6
EF183	5/9
EF184	5/9
EF804	20/5
EH90	6/6
EL32	3/6
EL33	12/-
EL34	9/6
EL36	8/6
EL41	9/3
EL42	9/9
EL81	8/-
EL83	6/9
EL84	4/6
EL85	7/6

EL86	8/-
EL91	2/6
EL95	5/-
EM71	14/-
EM80	5/9
EM81	6/9
EM84	6/-
EM85	11/-
EM87	7/3
EY51	6/9
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EY83	8/3
EY84	7/6
EY86	6/-
EY87	6/-
EY88	7/6
EY91	3/-
EZ40	7/3
EZ41	7/3
EZ80	4/3
EZ81	4/6
GZ33	12/6
GZ34	10/-
GZ37	14/6
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HVR2A	8/9
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KTW63	5/9
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MHLD6	7/6
MKT4	19/6
N78	38/4
PABC80	7/3

P61	2/6
PC86	9/6
PC88	9/6
PC95	8/3
PC97	7/9
PC900	8/3
PCC84	6/-
PCC85	6/6
PCC88	9/9
PCC89	9/6
PCC189	9/6
PCF80	6/6
PCF82	6/-
PCF84	8/-
PCF86	8/6
PCF801	7/-
PCF802	9/-
PCF805	8/9
PCF806	11/6
PCL81	9/-
PCL82	7/-
PCL83	8/9
PCL84	7/6
PCL85	8/3
PCL86	8/3
PEN45	7/-
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PL36	9/6
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PL81A	10/6
PL82	6/6
PL83	6/6
PL84	6/3
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PL509	28/9
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PY80	5/3
PY81	5/3
PY82	5/-
PY83	5/6
PY88	6/3
PY800	6/6
PY801	6/6
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U19	34/6
U22	7/9
U25	13/-
U26	11/9
U31	6/-
U33	29/6
U35	16/6
U37	34/11
U45	15/6
U76	4/9
U191	12/6
U251	16/-
U282	8/-
U301	11/-
U404	7/6
U801	17/6
U4020	6/9
UABC80	5/9
UAF42	9/6
UB41	6/6
UBC41	7/6
UBC81	7/-
UBF80	5/9
UBF89	6/9
UBL21	9/-

UC92	5/6
UCC84	8/-
UCC85	6/6
UCF80	8/3
UCH21	9/-
UCH42	9/3
UCH81	6/6
UCL82	7/-
UCL83	9/3
UF41	9/6
UF42	9/-
UF80	6/9
UF85	6/9
UF86	9/-
UF89	6/3
UL41	9/6
UL84	6/6
UM80	5/-
URIC	10/6
UU5	7/-
UU8	14/-
UY1N	9/-
UY21	9/6
UY41	6/9
UY85	5/6
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AC126	2/-
AC127	2/-
AC128	2/-
AC154	5/-
AC156	4/-
AC157	5/-
AC165	5/-
AC166	5/-
AC168	7/6
AC177	5/6
ACY17	3/-
ACY18	3/8
ACY19	3/9
ACY20	3/6
ACY21	3/9
ACY22	3/6
ACY28	4/-
AD140	7/6
AD149	8/-
AF114	4/-
AF115	3/-
AF116	3/-
AF117	2/9
AF119	3/-
AF125	3/6
AF127	3/6
AF178	10/-
AF180	9/6
AFZ12	5/-
ASY28	6/6
BA115	2/8
BA129	2/6
BA130	2/-
BC107	4/-

BC108	3/6
BC109	4/3
BC113	5/-
BC115	3/-
BC116	5/-
BC118	4/6
BCY10	5/-
BCY12	5/-
BCY33	5/-
BCY34	4/6
BCY38	5/-
BCY39	4/6
BD119	9/-
BF154	5/-
BF159	5/-
BF163	4/-
BFY50	4/-
BFY51	4/-
BFY52	4/6
BY100	3/6
BY234	4/-
BY236	4/-
BY238	4/-
BYZ12	5/-
BYZ13	5/-
GET103	4/-
GET113	4/-
GET118	4/-
OA70	3/-
OA79	1/9
OA81	1/9
OA90	2/6
OA91	1/9
OA95	1/9
OA182	2/-
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OC22	5/-
OC23	5/-

OC25	5/-
OC26	5/-
OC28	5/-
OC30	5/-
OC35	5/-
OC36	7/6
OC38	11/6
OC41	10/-
OC44	2/-
OC45	1/9
OC46	3/-
OC70	2/3
OC71	2/-
OC72	2/-
OC74	2/6
OC75	2/-
OC76	2/6
OC77	2/6
OC78	3/-
OC78D	3/-
OC81	2/-
OC81D	2/-
OC82	2/3
OC82D	2/3
OC83	2/-
OC84	3/-
OC123	4/6
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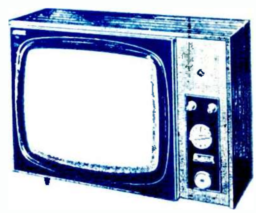

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A

Practical Television

MARCH 1969
VOL. 19 No. 6
issue 222

Progress of P.TV.

MANY readers may be surprised to know that Practical Television first came on the scene as early as 1933 when, in the December 9th issue of Practical Wireless, it was contained as a supplement. It continued to appear monthly until September 1934 when it was launched as a magazine in its own right under the title of Practical Television and Short-Wave Review. It continued under its own banner for a year and then reverted to a weekly supplement in Practical Wireless until September 1940 when that periodical changed from weekly to monthly publication. A year later, due to wartime circumstances, P.W. was reduced in page size and although Practical Television was still incorporated in the title of the joint magazine very little TV news, naturally, can be found in those war-time issues.

After the war, however, with the re-opening of the television service Practical Television became a reality again in the form of a monthly supplement in the parent magazine, starting in 1949, although many articles of TV interest had been appearing in P.W., dealing mainly with those celebrated green-eyed monsters using war-surplus units.

By April 1950 the time was judged right for setting P.T. on its own feet again and from that date it has appeared regularly each month in the familiar format. This brings us up to date in this thumbnail history, and to the notice at the foot of this column. With the growing complexity of modern circuitry more space was needed to display diagrams; this is only one of the advantages readers will derive from next month on.

W. N. Stevens—Editor

From the next (April) issue, on sale March 21, PRACTICAL TELEVISION will appear in a brand-new attractive format, with an increased page size. In order to carry out these improvements it has been necessary to increase the price to 3s. We are sure readers will like the improvements and will understand the reasons for the increase in price.

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THE NEXT ISSUE DATED APRIL WILL BE PUBLISHED ON MARCH 21

TELETOPICS

BBC's ADVANCED FIELD-STORE TV STANDARDS CONVERTER

RECENTLY we reported the BBC's sound-in-vision system and since then we have had revealed to us the latest world "first" from the BBC Engineering Research Dept., their Advanced field-store TV standards converter. This is an all-electronic equipment for converting US 525-line, 60 fields NTSC signals to the UK (and most of W. Europe) 625-line, 50 fields PAL standard. Simple line conversion systems merely repeat a line every so often in order to increase their number, but the Advanced converter creates a completely new set of 625 lines by adding successive pairs of lines together in certain proportions. Subsequently one field in every 6 is omitted to achieve field conversion. The quality of the results is èxceptional, and in comparison with earlier equipment the Advanced converter gives a picture of the correct dimensions and sufficiently stable to be able to be mixed with locally generated signals, giving production staff full flexibility in programme editing. The equipment uses over 6,000 transistors and banks of field- and line-frequency delay lines, and has suffered only minor faults at a rate of one per month since its first use during the Olympic Games in Mexico. World orders approaching 100 are anticipated at a price running to six figures per unit.

GRANADA'S TV CENTRE CONTROL

THE television centre control system has been installed by Marconi at the Manchester TV Centre of Granada Television in contracts totalling £1 million in value. It is now in operation, enabling personnel in a single control suite to select, assemble and distribute the whole station's output. Programmes for local transmission, or for other programme companies, can now be handled with an efficiency which was impossible to achieve by previous techniques.

Key to this unified method of controlling a television centre is an elaborate Marconi switching system, like a miniature telephone exchange. This handles all the signals which control the operation of tape recorders, telecine machines, etc., and also all the programme signals.

This photograph shows the control suite. The operator on the right controls the station output to the network, and the operators on the left are concerned with the assembly of individual programmes including advertisement and continuity insertions for local transmission.

AERIALS VACATION SCHOOL

THE IEE Electronics Division is organising a vacation school on aerials. This will be held at the University of Birmingham from the 7th to 19th July 1969.

It is expected that the school will prove attractive to the younger graduate entering the field of aerials whether in research, development or application. The course has also been designed as a refresher course for the more experienced person and as an introductory course for those transferring to aerial work from other fields.

The course will commence with a survey of basic concepts and theoretical methods. This will be followed by accounts of recent work on: wideband dipoles and frequency - independent aerials, linear, circular and planar arrays and beam-scanning microwave aperture aerials and feeds, travelling wave tubes.

Also, lectures will be arranged on the following topics: synthetic aperture techniques, self focusing arrays, within-pulse scanning, holography, satellite - communication earth-station aerials.

SOVIET VTR

A NEW video-tape recorder designed by Soviet engineers weighs no more than 88 lb. and is built around semiconductor units and miniaturised parts.

The video-tape recorder may follow and "memorise" instantaneous processes which the human eye is unable to trace (for instance, instantaneous chemical reactions). It makes it possible to trace such phenomena to the minutest detail. For this purpose the recorded tape must be screened in slow motion. Phenomena occurring in the course of material treatment can be studied in this way.

It is hoped to use the video-tape recorder in the future to relay films from one cinema centre in each residential area to the screens of TV sets.

EMI COLOUR TV MARKETING IN USA

ELECTRIC and Musical Industries Ltd. (EMI) and International Video Corporation (I.V.C.) have announced a joint marketing agreement whereby I.V.C. will sell EMI colour television cameras and broadcast equipment in the U.S.A.

The two companies will introduce a 3-tube colour television camera for broadcast use; developed by EMI for the U.S.A. market. This new camera will be priced in the U.S.A. at about 72,000 dollars. The EMI 4-tube camera type 2001, currently in extensive use in Europe and United Kingdom, will also be marketed by I.V.C. in the U.S.A. The cameras will be shown at the National Association of Broadcasters Convention in Washington D.C. next month.

SENIOR BBC ENGINEERING APPOINTMENTS

THE following new BBC appointments and changes of organization took effect on 1 February 1969:—

Mr. G. G. Gouriet, CEng, FIEE, became Chief Engineer, Research and Development, and co-ordinates the work of the Research and Designs Departments.

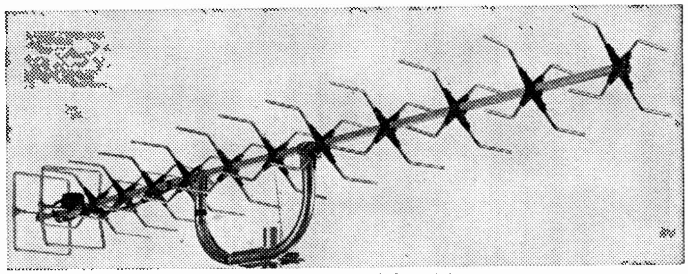
Mr. D. R. Morse, CEng. FIEE, became Chief Engineer, Capital Projects, and co-ordinates the work of the Building Department and the two Planning and Installation Departments (Studios and Transmitters).

Mr. Gouriet will be succeeded as Head of Research Department by R. D. A. Maurice, OBE, Dr-Ing ESE. CEng, FIEE at present Head of Designs Department. Dr. Maurice joined the BBC Research Department in 1939 and after some years in the Receiver and Measurements Section he transferred to the Television Group and became Head of the Group in 1958. He was appointed Assistant Head of Research Department in 1961 and Head of Designs Department in March 1968.

DON'T FORGET THE FILMSHOW—SEE PAGE 271

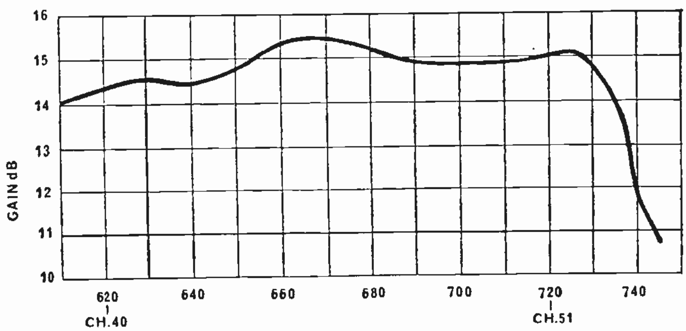
J-BEAM'S MULTIBEAMS

VIEWERS in u.h.f. fringe areas will soon be seeing a new aerial shape with the introduction of the Multibeam high-gain range of aerials by J-Beam Aerials Ltd. The distinctive feature of the new aerials is the design of the director elements (see photo). These



The MBM46 u.h.f. aerial.

are in groups of four in a modified X-formation simulating the director arrangement in a four-square stacked array but with the advantage of simplified, single-boom mounting. The system has been in use for some time on the Continent, but J-Beam have found that their Parabeam skeleton-slot radiator and reflector are well



The gain-curve o the Multibeam ...BM38 u.h.f. aerial.

suited to use with this type of director arrangement. Correct matching to the feeder is by means of an inverse balun. The range consists of four models, the MBM38, MBM46. 2MBM46 (two MBM46s side-by-side) and the 4MBM46 (four MBM46s in four-square stacked array).

ITA's ANNUAL HANDBOOK

THE ITA annual handbook for 1969 contains much useful reference material on the structure and technical operations of Independent Television in the UK. This seventh edition gives fresh details of the extensive plans for the ITV colour service on 625-line u.h.f. which is expected to begin initially from four main stations by late 1969 or early 1970. New maps show the estimated service area for the first seven main u.h.f. stations. Details are also given of the first 26 main stations, expected to be in service before the end of 1971, and of the first 12 relay stations which are likely to be in service by the end of 1970. Advice is provided on the reception of u.h.f. transmissions and colour, and field-strength maps for the ITA network of some 40 v.h.f. transmitting stations are included with an account of developments in each of the regions.

There are condensed details of the facilities and operation of the 15 independent television programme companies and ITN, with information on a number of new studio centres now being prepared for 625-line colour operation. Staff lists of ITA and programme company personnel are a useful feature.

With 236 pages "ITV 1969—A Guide to Independent Television" is published by the ITA at 10s 6d.

PRACTICAL AERIAL DESIGN PART 1

A. J. WHITTAKER

AERIALS for television are in reality derivations of the fundamental Hertzian dipole or the quarter-wave Marconi aerials. However, they differ from the ordinary radio or broadcast aerials in that they are self-tuned to the frequency of the transmitting station. Let us first consider the Hertzian dipole aerial. A dipole is fundamentally a half-wavelength rod. For television purposes this takes the form of a copper or aluminium tube of about $\frac{3}{8}$ to $\frac{1}{2}$in. diameter split into two in the centre to form two quarter-wave aerials. The feeder is connected at this point which has a typical characteristic impedance of 75-80Ω.

DIPOLE CHARACTERISTICS

The voltage and current waves on such a system are shown in Fig. 1. It will be seen that there is a current anti-node (point of high amplitude) and a voltage node (point of low amplitude) at the aerial centre, giving an impedance at this point of typically 75-80Ω. The impedance at the aerial ends may be 3,200Ω or a ratio of 1:40. Such an aerial is connected to the television set via a concentric feeder such as a coaxial cable having an impedance of 75Ω. The aerial will then be correctly terminated with minimum standing waves on the feeder.

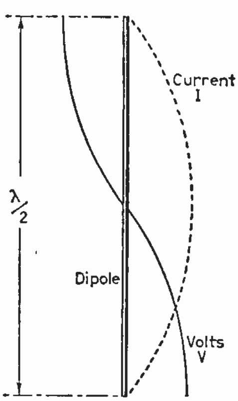


Fig. 1: Voltage/current characteristics of a half-wave dipole.

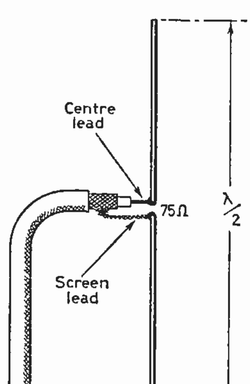


Fig. 2: Feeder connection to the centre gap in a half-wave dipole.

Figure 2 shows a dipole aerial with its feeder connected. The total length of the aerial is $\frac{1}{2}\lambda$ (wavelength). A Band I aerial, for instance for London with a vision frequency of 45Mc/s, will have a length of 468/45=10ft. 4in. A Band III aerial, for example for Mendlesham on a vision frequency of 204·75Mc/s, will have a length of 468/204·75=2ft. 3in. approximately.

DIRECTIVITY

The polar diagram for a dipole aerial is a figure-of-eight form, the maximum pick up being at right-angles to the plane of the aerial. If the transmitter aerial is horizontal the receiver aerial should be likewise (i.e. horizontal polarisation) and if the transmitter aerial is vertical the receiver aerial should also be in this plane (i.e. vertical polarisation). Figure 3 shows the polar diagram of a dipole aerial. From this polar diagram it will

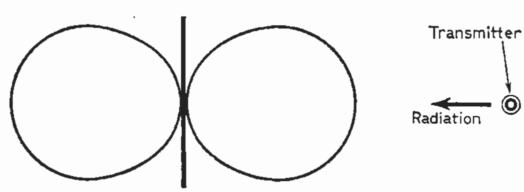


Fig. 3: Figure-of-eight dipole polar diagram.

be seen that the aerial is sensitive to signals arriving from the transmitter and also from the opposite direction. These signals from the opposite direction may be in the form of noise, for example from passing traffic, or from another station. Thus the signal-to-noise ratio of this system could be poor when sited in areas of poor signal strength.

REFLECTOR

The situation can be much improved by adding a reflector element to the dipole. Figure 4 illustrates a simple dipole aerial with reflector. Adding a reflector improves the forward gain and narrows the angle of pick up, reducing the pick up

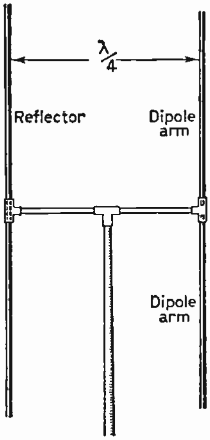


Fig. 4: Dipole plus reflector H aerial.

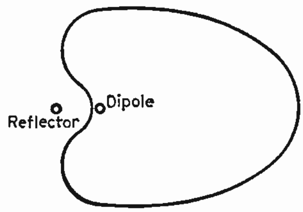


Fig. 5: The effect on the polar diagram of a dipole of adding a reflector element is to produce a cardioid polar response as shown here. This has good directional characteristics.

of unwanted signals. The polar diagram of a dipole-plus-reflctor combination is shown in Fig. 5.

The passing television signal from the transmitter induces a voltage on the main dipole aerial rod. A quarter of a cycle later (90°) a voltage is induced on the reflector since the reflector is spaced a quarter wavelength behind the dipole. A current flows in the reflector lagging 90° behind the cause producing it (i.e., the reflector voltage). As a result the reflector re-radiates, the resultant field now lagging 270° on the main dipole voltage. A phase lag of 270° may be considered as a 90° phase lead. By the time the re-radiated wave has passed through the 90° or quarter-λ space between the reflector element and the dipole the energy will be in phase and will add to the initial signal induced on the dipole. Director elements have a similar action though their effect on the dipole is less pronounced as the spacings are different. We shall look further into the action of the director elements later.

FOLDED DIPOLE

The reflector element has a transformer coupling effect on the dipole and this reaction has the effect of lowering the characteristic impedance, i.e. the terminating impedance of the dipole. This causes a mis match between the aerial and the 75Ω feeder. The spacing between the reflector and dipole has a great influence on this; for instance if the reflector spacing is very much less than a quarter wavelength the termination impedance may fall to as low a value as 10Ω.

To combat these effects and to make it possible to add further parasitic elements in the quest for increased aerial gain, bandwidth and directivity, the folded dipole was developed. This is in effect two dipoles connected in parallel. We now have a system in which the centre impedance of the aerial is about 300Ω or four times the impedance of the single dipole. Judicious adjustment of reflector and director elements will bring this down to 75Ω to match the feeder. Fig. 6 shows a practical form of folded dipole. The aerial rod is a full wavelength long overall and is usually made of ⅜in. aluminium tubing. Spacing between the two dipoles is typically 2in.

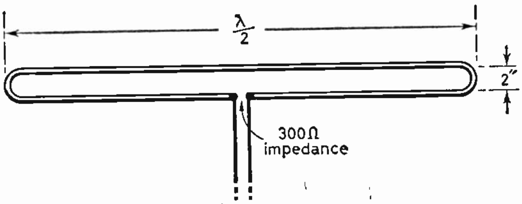


Fig. 6: The folded dipole.

MISMATCH EFFECTS

If there is a serious mismatch between the feeder and the aerial, standing waves will be set up on the feeder due to reflections caused by the mismatch. We will discuss feeders and the affects of matching and balancing later in this series. Reflections in the feeder will cause a television picture to have ghost images. These are a ghost of the picture image displaced to the right (because the cathode-ray tube spot travels from left to right in building up the line structure of the picture). If the feeder is less than 100ft. these effects are usually negligible. However, if longer feeders are mismatched the images become blurred and as the length increases a distinct ghosting is observed.

YAGI ARRAY

Adding reflectors and director elements to the aerial system makes the aerial system into a Yagi array. The general form is shown in Fig. 7. The director rods are usually spaced ⅛λ in front of the dipole for Bands I and III, but this is not critical. The length of the director element is 0·43λ, but if the directors are cut progressively shorter in the direction of radiation the bandwidth may be broadened.

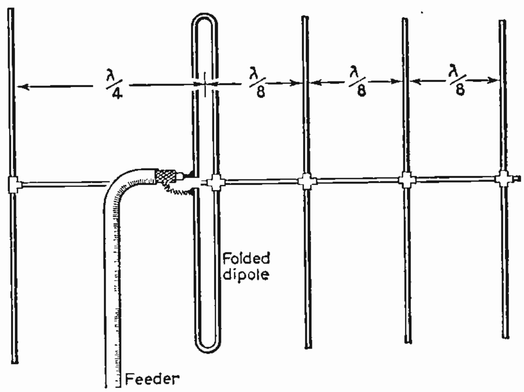


Fig. 7: Yagi array with three directors.

ELEMENT DIMENSIONS

The dimensions of a television aerial are not critical since the aerial must pick up both sound

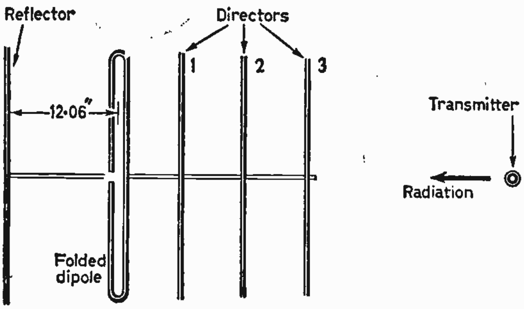


Fig. 8: Typical five-element Yagi array.

and vision signals. Some manufacturers cut their aerials to the vision frequency whilst others favour cutting the length midway between vision and sound.

Dipole length in feet may be calculated from the formula $468/f$, where f is the frequency in Mc/s. From this the length of a dipole for the London transmitter at Crystal Palace works out at: vision frequency 45Mc/s, dipole length 10ft. 4in.; sound frequency 41·5Mc/s, dipole length 11ft. 3in.; midway between sound and vision, 43·5Mc/s, 10ft. 8in.

Figure 8 shows a typical five-element Yagi array for television reception on Band III. The lengths of the various elements are given below calculated for the Mendlesham ITA transmitter whose vision frequency is 204·75Mc/s and sound 201·25Mc/s. Thus cut to a frequency of 203Mc/s (about midway between vision and sound) the length of the reflector element is 2ft. 3in., the length of the dipole 2ft. 3in. (full length folded 4ft. 6in.) the first director 2ft ($0{\cdot}43\lambda$), second director 1ft. 11½in. and the third director 1ft. 11in. The director lengths are a half inch shorter in the direction of radiation to improve the bandwidth. The reflector spacing is $0{\cdot}23\lambda$, the reaction of this on the main dipole giving a closer match to the 75Ω feeder.

MARCONI AERIAL

Figure 9 shows the arrangement of a quarter-wave Marconi aerial with earth counterpoise. This is primarily for use as a loft aerial where space may be limited. This aerial is electrically half the height of the dipole, its surge or characteristic impedance being 40Ω. This inverted-T form of aerial should be used in areas of good signal strength only and should be set up with its counterpoise earth rod set at right-angles to the direction of the transmitter.

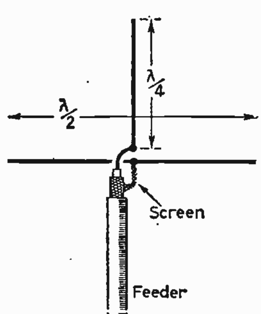


Fig. 9: Marconi aerial.

FRINGE AERIAL

For fringe area reception it may be necessary to arrange matters so that the maximum forward gain is available from the aerial system while taking extra precautions to minimise as far as practicable intereference pick up. An aerial system suitable for this may take the form shown in Fig. 10, consisting of a seven-element aerial with a folded dipole, three reflectors located on a parabolic curve of which the dipole is at the focus (this arrangement narrows the angle of pick-up) and director elements. Figure 11 gives the general plan of the system. By careful adjustment of the spacing of the reflectors the aerial impedance can be made a good approximation to 75Ω to match the feeder.

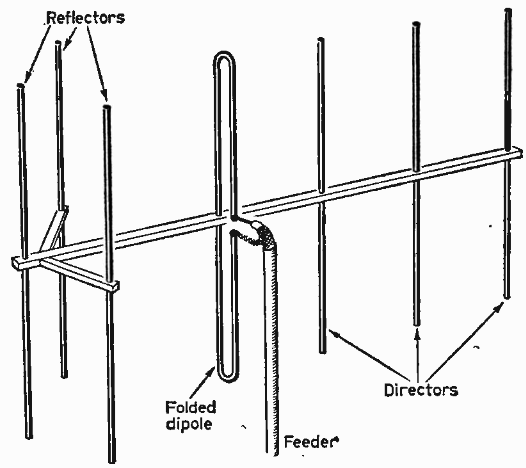


Fig. 10: Fringe aerial for maximum front-to-back pick-up ratio giving minimum interference.

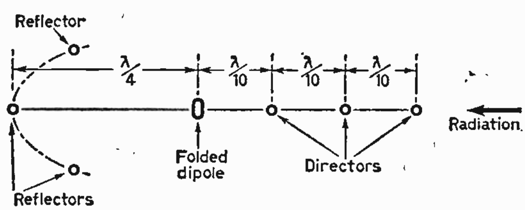


Fig. 11: Plan details of the fringe aerial.

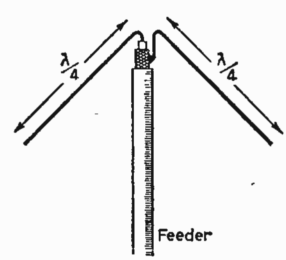


Fig. 12: Inverted-V aerial.

INVERTED-V AERIAL

Another type of loft aerial is shown in Fig. 12. This is the inverted-V aerial and is really a dipole shaped to form an inverted-V. This type of aerial is primarily intended as a loft aerial and should be used only in areas of good signal strength.

Next month we will give practical details of a Band I and Band III loft aerial for fringe-area working. We shall also discuss aerial feeders and the balance-to-unbalance (Balun) quarter-wave matching line.

TO BE CONTINUED

INSTALLING and SERVICING COLOUR RECEIVERS

PART 6

P. G. ALFRED

MANY of the circuits in a colour receiver are basically similar to those in a monochrome one. It may be helpful to list these and to mention briefly any points of difference and their importance in colour working.

U.H.F. tuners need to have good frequency stability in order that the colour subcarrier comes at the right point on the i.f. response. Alternatively a.f.c. can be used to ensure accurate tuning, and this is in fact used on a number of models. Servicing u.h.f. tuners needs special skills and equipment and should not normally be attempted. Even taking the cover off can be enough to disturb the alignment, and as a general policy it is best to leave well alone and to return any faulty tuners to the setmaker's service department. If a fault is suspected check it by substituting a tuner from a working receiver. The requirements of v.h.f. tuners are the same as in those fitted in monochrome receivers, and the problems are the same also.

The i.f. circuits use well-established techniques and there are only minor differences in the shape of the passband. The attenuation of the sound carrier at the luminance and chrominance detectors (often combined) is usually greater than in monochrome receivers, and should be -30 to -40dB referred to the peak of the passband. The shape of the response must be smooth and well controlled near the colour subcarrier at 35·07Mc/s, and is commonly 3-6dB down when a simple detector is used for both luminance and chrominance. This falling response is usually compensated in the chrominance channel by a high-pass filter. This flattens out the response by restoring part of the upper chrominance sideband, and makes r.f. tuning less critical for the viewer.

There tends to be more variety in the a.g.c. circuits than we have been accustomed to in the past because mean-level a.g.c. will produce disturbing shifts of black level on a colour picture. The usual arrangement is sync-tip detection on 625-line operation, but gated circuits may also be encountered. Servicing a colour i.f. strip presents very few problems. If realignment is necessary, for example, because you have changed a coil, do it with special care and follow the instructions in the service manual.

Luminance Channel

In the luminance channel a delay line of about 700nS is impedance matched to the detector, and matched again to the output stage. A puzzling loss of signal can sometimes be traced to this line being open-circuit.

The luminance output stage is very similar to the video amplifier in a monochrome receiver. The main point of difference is the provision of two potentiometers in the anode circuit returned to a reference d.c. potential of about 180V. These are used for adjusting the drive to the green and blue cathodes of the c.r.t. in the correct proportions for good grey-scale tracking. Any fault in the circuitry will be seen best on either 405- or 625-line monochrome pictures. The presence of colour information will only confuse the issue.

Field Timebase

There are no special performance requirements except that more scan energy is needed because the volume of the magnetic field in the deflection coils is larger for a colour c.r.t. Note the connections to the raster correction and field convergence circuits, because any fault in the output stage will affect these also, and vice-versa.

Line Timebase

The line oscillator in a colour receiver needs to be a flywheel-type of good performance. The reason for this is partly to get good synchronisation of the picture and also to ensure accurate timing of the flyback pulses which are used to carry out important gating functions in the decoder burst processing and clamp circuits. Faults in the line sync or output stage will cause corresponding defects in the colour performance of the receiver.

However the most common causes of trouble in the line timebase are failures of various kinds in the line output stage itself, resulting in loss of scan or e.h.t. These faults are often difficult to diagnose in monochrome receivers and are correspondingly harder to find in colour receivers where it is necessary to switch off before removing the screening can in order to avoid any possible dangers from X-ray radiation (if an e.h.t. voltage-tripler circuit is used this hazard does not normally arise). It is in this kind of situation that a systematic approach based on a knowledge of how the circuit works pays handsome dividends.

Fortunately there are a few invaluable signposts that make life a lot easier than might otherwise be the case. Broadly speaking a conventional line output stage can be divided into two parts. The output transformer primary winding, the boost diode and output valves provide the scan; while the overwind and e.h.t. circuits process some of the primary energy to give the focus voltage and e.h.t. It is therefore quite common to find that the primary circuits are working normally but there is a complete absence of e.h.t. The converse does not apply however: if the primary is faulty the e.h.t. will also be affected because the supply of energy to the overwind will have been reduced. An understanding of this basic fact is the first step in line output stage fault-finding.

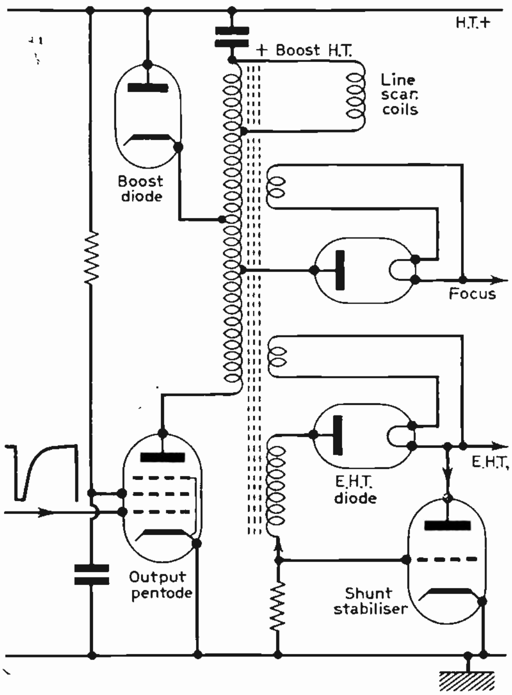


Fig. 19: Very much simplified circuit of a colour receiver line output stage. The focus voltage is sometimes obtained from a tapped v.d.r. connected across the e.h.t.

Most colour receiver line output stages can be simplified to the basic circuit shown in Fig. 19 where linearity controls, switching, third-harmonic tuning capacitors and chokes, convergence circuits, raster correction and centring components, etc. have all been omitted in the interests of clarity. This diagram helps to illustrate the point we have just been making, that the e.h.t. circuits are dependent upon the proper working of the primary, but not necessarily vice versa. It should be borne in mind of course that a drastic e.h.t. fault such as a short-circuit will mop up so much energy that the scan current in the primary will be affected.

Although we cannot draw up a plan of campaign for tackling each and every fault in all the different designs of line output stage we can nevertheless pick out the more important signposts which will provide useful information in nearly all cases. Here they are: (1) boost voltage; (2) mean h.t. current; (3) third-harmonic tuning.

Of these the first item to check is the boost voltage—usually of the order of 600 to 1,000 V—because it can provide some very clear-cut information. For example if the boost voltage is correct we can safely assume that the whole transformer circuit is operating correctly and that there is no short-circuit on the e.h.t. This one measurement if correct immediately clears up suspicion about three-quarters of the line output stage. If on the other hand the voltage is low we need further information in order to narrow down the field. This can often be obtained by measuring the mean h.t. current drain through the output stage.

A low mean current suggests a valve fault, which can be checked by substitution. No current implies an open-circuit winding or fuse, or a valve cut-off. This can be checked with a multirange meter. A high mean current is usually caused by shorted turns or an internal short-circuit in a valve.

The more common faults and their effects on boost voltage and mean current are listed in Table 5. In addition to these it is useful to bear in mind that capacitors with high pulse voltages across them tend to go short- or open-circuit. This often produces the same effect as a short-circuited or open-circuited primary winding and will affect the boost voltage, depending upon the function of the capacitor.

The third-harmonic tuning of the transformer can also provide useful information occasionally. Typical waveforms are illustrated in Fig. 20. If the tuning is normal for a particular design of line output transformer we can deduce that: (1) the load on the transformer is approximately correct; (2) no scanning or e.h.t. winding is short- or open-circuit. This is in most cases a cross check on the boost voltage measurement but it will also provide a more sensitive indication of a short-circuited turn in the transformer windings or a fault in a third-harmonic tuning choke.

Reverting to Table 5 it is clear that in most cases it will be useful to measure the boost voltage and h.t. current drain as a matter of routine together with the screen voltage of the output valve (unless there is no h.t. current flow). These three measurements assessed in combination will often give a fairly clear indication of what kind of fault is present and which part of the circuit should be investigated more closely. Of almost equal importance is the fact that they will tell you which circuits are operating correctly. This not only helps to take some of the confusion out of the problem but also saves wasting time on irrelevant issues.

The results of measurements made on previous occasions will be found even more useful in line output stage servicing than in most other circuits. It is recommended that you take particular care to build up your own list of faults and measurements because these will provide an invaluable

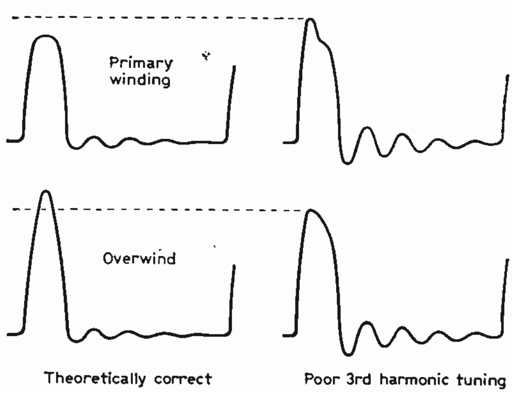


Fig. 20: Line output transformer primary and overwind waveforms show whether the third harmonic tuning is correct. Any deviation indicates a change of energy, capacitive or inductive loading.

Table 5: Routine measurements on a line output stage for no raster condition. (Measurements should be assessed in combination)

Basic causes: No scan current and/or no e.h.t.
Likely faults: Inadequate h.t.—e.h.t.—oscillator drive.
Likely causes: Faulty valves—transformer windings—components generally.

Check (1): Boost Voltage

Low	*Normal*	
(a) Primary winding scanning faulty or (b) Excessive e.h.t. load	Scanning OK C.R.T. electrode voltage faulty	
(a)		
s/c or o/c output valve o: boost diode	Focus voltage low	Low e.h.t.
No oscillator drive	Focus diode (if used)	Overwind o/c
s/c or o/c primary windings	Focus potentiometer network	E.H.T. diode low emission—o/c anode—o/c heater
(b)		
s/c e.h.t. diode or heater		Shunt stabiliser cut off or low emission
s/c or heavily conducting shunt stabiliser		

Check (2): Mean h.t. current

Low	*Normal*	*High* (at or near h.t.)
Partial or complete discontinuity	Scanning OK	Partial or complete s/c
Scan and e.h.t. low	E.H.T. or focus voltage low	s/c output valve, boost diode, e.h.t. diode or shunt stabiliser
o/c or low emission output valve or boost diode	Check e.h.t. diode and focus network	No oscillator drive
o/c winding or deflection coils		s/c windings

Check (3): Screen voltage of output valve

Low	*Normal*	*High* (at or near h.t.)
Anode current low	Anode current correct	Valve cut off or low emission
Anode circuit probably o/c	Drive OK Primary OK E.H.T. load OK	Measure control grid and cathode voltages
Check boost diode and anode winding	Check e.h.t. diode	Change valve

means of interpreting the results of routine checks.

Convergence Circuits

Although the convergence circuits use techniques which have no counterpart in monochrome receivers there is no particular difficulty in fault diagnosis. Indeed you might even regard the process as easy. There is only one qualification. You *must* know the function of each control and exactly what effect it has on the picture. Then when a fault occurs it is a simple matter to isolate the cause.

First check whether the fault is in the horizontal or the vertical convergence circuits, or both together (see Part 2 of this series). Does it occur on 405-line operation or 625 lines or both? Does it affect blue or red-green or both together?

If a whole group of controls is affected the fault must lie in the common feed to these circuits. If it is confined to a single convergence function check each control in turn to find the faulty one. There is only a comparatively small number of components in a convergence network and the systematic approach outlined above should reduce the field of uncertainty to a current or pulse feed, a particular system switch contact or the choice of two or three components. It all depends upon intelligent use of a circuit diagram and knowing how the particular model *ought* to behave.

Take clamp diodes for example. Some receivers are fitted with so-called clamping diodes which do not actually clamp but rather control the amount of d.c. in the convergence coils so that the convergence in the centre of the picture stays unchanged when horizontal parabola controls are operated. This makes the adjustment of dynamic convergence much easier. It is not unknown for these diodes, or transistors connected as diodes, to develop a fault. When this happens the convergence in the centre of the picture will not stay constant when the controls are operated and this immediately gives you an important clue. A fault which might otherwise be somewhat obscure can be diagnosed in a minute or two by a sharp-eyed service engineer who knows what to look for.

In the very small proportion of difficult cases a scope can be used to compare the voltage and current waveforms with those in a known good receiver step by step. Start at the current or pulse source in the line or field timebase and work

—continued on page 260

The Discovery of cathode rays

K. T. WILSON

WE use the words "cathode rays" with great familiarity nowadays and the cathode-ray tube is an everyday object; yet few understand just what is meant by cathode rays and fewer still appreciate what an immense discovery was marked by the first reported observations of cathode rays. It revolutionised our ideas of the structure of materials and of electricity and started a completely new science, atomic physics. In this article we trace some of the steps in the discovery and use of cathode rays which have led to the familiar devices of our time.

In the middle of the last century all substances were thought to be made up of atoms which were thought of as small particles of pure substance which could join up in large numbers to form the materials familiar to us. When all the atoms of a substance are identical we term the substance an element and the chemists know that all other substances are made up out of different elements joined together; no new substances can be made from a single element. From the chemical evidence then available atoms were thought to be the simplest possible units of material, incapable of being split up into anything else.

At the same time the science of electricity had been making rapid progress. The conduction of electricity through a large number of solid substances had been known for a long time and Michael Faraday had investigated the conduction of electricity through liquids in 1833, an investigation which had resulted in Faraday's Law of Electrolysis and the discovery of the technique of *electroplating*. Practically nothing, however, was known about the conduction of electricity through gases, and several physicists began to turn their attention to this problem. Their early efforts met with complete failure; electrical instruments of that day were totally incapable of detecting the minute currents which flow in air between two plates with a voltage applied; even today the currents are too small to detect with normal apparatus such as a microammeter.

Early Experiments

In the middle of the last century, however, a number of physicists (Geissler, Plucker, Hittorf) had the idea of reducing the pressure of gas while testing for conductivity. If a tube is constructed (Fig. 1) with an electrode (platinum in early tubes) sealed at each end and a T-arm connected so that air can be pumped out of the tube a voltage can be applied to the gas inside the tube as the pressure becomes less.

This type of tube, the Geissler tube, is still obtainable and is used in teaching the elementary features of cathode rays. Before pumping starts the 6kV across the tube has no effect; the pressure inside the tube is the pressure of the atmosphere, enough to hold up a column of mercury 760mm. (about 30in.) high, and measured in terms of this height of mercury. At a pressure of about 5mm. of mercury, however, long sparks begin to pass between the electrodes and as the pressure continues to drop these broaden out and become less spark-like so that at a pressure of 2mm. the space between the electrodes is filled by a glowing column of conducting gas. An increase of current through this gas causes a *drop* of voltage and so a ballast resistor must be used in series to prevent excessive currents from flowing.

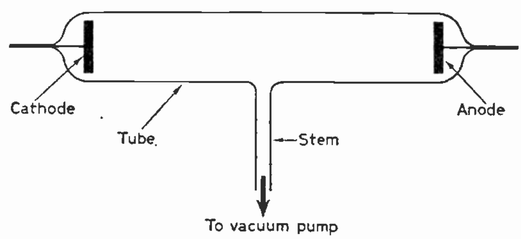


Fig. 1: The Geissler tube.

At this pressure tubes of this type may be sealed off and used for decorative lighting; they are used in the familiar illuminated signs. To improve colour the tube may be filled with a gas other than air before pumping (gases such as neon, xenon, carbon dioxide) to give the tubes used as "architectural lighting." Such lights and illuminated signs need a high voltage supply and a ballast choke and, by law, one switch for the high voltage supply must be outside the building for the use of firemen.

Coming back to the Geissler tube, however, the glow becomes rather fainter as the pressure drops and at 0·1mm. it breaks up into definite regions—a blue glow round the cathode, a dark space, another glow, another dark space and then a column of narrow pink bands of glowing gas all the way to the anode. As the pressure is reduced still further, the dark spaces and the cathode glow increase in size until at about 0·01mm. of mercury the glow round the cathode has spread over the whole tube and is very faint. At this stage the walls of the tube glow green due, as we now know, to bombardment by "cathode rays". At still lower pressures the walls of the tube still appear green, though no glow can be detected inside; finally all the effects disappear as the pressure reaches 0·0001mm.

It was noticed early on that when the glass glowed the glow did not extend over all the glass and a region round the anode did not glow. The theory was put forward that the glow was caused by something coming from the cathode of the tube and did not appear in the anode region because the glass there was shadowed by the anode electrode. This was tested by the famous "Maltese Cross experiment" in which a piece of metal in the shape of a Maltese Cross was placed in a tube between cathode and anode (Fig. 2).

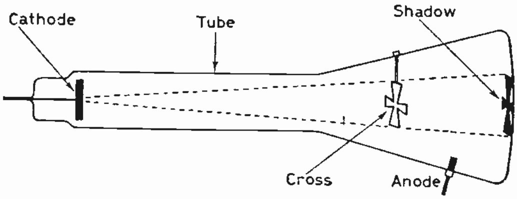


Fig. 2: The "Maltese Cross" experiment.

When the pressure in this tube reached 0·01mm. the shadow of the cross could be seen faintly on the glass. This confirmed that whatever was present in the tube came from the cathode and cast sharp shadows in the same way as rays of light; the phenomenon was therefore called "cathode rays". This discovery aroused intense interest because all gases seemed to give identical effects, and this seemed to point to something which was common to all substances. For the first time researchers began to suspect that the atom might consist of smaller parts.

In 1858, Plucker found that the green glow on the glass could be moved around (using the tube of Fig. 3) by moving a magnet near it. As a wire

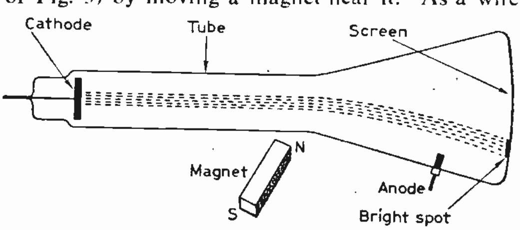


Fig. 3: A magnet deflects the cathode rays.

carrying a current also moves in the field of a magnet this suggested that cathode rays were a form of electric current. Experiments were carried out on the effect of cathode rays on substances and a large variety of substances, mainly mineral samples, were discovered to glow brightly when struck by the rays. The ingredients of the minerals were isolated and used as *phosphors* to coat the glass of discharge-tubes so as to make the effects of the cathode rays more obvious; the same substances are still used as phosphors today and one, zinc sulphide, is the basis of the phosphors still used in modern monochrome c.r.t.s.

The cathode rays had other effects on substances. A small block of metal could be made white-hot when struck by them proving that the rays carried energy. An even more striking experiment was the "Paddle-wheel experiment" (Fig. 4)

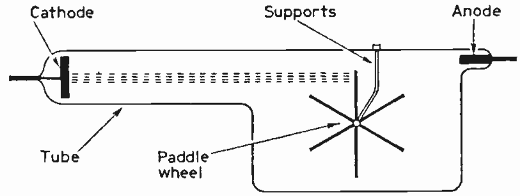


Fig. 4: The paddle-wheel experiment.

in which cathode rays were forced to pass on to the plates of a miniature paddle-wheel within a discharge tube. The energy of the rays was enough to cause the paddles to turn showing that the rays exerted mechanical force. The heating of substances by electron beams is now used extensively (see *Electron Beams at Work*, PRACTICAL TV, November 1966); and though the mechanical force of an electron beam has never been used for any practical purpose the paddle-wheel experiment made history because it suggested that the cathode rays might in fact be a stream of moving particles.

The physicist Perrin (1895) argued that, if this was true, the particles must each carry some small electric charge. This was proved (Fig. 5) by

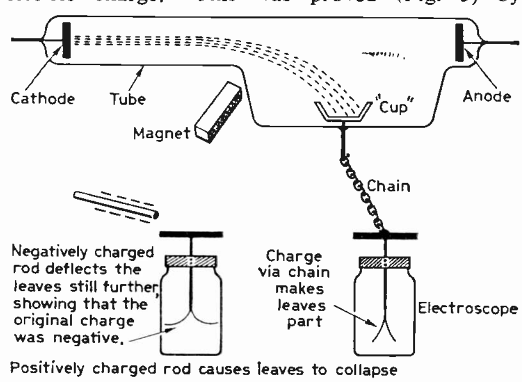


Fig. 5: Proving that electrons carry a negative charge.

deflecting the rays in a discharge tube (using a magnet) so that the rays hit an electrode connected to an electroscope. An electroscope is a type of electrostatic voltmeter capable of detecting small amounts of charge by the voltage which appears when the electroscope is charged up. This proved that the particles carried charge and the fact that a positive charge was required to neutralise the charge on the electroscope showed that the charge on the particles must be negative. This had been suspected from earlier experiments by Goldstein (1876) which showed that negative electrodes repelled the cathode rays and positive electrodes attracted them (Fig. 6).

By the end of the nineteenth century crude forms of cathode-ray tubes could be made. The source of the cathode rays was still the electrical discharge through gas but the use of a fluorescent

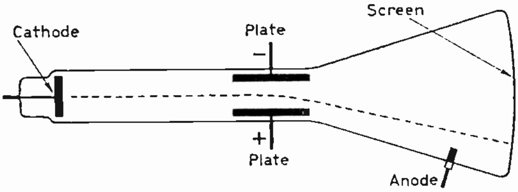


Fig. 6: Deflection by charged plates.

screen and the use of deflector plates was established. This was no production item, however, but a costly hand-made tool of scientific research as incomprehensible and useless to the average man as today's huge and costly linear accelerators seem to many people today.

At Cambridge in the 1890s J. J. Thomson was making a series of measurements with a view to discovering what kind of particle this was whose flow had been called cathode rays. There seemed no way of measuring either the weight of the particles or the amount of charge carried by them but, in an ingenious experiment, Thomson found that the ratio of electric charge to weight could be measured.

The beam of cathode rays from a gas discharge tube (Fig. 7) was deflected by a magnetic field

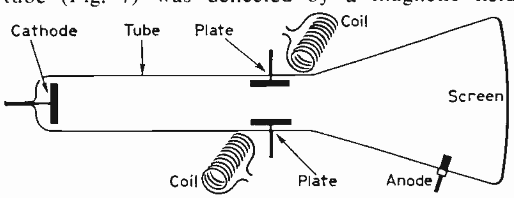


Fig. 7: The Thomson experiment. Prof. Thomson was awarded the Nobel Prize for Physics in 1906.

whose strength could be measured. The beam was then deflected back by adding an electric field (applying a voltage to the deflector plates). When the two fields balanced in this way the speed of the particles of cathode rays was given by the ratio of the electric field to the magnetic field, E/B. This gave a speed for the particles of about one million metres per second (about 615 m.p.h.). With the electric field switched off, he then measured the radius of the curve through which the beam bent. The ratio of charge to weight was then given by E/rB^2 where r was the radius. The ratio proved to be 10^6 units of charge per gram of weight.

The ratio of charge to weight was so high compared to the charge to weight ratios which chemists had discovered for ions in solution that the particle must have had either very low weight or very high charge. Thomson thought that the charge on one particle was probably the same amount as the unit of charge which appeared on one ion in solution and that the weight of the cathode-ray particle was very low, about 1/1840th the weight of the lighest known atom (hydrogen).

This meant that atoms could be split and that smaller particles existed; Thomson looked on this particle, which had so much electric charge compared to its weight, as a unit of electricity and called it the *electron* after the Greek word meaning amber since the earliest ever description of static electricity had been from an ancient Greek writer describing what happened when a rod of amber was rubbed with the fur of an animal.

Thomson's hunch about the size of the charge on the electron was not completely confirmed until 1908 when Millikan measured the charge in an ingenious experiment. His apparatus is represented diagrammatically in Fig. 8. Small drops of oil

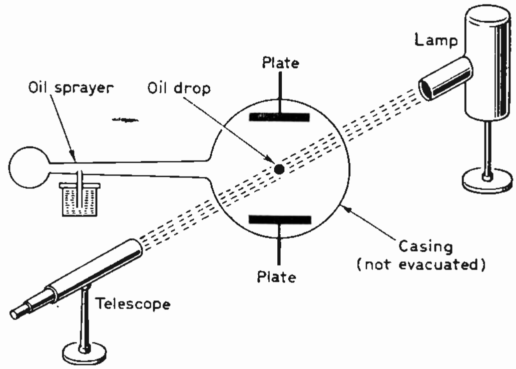


Fig. 8: The Millikan experiment. Prof. Millikan was awarded the Nobel Prize for Physics in 1923.

could be sprayed into a space between two plates connected to a power supply. By the action of spraying, the oil drops obtained a charge which was very small because of the very small size of the drops. Millikan reasoned that the charge on the drops was due to a whole number of electrons on each of them and that this number would change constantly if a radioactive material were present. By measuring the different rates of rise and fall of an oil drop between charged plates as the drop gained and lost electrons he showed that the gains and losses were always multiples of a fixed quantity, just as walls are made of different numbers of bricks, and that the fixed quantity was the charge on the electron, 480 pico-units of charge per electron (a pico=1/million million).

This work established both the charge and the weight of the electron and also that it was a particle obtainable from all materials. Studies of radioactive materials showed that electrons could be given off from such substances also and physicists began to look around for other sources of electrons. It was known that the action of heating a substance causes increased vibration of its atoms and it was argued that heating might be continued to such an extent that the atoms themselves would disintegrate and part with their electrons. This heating however would have to be carried out in a vacuum otherwise the electrons would simply collide with the atoms of air all around, lose their energy and return.

Electron Emission

Langmuir and Richardson were the men next involved in the experiments which followed—heating wires of material close to an anode all encased in an evacuated bulb, with a high voltage applied between the wire and anode and a meter in series to discover if any current flowed (Fig. 9). Most wires melted with no deflection on the meter, and curiously no one remembered an effect noticed many years earlier. Edison in 1882 had

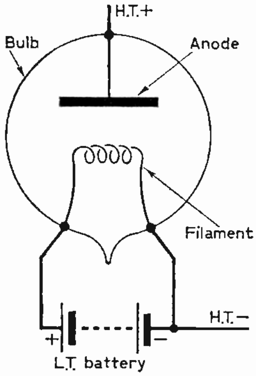


Fig. 9: An early diode.

noticed that if he inserted an additional wire into an electric light bulb he could pass current to it if it were positive to the filament. He reported the effect, called the Edison effect, and then he and everyone else forgot it. He had been looking for a method of stopping electric light bulbs from blacking with age and was not particularly interested in his other discovery!

Wires of tungsten as used in electric light bulbs were suitable, however, and currents were observed on the anode meter. The diode had arrived!

Development of CRTs

This new source of electrons was soon exploited to make the valves which were soon being widely used for transmitters and it was not long before the principle was being applied to cathode-ray tubes. A typical cathode-ray tube of the 1910-1920 period is illustrated in Fig. 10.

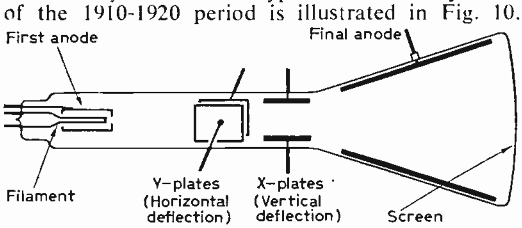


Fig. 10: An early cathode-ray tube.

The electrons are obtained by heating a thoriated-tungsten filament (which gave off electrons at a lower temperature than tungsten alone) and formed into a beam by accelerating them to the first anode which was pierced with a hole which determined the beam diameter. Normally this beam would spread out so that the spot on the screen would be fairly large, but the tubes were pumped to a poor vacuum and the effect of the remaining gas was to focus the beam to some extent.

It was with such a tube that the true inventor of television as we know it, Alexander Campbell-Swinton, designed his television system of 1910. He foresaw that the need for rapid scanning together with perfect synchronisation ruled out all mechanical methods for high definition work and realised that the cathode-ray tube was the perfect medium for the receiver. He went as far in his patent as to describe how a modified type of cathode-ray tube would be required as the pickup device in the camera, a remarkable prophecy of what was eventually to come. As is the case with all men ahead of their time his work was neglected and forgotten.

It was not until the 1930s that the form of cathode-ray tube recognisable to us emerged. Gas focused tubes were unreliable and had a short life since the pressure of gas within the tube varied with temperature and with the state of the seals of glass to metal. Better vacuum pumps enabled us to make high-vacuum c.r.t.s which then had to be focused by some other means; thus magnetic and electrostatic focusing systems started to be used. The tungsten "hairpin" filament gave way to the indirectly-heated oxide cathode used in valves, emitting electrons at a temperature less than half that used for tungsten. Nevertheless the cathode-ray tube was still an instrument of research, not a mass-produced item.

The start of public television broadcasting changed all this. There was now a market for cathode-ray tubes of large size (oddly enough, the 9in. and 12in. sizes were more popular *after* the war, due to a glass shortage), magnetically focused and deflected since this was more convenient than electrostatic deflection. Though the war stopped production of TV tubes large tubes were required for radar purposes and small electrostatically focused and deflected tubes (such as the VCR97) were made in huge numbers both for radar and for oscilloscope purposes.

Post-War Developments

The development of the television c.r.t. after the war was very rapid. Early tubes had a short life due to a burning effect in the centre of the screen. This was found to be due to ions, large portions of atoms which travelled from the cathode to the screen but which were hardly deflected by the deflection coils due to their large weight. One solution was to tilt the electron gun so that both ions and electrons struck the walls of the tube: the electron beam could then be deflected back to the correct direction by a small magnet, the ion-trap magnet. It was found also that a thin layer of aluminium behind the screen phosphor had the effect of increasing the light output of the tube (by reflecting light which would normally have been absorbed into the tube) and cutting down the effects of ions. The aluminised screen was useful only if accelerating voltages were high, over 5kV; but such voltages were already common and higher values of e.h.t. were being used. By the early fifties such a triode tube using permanent magnet focus. 50° deflection and an aluminised screen was the last word in television.

It is interesting to enumerate the changes since: wide-angle tubes of 70°, then 90°, then 110° were introduced and with them came correction magnets round the rim of the tube to try to correct the defects of wide-angle scanning; electrostatic focusing, cutting out another expensive component, arrived in the early sixties; the efficiency of phosphors has improved immensely, and the triode tube is now unknown.

Shall we see any further changes in tubes for monochrome television now that colour is here? It was widely predicted several years ago that tube design was fixed, yet that prediction was blown sky high by the arrival of small tubes for portable sets. All the same there is every indication that the days of large changes in monochrome tubes are past and only small improvements can now be expected.

TELEVISION RECEIVER TESTING

Part 9 by Gordon J. King

POWER SUPPLY TESTS—Cont.

IN Part 8 we concentrated on tests in the series-connected heater chain and before going on to tests in the h.t. and e.h.t. circuits we must briefly consider two different heater systems. First there is the system which employs a rectifier in the series chain instead of the conventional dropper resistor to set the heater current; and second there is the original mains-transformer-derived heater circuit which, with the coming of colour sets and hybrid and fully-transistorized models, is again becoming popular.

Rectifier Voltage Dropping

The series chain with a rectifier is shown in Fig. 1. It will be noticed that the rectifier is one of the latest silicon devices with a very low forward resistance. This means that it can pass high currents (when suitably heat-sinked) without getting unduly hot (nowhere near as hot as a mains dropper, for instance!). The series heater chain is designed so that it together with the series rectifier passes a current that matches that required by the heater of each valve (and tube) in the chain. How this happens may not be immediately obvious from the above statement that the series rectifier possesses a very low forward resistance, assuming that this *resistance* takes the place of that of the mains dropper. In reality this is not true, for the circuit works by virtue of the heaters receiving pulses of current on every positive half-cycle of mains input instead of on both positive *and* negative half-cycles as is usually the case. The heating power of the mains supply is equal to 0·707 times the peak value, so it is obvious that if only one half-cycle of mains current is utilised per cycle the heating power for a given peak value is going to be less. Thus the mains dropper and its attendant heating problems are avoided.

The mains input end of the chain is connected to the usual two-pole on/off switch and mains fuse, while it is not uncommon to find a voltage regulating adjustment as provided by the flying lead and the two 47Ω resistors in Fig. 1. With the resistors short-circuited, the chain is designed to yield the required value of heater current from 200-210V a.c., while adjustment is made by the addition of one 47Ω resistor for 220-230V supplies and the two resistors of that value for 240-250V supplies. Sometimes the cathode side of the heater chain rectifier is connected to the anode of the h.t. rectifier.

When checking this type of circuit it is desirable first to disconnect the heater circuit from the cathode of the heater rectifier and the anode of the h.t. rectifier (if connected at this point) and measure chain continuity between chassis and the disconnected end of the chain. If continuity is indicated by this test, then lack of heater current would be caused either by open-circuit of one of the voltage regulating resistors or failure of the heater chain rectifier, assuming that the on/off switch and fuse are in good order. It is not very often that the rectifier fails, and the most common cause of lack of l.t. current in this type of circuit is heater open-circuit or failure of one of the voltage regulating resistors.

When testing in this circuit, however, it should not be forgotten that the heater current no longer comprises true 50c/s a.c., but is in the form of a pulsating d.c. so that it is possible to measure a d.c. potential between the chassis and the start of the heater chain. If it is attempted to measure the overall chain voltage with an a.c. meter a true reading will not be obtained since the meter will almost certainly be scaled in terms of r.m.s. voltage as derived from a sinewave of not excessive distortion. It should also be understood that the application of d.c. voltage to the mains input will severely over-run all the heaters because the heater current would then be limited only by the forward resistance of the rectifier which as we have already noted is very low. Sets with this kind of heater circuit are therefore suitable only for use on a.c. mains inputs in spite of the heaters being connected in series and the lack of a mains transformer.

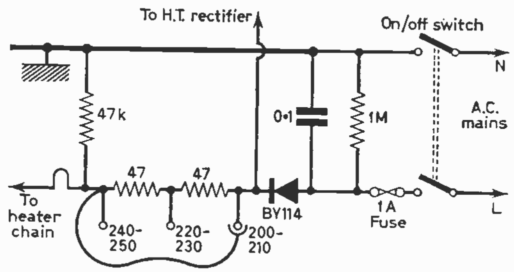


Fig. 1: A series-connected heater chain controlled by a series BY114 silicon rectifier.

Mains Transformers

Although very popular during the first few years of television after the war, very few monochrome sets currently in use embody mains transformers. In almost all of them the heaters of the valves and picture tube are powered by being in a series circuit of some kind across the mains supply, as this and last month's article have illustrated. A very small minority of KB models however kept to the transformer idea well after other makers had changed over to the so-called a.c./d.c. technique, and some of these are almost certainly still in service. There is also at present the Decca "Professional 23" which uses a mains transformer.

Not all sets using mains transformers had a separate h.t. winding, for the a.c. supply for the h.t. rectifier was derived from across the primary winding which served essentially to activate the heater supply secondary winding or windings. It was not uncommon, though, for the voltage adjustment tappings on the mains primary winding to be arranged to provide an autotransformer effect for the h.t. supply. In all cases, however, the heater windings were isolated from the direct mains supply.

The valve heaters—sometimes with the heater of the picture tube—are all connected in parallel in this type of set (though not in the Decca Professional 23 just mentioned). This results in an addition of currents, the voltage being equal to that of each valve. Thus while the heaters are probably rated at 6·3V 0·3A the heater winding is called upon to deliver 0·3A times the number of heaters—20 heaters adding up to 6A, but still at 6·3V. This is the direct opposite of the series chain system where the voltages add up and the current remains as per heater rating—typically 0·3A.

Testing Parallel-connected Heaters

A big testing advantage of the parallel-connected system is that failure of the heater of one valve does not cause all the others to de-energise. Thus if one heater is unlit—*all* the others glowing normally—there is a 90 per cent chance that the heater is open-circuit and at the simplest it is just a matter of changing that one valve to prove the possibility. The remaining 10 per cent of causes of the symptom lie in badly soldered connections in the heater supply link or to the heater tags of the valveholder, an open-circuit decoupling choke when fitted or poor connections between the heater pins of the unlit valve and the heater sockets of its holder, a possibility which can be proved easily by wriggling the valve in its socket (if it lights when so disturbed cleaning the pins with fine emery paper will clear the trouble in most cases).

If the heaters of a parallel system appear to be under- or over-run (dim or too bright) the on-load heater voltage should be measured with a fairly accurate a.c. voltmeter, and for optimum performance of the set and maximum life of the valves the voltage should be very close to the specified heater rating. It is noteworthy that premature valve failure is caused as equally by the heater being under-run as over-run, and in the former case the performance of the set will also suffer generally, exhibiting such symptoms as low sensitivity, insufficient width and/or height, poor scan linearity and so forth. It is really surprising how often the heater power is overlooked when investigating a symptom of this kind.

The importance of this will develop with colour sets, for it is not unusual for these—indeed, almost all models to date—to feature mains transformers with a separate secondary winding for at least supplying power for the internally connected three heaters of the three-gun colour picture tube. These heaters are usually connected in parallel so that the winding has to deliver 6·3V at an ampere or so. We will return to the power sections of colour sets later, but for the time being let us have a look at the tests that can be applied to the h.t. circuits of the popular type of monochrome set.

HT Circuits

The type of circuit which is now found in the majority of sets is shown in Fig. 2. This uses the latest silicon semiconductor rectifier, which is fed from the live a.c. line through a surge limiting resistor of 20Ω to its "anode", indicated by the arrow-head of the rectifier symbol. The reservoir capacitor is C1, with C2 as the smoothing filter in conjunction with R1. Similar smoothing filters (capacitor-resistor combinations) are also likely to be found in the h.t. feeds to other parts of the circuit. That in Fig. 2 supplies the h.t. voltage for the audio sections, while others might be used for the line and field timebases and the i.f. channels.

The capacitor across the rectifier is now a common feature, its purpose being to reduce the possibility of damage to the rectifier by very peaky transients and to minimise modulation hum troubles.

In the event of the heaters working all right but lack of h.t. supply the first test should be for a.c. voltage at the anode of the rectifier, shown by Test 1 in Fig. 2. If voltage here is absent then the test should be made at the input of the surge limiter, as shown by the dotted line arrow of Test 1. If the heaters are alight there is virtually nothing (excepting a broken connection) that could prevent the presence of a.c. voltage at the bottom of the surge limiter. A common trouble is open-circuit of the surge limiter resistor; but since this acts also as a safety device on the h.t. supply its failure could well indicate a short somewhere on the h.t. circuits, most likely across C1 the reservoir capacitor or the rectifier itself. Before replacing this component therefore it is wise to check the insulation resistance of the h.t. line feed—Test 2.

The rectifier—after being disconnected from the circuit—can be tested as shown by Test 3. Here

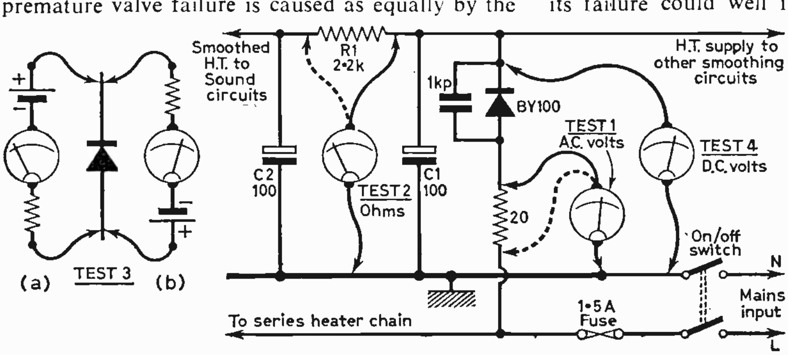


Fig. 2: Testing the h.t. supply circuits.

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the test meter is basically an ohmmeter which when connected with the battery positive terminal to the rectifier cathode will normally show a very high resistance (a) and a very low resistance the other way round (b). If a low resistance is given at both (a) and (b) then the rectifier is shorting and needs to be replaced. A high resistance reading both ways would signify an open-circuit but this would not cause overheating or failure of the surge limiter, although the possibility of a short occurring initially—leading to open-circuit—should not be dismissed. The rectifier shunt capacitor should also be checked for insulation resistance.

If a.c. is present on the rectifier anode, a d.c. voltage test should be made at its cathode, Test 4. The voltage here should be fairly closely matched to the a.c. r.m.s. voltage at the anode. If the voltage is significantly low, however (say 150V), the trouble could be caused either by an abnormally high load current due to a fault elsewhere in the set or open-circuit of the reservoir capacitor. The former would almost certainly show up as severe overheating of the surge limiter and/or the smoothing resistor R1, and owing to the low forward resistance of the silicon type of rectifier the current would have to be exceedingly high to result in a significant voltage drop across the rectifier itself! Nevertheless many older sets still use the metal type of h.t. rectifier and such a voltage drop across these is not uncommon with heavy load currents.

It is noteworthy that open-circuit of the reservoir capacitor will produce very high ripple currents through R1 and the smoothing capacitor C2, and this is often sufficient to overheat R1 giving the false impression that poor insulation exists in C2 or elsewhere on the h.t. circuit!

In sets with selenium (metal) h.t. rectifiers a d.c. voltage at the cathode below the r.m.s. a.c. voltage at the anode invariably denotes rectifier wear, the trouble and its resulting symptoms—such as low width, poor brightness, low sensitivity, bad linearity and so forth—clearing completely on replacing the component.

If necessary tests have to be made in the other smoothed and filtered sections of the h.t. circuit: a leaky or shorting soothing capacitor is usually indicated by an overheating associated smoothing resistor.

Boost HT Testing

The biggest h.t. testing ambiguity occurs in connection with the boosted h.t. circuits and the e.h.t. circuits—first the boosted h.t. circuits. The boosted h.t. is derived from the action of the line output stage, the resulting extra potential from this source being added to the basic h.t. line voltage giving the boosted supply across the boost reservoir capacitor as shown in Fig. 3.

Here it will be seen that the boost reservoir capacitor is connected between the top of the line output transformer (LOT) and the ordinary h.t. plus line and that the actual boosted potential occurs at the LOT end relative to chassis. In many receivers, however, using the desaturated line output transformer technique, the boost

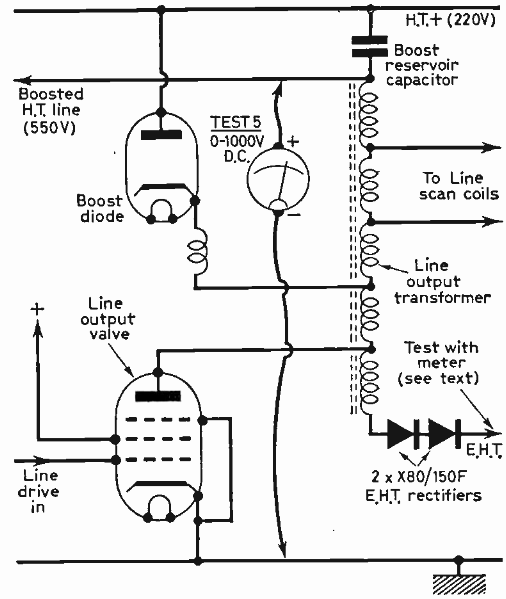


Fig. 3: Basic line output stage circuit showing the derivation of the boost supply and, from two semiconductor rectifiers, the e.h.t. supply.

reservoir capacitor(s) is connected between the primary and secondary windings of the LOT.

While it does not need a meter of particularly high sensitivity (see Part 8) to measure the boost voltage accurately across the boost (reservoir) capacitor, this line is rarely fed direct to the various circuit sections which call for a higher-than-normal h.t. supply: it is more usually fed through very high-value resistors, decoupled with capacitors. A typical example is the feed to the first anode of the picture tube, which is invariably through a resistor of several megohms. Now since the first anode of the picture tube represents an easy-to-get-at test point many technicians dart straight to this point for the first boosted h.t. voltage test and are often disappointed at the low voltage reading they achieve!

This is often caused not by boosted h.t. supply trouble but by the test meter shunting the high-resistance feed circuit. What happens is that the test meter causes the current in the high-value feed resistor to rise substantially above the normal (first anode for example) current handled by the resistor, with a significant rise in voltage drop across it reflected in the lower-than-correct voltage reading. As was shown in Part 8, the higher the sensitivity (ohms/volt value) of the meter the less the reading error.

Boost Feeds

It is the general practice these days for the boosted supply to feed the focus electrode of the picture tube (as well as the first anode) and the field timebase generator valve, as shown in Fig. 4. Notice here the high-value resistors in the focus potential-divider and in the anode circuit of the field generator.

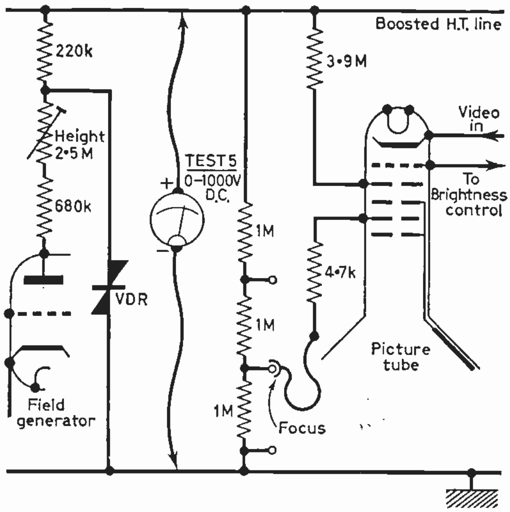


Fig. 4: Uses made of the boost h.t. supply.

The correct voltage reading at the anode of the generator is possible only by using a valve-voltmeter or equivalent transistorized instrument. However it is desirable not to take the reading from the working anode of a timebase for this means very little: the best place to check the boosted potential is from the reservoir capacitor, using a 20,000 ohms/volt (or more) test meter as shown by Test 5 in Figs. 3 and 4.

The voltage-dependent resistor (v.d.r.) forming a potential-divider to chassis from the boosted h.t. line in conjunction with the 220kΩ resistor in Fig. 4 provides the generator with a degree of regulation. This is because the v.d.r. decreases in resistance as the voltage across it rises. Should the boosted h.t. voltage drop for some reason or other this will increase the resistance of the v.d.r. thereby adjusting the potential-divider ratio to hold the voltage at the tapping point (to the height control) fairly constant and in this way retaining a constant amplitude of field scan.

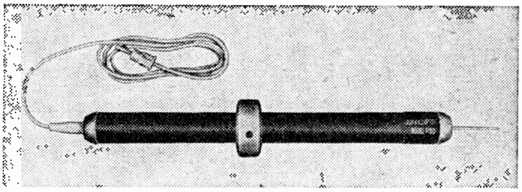


Fig. 5: E.H.T. testing voltage multiplier by Salford Electrical Instruments Ltd.

EHT Tests

There is only one accurate way of checking the e.h.t. voltage, and that is with an e.h.t. voltmeter or ordinary 20,000 ohms/volt testmeter (or electronic testmeter—such as a valve-voltmeter or transistorized equivalent) to which has been connected a high-voltage probe. Such a probe acts as an extra series resistance which enlarges the full-scale reading of the instrument. The trend now with colour sets coming into being with their 25,000 volts e.h.t. potential is to enlarge the reading to 25kV f.s.d., and provided one has a meter of 20,000 ohms/volt sensitivity there are several e.h.t. probes which can be used successfully. This is far better than trying to test the magnitude of the e.h.t. voltage by arcing. Moreover with the coming of semiconductor e.h.t. rectifiers (such as the two series-connected X80/150Fs in Fig. 3) sparking or arcing can encourage junction collapse due to transient effects; it can also cause the transistors (or some of them) in hybrid sets to fail. Thus the days of testing e.h.t. voltage by the old spark method are now expiring.

Most sets today have a regulating device for the boosted h.t. and e.h.t. voltage in the form of

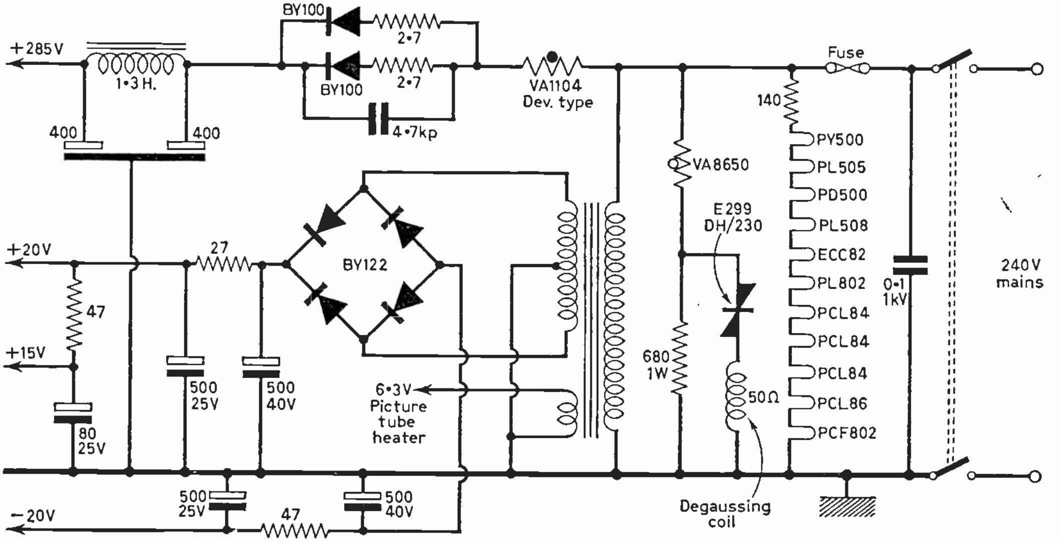


Fig. 6: Power supply circuits for a colour receiver, developed by Mullard.

a kind of "a.g.c." system in the line output stage. This uses a v.d.r. to rectify the pulse signal coupled in from a tapping on the LOT, the resulting d.c. voltage, rising and falling with decreasing and increasing e.h.t. loads, being used to control the effective "gain" of the line output valve so as to counteract the effect of the load changes. A preset adjustment is often provided which needs to be set accurately by a meter reading the boosted h.t. voltage or e.h.t. voltage. Colour sets have a similar preset for adjusting the e.h.t. voltage, for if this rises above the 25kV limit the tube can radiate dangerous X-rays. It is bad practice to delve into the e.h.t. section of a colour set when it is active for fear of X-ray hazards. And spark tests are definitely "out" on colour sets! Fig. 5 shows an e.h.t. voltage extension probe by Salford Electrical Instruments Ltd.

Colour Receiver Supplies

Finally a word or two about colour set power sections. Figure 6 shows such a circuit developed by Mullard engineers and already adopted by some setmakers, in which the heaters of the valves (not the picture tube) are connected in series, with a 140Ω dropper, across the double-pole switch in the mains supply source. This is, of course, identical to the type of heater circuit explained in Part 8 but with fewer heaters, not only because the tube heater is missing from the chain but also because most of the stages in the set employ transistors—this, in common with most commercial counterparts, being of a hybrid design.

It will be seen that one side of the mains input (this should be the neutral side) is connected to chassis in the ordinary way, but that a mains transformer is used for supplying power to the colour tube heaters and for deriving, via a bridge rectifier and smoothing system, power for the transistors, yielding three outputs, two plus potentials at 15 and 20V and a minus potential at 20V. It is interesting to observe exactly how this is achieved.

Degaussing Circuit

The h.t. supply for the valved parts of the set is obtained by a pair of parallel-connected silicon power diodes or rectifiers each with a 2·7Ω limiter and a parallel capacitor between them. The negative temperature coefficient resistor (thermistor) ensures a gradual build-up of the h.t. potential while the 1·3H choke affords better smoothing facilities than a resistor at high currents. The network of positive temperature coefficient thermistor, voltage-dependent resistor and ordinary resistor in the degaussing circuit provides automatic degaussing immediately the set is switched on, by passing a high initial current through the degaussing coil which swiftly falls by the controlling action of the network of components just mentioned. Future articles in these pages will describe the action in greater detail and to investigate the system here would be to go beyond the present brief of set testing.

Next month we shall swing back to see how best we can test sets with flywheel-controlled line synchronising.

TO BE CONTINUED

COLOUR RECEIVER SERVICING

—continued from page 251

steadily along the network adjusting each control of the faulty receiver in turn to see if you can get the same waveform as in the good receiver. This procedure should quickly isolate the cause of the trouble.

Grey-scale Tracking

If you suspect a fault in the grey-scale tracking arrangements, kill the colour, or switch to a 405-line signal, and inspect the monochrome picture. If you can see any colour *at all* it can only be due to errors of purity, convergence, or grey scale. Purity errors show up as stationary patches of spurious colour—mostly near the edges of the screen. Misconvergence causes colour fringing on picture outlines. A faulty grey scale can be spotted immediately because either the dark-grey areas of the picture or the highlights will be coloured instead of being neutral. In some cases both are wrong, together with all the half tones in between. Occasionally you find that the whites and dark greys are correct but the mid greys are coloured. This is an example of a true *tracking* error and is usually caused by difference in c.r.t. gun characteristics.

The first thing to do is to try setting up the grey scale by the normal procedure (see Part 3 in this series). It may just be a simple maladjustment caused by ageing of carbon potentiometers or resistors or a change of h.t. potential. If a fault exists it will now be obvious which end of the drive is affected: highlights or near black level.

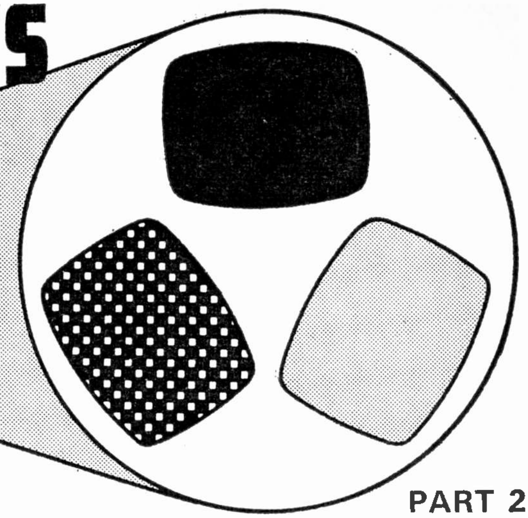
The highlights are controlled by potentiometers which adjust the a.c. drives to the three c.r.t. cathodes in the correct proportions to give a white-light output. Measuring a few voltages and resistances with a multirange meter will soon disclose the culprit.

Similarly the near black areas of the picture are adjusted by three potentiometers which are used to get the same black level at each gun: i.e. coincident cut-offs. If this state of affairs can not be achieved it is usually caused by a fault in the potentiometer networks between the boost h.t. and chassis. Bear in mind however that a d.c. error on other tube electrodes will have the same effect as maladjustment of the potentiometers. For instance a failure of one of the three colour-difference output clamps on the grids of the c.r.t. will upset the grey scale. It will also of course distort the colour performance, and herein lies a useful clue.

This is yet another example of the value of observation and deduction. However if you simply look at whatever picture you happen to have displayed at the time you may be missing vital evidence. Think carefully and ask yourself what you ought to be looking for and what picture conditions will show the effect most clearly. Do you want a colour picture or a monochrome one? Which controls should be adjusted in order to provide more information to form the basis for further deduction?

TO BE CONTINUED

EXPERIMENTS IN COLOUR TV



MARTIN L. MICHAELIS, M. A.

PART 2

THE complete circuit of the general-purpose tritch was shown in Fig. 2. The heart of the circuit is the ring-of-three counter using transistors Tr4 to Tr9. This ring comprises three bistable multivibrators. Each of these bistable multivibrators will remain indefinitely in either one of two states, with the left transistor Tr4, Tr6 or Tr8 conducting or the right transistor Tr5, Tr7 or Tr9 conducting. A disturbance from an external source is required to change the circuit from one of these stable states to the other. Whichever transistor of each pair is conducting holds the other one cut off because the two bases are connected via crossed-over voltage dividers from the respective collectors. The small-value capacitors between opposite base and collector in each combination speed-up the switch-over between the two states when a switching pulse arrives.

All the left-hand emitters are coupled together via a common emitter network R8, R9, R10 while all the right-hand emitters are coupled together via the common emitter resistors R29, R30. The net resistance of the latter is about one half that of the former network. The condition for equal emitter potentials of all six transistors, which must be satisfied for every stable state possible for the circuit as a whole, is therefore that always one left-hand and two right-hand transistors must be conducting. Which particular left-hand transistor is conducting immediately after switch-on is decided by chance or slight circuit asymmetries due to component tolerances.

CIRCUIT SWITCHING

To make the circuit switch over into another state a negative pulse is applied briefly to the left-hand emitter line of sufficient amplitude to cut off whichever left-hand transistor is at the time conducting. For the duration of this input pulse none of the left-hand transistors are conducting but all three right-hand transistors are. The right-hand partner of the left-hand transistor just cut off produces a sharp positive flank at its collector as it switches on and this is passed on by the interstage capacitor C6, C9 or C2 to the base of the left-hand transistor in the *next* bistable multivibrator. Provided the differentiated pulse passed on via C6, C9 or C2 persists longer than the input pulse applied to the left-hand emitter line, the left-hand transistor *next to the one previously conducting* will switch on and remain conducting. The conducting left-hand transistor thus moves cyclically one step round the ring in the sense of rotation dictated by the sense of connection of C6, C9, C2, for every input pulse. It comes round to the original position on every third input pulse.

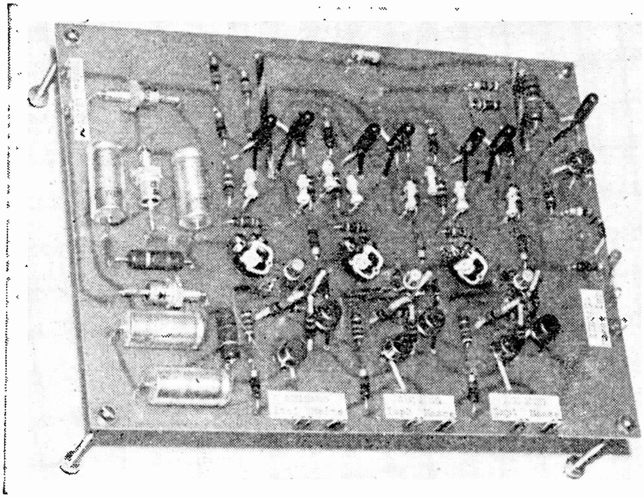
INPUT FREQUENCY

The actual input frequency is immaterial and may even be quite irregular. Thus the circuit will cope with any input frequency from virtually zero up to about 16kc/s and will thus function at television field or line frequencies without modification. Each left-hand transistor conducts for one input pulse interval and remains cut off for the next two, whereas each right-hand transistor is cut off for one input pulse interval and remains conducting for the next two. The relationships were shown in Fig. 1 in terms of the nominal waveforms.

INPUT MATCHING CIRCUIT

The input pulses must rise to at least +3V in not more than half a microsecond and must remain above +2V for at least 10μsec. There is no other restriction. Thus brief rectangular pulses or even symmetrical square waves from a multivibrator are just as satisfactory as the pips depicted for the input trigger waveform in Fig. 1. Waveforms with a slower rise time will not fire the circuit but can be converted to a satisfactory form simply by being passed through a Schmitt trigger stage. Thus any waveform whatsoever is suitable as the basic trigger waveform.

C3 and R4 produce the input differentiation necessary to ensure that the pulse at Tr3 emitter is always shorter than the interstage pulse duration



Photograph of the completed tritch module.

via C6, C9, C2. Otherwise the switching would be erratic or absent instead of cyclic. D1 holds off negative spikes from the differentiation process. An amplified inverted (now negative) pulse appears across the collector load R7. The values of R7 and R6 are chosen so that Tr2 saturates for input pulse amplitudes slightly above the threshold. The circuit will thus accept any larger input amplitude within reasonable limits without calling for a gain control.

EMITTER-FOLLOWER

Tr3 is an emitter-follower. When it is briefly switched on by each input pulse the impedance between its emitter and chassis is very small. This must not appreciably disturb the ratio of the respective common-emitter line loads otherwise erratic performance or even sustained self-oscillation is possible. R9 must thus be much smaller than R8 so that Tr3 is called upon to develop quite high pulse power since the voltage across R10 must remain adequate in spite of the drop across R8 and the combined drop across R8 and R10 also sends current through R9. Hence Tr3 is operated as an emitter-follower. An OC71 with as high a current gain as possible should preferably be selected for this position.

OUTPUT STAGES

Tr10-Tr11, Tr12-Tr13 and Tr14-Tr15 comprise three identical Darlington pairs as output stages. This gives a very low output impedance of about 10Ω so that considerable pulse currents can be drawn from P1, P2, P3, e.g. for feeding synchronising solenoids directly. The product of C1a-c and R33, R36 or R39 determines the duration of the output pulse. Change the value of C1 for obtaining other pulse durations. The value shown gives a time constant (width at $1/e$ of peak amplitude) of about 0·3msec. This is probably suitable for most field sequential systems although longer pulses may sometimes be required in which case make C1 proportionately larger. About 500pF will probably be satisfactory for most line sequential experiments. Diodes D2, D3, and D4 hold off the differentiated spikes of the unwanted polarity.

BOOST AMPLIFIERS

The circuit (Fig. 2) also shows three optional output boost amplifiers, Tr1a-Tr1c. Without these amplifiers a maximum output pulse amplitude of about +2·5V peak is obtainable at P1, P2 and P3. With these boost amplifiers the maximum output amplitude becomes about +10V. Since the output impedance is about 10Ω in either case we can obtain a maximum current of 125mA in the former case or ½A in the latter case, through a matched 10Ω load. In either case a smooth control from zero to maximum available output is possible with VR1, VR2, VR3. When the boost amplifiers are used note that maximum output is obtained just *before* the slider of VR1, VR2 or VR3 reaches the end of the track to which R14, R20 or R26 is connected because Tr1 saturates at this point and there is a slight drop over the last part of the tracks of the preset potentiometers. When not using the boost amplifiers, i.e. if a maximum available output of +2·5V 125mA is sufficient for the particular application, take C1 straight to the slider of each corresponding preset potentiometer, omitting Tr1, R1, R2 and R3.

With the boost amplifiers an output pulse is produced whenever the respective left-hand transistor of the ring counter cuts off. Without the boost amplifiers the output appears when the respective left-hand transistor cuts on. This simply amounts to a 120° phase advance in the ring, i.e. one input pulse interval, and is thus without significance for the overall performance.

ALIGNMENT

The circuit is not critical. It will normally work with any good specimens of OC71 transistors and ±10% tolerance resistors. If performance is still unsatisfactory after attention to the adjustment of R10, R29 and R30 values described below suspect that the components used in the ring are too far off match. Wherever possible select resistors of closer tolerance than ±10% in the ring and select six OC71s whose current gains are as nearly equal as possible, checking with a transistor tester. This is not essential but it makes the circuit stable over a wider temperature range which may be an important consideration when incorporating the module in converted monochrome TV receivers fitted with many valves.

The input matching circuit and the output stages are uncritical.

After completing construction according to Fig. 3, find out which changed total resistance value for R29+R30 makes the circuit cease to switch cyclically at the one extreme, or burst into sustained self-oscillation at the other extreme.

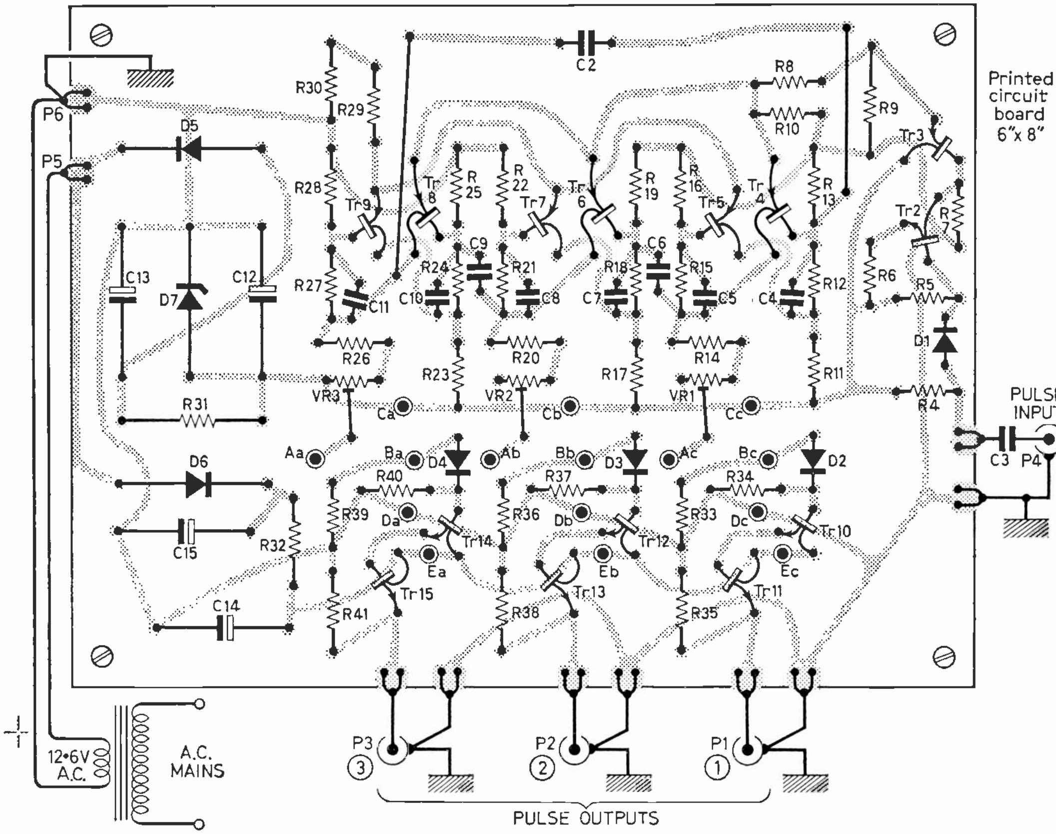


Fig. 3: Layout details of the tritch printed board. See also Fig. 4.

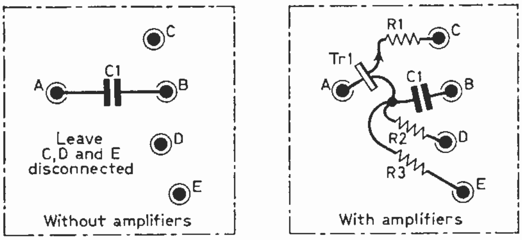


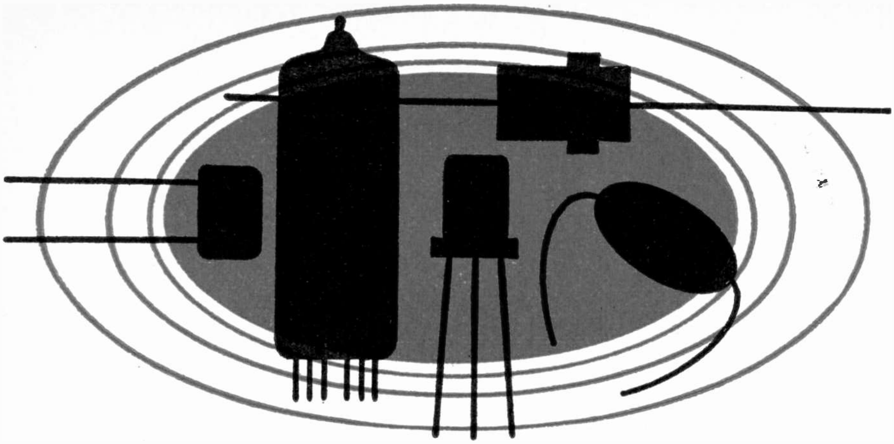
Fig. 4: Connections to points A, B, C, D and E with and without optional amplifiers.

Multiply these two limit values together and take the square root. Select two resistors for R29 and R30 such that their sum is as closely as possible equal to the determined square-root value. This gives optimum stability over the widest possible temperature range. If the determined square-root value comes out at much less than 180Ω select the next higher preferred value for R10 and determine the new square-root value for R29+R30. Conversely take the next lower preferred value for R10 if the square-root value for R29+R30 comes out much greater than 180Ω.

The best way to check whether the circuit is performing correctly for purposes of adjustment and alignment is as follows. Set an oscilloscope to the external trigger mode and feed the trigger input socket of the oscilloscope from P1. Now touch the Y amplifier signal probe to P4 and adjust the timebase speed so that three pulses are seen, one at the left, one at the centre and one at the right of the screen. Now touch the signal probe on to P1. Only the pulse at the left of the screen should appear. Then touch the signal probe on to P2. Only the pulse at the centre of the screen should appear. Finally touch the signal probe on to P3. Only the pulse at the right of the screen should now appear. If switching is erratic all three pulses (maybe flickering or with different intensities) will appear in all cases: none will appear if the circuit is not switching at all.

FINAL CHECK

Finally check the waveforms at the junction of R2, R3. These should be squarewaves with 2:1 symmetry ratio. Make sure that all outputs as well as the waveforms at the junctions of R2, R3 disappear completely when the input pulse feed is disconnected. This checks that the circuit is not oscillating of its own accord. If it is found to be oscillating without an input the value of R29+R30 is incorrect. Correct as already described in the section on alignment.



VA
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PART

A SURVEY of readers' TV fault queries shows that a substantial proportion make reference to a valve, rectifier or resistor that overheats, especially where line faults are concerned. Naturally readers want to know the most effective action to take since the longer the set is on during tests the greater the possibility of doing damage to the valves and associated components (if most tests are made with the set switched off it will generally be found to be all the more difficult to localise the defect).

What then is the professional's way of clearing this type of fault? Taking line faults first, since they so often cause the line output valve and boost rectifier to overheat, the first thing is to fully note all symptoms. For example, does a fairly normal raster appear then increasingly reduce in width as the line output valve overheats; is line whistle present; is there slight but insufficient a.c. at the anode of the e.h.t. rectifier; and if the line output valve gets extremely hot is it the screen winding that glows or the actual anode? Consideration of these points will reduce the number of possible causes.

Line output valve overheating

If for example the valve screen runs red hot, there is almost certain to be zero voltage on the anode, which in turn is generally a result of the boost rectifier having an internal disconnection to its anode or cathode. A secondary possibility is that a miniature top-cap mounted b.k. choke is open-circuit. On the other hand if the pentode starts to glow cherry red fairly soon after being switched on it can be taken as certain that the valve has no grid input or drive. Line output pentodes are never given fixed bias but develop the required negative grid potential from the modified sawtooth input so that absence of input means zero bias. Complete lack of input is often due to a line generator failing to oscillate, so the best first move is to replace this valve.

Replacing line timebase valves

However, a word of warning is necessary before making valve replacements in the line circuit. If, for example, a new cold line generator is fitted to an already warmed-up receiver, even if it proves to cure the complaint it will cause the pentode to run with zero bias till it begins to oscillate when the sudden onset of operation in the pentode can often instigate interelectrode sparking due to the rapid reduction of anode current from a highly inductive source.

If a cold boost rectifier is fitted to a fully warmed-up receiver absence of anode voltage to the pentode will certainly run the screen red-hot till the rectifier passes current. The high heater-cathode insulation of boost rectifiers generally extends their warming-up time by 50 seconds over ordinary valves so that here again great stress will be put on the pentode and inter-electrode sparking can occur *unless the set is allowed to cool down between each valve replacement*. This is a time consuming procedure, but highly important.

Line generator circuits

Line generator circuits vary widely, but can generally be divided into four categories. (1) A double-triode or triode-pentode multivibrator as the line generator, with the line output valve purely a power amplifier controlled by the oscillator output. (2) A triode blocking oscillator feeding the line output stage. (3) A sinewave pentode oscillator with the line output valve again being used as purely a power amplifier, but with additional circuitry to shape the sine-wave to the required waveform (used in modern GEC/Sobell, K-B/RGD and Alba monochrome receivers and most colour receivers). (4) A triode which in conjunction with the line output valve provides the multivibrator action. Failure of the latter valve will also therefore prevent line generation. This system is used mainly in older 405-only models.

Faulty self-oscillating timebase

Identification of the system employed and generator valve therefore becomes the first move. In systems (1), (2) and (3) the line output valve has no effect on line frequency—only on line amplitude. In older models using system (4) the complementary oscillator valve is usually the triode section of an ECL80, PCF80 or similar triode-pentode type. To assist in localising this valve when the service manual is not to hand, follow the line hold control wiring and look for

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the essential cross-connected capacitors from triode anode to line output valve grid and from a tapping on the line output transformer or the screen of the line output valve to the triode grid. A cross-coupling capacitor from a tapping on the line output transformer will be of the high working voltage, disc-ceramic type possibly mounted on the line output transformer frame. Should replacement of this valve fail to provoke oscillation, remove the top cap of the boost rectifier—in these older models it will almost certainly be a PY81—and note if oscillation of some sort develops. If it does this is a sure indication that the boost reservoir capacitor is short-circuit, for normally of course this action removes h.t. from the pentode anode. This capacitor will be a fairly sizeable, high working voltage type mounted close to the line output transformer and making a resistance test from the PL81 anode lead should soon locate it.

If tests prove that this boost capacitor is not short-circuit it may be worth while to shunt another across it in case it is open-circuit, although normally such a fault should not prevent oscillation but only restrict and distort the line scan. However, it must be considered a possibility. Next remove the e.h.t rectifier in case an internal short-circuit is loading the line output transformer too heavily to permit oscillation.

Should the tests and replacements so far suggested fail to restore line generation and therefore stop the line output valve grossly overheating, the fault will probably be a component defect or wiring disconnection in the triode circuit. If anode voltage is present check for solder blobs shorting the grid circuit in printed-circuit receivers and check that the vital feedback capacitors are in order and not dry-jointed. Only very rarely are the line output transformers or scan coils at fault, for it usually requires an extremely heavy short-circuit across these windings to completely prevent oscillation.

Testing generator stages for oscillation

As the line output valve plays no part in the production of the line oscillation but only in its amplification in methods (1), (2) and (3), complete lack of grid drive in these cases can be caused by the triode, double triode or triode-pentode line generator stage or more rarely by a break in the feed circuit to the line output valve grid.

To check if an oscillator valve is working, test for the presence of negative voltage on the grid which will tend to vary as the line hold control is swung from one extreme to the other. In almost all instances this voltage will not be present thus showing that the defect is in the oscillator stage itself and not in the feed to the line output valve. Don't forget however that absence of this voltage will result in lower anode and screen voltages than are indicated in the service manual due to the resulting increased anode and screen currents.

Multivibrator faults

The multivibrator type generator, whether double-triode or triode-pentode, is generally a trouble-free stage and having few components and no transformer it is a simple matter to change all "possibles" to thus quickly restore operation. With circuits of this type it is possible to check most resistors without having to isolate them, but the small value capacitors, which may be open-circuit, value reduced, or have a leak that only shows up in use are difficult to test with any degree of certainty. When in doubt replacement is the best procedure, especially in cases of intermittency or when oscillation occurs but gradually or spasmodically changes frequency.

Multivibrators can of course be of two types: (a) as previously described with cross-connected capacitors from each valve grid to the other's anode (or occasionally screen in the case of a triode-pentode); (b) with one valve anode capacitively coupled to the other valve grid but with a common cathode resistor (see Fig. 1) to provide the second feedback link. This cathode resistor must only be shunted by a small capacitor as of course full decoupling would reduce the common impedance to an insufficient value. This common cathode resistor method is widely used in Bush receivers, employing a PCF80 valve. A short-circuit across this cathode resistor will of course prevent oscillation.

Blocking and sinewave oscillators

With the blocking and sinewave oscillators employing transformers there is always the possibility that a break or partial short-circuit can develop in one of the windings to prevent oscil-

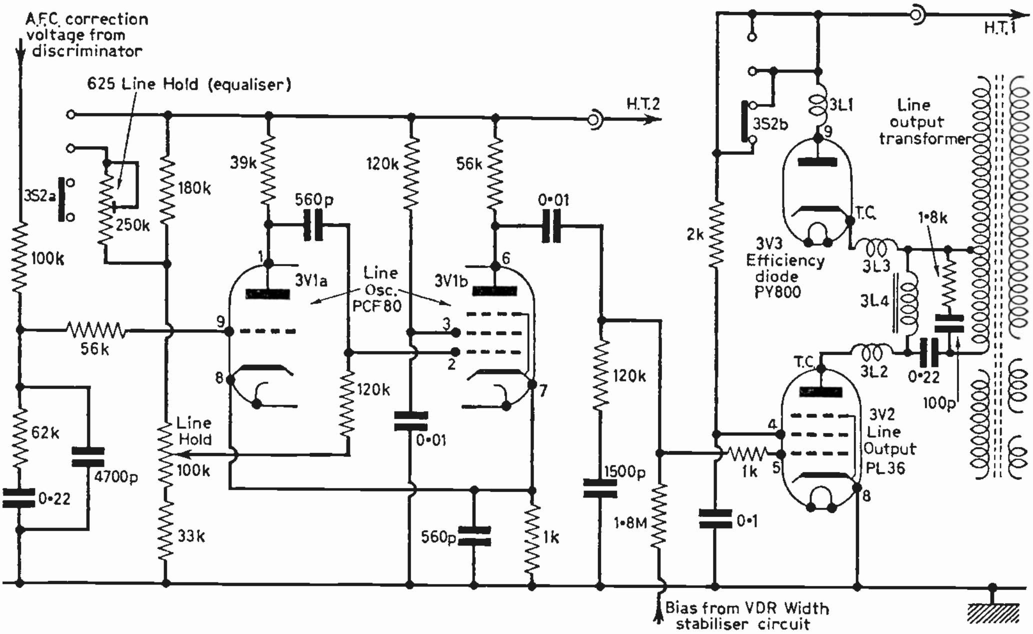


Fig. 1: Basic line circuits of a modern dual-standard receiver (Bush-Murphy) using a triode-pentode multivibrator of the cathode-coupled variety as the generator stage. A short-circuit in the 560pF cathode capacitor will prevent oscillation by shorting the 1kΩ common cathode resistor.

lation although generally these transformers prove very reliable in practice. The most usual indication of a transformer partial short-circuit or leakage from either winding to core is sudden change or intermittent variation in locking position on the line hold control.

Excessive screen grid voltage

After complete failure of the line generator causing the line output anode to run red-hot the most common cause of overheating is marked over-running of the valve due to (a) excessive screen grid voltage or (b) inadequate drive or bias. The first of course is very common and is due to the screen feed resistor reducing in value through continual use. If any carbon feed resistor is discoloured it is certain to have had a value reduction and should be immediately replaced. The value of line output valve screen feed resistors varies widely so that usually the manual must be consulted to determine the exact value, which tends to average 2·2-2·7kΩ.

Inadequate drive or bias

Inadequate drive and thereby inadequate bias is often caused by a low-emission line generator, possibly the ECC82 double-triode being the most common offender; but it must not be overlooked that a wrongly set or defective v.d.r. width regulating circuit, almost universally used in dual-standard receivers, could also be the cause. The setting of these controls is very important for correct running of the line output valve, and several makers issue a "drill" for their optimum adjustment. GEC for instance stipulate that the

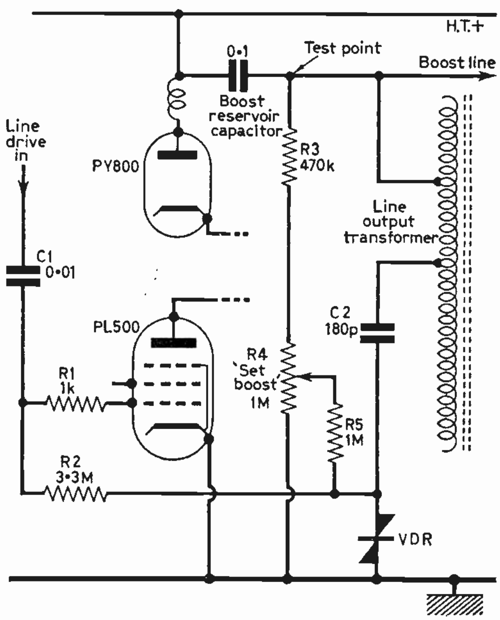


Fig. 2: Basic v.d.r. self-compensating width system (GEC). The circuit operates by rectifying the line pulse sample across the v.d.r. to increase PL500 bias if the line scan amplitude tends to increase. The "set boost" width control produces optimum width when the voltage at the test point is 770V. C2 couples the line pulses to the v.d.r. and R4 sets the operating point of the stabilisation circuit.

width control potentiometer, termed the "set boost" in this usage, should be adjusted to give a boost rail voltage of 770V at a designated test point. If the line linearity sleeve is correctly set the width should then be correct. Once the width is set in this manner it is self-compensating for mains voltage variations. Boost rail limits at the test point are 750-790V and the makers emphasize that damage can be done to the output valve if these values are exceeded.

VDR width stabiliser circuits

The basic features of the v.d.r. width stabilizer are shown in Fig. 2. This circuit with minor variations is used in most current receivers. A v.d.r. (voltage-dependent resistor) functions as a type of rectifier to non-symmetrical inputs, and when fed with a sample line pulse via a capacitor connected from the line output transformer produces a bias that offsets any change in mains voltage variations. It should also be mentioned that inserting width/linearity sleeves too far in scan coil assemblies can result in some overloading of the line output valve which can thus shorten its life and can also result in the scanning coils overheating.

Leaky couplers

As the line output valve grid is usually capacitively fed from a fairly high voltage point a leak in this feed capacitor would naturally reduce the effective valve bias, but such failures are extremely rare. The most recent instance the writer encountered was in a 17in. (405-only) GEC receiver and the complementary symptom to overheating of the PL36 was insufficient width which progressively reduced with time. Slight leaks in such grid capacitors are extremely hard to detect in use since the slight positive leakage is swamped by the negative autobias voltage developed by the pentode grid, although naturally this positive leakage reduces the intended negative grid potential. Possibly the simplest way of measuring for a slight leak of megohm value is simply to connect one end of the capacitor to the h.t. rail or any convenient point and with a voltmeter of high internal resistance check for any voltage at the free end. For example a meter of 5,000 ohms/volt on the 200V range has a total resistance of 1MΩ. If placed in series with a 200V d.c. supply an indication of say 5V would show a capacitor leakage of closely 40MΩ. The greater the meter resistance, the higher a resistive leak it will indicate. If the line output valve is removed and a shorting link or equivalent value heater resistor placed across the valveholder heater pins to maintain continuity, then the capacitor can be tested in situ on temporarily preventing operation of the line generator. This latter is most easily done by short-circuiting the line generator grid to chassis.

Quick line drive checking

The practice of removing the line output valve but maintaining the heater chain intact with a shorting link or resistor is of value when investigating complete lack of input to prevent damaging the valve. With line output valve heater voltages tending to average about 20-25V, a 50Ω, 10W resistor will maintain a close to normal heater-circuit current.

Onset of oscillation by the line generator can always be detected by the appearance of negative voltage at the valve grid and its feed to the line output stage by an a.c. voltage at the pentode grid.

EHT shorts

On occasion it may be found that the anode of the e.h.t. rectifier is running red-hot thus indicating a near short-circuit across the e.h.t. output. In many instances on removing the anode cap to the c.r.t. the fault will go thus proving that the c.r.t. has an internal short-circuit. In fact as the e.h.t. voltage is so high the tube need only have a heavy leak from anode to any earthy point to grossly over-run the e.h.t. rectifier. Some older models had a high working voltage capacitor connected across the e.h.t. output; this commonly broke down but there are few such receivers in use to-day.

Should removal of the c.r.t. anode cap fail to remove the e.h.t. short-circuit the only possible conclusion is that the transformer winding feeding the rectifier heater is shorting to the transformer core. Usually before the insulation of this winding completely breaks down it will have caused intermittent sparking or arcing across. Fortunately this is one line transformer fault that can always be remedied and only necessitates rewinding the few heater turns with a new length of e.h.t. wire. Usually the e.h.t. wire is wound on an insulating ring or former mounted on the core, but if as often happens the replacement e.h.t. wire is too thick to permit the required number of turns to be rewound back on this former it can be removed and the fresh wire directly wound on the core.

In the many Thorn receivers that use miniature stick rectifiers and h.w.v. capacitors in an e.h.t. trebling arrangement any failure of individual components is rectified by changing the entire unit which simply clips on to the top of the jelly-pot transformer. However, there are several varieties of this clip-on unit and although all look very similar and will interchange, to maintain correct e.h.t. voltage for each particular model, e.g. 19in. or 23in., the appropriate type must always be used.

CONTINUED NEXT MONTH

UNDERNEATH the dipole

WHEN do engineers become artists or conversely artists become engineers? Or when do their vocations mix? These questions are almost unanswerable without parameters or some terms of reference laying down exactly their characteristics for qualification as an artist, be he (or she) an actor, dress designer, sculptor or musician, or an artist in water colours or oils. A skilled photographer can now make accurate colour records on film for stills or motion pictures. He can choose the exact moment for exposure(s) because he is both an engineer and an artist, with the logic of an engineer tempered by the emotion of an artist.

Such new blends of thought are more clearly illustrated in colour television than any technical development for years. Just as a skilled musician can orchestrate on a big scale his interpretation of the top line melody, bar by bar, so can the engineer-artist arrange his colour lighting patterns, delicately painting the scenery, the actors or the orchestra itself with colour designs from various light sources. How can he recreate such a premeditated kaleidoscope of colour with complete technical control?

I feel sure that Frederic Bentham, whose virtuosity on a Strand lighting console is famous all over the world, would say: "Elementary, my dear Iconos! It's recorded on a magnetic tape. Just recall the colour designs by pressing buttons, bar by bar, as necessary." Taking no notice of me whatever, as he changed from his Dr. Jekyll engineering-logic-frown to his Mr. Hyde artistic emotional psychedelic trance, as he bent over the mystic 240-memory, six-manual IDM keyboard and commenced his colour recital searching feverishly for the 7-colour "Lost Chord". I will stop pulling his leg as he approaches pedal notes.

Portraiture—1958

I will quote from a paragraph I wrote in PRACTICAL TELEVISION in the April issue, 1958 not long after the ITA had started and TWW's Pontcanna Studios in Cardiff were in operation:

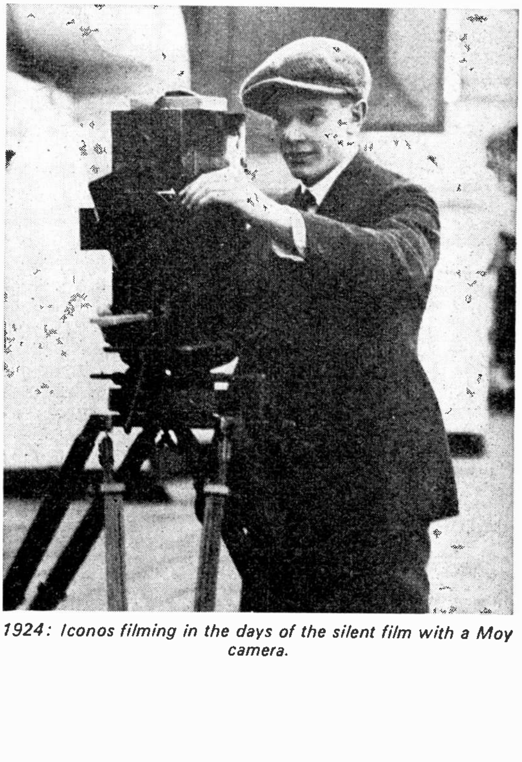
"The successful television engineer who is on the staff of a television programme company must, in many jobs, be an artist and a showman as well. Not enough attention is paid by studio cameramen and lighting engineers to the elements of picture composition and lighting. There have recently been some horrifying examples of unflattering television portraiture on both ITA and BBC. *This Is Your Life* has been running quite a long time but there have been occasions when the cameras have treated the "victims" of this programme and their friends most unkindly, turning good-looking people into lined and ugly ghosts of themselves . . . Engineers and producers should be given a course in the principles of portraiture, pictorial composition and lighting."

That was written in *Underneath the Dipole* long before the arrival of the u.h.f. aerial, 625 lines and colour. Eleven years later it is pleasant to write that the BBC have extended their technical courses in a very logical manner, integrating the training of lighting engineers, designers of sets and costumes, vision mixers and make-up artists. Their close collaboration is obvious to viewers able to see their combined efforts in colour. All these departments make important contributions, plus many others, such as directors, producers, writers, graphics designers, and not forgetting the engineering types who tweak the pictures into shape. BBC credits usually come on the screen at the end of each studio stage colour programme item and the names of Sam Barclay, Geoffrey Shaw, Bob Wright, Peter Catlett, Denis Channon, and Jim Purdy deserve special mention for their superb artistic contributions.

Colour progress

The quality of BBC colour improves week by week—not just year by year. Soon, in the London area at any rate, we will be seeing colour on ITA and I have already seen a videotaped ATV programme *Tom Jones* in superb colour, reproduced on a closed-circuit monitor. It has

Then . . . . .



1924: Iconos filming in the days of the silent film with a Moy camera.

been transmitted in the UK in black-and-white but for world export has been transferred to colour film, many copies having already been exported on 16mm. film as well as 35mm. It will certainly be shown again in a few months time—in colour.

Progress in colour filming has been made on both 35 and 16mm. gauges by the BBC, who have now overcome the difficult problems of cutting from interiors to exteriors without abrupt quality changes. The sharp difference in colour balance between the two sources—videotape and film—is smoothed out with magic electronic circuitry evolved by the BBC research department, who are now entitled to be regarded as artists in their own right.

The Borderers

A splendid example of such interior to exterior sequences is *The Borderers*, a thrilling historical series of the skirmishes north of Carlisle. Scottish scenery has made a delightful background to the series which has become a kind of mediaeval cowboy romp around the stone walls and castles on each side of the Scots-English border. The horses, the swords and the skirmishes give a welcome change of background from the cinema-type Westerns with their waxed moustached sheriffs and trigger-happy bandit gangs leaning on the saloon counters. "Horse Operas" they called these in Hollywood about twenty years ago. In this day and age expensive, glossier, larger and more violent cowboy films for the cinema are shot in Spain, no doubt called musically "Fandango Cavallo." I suppose we can look upon *The Borderers* as a "Scottish-opera bouffe equestrioso" (North of the border) or "Carlisle cantata bravura" (South of the border).

My BBC friends have told me that this odd but exciting border horseplay has had a lot of teething troubles in its making, both artistic and technical. Putting on my horse vet's hat and looking in the mouth of this BBC gift horse I declare it to be sound and healthy!

. . . . . *and Now!*

1969: Iconos at a Marconi Mk IV TV camera during a recent visit to Westward Television, Plymouth.

The export market

The export market for many of these British-made videotaped series has been expanding rapidly, both for colour telecine and black-and-white. A far greater export field is reached at present by supplying copies of TV series photographed on film and released on both 35mm. and/or 16mm. gauges. Still further expansion is likely to be made with the Vidtronics and other systems for transferring from videotape to film, 35mm. or 16mm. I can imagine those Scottish cowboys having a great appeal to television viewers in Texas, where everyone has a colour set. Mind you their NTSC 525-line colour receivers are not quite so reliable as the PAL 625-line ones we have in Britain. The Campbell tartan might suddenly take the colour patterns of the Gordons or the Stuarts clan! "Never twice the same colour!"—Remember?

Our expanding exports to America have not been confined to films and tapes. The British equipment products have gained much favour with all the big networks, with large orders for colour television cameras from EMI and Marconi as well as for black-and-white TV. There is preference towards the four-tube camera (R, G, B plus luminance) for studio and interior usage, but the smaller three-tube camera is most popular for outside broadcasts. Big British advances have been made in transferring from tape to film too. The British Rank Taylor Hobson television zoom lenses are very widely used.

There are problems about exporting telecine equipment of the flying-spot type to the USA and other countries whose electrical mains supplies are on 60c/s. For the UK and all countries on 50c/s mains flying-spot telecine has many advantages, particularly in the field of colour TV. Nearly all BBC, ITA AND ITV organisations use a large proportion of flying-spot machines for films and slides. They have become even more popular with the approach of colour on three u.h.f. channels. Nevertheless Rank Cintel have a large export order book, with half a million pounds' worth of flying-spot machines for Scandinavia.

E. A. R. Herren, Managing Director of Pinewood Studios, recently referred to the advances being made in British film studios with new equipment and new electronic techniques suitable for films and/or television, compared with those in Hollywood. "They were so far ahead at the end of the war that they let themselves go," he said, adding dryly, "and we quietly took over. Now they'll be back in with both feet. I look forward to a great race for the benefit of technical excellence all round. There's no harm in good successful competition."

I must say that I liked the "curtain" lines to the interview Mr. Herren gave to the trade press: "We have the knowhow, the talent and the brains. But we don't have the bottomless well of dough the Americans have. The Americans open their cheque books; we open our minds."

Iconos

Workshop HINTS

by VIVIAN CAPEL

OVER a period of years the professional service engineer picks up many hints and tips which are the result of observation and his own experience. These may involve short cuts in diagnosis and repair or those making routine jobs easier. Also in his storehouse of accumulated experience will be the many pitfalls to avoid. These rarely get into the technical books and so the amateur or beginner must go through the long and laborious task of finding out for himself. In this new series however we shall be presenting hints to make work on the bench and elsewhere much easier for the novice as well as perhaps providing a useful tip or two for the professional.

Diagnosing Faulty Transistors

When fault finding in faulty transistorised equipment the transistors themselves will obviously come under suspicion. The "correct" way of testing, after taking voltage measurements, is to remove the suspected transistor and check it on a transistor tester or fit a substitute. Sometimes however the lead-out wires of the original transistor are very short and inaccessible so that fitting a heatsink is difficult if not impossible and the act of unsoldering and freeing the wires often leads to damage to the transistor which subsequently may be found not to have been the cause of the fault.

In many cases it will be found that there is no need to unsolder the original. A replacement transistor can be connected across the print in parallel with the suspected one. To avoid damaging the original, just hold the iron on the print long enough to tack the wires of the substitute in place; a tidy joint does not matter at his juncture. It will also help if the joint can be made at some point on the print away from where the wires of the original are soldered.

In many cases it will not even matter whether the substitute is of exactly the same type as the suspected transistor, as long as it is of the same class i.e. r.f., a.f., or power type. It will of course be essential to use a pnp type across a pnp one and an npn one across one of this type. While this procedure can be followed with small power-output types such as those used in the output stages of battery portable radios it is not wise for higher power applications where one of the correct type should be used after removing the original. In most cases though bridging across the transistor in this way will get the equipment working if in fact the suspected one was faulty.

The exception to this practice is if the original transistor has gone short-circuit. In this case a parallel substitute will have no effect, but a short-circuit transistor should be easily recognised from the original voltage checks.

Replacing Transistors

Our next hint follows logically on the last one. If a transistor is proved faulty then it will have to be replaced properly by one of the correct type. This is not always as easy as it sounds. First of all the old transistor must be removed, which is quite straightforward if we know it is defective as there is no need to take precautions to avoid further damage. The holes must then be cleared in the print and then the three wires (or four in the case of those transistors having a screen) must then be introduced into the holes. It is this latter operation which sometimes proves difficult. Especially in small personal portable radios, the holes are sometimes obscured by a forest of other components. When trying to get the second or third wire in the first one will often slip out. If we solder each wire as we go we will probably find that the wires are of the incorrect length and will afterwards need to be unsoldered and pushed through farther. Cutting all the wires to the approximately right length to start with is not much help either, as this then brings the body of the transistor close to the panel and makes it difficult to insert the remaining wires.

One simple method of overcoming these difficulties is to cut all of the wires at slightly different lengths. As there are about 2in. of wire to the majority of transistors one wire can be left at the full length, the next cut to $1\frac{1}{2}$in. and the third to 1in. The longest is first inserted into its appropriate hole in the panel and because they are shorter there will be no fouling of other components by the remaining wires. When the first one is pushed in the second longest is then introduced into its hole. By this time at least half-an-inch of wire will be through the first hole so there will be little likelihood of the first wire slipping out.

Lastly the third wire is inserted into its hole. In the same way the second as well as the first wires will be retained and will not escape. With all three wires in place the transistor can be pushed home into its correct position and all the wires will thus slide through their holes until the correct length remains above the panel. Before cutting to size on the other side of the panel the wires should be soldered. The surplus length of wire will help to conduct some of the heat away from the transistor although a heatsink should also be used; also if the wires are cut before soldering there is the possibility of the shortened wires slipping out of their holes. Trim the wires to length after soldering.

Removing Solder from Printed Circuits

One of the essential processes in replacing a transistor or any other component on a printed circuit is to clear out the holes so that the wire ends or terminal posts can be introduced, and to remove any excess solder. It is true that wires can be introduced into the holes in the print with solder still covering them by keeping the solder molten with the iron but this is rather clumsy and damage can result to the print itself.

The best way of removing solder from print is undoubtedly the use of a solder pump. There are a number of these on the market at present and in most cases they consist of a soldering iron with a hollow bit and an airline leading to a footpump. Operation of the pump causes suction in the bit which draws up the molten solder away from the print and deposits it in a reservoir which can later be emptied. A number of these devices were given a workshop test and one of the most effective was also one of the cheapest and simplest. This was the Picard Solder Pump, which operates something like a spring-loaded bicycle pump. The solder is melted with an ordinary soldering iron, the nozzle of the pump introduced into the solder and then a button on the pump depressed. This releases the spring which causes the handle to fly out and suck up the solder into the pump. Because the nozzle is made of Teflon rather than metal it does not cool the molten solder which therefore does not solidify.

The professional engineer or the amateur who does a lot of work on printed circuits will find this instrument invaluable. The amateur with only an occasional need may however seek an alternative method of solder removal from printed circuits.

One method which has been advocated by makers of printed circuits is first of all to melt the solder with a soldering iron and then to remove the excess by means of a wire brush. This is quite effective but rather messy. It is easy with this technique to spread the solder over the surface of the print and cause numerous short-circuits some of which may not be noticed and can be intermittent in nature leading to a whole lot of trouble later.

A dodge which has been found quite successful is to make use of the capillary attraction of copper braid for solder. The braid can be obtained from old lengths of coax cable and can be removed from the cable and cut up into three- or four-inch lengths ready for use. These can be flattened but not stretched.

When it is necessary to remove excess solder from the print the solder is first made molten with the soldering iron and then the end of one of the lengths of braid is introduced. The braid will become tinned with the solder which will creep along its length. The process is much slower than the use of a solder pump but can be hurried somewhat by pushing or pulling the length of braid through the pool of solder rather than waiting for it to creep along. It is surprising the amount of solder than can be taken up in this way. When the braid is fully tinned it is discarded and another length used.

Using copper braiding to absorb solder

Temporary Component Bridging

During the course of servicing it is often necessary to bridge a suspected component with a substitute as a test of its goodness. Suspected open-circuit capacitors in particular are frequently checked in this way. These may be tacked on to the tags or print by means of a quick joint, but each time this means switching off the receiver, using the soldering iron and then switching on again, only to reverse the process if the test proves negative.

In order to save time the wire ends of the component can often be used as prods with a press contact being made to the appropriate part of the circuit. The snag with this is that contact is not always very good and any extra pressure in order to achieve good contact results in the wires buckling. It is difficult too to make contact with both wires at the same time at the correct places without either coming adrift.

A simple solution to this problem is to form a hook at the end of each wire by bending the wire back on itself. These can then be hooked around the wires of the original component: contact is maintained by gently pulling the wires so that the wires will not bend or slip off as they can do when used as a prod. The component can often be left hanging by its hooked wire ends while other tests are made.

TO BE CONTINUED

A SIMPLE FLYING SPOT SCANNER

PART 2

S. M. LINDSAY

CONSTRUCTION falls into three main parts: (1) Modification of two TV sets for use as scanning and display units. (2) Building the photomultiplier bias unit and video amplifier. (3) Construction of a suitable power supply unit. All the equipment has been designed for maximum simplicity and virtually no special setting up adjustments are needed. It is probably best to assemble the power supply unit first so that power is available at each stage of construction.

Video amplifier

The video amplifier consists of three pentode amplifier stages driven from the photomultiplier which is mounted on the same chassis. Fig. 6 shows the circuit. The photomultiplier tube consists of a series of electrodes each maintained positive with respect to the one before it. The cathode has a photosensitive coating which emits electrons when light falls on it. These are attracted to the next electrode (dynode) from which on average several more electrons are emitted for each one striking it. These fall upon the next dynode and so on giving possible multiplication of over a million times at the anode. With such gain the biasing voltages supplied to the dynodes must be regulated to maintain a stable output.

The Z77 was chosen for the video stages because it is widely available and because of its gain and noise factor. This valve and many of the other components can be found on an old i.f. chassis (the author found such a chassis very convenient for building the amplifier on). The physical layout is not critical but particular attention should be paid to screening: the vertical dotted lines in Fig. 6 show the parts of the circuit to be screened from each other. The usual constructional techniques regarding heater wiring, etc., should be employed. The 931A photomultiplier bias is derived from addition of the 300V h.t. line and a 450V negative line.

Trouble can be experienced from afterglow; that is the phosphor on the scanning tube may continue to glow some time after the spot has passed it causing smearing of the image the photocell "sees". This is equivalent to integration of the waveform within the amplifier and can be corrected by differentiation: there is a degree of differentiation across V1 which would compensate for this effect in most cases.

Simple test

The output is negatively modulated, that is zero illumination produces maximum output voltage. A very simple "go-no-go" test is to connect the output of the video amplifier to a voltmeter switched to the 200V range and strike a match in front of the phototube cathode: a significant drop in voltage should be noticed.

Modifications to the sets

As direct connections have to be made to the television chassis first check that they are not live. Wire the mains leads to a three pin plug making sure that there is no direct connection between the chassis and the "live" lead.

In both the scanner and display unit the drive to the tube from the set's video amplifier stage must be removed. In nearly all sets the tube is cathode modulated and it is an easy matter to locate the cathode lead. This is easily distinguishable since it is generally the longest lead to the tube base, very often yellow in colour, and running from the tube base to the video output valve. It is frequently terminated in a small plug which fits into a socket near this valve. The cathode pin on most octal based tubes is pin 8 whilst on B12A bases it is pin 11. If in doubt consult the manufacturer's data. To check that the tube is cathode modulated obtain a picture on the screen, measure the d.c. bias present on the cathode, disconnect the cathode pin and place a d.c. bias on the cathode from your own power supply unit: a raster free from any detail should be obtained. Provided the cathode is kept positive with respect to the grid

A scanned negative reproduced as a "positive print" on the display unit.

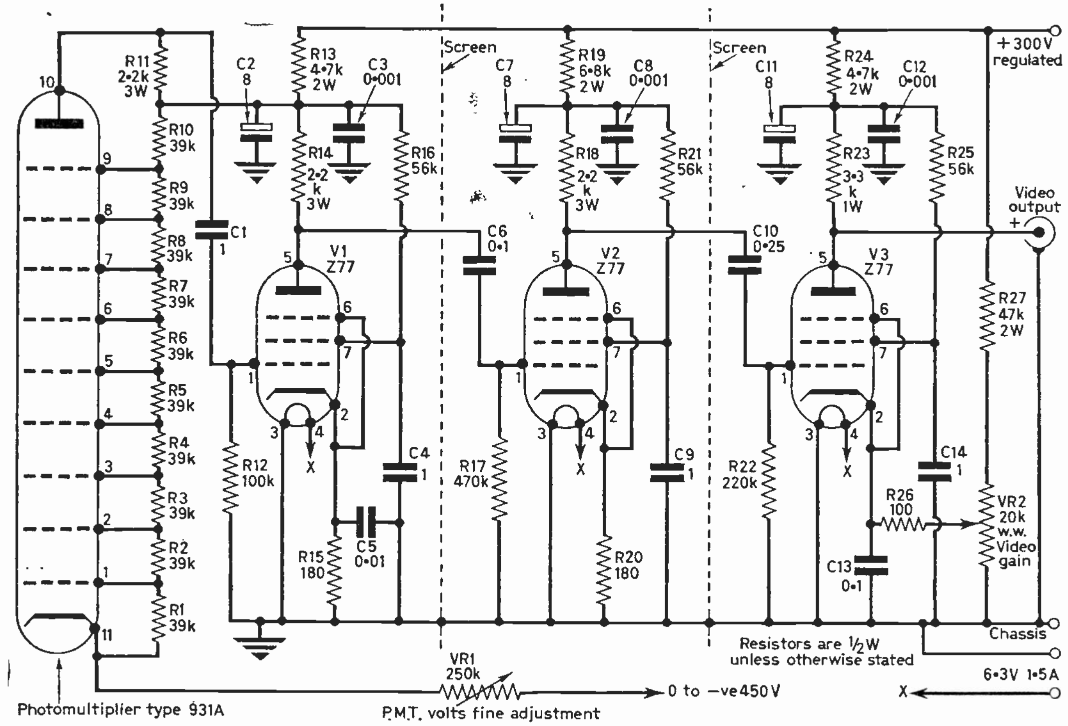


Fig. 6: Photomultiplier tube and video amplifier circuits used by the author.

this could alternatively be isolated and modulated.

The only modification required to the scanner is to isolate the cathode and bias it suitably from your own power unit. The tube cathode in the display unit is fed from the output of the video amplifier via a potentiometer. It is advisable to make arrangements to display the actual picture transmitted by the BBC (or ITV) so that quick checks can be made on the synchronisation of both rasters. It is probably best to fit both the cathodes with flying leads and plugs so that the cathodes can be switched from operation from the external inputs (video amplifier and bias supply) to operation from the sets' own internal video signals. An ordinary changeover switch is not recommended since there may be enough leakage across it to display faintly the transmitted picture at all times. The set up is shown in Fig. 7.

With the power supply unit the constructor is free to do as his spares box dictates bearing in mind that the required voltages are: 0-450V negative with respect to earth (for the photomultiplier basis) at 20mA and stabilised. 300V positive with respect to earth, stabilised and at approximately 50mA, for the video amplifier h.t. 0-150V positive with respect to earth for scanner tube bias. 6·3V a.c. at 1·5A for the heaters. Good smoothing is necessary to obtain pictures free from hum bars (vertical black bars).

Setting up and operating

The electrical layout is shown in Fig. 7. Initially the sets should be connected for normal operation (cathodes connected to the internal video amplifiers) and tuned for best BBC picture. Both sets can be fed from one domestic television aerial using a star network (see Fig. 8) which is suitable in areas where the signal is strong enough to permit a 6dB loss. The scanner is then set up to display a plain raster synchronised to the BBC signals by leaving it tuned to the BBC and reconnecting the cathode lead to the bias from the power unit. Varying this bias varies the brightness of the raster.

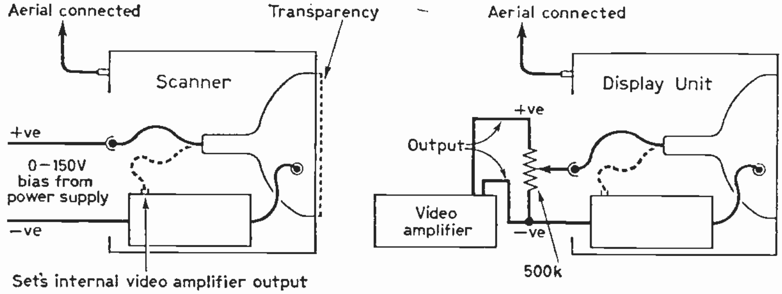


Fig. 7: Biasing the scanner and display units.

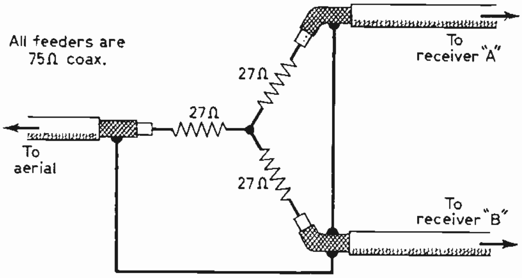


Fig. 8: Star network for feeding two sets.

The photomultiplier unit is then placed opposite the screen so that the light from the screen falls on the cathode (a clearly visible opening in the internal structure) and the video amplifier connected to the display unit as shown in Fig. 7. Extraneous light should be excluded from the vicinity of the phototube (a little daylight is permissible but electric lighting will introduce hum bars on the display screen).

The video amplifier and display set can now be switched on and a hand waved in front of or a piece of tape stuck to the scanning screen should be visible as a shadow on the display screen. If the picture streaks the photomultiplier voltage should be reduced. If it tends to go negative reduce the video gain and/or the photomultiplier bias voltage. Contrast can be increased by increasing the video gain, the photomultiplier bias or the brightness of the scanning raster. The author made up a crude test card on a piece of glass plate which was placed in front of the scanning screen.

Transparencies may be displayed using the set-up shown in Fig. 9. L1 focuses the image of the screen so that it covers the transparency and L2 focuses the image so that it covers as much of the photomultiplier cathode as possible.

COMPONENTS LIST

Resistors:

R1–R10	39kΩ ½W 5%	R19	6·8kΩ 2W
R11	2·2kΩ 3W	R20	180Ω ½W
R12	100kΩ	R21	56kΩ ½W
R13	4·7kΩ 2W	R22	220kΩ ½W
R14	2·2kΩ 3W	R23	3·3kΩ 1W
R15	180Ω ½W	R24	4·7kΩ 2W
R16	56kΩ ½W	R25	56kΩ ½W
R17	470kΩ ½W	R26	100Ω ½W
R18	2·2kΩ 3W	R27	47kΩ 2W

VR1	250kΩ log. carbon pot
VR2	20kΩ w.w. pot

Capacitors:

C1	1μF 350V paper
C2	8μF 350V electrolytic
C3	0·001μF 400V mica
C4	1μF 350V paper
C5	0·01μF 150V paper
C6	0·1μF 350V paper
C7	8μF 350V electrolytic
C8	0·001μF 400V mica
C9	1μF 350V paper
C10	0·25μF 350V paper
C11	8μF 350V electrolytic
C12	0·001μF 400V mica
C13	0·1μF 150V paper
C14	1μF 350V paper

Valves:

V1–V3 Z77 (EF91)
Photomultiplier 931A with base (equivalents 1P21, 27M1)

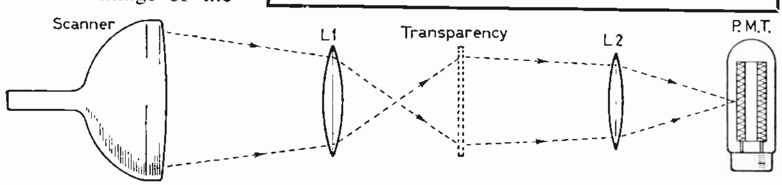


Fig. 9: Lens system suitable for use when scanning transparencies.

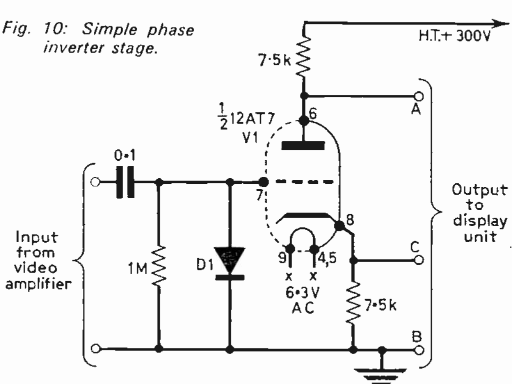


Fig. 10: Simple phase inverter stage.

The experimentor may want to televise live subjects. This can be done by reflecting the raster off the subject on to the photomultiplier. It is very easy to display photographic negatives as positives by inverting the phase of the video signal from the video amplifier. This can be done using the phase inverter stage shown in Fig. 10. It is run from the video amplifier power supply and is connected between the output of the video amplifier and the display unit. The author used half a 12AT7 for V1 and a small silicon diode for D1 to provide d.c. restoration. A normal output is available between C and B and an inverted output between A and B.

There are many experiments that can be done with this simple equipment. For example the amateur can easily transmit u.h.f. vision signals to compatible equipment since no sync signals need be transmitted and the video output could be used to modulate the screen of a 435Mc/s power amplifier with no need for black-level clamps, sync adders, etc.

Servicing TELEVISION Receivers

No. 155 DEFIANT 9A61U SERIES
—continued

by L. Lawry-Johns

Sound Instability

The method of returning the loudspeaker and the PCL82 triode cathode pin 8 to chassis is worthy of close study. Whilst there is nothing wrong with using the braiding of screened cable as a chassis return, to return several points, output and audio, via one clip can be a source of trouble.

Therefore when faced with a positive feedback howl, try bonding the screened cables direct to chassis, i.e. do not rely on SK1/3.

Sound Distortion

Check the PCL82, its bias resistor (390Ω), capacitor 113 0·01μF and resistor 177 (5·6MΩ).

AGC Faults

Faults in the contrast circuit are likely to cause some headaches. Normally loss of gain with an overall grey picture can be rectified by valve replacement or locating faulty resistors in the video stage. On occasions, however, the fault will be found to be due to a heavy negative voltage on the a.g.c. line which the contrast control will not back off. When this is encountered much time can often be saved by checking the resistor 146 (100kΩ) from pin 1 of the PCL84 to chassis. When this resistor goes high the a.g.c. applied to the controlled valves is excessive, causing severe loss of gain.

The opposite effect may be encountered, where the a.g.c. voltage is very low. This causes overloading, resulting in a negative picture. Quite often this is due to nothing more than a faulty valve, say the PCC189 or the EF183, and these should be checked.

If these and the PCL84 are in order and the trouble is definitely in the a.g.c. line, check capacitor 126 (0·47μF) which may be found either leaky or a complete short. Check the other capacitors and the small M3 rectifier if necessary.

Defective Resistors

These and other earlier Plessey designs are particularly prone to give trouble due to resistors changing value. This occurs mainly in the video stage although in the series under discussion the sync separator stage is also affected.

In the video stage it is the 18kΩ resistor which changes value and causes a heavy current flow. This in turn affects the associated resistors. This fault should not be confused with the "cook-up" which results from an internal short in the PCL84. This does not affect the 18kΩ resistor but certainly affects the 2·2kΩ resistor and the detector diode. Replacement of the PCL84 and the damaged resistors will only restore a picture on one channel or rather standard if the diode which was in use when the fault occurred is also replaced.

In the sync separator stage the 100kΩ resistor (322) changes value and causes initially a loss of sync. Then as the current increases 331 also goes down leaving an almost dead short before the fuse

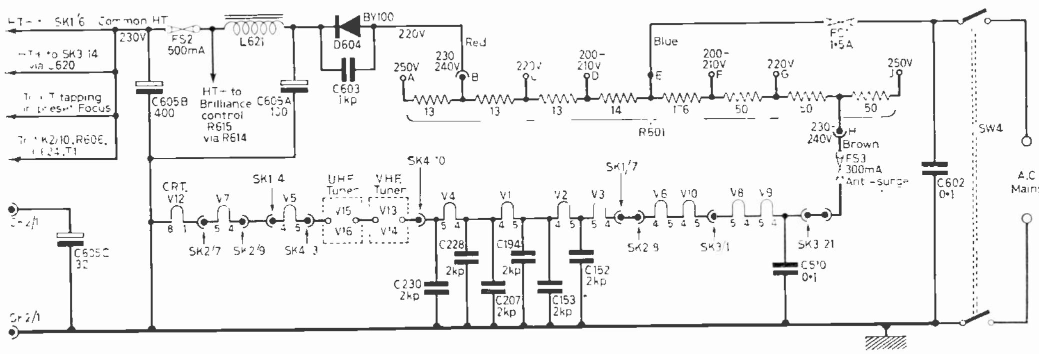


Fig. 5: Power supply circuits and heater chain.

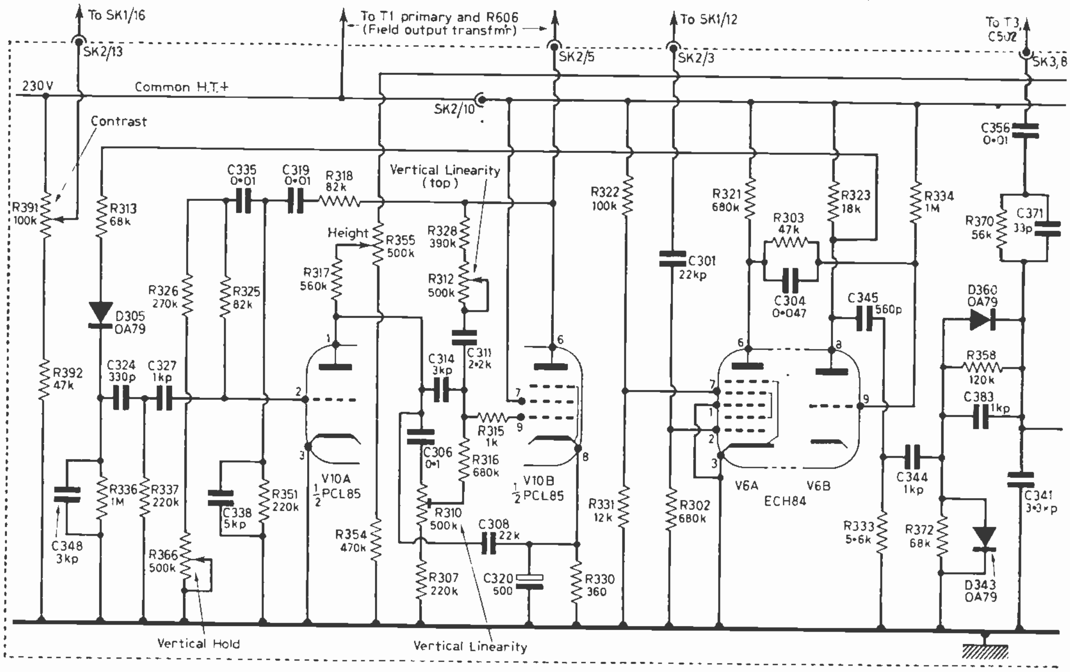


Fig. 6: Circuit diagram of the timebase circuits.

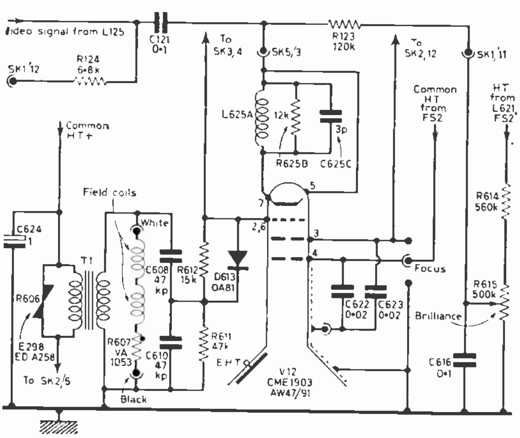


Fig. 7: Picture tube circuitry.

fails or the resistors disintegrate. Again this should not be confused with the effects caused by a faulty ECH84 (V6). The writer has not as yet found an internally shorted ECH84 but there is no reason why it shouldn't happen.

Tuner Units

The v.h.f. tuner uses a PCC189 r.f. amplifier and a PCF801 frequency changer. It is of the turret type with clip-in coil biscuits which makes conversion to v.h.f. relay operation a simple matter.

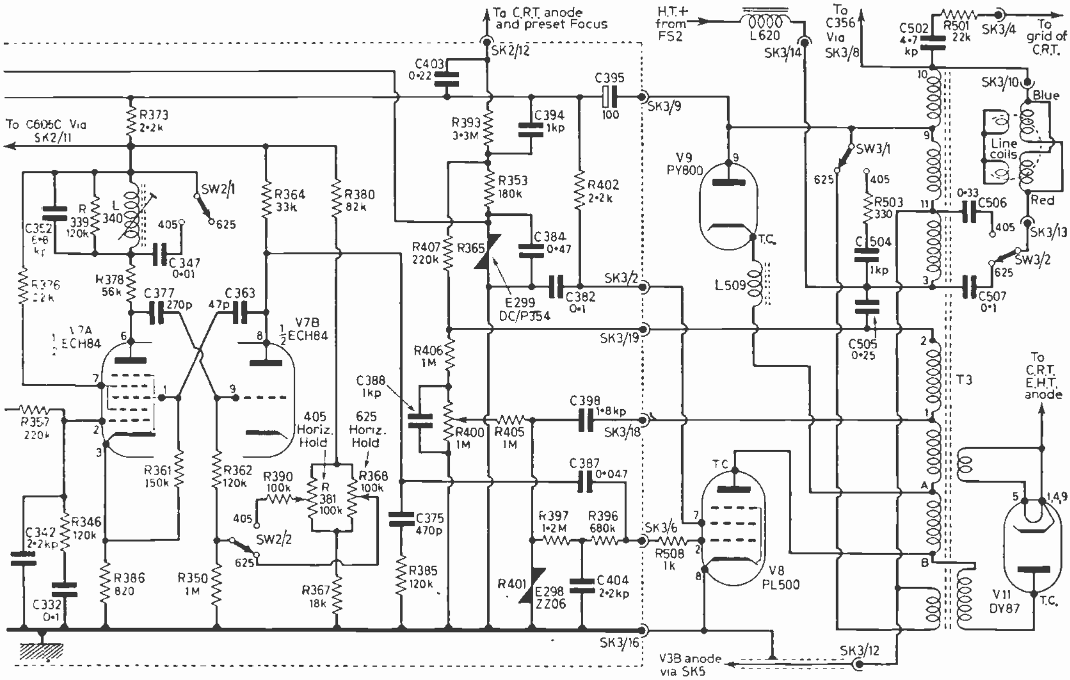
The u.h.f. tuner is of the valved type with a PC88 r.f. amplifier and a PC86 oscillator-mixer. The output i.f. is fed for extra amplification to the v.h.f. tuner mixer which then acts as an i.f. amplifier. It can therefore be seen that a fault in the u.h.f. tuner will affect u.h.f. only whereas a fault in the PCF801 stage or supply will affect both v.h.f. and u.h.f. On some models the u.h.f. signal passes through both valves in the v.h.f. tuner unit.

VALVE VOLTAGES

The readings in the following table were taken on 240V a.c. with a medium strength locked signal, average contrast and the boost voltage set to 860V on 405 using a 20,000Ω/volt meter.

Valve	*Anode V*	*Screen V*	*Cathode V*
V1 ..	190	120	0·3
V2 ..	210	210	3
V3A ..	135	200	6
V3B ..	− 35	—	17
V4 ..	220	140	0·5
V5A ..	80	—	—
V5B ..	220	180	13
V6A ..	11	23	—
V6B ..	100	—	—
V7A ..	80	175	5·9
V7B ..	165	—	5·9
V8 ..	—	210	—
V10A ..	100	—	—
V10B ..	218	228	21

continued on page 278



Defiant 9A61U series of receivers.

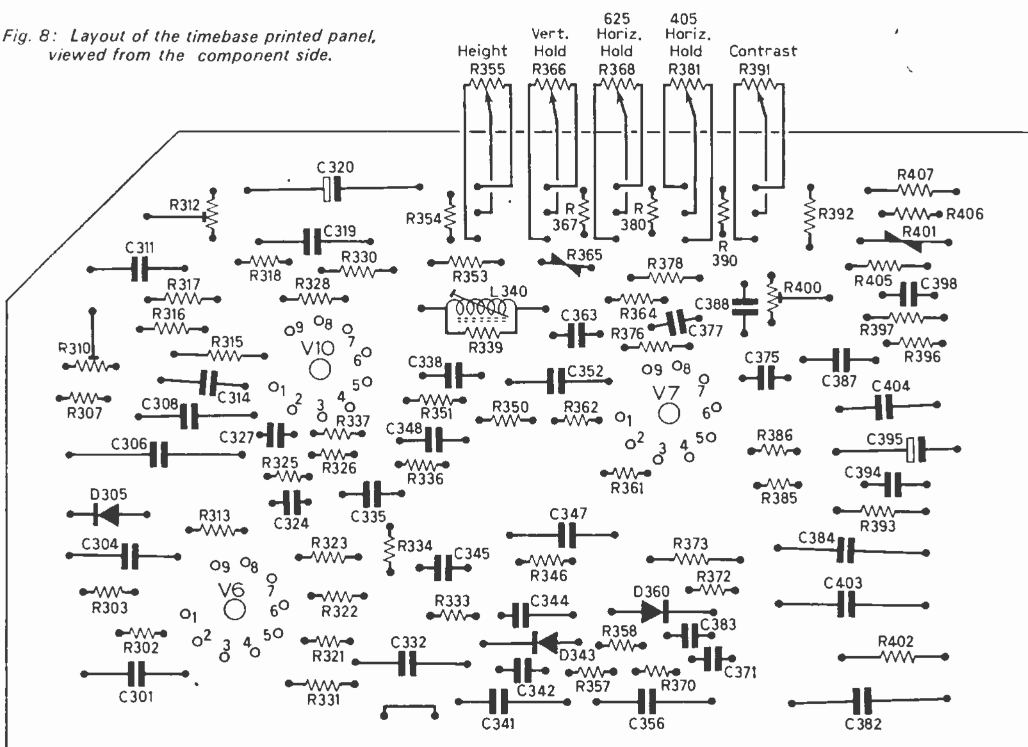


Fig. 8: Layout of the timebase printed panel, viewed from the component side.

SERVICING TV RECEIVERS

—continued from page 276.

Loss of gain on v.h.f. only, producing a grainy picture particularly on Band III, would suggest a low-emission PCC189. Complete loss of signals is more often due to a faulty PCF801. When all signals are lost or are weak do not omit to check the EF183 common i.f. amplifier.

Width Setting

The width control should be adjusted with zero beam current and nominal mains input to obtain a boost rail voltage of 855V measured between the junction of resistors 406 and 407 and chassis (socket 3, pin 19 on the timebase circuit board).

Further adjustment for correct picture width may be made with the width control, provided that after such adjustment the boost voltage is within the limits 830-880V (otherwise damage to the line output stage may result).

Picture Rotation & Linearity Sleeve

Loosen the scanning coils clamping screw and rotate the coils until the picture is straight. The coils must be seated as close to the tube flare as possible. Take care to avoid displacing the linearity sleeve. The inner face of the linearity sleeve moulded support frame should be exactly $\frac{7}{32}$ in. from the outer face of the moulded scan coil former.

Oscillator Adjustm nt

Trimming tool should be $\frac{5}{64}$ in. wide, $\frac{1}{64}$ in. thick and approximately 1 in. long. Remove channel selector and fine tuning knobs and insert tool in hole on the chassis and tuner unit to adjust frequency of whichever coil is in the circuit.

Contrast Balance

Apply test card modulation to aerial inputs (405 and 625) and connect an oscilloscope to the picture-tube cathode. Switch to 625 lines and set contrast control for 20V p-p at picture-tube cathode. Switch to 405 lines and adjust preset contrast balance control (107) for 20V p-p at picture-tube cathode.

AM Rejection

If necessary adjust preset control 190 to eliminate buzz on 625-standard sound.

DC Resistances

T1 pri. 340Ω, sec. 5·2Ω, SK2/5, SK2/10 and field coils disconnected. T2 pri. 410Ω, sec. 4Ω, SK1/5, SK1/6 and speaker disconnected. T3 V11TC to B 200Ω, B to A 4Ω, A to 1 11Ω, 1 to 2 1Ω, 3 to 11 1·2Ω, 11 to 9 1·1Ω, 9 to 10 1·7Ω. Line coils (disconnected) 7·3Ω red-blue, field coils 22Ω white-black.

NEXT MONTH: THORN 950/960 CHASSIS

DX-TV

A MONTHLY FEATURE FOR DX ENTHUSIASTS

by Charles Rafarel

WE have to report the continuation of the awful DX conditions both SpE and Trops. Sooner or later, however, we must reach the nadir and happier days DXwise will return.

To give a fair assessment of what results have been like I am going to give a combined log by myself, R. Bunney and M. Opie, all resident in this South of England area, as I feel that this will give fuller coverage. For myself the most significant opening was on Christmas morning when USSR was in for nearly an hour on Channel R1 with test cards. There were two of them, displaced by about a third of the width to the right. There was something a little curious about the right-hand card. It did not appear to have the usual "Tablitza 0249" on its left-hand side but something else which was not decipherable due to the overlap of the two cards. Did anyone else note this?

SpE log for period 14/12/68 to 13/1/69:

14/12/68 Holland E4 (unusual SpE), E. Germany E4, Sweden E4.
16/12/68 E. Germany E4.
17/12/68 E. Germany E4.
19/12/68 Norway E4.
21/12/68 Spain E2, Hungary/Poland R1.
22/12/68 E. Germany E4.
23/12/68 Czechoslovakia R1, Hungary/Poland R1, E. Germany E4.
25/12/68 USSR R1 (two cards as above).
29/12/68 Norway E2, Switzerland E4.
3/1/69 Spain E2.
6/1/69 E. Germany E4.
7/1/69 Sweden E2.
8/1/69 E. Germany E4.
10/1/69. E. Germany E4.

The Tropospherics have been very poor in this area but I see from readers' reports from other areas, notably in the Midlands and the North, that DXers have been having quite a ball with u.h.f. reception from Sweden! Down here the best day was 3/12/68 with a lot of French u.h.f., even a new one Bourges Ch. 26 and still even more of an event these days an unidentified W. German on Ch. 26 on colour bars as well. Elsewhere 13/12/68 was the day!

The USSR forward scatter network continues to be active nearly every day. Two Venus space shots have been launched but I do not think that these were connected with the speech channels.

USA paging stations are reported by D. Kelly of NI, and R. Bunney, so they too are still around.

Norway Gulen Ch. E2 is now up to 30kW and W. Germany Hesselberg Ch. 32 up to 250kW. There is a new W. German, Wesel/Niederheim Ch. 35, 500kW horizontal. E. Germany is now using at least three types of test card: (a) black bar with DDR plus a row of small unreadable letters and DFF on it; (b) black bar with DFF Berlin on it; (c) the same but with a white circle. In addition to our information that there is no nationwide TV service in Greece, E. Evans has kindly given us some news of TV in the Athens area. It seems that there are two TV stations (alas in Band III), the National Broadcasting Institute (experimental commercial) on Ch. E5 0·25kW and Greek Armed Forces TV (irregular) on E10, 100kW.

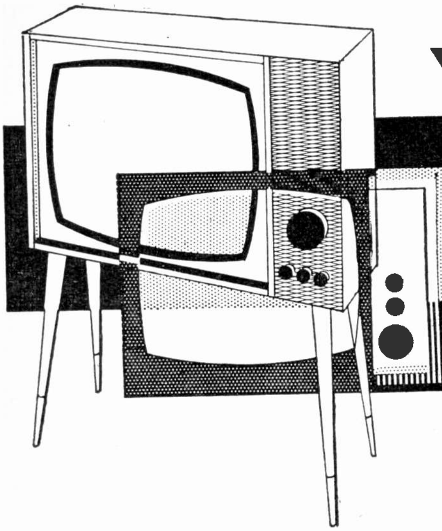
We have news of what I can only describe as a horror system. Details are available in the USA of a relay attachment for TV sets which operates from the video output to activate a cinecamera to record what appears on the screen. The idea is to leave the set running on a certain channel in the absence of the owner so that if and when a SpE burst arrives the results of the opening are recorded for later examination and presumably claimed as a success by the ?DXer! Ingenious, yes, but I ask you is it really DX? Any comments?

A comment here for would-be colour DXers. I hear that DX reception in colour can be very tricky. The maximum signal is essential—a weak one will produce only a black-and-white image—and even a comparatively strong one will give no colour if the aerial is even slightly off the transmitter direction.

The best reports this time cover u.h.f. I. Beckett of Buckingham reports reception on 13/12/68 of Sweden Göteborg Ch. 30 and Uddevalla Ch. 23, and in Band III Denmark Aalborg Ch. E5. On the same date but further north a new DXer Bruce Thomas of Castleford, Yorks had quite a fantastic u.h.f. log with Sweden Uddevalla Ch. 23, Göteborg Ch. 30, Orebro Ch. 48 and Ch. 27 ? location, W. Germany Bremen Ch. 22, Cuxhaven Ch. 24, Bremen Ch. 32, Niebull Ch. 34, Osnabruck Ch. 39 and Hamburg Ch. 40, Holland Lopik Ch. 27 and Wieringermeer Ch. 39, also France Lille Ch. 21. In Band III he had Denmark E5, E7 and E10, Norway E6 and E9, Sweden E7, and in Band I (Trops again apparently) Sweden E3 and E4, Norway E4 and the EBU card on E4, W. Germany.

Another new reporter to us is C. Hayden of Winchester. This past season he had Finland E2, W. Germany E2, Spain E2 and E4, Holland E4, Norway E2, Belgium E2 and France F2, F8 F10 and Ch. 21 Lille and Brest following new aerial arrays with rotator motor.

The above reports are most heartening indeed for u.h.f. DX. In some cases the distances are pushing up to 700 miles. Gone are the days when we thought of the limit as about 200/250!: u.h.f. seems to be better than Band III!



Your Problems Solved

Whilst we are always pleased to assist readers with their technica 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 283 must be attached to all Queries, and a stamped and addressed envelope must be enclosed.

The coupon from page 283

FERGUSON 317T

Accidentally I inserted a PCC84 in the V2 socket instead of the PCF80. The valve sparked inside and since then the picture is very weak and the contrast control seems to make very little difference. There doesn't appear to be any resistor burnt in the tuner.—S. R. Woodcock (London, N.10.).

We assume that you have replaced the affected PCC84. If so then it is likely that the h.t. feed resistor to the PCF80 valve overheated and changed in value. Check all h.t. feeds on this valve; also if necessary the associated ceramic bypass capacitors.

STELLA ST1007U

I am getting sound-on-vision on BBC. The ITV is OK. I cannot adjust the fine tuner any further as it is at the end of its travel.—T. Brimelow (Lancs).

The PCF80 could have an influence upon the tuning drift. However since it is confined to BBC we would suggest you remove the channnel switch knob and retune the oscillator coil as indicated in the manual.

KB KV003

After recent servicing I found that movement of the v.h.f. aerial plug gave rise to picture unsteadiness and upon inspection discovered that a small resistor and a capacitor on the v.h.f. aerial input panel were cracked.

The resistor is between the aerial centre pin and earth and the capacitor is between the centre pin and the core of the feeder to the tuner.

I shall be glad if you can let me know the value of these components so that I may replace them.—M. Trangmar (Kent).

The resistor is for static discharge and is 2MΩ or thereabouts, while the capacitor is a mains isolator and should not have a value exceeding 0·005μF and should have a 1,000V d.c. rating or 250V a.c. rating. Make sure that the proper replacement is used here.

EKCO TC267/1

I have recently been troubled by flashing white dashes which start on the left-hand side of the screen and extend across about two-thirds of the screen. If I run this set with the contrast control advanced and the brilliance reduced the flashing is reduced. If I advance the brilliance control the flashing then takes a more definite form in a continual zig-zag white flashing at about two-thirds of the distance across the screen extending from the top to bottom accompanied by picture distortion in the form of line tearing.

I have changed the U301 and 20P4 and main smoothing capacitors and made visual checks for shorts in the h.t., etc., but have been unable to eliminate this fault.—W. Dale (Hants).

A frequent cause of your trouble is a defective line output transformer in which case the casing holding the e.h.t. rectifier will have been badly burned or buckled. Check also that the line linearity choke has not slipped down its former to touch the chassis.

BUSH TV22

Is a PL36 line output valve a satisfactory substitute for a PL38? I require the valve for this set and have found that PL38 valves are rather difficult to obtain these days and are very expensive.—J. W. Perryman (Warwickshire).

A PL36 will not function in place of a PL38 in a Bush TV22. PL38 valves are offered for sale by advertisers in each issue of PRACTICAL TELEVISION.

DECCA DM4/C

The top half of the picture fills the screen with the bottom half of the picture superimposed on it.—J. Grayson (Sheffield).

The valves to check are on the right of the centre screened section.

On early models check the ECL80 valves, on later check also the PCL82. Check associated components, capacitors, etc., and the field deflection coils.

BUSH TV24C

The trouble is that when I first switch the set on the sound comes on as it should do, but as soon as the e.h.t. strikes and the picture comes on the sound disappears and a low-toned hum occurs. This eventually subsides and the sound comes back to normal after about 20 minutes. This only happens on ITV, not on BBC. After switching on first time the fault that I have described can be rectified by tuning with the tuning knob until I get good quality sound and vision, but after the 20 minutes the picture has patterned and is off tune.

All this has happened over a period of six months in which the time taken for the sound to come back to normal increased.—C. Stanley (Staffordshire).

Check the heating time of the valve heaters, i.e., how long before 300mA is being drawn. If this is much delayed, change the thermistor; VA1005 or CZ1. If the heating time is normal either change the tuner unit or increase the ventilation efficiency.

DECCA DM4C

The picture is rather pale. When I tested the h.t. voltage I found it to be 230V 90mA d.c. on radio but it dropped to 175V 200mA on vision.

I changed the two PY32 rectifiers for one BY100 but the voltage remained about the same. —G. Hathway (Bristol).

The rather low h.t. voltage does seem to indicate something is amiss in the h.t. supply but the current consumption of 200mA cannot be regarded as excessive.

Check the video amplifier circuit, valve EF80 and associated resistors and the 500pF capacitor. Also check the tube emission and voltage supplies.

FERGUSON 306T

The picture ballooned on turning the brilliance control. I changed valves EY86, PL81 and PY81. This cured the trouble until recently. Now the picture contracts from the sides and stretches in height when the brilliance control is advanced. This occurs about an hour after the set is switched on.—A. French (London, W.6.).

We would suggest you replace the 47kΩ resistor in the PCF80 line oscillator stage and the associated 0·001μF capacitor which couples to the PL81 grid circuit from this resistor. Check the PY32 (PY33 is the replacement type).

RGD DEEP 17

Recently the picture went blank. No raster could be discerned. This happened after several weeks of trouble with the top of the picture elongating. I have renewed valves PCF80, PL81, PY81, PY32, PCL82 also one resistor in V11 (EF80) circuit. The result is very poor sound and still a blank screen with no raster.—H. Horner (Hampshire).

First check the h.t. voltage. If this is normal check the operation of the line timebase, whistle, line drive, screen feed to PL81, boost line capacitor, etc. If the timebase is working but there is no e.h.t. at the tube, check the e.h.t. rectifier. Check voltages throughout the set.

KB LFT50

There is a faint picture on the screen but moving the brightness control does not alter anything. I have checked 6U4GT—6CD6G—8D3 and R12 all in the e.h.t. can. At the line output transformer end of the R12 there is a nice long blue spark but at the other end the spark can hardly be noticed.—R. Copley (Yorks).

The tube appears to be at fault with an open-circuit grid. A high pulse voltage applied between the grid and the cathode (tube base off) may weld up the electrode but this must be carefully done and is not always successful.

BUSH TV62

There is no raster. The sound is good but broken by a popping noise. I have changed valves PL81, PY81 and EY86.

The PCF80 seems to be running rather hot. Prior to the above fault when the picture and sound were good the picture and sound would go off together and by switching to and from another channel would come back again.—T. Edwards (Sussex).

Check the main electrolytic capacitors in the front end of the right-side chassis. The PCF80 on the left-side (rear) is the video amplifier. It may overheat due to lack of decoupling in the i.f. stage if the above-mentioned electrolytics do not prove responsible for this fault.

PHILIPS 2168U

The trouble started with the picture breaking into a raster of lines irregular in length, with a black band down each side of the screen. The sound remained very good.

I changed valves PL36, PY81, EY86 and after three days of fiddling with the controls I achieved a picture. The only thing is now that the picture occasionally shows a spike in the centre of the screen with the original fault returning for a few seconds. When this occurs with the aerial removed there is no line whistle apparent. The height control is set at its maximum and there is a gap of ½in. at the bottom and top of the screen.—T. Sullivan (Kent).

Check the resistors associated with the height control circuit to the boost line. Check the focus control and the decoupling capacitor to the h.t. line.

Also check the ECL80 next to the PL36 and look for sparks inside the PL36 and PY81. Replace as necessary. The line output transformer could be at fault.

REGENTONE 192

After about an hour the picture suddenly disappears leaving a raster with a ragged modulation but no evidence of a picture. At the same time the sound increases in intensity. If the contrast is turned down the picture returns to normal and if the set is turned off for a few minutes the picture also returns to normal.—D. Jones (Manchester 20).

Check V4 EF184 and V5 PCL84.

If these are not at fault (proved by replacement), check C37 (pin 8 of V4 to chassis) which is a 0·001μF, and the alignment of IFT2.

PYE CTM17

The raster is adjusted to just fill the screen but on BBC-1 a dark vertical strip appears on the left-hand side of the screen. The width of this varies from programme to programme and is usually between ½ and 1in. By increasing the brightnesss the line scanning can be seen to still start at the edge of the screen.

This is presumably caused by the line oscillator triggering early, and results in the loss of a corresponding strip from the right-hand side of the picture. The flyback sometimes appears as a fold-over at the right-hand edge.

I have a circuit diagram and have tried replacing the relevant valves, but to no avail.—J. W. Attwood (Southampton).

We advise you to check the 0·05μF boost capacitor mounted on the line output transformer behind the PY81. Alternatively your trouble can be due to ghosting caused by a fault in the aerial system.

EKCO T330

I am giving this set to a blind person. Could you tell me if there is a fairly simple way to remove the tube and use the set for sound only.—E. S. Giles (Surrey).

To render the tube inoperative set the voltage selector to 250V and short pins 1 and 12 of the c.r.t. base across to preserve the continuity of the valve heater chain. Remove the U26 e.h.t. rectifier or just remove the e.h.t. connection if the tube is to be taken out completely.

QUERIES COUPON

This coupon is available until MARCH 21, 1969, and must accompany all Queries sent in accordance with the notice on page 281.

PRACTICAL TELEVISION, MARCH 1969

TEST CASE -76

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

? *A Bush TV141 was originally found to have a faulty line output transformer, and signs indicated the possibility of overheating. A replacement transformer was fitted and a good picture was restored with no apparent malfunctioning of the line timebase. The set was returned to the customer, but after a couple of weeks of operation it was returned with exactly the same symptom.*

A further transformer was fitted, but this time the set was allowed to run under observation in the workshop, and it was soon noticed that the line output valve was running very hot—with the anode almost red hot. The set was switched off and the temperature of the line output transformer was checked roughly with a finger. This, too, appeared to be running much warmer than is usual with this model.

What was the possible cause of this trouble, and how could the service technician ensure that the replacement transformer would not fail in exactly the same way again? See next month's PRACTICAL TELEVISION *for the solution and for a further item in the Test Case series.*

SOLUTION TO TEST CASE 75

Page 236 (last month)

The line output stage is very critical of line drive frequency, and although an oscillator running at the wrong frequency will give almost normal negative voltage at the control grid of the line output valve, the anode side of the output valve with its transformer will fail to load properly. Thus while the grid voltage will appear normal the pulse amplitude at the anode of the e.h.t. rectifier (and of course the e.h.t. voltage itself) will be very low—as described in last month's symptom.

Normally the line whistle can be heard on 405 lines, especially when the line hold control is adjusted with the aerial disconnected, thereby allowing the line oscillator to run free (no sync control), and since the whistle was not audible the enthusiast should have referred back to the oscillator after making sure that the output stage components were without obvious defect.

In the Bush TV108 a 250pF compression trimmer is located between the anode of one and the grid of the other of the two line oscillator triodes, and the trouble was eventually located to a fault in this, causing it to go almost completely open-circuit thereby stepping up the drive frequency well out of loading range of the output transformer.

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