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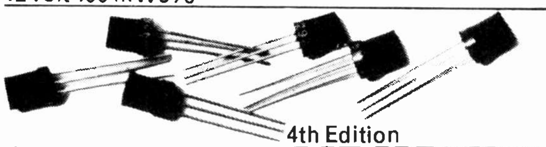

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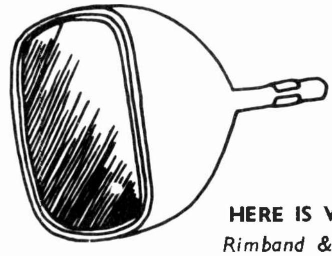

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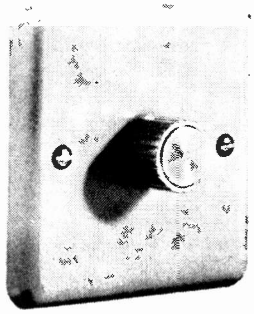

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TELEVISION

VOL 23 No 3
ISSUE 267

SERVICING·CONSTRUCTION·COLOUR·DEVELOPMENTS

JANUARY 1973

TURBULENT TIME AHEAD

By July 1976 the future of the BBC and the IBA must be decided since the BBC's Charter and the IBA's powers then come to an end. Already the opening shots in what will probably be the most turbulent period to date in the history of the politics of broadcasting in the UK are being fired. The point being of course that there could be rich pickings indeed if the two authorities were dismantled or rearranged in some way. Just such a suggestion has now been made by—well, who would you expect but the Incorporated Society of British Advertisers and the Institute of Practitioners in Advertising.

What the Institute and Society are really after is BBC-1. A second "general interest" channel would clearly give greater scope to the hucksters of the market place than that other frequent proposal a second IBA channel. The Institute and Society propose a Broadcasting Council : this would have "ultimate responsibility" over a severely mauled rump BBC operating a public service channel and a couple of commercial channels operated by "contractors" in one case and a "publicly owned company" in the other—it seems that the IBA would completely disappear in the process. What the "ultimate responsibility" of the suggested Broadcasting Council would be is anybody's guess, but it would clearly have far less impact on broadcasting than the present authorities.

We view such proposals with the gravest suspicion. The services provided by the BBC and IBA together are simply not equalled in any other part of the world. There is plenty of scope for the development of alternative services in the years ahead: the BBC's Director of Engineering James Redmond recently spoke of the likelihood of 10-11 channels eventually being available in the UK as a result of technical advances. In the meantime to destroy the BBC and IBA and all they represent in terms of solid achievement and experience for the sake of making a grab for BBC-1 strikes us as being the most irresponsible approach possible to the future of broadcasting in the UK.

Readers will notice the absence this month of a by now very familiar name at the foot of this column: Norman has left us to concentrate on other ventures and we wish him well.

THIS MONTH

THE NEXT ISSUE DATED FEBRUARY WILL BE PUBLISHED JANUARY 15

Cover : Grateful acknowledgements this month to **Servitronix Ltd.** (572 Kingston Road, London SW20) for their co-operation in letting us use their premises to take this month's cover photograph: we need hardly say what you can get there !

TELETOPICS

NEW APPROACH TO 110° COLOUR

So far as the UK is concerned the problems of 110° deflection colour tubes have remained very much in the setmakers' research laboratories. A number of sets imported from the Continent are fitted with 110° shadowmask tubes but no UK setmaker has announced a model using such a tube. The problems associated with such tubes are that appreciably greater scan power is required and that dynamic corner convergence is much more difficult to achieve compared to the present generation of 90° deflection tubes. Reducing the tube neck diameter—the so called narrow-neck tube—from the standard diameter of approximately 36.5mm. to roughly 29mm. reduces the scan power requirements considerably but introduces other problems. Now Toshiba have announced a new tube, type 510DMB22, in which a new approach to these problems has been adopted. The new tube maintains the standard neck diameter but the three electron guns are mounted in-line, i.e. in the same horizontal plane instead of the usual triangular configuration. The other departure is that the tube flare is of rectangular instead of conical shape. This means of course that the deflection yoke is also rectangular. In addition a field controller, which consists of a magnetic pole structure situated between the convergence and deflection centres, is incorporated to provide automatic convergence and purity correction at the corners of the picture. Toshiba say that the new design results in a tube whose deflection power requirements are less than those of any other type of 110° colour tube while the ease and accuracy of convergence and improvement in other characteristics give it advantages over all other types so far developed.

CEEFAX: INSTANT NEWS BY TV

The BBC has devised a system which it calls Ceefax to enable TV receivers to display on the instruction of the viewer information such as weather reports, news, sports results—in fact anything which can be presented in the form of printed words. The proposed Ceefax service, which is to be given international trials this summer, uses transmission methods compatible with the normal transmitted television signal: in fact the information is sent during the field blanking period when the scanning spot is returning from the bottom to the top of the screen to commence the next field scan. A separate unit connected to the receiver will of course be necessary to process the data signals transmitted during these periods. This unit will incorporate an electronic memory to store the information and an alpha-numeric character generator to provide a suitable signal for the receiver circuits. The transmitted information will be stored in the unit as a number of complete "pages"—a total of some 30 of these is envisaged, each of about 100 words. One advantage of the system is that the pages can be continuously up-dated so that the viewer is given an instant news service. The unit will be provided with a selector to enable the viewer to choose any of the stored pages for display on the receiver screen at any time he wishes. The system has been patented and the viewer units, which could be in production within three years, are expected to cost in the region of £50. The BBC is at present investigating different methods of instrumentation for the system.

COLOUR DELIVERIES PASS MONOCHROME

Deliveries of colour sets to the trade are now running well ahead of monochrome deliveries. The latest figures, for August, were 110,000 colour sets and 89,000 monochrome sets. The total number of colour sets delivered this year must by now be well in excess of a million, having reached 982,000 at the end of August. This represents a rise of 109% compared to 1971. Deliveries are still not matching demand, with traders subject to allocations: a BRC representative has suggested that it will be next May before supply catches up with present demand and, just possibly, a buyers market develops (Japanese setmakers are expected to have taken some 15% of the UK colour set market by then).

IBA DEVELOP WORLD'S FIRST DIGITAL FIELD-RATE STANDARDS CONVERTER

IBA engineers recently demonstrated the world's first digital field-rate television picture converter which has been designed for the conversion of US standard NTSC colour signals to the European standard with either PAL or SECAM colour encoding. The equipment was developed in just under a year as part of the IBA's programme of investigation into digital TV techniques and incorporates what is believed to be the world's fastest special-purpose digital computer. The demonstration was certainly impressive, the output pictures often being an improvement on the originals since the equipment effectively suppresses some of the features of the NTSC system which can mar the display. The equipment is compact—is actually smaller than the present analogue converters—requires no line-up or attention and is confidently expected to prove itself completely stable in operation. IBA call it "Dice"—digital intercontinental conversion equipment. The cost is also no more than that of the cheapest of the existing analogue converters—though the main storage devices alone represent more than 15 million transistors.

The equipment's information store stores two complete fields—this is what is meant by a field-rate converter—the output pictures consisting of varying proportions of two successive input fields. It is desirable to go to this degree of complexity in order to maintain accurate translation of movement during the conversion process.

UHF SERVICE EXTENSIONS

Two further main u.h.f. stations are now in operation. All three programmes are being transmitted from **Darvel** (Ayrshire), ITV (Scottish Television) on channel 23, BBC-2 on channel 26 and BBC-1 on channel 33. The fourth channel allocated to this transmitter is ch. 29. Horizontally polarised group A receiving aerials are required. The other main station is **Beacon Hill** (South Devon) which is now transmitting BBC-1 on channel 57 and BBC-2 on channel 63. The other two channels allocated to this transmitter are 53 (fourth) and 60 (ITV). Horizontally polarised group C receiving aerials are required. In addition the following relay transmitters are now in operation:

Aberdare (Glamorgan) BBC-Wales ch. 21 (aerial group A, vertical polarisation).

Perth ITV (Grampian Television) ch. 49 (aerial group B, vertical polarisation).

Kendal (Westmorland) ITV (Granada Television) ch. 61 (aerial group C, vertical polarisation).

NEW COLOUR SET FOCUS ASSEMBLY

A thick-film focus potentiometer unit has been introduced by Coutant Electronics Ltd., Trafford Road, Reading. It incorporates series h.t. and earthing resistors in addition to the potentiometer itself and has a flame-retardent housing. The unit can be used to replace v.d.r. focus assemblies, the thick-film construction providing high-value resistors with good voltage and temperature stability. It is suitable for use with any current Thorn, ITT or Mullard tube.

SET NEWS

Pye have introduced a new 22in. colour set, Model CT205, to replace their previous Model CT202. The new model has a recommended price of £275 and is fitted with the Pye group's 697 chassis and a varicap tuner. The only other set announced by a UK setmaker this month is the **Murphy** Model V2829, a 20in. monochrome receiver with the recommended price of £83.50: the set features an expanded polyurethane cabinet with matt white finish and varicap tuning.

Announcements of new colour models are coming thick and fast from Japanese setmakers. **Sony** have introduced a version of their well known set fitted this time with an 18in. Trinitron tube. **Sanyo** have announced their first colour set for the UK market, the 16in. portable Model CTP370 which has a recommended price of £209.95. **Mitsubishi** intend to launch on the UK market two colour receivers, one fitted with a 14in. tube and having the recommended price of £199, the other with a 20in. tube and recommended price of £268. These sets will feature automatic touch-button tuning and instant warm up. A one year parts-plus-labour guarantee is to be given with a parts only guarantee for the second year: alternatively a five year parts-plus-labour guarantee is to be offered at an extra £8. Trade enquiries can be made to Mitsubishi Electrical Service, Bowbell House, Bread Street, Cheapside, London EC4. **Sharp** have announced two monochrome mains/battery portables, the 10P-16H with 10in. tube and recommended price of £67.25 and the 12P-17H with 12in. tube and recommended price of £71.50.

From Europe come a couple of **Siemens** monochrome receivers, introduced by Interconti Electronics Ltd. (Albany House, Petty France, London SW1). The Alpha 31 is a portable model fitted with 12in. tube and suitable for operation from the mains, a 12V car battery or a rechargeable battery pack: the set is housed in a wrap-round style cabinet and has a recommended price of £92.94. A similar mains-only model, the Alpha 44, is fitted with a 17in. tube and has a recommended price of £101.79. Hadley Sales Services of 112 Gilbert Road, Smethwick, Warley, Worcs. intend to import Spanish sets in the **Iberia** range. The first model will be a 12in. mains/battery portable, Model VP212. No prices have been announced: distribution is intended to be via bulk purchasing groups.

A new range of colour sets is to be introduced early this year by **Finlux.** These are to be fitted with a new thin-neck 110° deflection 26in. RCA colour tube which, say Finlux, has 1.7 million phosphor dots as against the conventional 1.2 million. The tube operates with a toroidal scanning yoke and the sets will feature instant-on picture and sound. A completely solid-state modular chassis is used.

LATEST MAZDA DATA BOOKLET

The 1972-3 edition of the Mazda Pocket Data Booklet has now been published with a cover charge of 21p. The 168 pages include comprehensive equivalents and replacements lists, also full details of the recently introduced Mazda range of u.h.f. aerials. Enquiries should be addressed to Publicity Department, Thorn Radio Valves and Tubes Ltd., Mollison Avenue, Brimsdown, Enfield, Middlesex. Trade discounts are available to those purchasing from Mazda wholesalers.

New listings include a range of monochrome c.r.t.s for portable sets, the CME1220 (12in.), CME1420 (14in.) and CME1520 (15in.), and Mazda's first 17in. and 20in. shadowmask tubes, the A44-271X and A51-110X respectively.

NEW WOLSEY UHF AERIAL

An interesting new u.h.f. TV aerial from Wolsey is called the Colour King and consists of four stacked dipole/reflector arrays. The aerial has been developed particularly for colour reception and for use in areas where ghosting is a problem. The good front-to-back ratio is a result of the large reflector system used. Other advantages claimed are that it is space-saving and easily installed. As the design is wideband a single model covers all channels. Enquiries to: Wolsey Electronics, Cymmer Road, Porth, Rhondda, Glamorgan.

Building a COLOUR SET

PART 1

BARRIE P. SPINK C. Eng.

FOR some two and a half years a large proportion of my time was devoted to building a colour receiver. Had a set design such as that at present being featured in TELEVISION been available the time required would of course have been very much less. Even so many enthusiastic constructors will doubtless wish to try their hands at assembling a set with the aid of the various surplus panels and parts that become available from time to time. The purpose of this article is to describe some of the problems likely to be encountered and the methods I adopted to solve them.

Before going into technical details some basic facts and everyday difficulties are worth pointing out. First total cost. In my case this amounted to some £160 though the c.r.t. represented a substantial proportion of this. Secondly time. To design layouts, make a wooden cabinet, construct boards and completely assemble and test the receiver took me about 1500 hours. Even working from a prepared design and with all components to hand such a project will take many hours over a considerable period of time. Thirdly domestic. The constructor requires a very understanding wife and family. Of necessity many hours will have to be spent in the workshop and this may give rise to the comment "I never see you except at meal times!" At a later stage, during monochrome testing and the converging of the three rasters, the co-operation of the family is needed. A frequent comment will be "When will the colour appear, you promised it three weeks ago and it is still the same!" I have unfortunately no answer to this and furthermore in my case three weeks became three months! In spite of all this I must say that the project presented a tremendous challenge: I'm sure that other constructors will feel the same way.

Test Equipment Required

The constructor will need to use the following servicing equipment during the testing of his set: (1) A good test meter with a resistance of at least 20kΩ/V. (2) An e.h.t. voltmeter capable of reading up to 25kV. Several designs have been featured in TELEVISION, e.g. in the February 1971 issue. (3) A wobbulator covering 30-42MHz. (4) A good-quality oscilloscope with a Y amplifier response to at least 7MHz. (5) Useful though not essential is a cross-hatch generator for convergence. Test card F can be used but this will restrict the time at which convergence can be done and take slightly longer. Also the results may not be quite as good. (6) Also useful but not essential is a video oscillator.

Cabinet

A good cabinet is absolutely essential for three reasons. (1) The appearance of the cabinet determines how acceptable the finished product will be in the home and represents the difference between a high-quality project and a second-rate job. (2) The c.r.t., which in the case of the 25in. type used in my receiver weighs about 39lb, is supported by the cabinet: in view of the cost of the c.r.t. one likes to be sure that it is properly fixed. (3) Since there is an e.h.t. of 25kV on the c.r.t. final anode and about 5kV on the focus electrodes the cabinet should completely enclose the c.r.t. I recommend that thought is given to the design of the cabinet, the layout of the controls, etc. at the beginning, with the electronics built to fit the cabinet. The constructor will also find it easier if the cabinet is made deep enough to completely enclose the tube and electronics and this will also enable a straight back to be used.

Signal Strength

For a colour set it is vital to have a strong *ghost-free* signal. One that is just good enough on black and white will almost certainly not be good enough for colour. To obtain a good clean signal a well engineered aerial system is necessary. A commercial colour receiver will give a reasonable picture on a signal as low as 80μV. However for amateur construction a signal as low as this would cause several problems: (1) A poor signal-to-noise ratio would make it difficult to examine video waveforms on the oscilloscope: the colour burst in particular would be affected. (2) Slight misalignment of the i.f. strip and chrominance channel would make the signal sink into the residual noise.

The constructor is recommended to try to get a minimum signal of 400μV on the worst of the three programmes. In this way any slight misalignments can be tolerated as there is always something in reserve. Personally I have the misfortune to live in an outer fringe area and have had to resort to a J Beam 4MBM26 array plus a mast-head aerial preamplifier. The signal strength measured at the aerial ranges from approximately 80μV on BBC-2 to 200μV on BBC-1.

Basic Receiver Design

At an early stage in building a colour receiver it is necessary to decide on a suitable layout. There are two possible approaches. First to have a chassis for the receiving and colour decoding circuits plus a timebase chassis incorporating the convergence and the power supplies. Secondly to opt for a completely modular design in which each subsection is on a separate board connected to the main frame by means of a plug and socket. The second approach has several advantages with the small disadvan-

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A59-13W	AW59-91	CME1201	CME2306	MW31-74
A59-14W	C17/1A	CME1402	CME2308	A50-120W/R
A59-15W	C17/5A	CME1601	CRM172	MW36/24
A59-14W	C17/7A	CME1602	CRM173	MW36/44
AW36-80	C17/AA	CME1702	CRM212	CRM141
AW43-80	C17/AF	CME1703	CRM211	
AW43-88	C17/FM	CME1705	23SP4	
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23″	9·75	7·25	
19″ Twin Panel	10·25	8·25	25″ £47·50
23″ Twin Panel	15·50	9·75	
16″ Panorama	8·50	—	26″ £49·50
19″ Panorama	9·38	6·95	
20″ Panorama	10·50	7·50	carr. £1·50
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tage of increased cost because of the plugs and sockets. The main advantages are that each subsection is small, hence easier to make and to work on at a later date, and the increased flexibility so that as technology progresses units can easily be updated and manufacturers' surplus units incorporated if so desired.

I adopted modular construction with flexible leads to a multiway plug on each board, the mating socket being fixed to the main frame. Each board was given thin alloy section brackets and fastened to the main frame by four self-tapping screws. Although it is possible to make boards with the plugs either fixed to them or etched into the printed circuit with a slide-in arrangement this is difficult and time consuming.

For safety reasons the set should be completely isolated from the mains supply. This can be achieved either by using a full a.c. design or by feeding the set through a standard isolation transformer. The second approach was the one I decided to use. Incidentally mains transformers should be mounted as far away as possible from the c.r.t. to reduce any chance of the magnetic field from the transformer interfering with the picture.

I decided to bolt the c.r.t. into the cabinet using four $\frac{5}{16}$in. diameter steel bolts. For fixing into the cabinet all colour c.r.t.s are equipped with four steel brackets spot welded to the steel Rimguard. The steel brackets each have a hole through them and the c.r.t. is bolted into the cabinet as shown in Fig. 1.

There are two types of Rimguard fitted to colour c.r.t.s. Rimguard-1 is fitted to the A63-11X series and Rimguard-3 to the A63-200X series. With Rimguard-1 types the steel Rimguard comes right

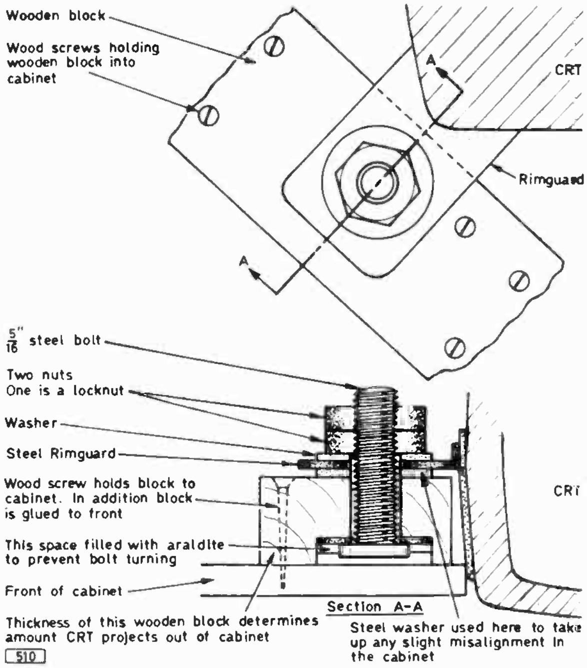


Fig. 1: Details of the method adopted for mounting the c.r.t. in the cabinet.

to the front so that a plastic mask is required to hide it. Also since it can be touched from the front it must be electrically isolated from the magnetic shield and should be connected to chassis through a $0.001\mu F$ capacitor in parallel with a $3.9M\Omega$ resistor. The Rimguard-3 type has the Rimguard set farther back making it almost impossible to touch from the front. This offers the following advantages to the home constructor: no mask is required, giving a cost saving of about £2 on an item extremely difficult to obtain; isolation problems may be reduced. If the Rimguard can be touched from the front however the above remarks apply.

Around the c.r.t. at the rear is a magnetic shield manufactured on a power press from cold-rolled mild steel of 22 s.w.g. (0.5m.m. thickness). This is fixed on the c.r.t. by four springs hooked into the holes provided in the Rimguard (if the Rimguard can be touched from the front however it must be insulated from the magnetic shield). The degaussing coils are fitted on the magnetic shield. My receiver is fitted with a Rimguard-3, push-through presentation A63-200X c.r.t., with a plastic mask and a bought-in magnetic shield fitted with hand-wound degaussing coils. When the set was first built the tube required degaussing using a hand-held degaussing coil. The degaussing coils were not intially connected and if my experience is anything to go by you will find that if you are prepared to hand degauss occasionally you will be unlikely to notice any ill effects on the picture.

Using Surplus Units

There are at present quite a number of surplus colour TV units on the market. There is no fundamental reason why these should not be used but as they are sold without guarantee they may well require repair. As far as the home constructor is concerned they may represent a considerable cost saving over brand new parts but the major disadvantage is that if there is a fault more unknowns have to be checked to find the trouble. A short by no means exhaustive list of surplus colour units follows.

Valve timebase unit: These are of Rank-Bush-Murphy origin and may or may not be faulty. They are well designed, well engineered units and are generally good value for money.

Scan coils: These are generally of Mullard design, type AT1022/05, suitable for 19, 22 or 25in. c.r.t.s. It is unlikely that there will be any major fault. In addition the similar Plessey scan coils are interchangeable with the Mullard version and will also work with most timebase units. More recent versions of these scan coils are optimised for a particular c.r.t. size but this is unlikely to make a noticeable difference to picture quality.

Convergence units: These are also available but it is vital to get one that is mechanically compatible with the scan coils so that they fit together. The Mullard type AT1023/05 will match the scan coils mentioned above. The later scan coil types AT1027/06 for 22 and 25in. tubes and AT1029/06 for 19in. tubes allow the constructor the choice of two methods of static convergence adjustment: (1) by means of a rotating permanet magnet (the AT4046 series which also match scan coils type AT1022/05); and (2) by means of passing d.c. through the field coils (the AT4045 series which match scan coils AT1027/06 and AT1029/06). Use of the latter units will enable the constructor to put all the convergence controls on one panel accessible from the front, making adjustment considerably easier. There are only a limited number of these units available however.

Convergence control panels: It is unlikely that these will be compatible with the design used by the constructor. If a panel is purchased however it will almost certainly contain most of the potentiometers and adjustable inductors necessary and as these items are difficult to obtain it would probably represent a saving in time even if not of total cost.

Shadowmask tube base panel: This item contains the socket to fit the tube base, the spark gaps and the protective resistors. It is almost certain that with minimum modification this can be made suitable for any design.

Tuner and I.F. panel: See below.

Miscellaneous units: Many other surplus units are available. There is no reason why these should not be used but it is vital to obtain the service sheet for the particular unit prior to purchase. Careful study of this will reveal if the unit is compatible with the design. It will also be an aid if the unit requires repair.

Tuner and IF Strip

For a colour set it is particularly desirable to have automatic frequency control (a.f.c.). On a dual-standard model the u.h.f. tuner usually injects into the v.h.f. tuner which then functions as the first i.f. stage feeding into the i.f. strip proper. On single-standard sets the i.f. strip has an extra stage of gain so that the u.h.f. tuner can feed straight into it. If a surplus i.f. unit is used it is important to bear these points in mind. Another possibility is to modify a black and white i.f. strip: this is not to be recommended however since manufacturers for economic reasons frequently trade bandwidth for gain by adjustment of the coupling factor in the design of the coils. In a monochrome receiver the bandwidth can be restricted to a maximum of 3.5-4MHz without seriously affecting picture quality. If such a strip was used for a colour set it could not be realigned and would remove the colour subcarrier. To summarise then, the constructor has two alternatives: to buy a surplus colour i.f. strip or to build his own.

If the second course is adopted it is imperative to follow a published design very carefully, particularly with regard to the value of the tuning capacitors, capacitor tolerances and coil spacing. It is also necessary to make a printed-circuit board (Veroboard is not suitable) to get a good stability factor. Screening of the first stage may also be necessary.

Whichever of the two alternatives the constructor adopts it is almost certain that the unit will require alignment. There is only one way to do this and that is to use a wobbulator: there is no other satisfactory way. The author realises that very few constructors will have access to a wobbulator. I can only suggest that you come to an arrangement with a local television dealer or attend an evening class in Radio and Television Servicing at a local Technical College in the hope that you will be able to use their wobbulator. (We expect to publish a design for the constructor soon—*Editor.*)

Tuner

Almost any u.h.f. tuner can be used but I strongly advise the purchase of one that is new and guaranteed working. Tuner units are difficult to repair and it is just not economic to purchase one of doubtful quality. If you find that the a.g.c. requirements of the chosen tuner are not compatible with the i.f. strip (usually caused by the tuner having a positive h.t. rail and the i.f. strip a negative one or vice versa) the tuner a.g.c. input can be fed from a potentiometer and divider chain across the h.t. rail. Use the potentiometer as a sensitivity control and adjust it for the best signal-to-noise ratio.

Since the receiver is to be used by wife and family a push-button tuner is a lot better than a rotary tuned one. One problem with a mechanical push-button tuner however is that the buttons do not always return to exactly the same place after a channel change. This necessitates slight readjustment of the tuner after channel changing. There is also a tendency for tuners to drift slightly and since the bandwidth of the colour subcarrier is approximately 1MHz it is easily lost. The way to alleviate this problem is to use a.f.c. Varicap tuners (e.g. the Mullard ELC1043) are now readily available and have the advantage that the tuner can be mounted straight on to the i.f. panel, only a d.c. electrical connection to the front panel being necessary for tuning purposes. A.F.C. is relatively easy to apply on this type of tuner.

I used a modified black and white i.f. strip of Pye origin with a push-button tuner of Allied Radio (GEC group) origin. Although several attempts have been made at realignment this has never been satisfactorily achieved and the response has a pronounced dip in the middle. This gives a poor differential phase characteristic, the effect of which on the picture is that the luminance signal is delayed in time with respect to the colour signal. The tuner operates satisfactorily although the buttons have a tendency to stick. I am at present building a proper colour i.f. strip with separate chrominance and luminance sections plus a.f.c.

The best advice on alignment is follow the instructions carefully, use a screened lead from the detectors to the display device and keep the input leads short.

Luminance and C-D Output Stages

One way in which the author's design differs from many is in the use of high-voltage transistors in both the luminance and colour-difference output stages. When the receiver was originally conceived I intended to use valves in these stages but with the introduction and reasonable availability of high-voltage transistors I decided to use transistors from the beginning. To be honest considerable concern was felt about this step into the unknown but since the television has now operated for many months without any trouble in this part of the set my personal feelings are that it was the right thing to do. In the case of the luminance amplifier with its bandwidth requirements of 5.5MHz a printed-circuit board was designed and constructed; in the case of the colour-difference amplifiers with their much reduced bandwidth requirement (approximately 1MHz) a piece of Veroboard was found to be adequate. Both amplifiers are a.c. coupled with d.c. restoration by means of driven clamp circuits. This technique alleviates any problems of d.c. drift.

In both these circuits two things are vital: adequate protection of the output transistors which are relatively expensive from flashovers in the c.r.t. (discussed later) and careful design of heatsink. A suitable design is shown in Fig. 2. It is designed to have a low stray capacitance to earth, to hold the transistor secure mechanically and to fix the whole assembly to the printed-circuit board. To improve heat dissipation the heatsink should be painted with matt black paint except for the area in contact with the transistor—this should be left clean and bright. When fixing the transistor into the heatsink a drop of silicone grease, Midland Silicones D.P. 2163 or other thermal grease should be applied to the mating surfaces to improve the thermal conductivity between the transistor and heatsink.

There will almost certainly be some peaking chokes in the circuit. These are best wound on a standard ⅜in. former, measured on an r.f. bridge and the core adjusted till the correct inductance is achieved. With very low inductance values (e.g. below 100μH) it is essential to use an r.f. bridge: the normal component bridge which works at a few kHz is most unsatisfactory for this job and will not produce a correct reading.

When construction is complete the luminance amplifier can be bench tested if a video oscillator is available. This is done by connecting across the amplifier output a small capacitor of value equal to the stray capacitance of the c.r.t. input and the c.r.t. base board in series with a resistor of value equal to the flashover protection resistor (typical values 1.5kΩ and 17pF). Simulate the brightness control with a potentiometer and connect to a suitable power supply. Before switching on check that there are no short-circuits between the high-voltage and low-voltage supplies. Switch on and check that the d.c. conditions are satisfactory, also that the transistors are not overheating. Connect an oscilloscope to the output through a $\times 10$ probe (this will prevent the circuit under test being unduly loaded by the oscilloscope). Then connect a resistor of 1kΩ across the input and using the 'scope Y amplifier with a.c. coupling look for any self-oscillation and noise. You will almost certainly find some 50 or 100Hz mains hum but provided this is below a few volts the driven clamp circuits will remove it.

If these tests are satisfactory terminate the video oscillator in 70Ω, remove the 1kΩ resistor across the input and feed a 1kHz input signal into the amplifier. A peak-to-peak output of 105V should be obtainable. As a final check plot a graph of the frequency response. This should be flat at about 1.5MHz and 3dB down at about 4.5MHz. Incidentally it will fall off at the bottom end due to the coupling capacitors, but the driven clamps will restore this end of the video spectrum.

CRT Base Panel

It is *essential* that a spark gap is provided for all the c.r.t. electrodes. Although there may be only an occasional flashover in the c.r.t. it is vital to have a spark gap to protect the transistors. The spark gaps can be bought as proprietary items, they can be made of two pieces of 16s.w.g. wire placed end to

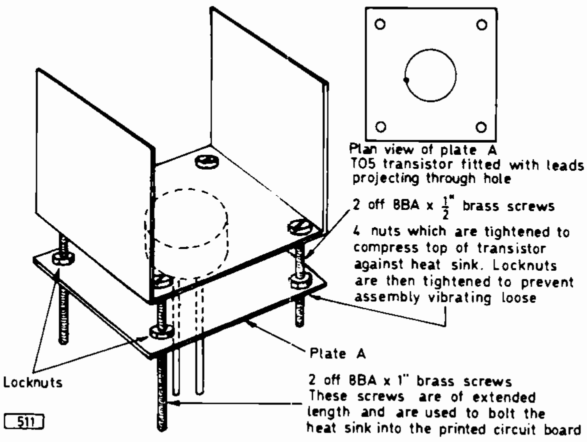


Fig. 2: Suggested low stray-capacitance heatsink for the luminance and colour-dfference output stages. Material 16 s.w.g. aluminium, painted matt black.

end or they can be etched into a printed-circuit base panel. For the constructor the most economical way is to make his own printed-circuit board complete with spark gaps.

The way to do this is as follows. Layout the design of the board on transparent graph paper, working with the component side uppermost. Mark in the locations of all components, with a dot where each hole is required. Colour in on the graph paper the lines of copper necessary to link the components, draw in spark gaps as shown in Fig. 3 and call this side 1.

When all this is complete turn over the graph paper to side 2 and place it on a piece of glass with a light underneath. This will make the paper translucent so that the coloured copper parts can be easily seen. Mark in the holes and colour in the required copper areas on side 2. Obtain the required piece of copper laminate and clean it thoroughly. Place the graph paper against the copper side of the board with side 2 uppermost and centre punch all the holes required. Remove the graph paper and drill the holes with a No. 55 drill. Using a tin of Humbrol model makers paint or one of the proprietary kits advertised and a fine paint brush copy side 2 of your drawing on to the copper side of the board. This may sound difficult but will in general consist of merely joining one hole to another with a painted line. Paint in the spark gaps to the shape shown in Fig. 3 and in the case of the smaller spark gaps paint across where the gap

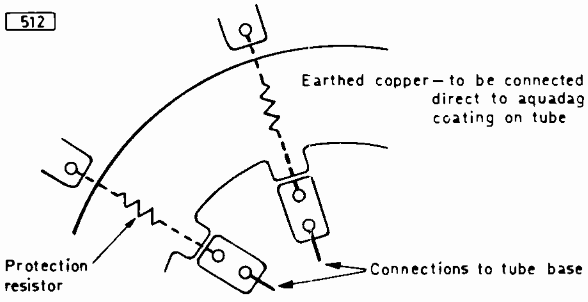


Fig. 3: Making printed-circuit tube base spark gaps.

should be. When the paint is dry dip the board in ferric chloride to etch away all the uncovered copper. After etching thoroughly wash the board in warm water and then remove the paint with a paint thinner. To form the smaller spark gaps the copper should be cut twice with a knife and the copper in between removed with a scriber. The size of the gaps should be: focus electrodes 5mm., other electrodes 0.3-0.5mm.

Associated with each electrode except the heater is a series resistor. This forms an important part of the protection circuit and should be located on the tube base panel as near the spark gap as possible. The earthy side of the spark gaps must be returned to the c.r.t. aquadag coating via a low-impedance path. The way I did this was first to make a harness of copper braid. This was fitted round the tube and held against it by springs. Four leads were taken from it to the earth point on the c.r.t. base panel. The c.r.t. magnetic screen was then fitted on the top of this harness and connected through a further connection to the earth point. One lead was taken from the earth point to the timebase chassis. It is also essential that the chassis does not come into contact with the c.r.t. and its magnetic screen at any point otherwise the flashover protection is nullified.

Timebases

One problem the constructor may have with the line output transformer concerns the tertiary windings which provide pulses for the decoder, for clamping, etc. On a surplus transformer these windings may give the wrong voltage or be connected in the wrong phase. The answer to the phase problem is simple: examine the output on an oscilloscope and simply reverse the connections to the windings if necessary. If the voltage is too high (unlikely) add a potential divider or change the value of existing potential dividers in the decoder. The worst possibility is that the voltage will be too low. There is nothing for it but to increase the number of turns on the winding. Extra turns should be put on to the transformer taking great care that the wiring is adequately insulated from the high-voltage sections —any flashover here would be an absolute disaster. With the aid of the oscilloscope connect the winding so that the voltage adds. Finally it is better to err on the high side rather than the low side.

The timebases generally follow normal black and white practice. Some early designs may however be intended to operate with a shunt stabilised e.h.t. supply. If a shunt stabiliser triode is employed a negative voltage can be derived from its grid circuit and used to limit the c.r.t. beam current to a safe value. If instead a tripler is used to derive the e.h.t. from an 8.4kV winding on the line output transformer the e.h.t. source impedance is much lower and a shunt stabiliser is unnecessary. To obtain a c.r.t. beam current limiting voltage when a tripler is used insert a 10Ω resistor into the cathode circuit of the line output valve. A large increase in c.r.t. beam current causes an increased current through the line output valve and hence an increased voltage across the 10Ω resistor. Decouple with a capacitor of say 100μF.

TO BE CONTINUED

RECONDITIONED TV SETS

A GUIDE TO RELIABLE RENOVATIONS

P. A. GRAVES

MANY readers will have noticed the growing number of shops selling reconditioned, secondhand television sets, often with an effective and long-lasting guarantee, and wondered what constitutes a reconditioned set and how they can obtain long reliable operation from older equipment. Reconditioning as distinct from the repair of particular faults is the process of completely overhauling a receiver and replacing not only parts which have failed but also parts which are most likely to fail, thereby ensuring trouble-free life in the future. Most of the following notes assume that the set is giving some sort of picture and sound output.

When reconditioning a set it is important to obtain a complete circuit diagram before starting work. Individual service sheets may be obtained from advertisers in this magazine: if a lot of work of this type is contemplated then a set of *Radio and Television Servicing* may prove to be a useful investment though the latest set goes back only to 1967 models.

As a start remove the chassis from the cabinet, putting the cabinet and all the screws, odd fixing clips and knobs carefully to one side. Using a soft paint brush and a vacuum cleaner thoroughly clean up the chassis, taking particular care to remove the dust that usually accumulates around the e.h.t. section. This is often a very messy job and is best done out of doors.

Tuner Overhaul

The following notes apply to the v.h.f. tuner: little can be done to a u.h.f. tuner beyond checking for obvious wires off or similar faults and trying replacement valves. There are several basic types of v.h.f. tuner and the following remarks must be interpreted accordingly.

In the case of tuners using a drum mechanism carrying removable wafers on which the coils are mounted (these wafers are generally known as biscuits) first remove the entire drum mechanism. This is usually secured by flexible wire springs which must be prised off. Clean the moving contacts on the biscuits and the fixed contacts in the body of the tuner with metal polish or switch cleaner, finally polishing them with a soft lint-free cloth. The fixed contacts may be retensioned by gently bending them slightly upwards. This must be done very carefully and in fact some engineers do not advise attempting it at all.

The other common type of v.h.f. tuner carries the coils mounted radially on a ceramic or plastic former. The metal cover should be gently prised off and the nut securing the former to the spindle removed allowing the former and the coils to be withdrawn, revealing the fixed contacts for cleaning.

Other types must be dealt with as appropriate.

While the tuner is dismantled make sure that the fine tuner works smoothly and grease all moving parts. Some people advocate that the contacts should be lightly greased: again this is a matter of personal preference. Change the oscillator anode supply resistor(s)—often two will be found in series. This is usually the biggest resistor in the tuner and a typical value is 8.2kΩ. Being tucked away inside the not very well ventilated tuner this resistor can get hot and change value, causing a shift of the tuner characteristics. Make sure that the wattage rating of the replacement is at least that of the original. Increased reliability can be obtained by fitting a higher rated component.

Tuner valves have to work hard to provide r.f. amplification and frequency conversion without contributing noticeably to the noise. A new set of valves in a reconditioned tuner will often work wonders.

An annoying source of intermittency in a tuner can often be traced to a cracked or broken feed-through insulator. Replacement is the only permanent cure and this requires the use of a large soldering iron and a lot of patience. Reconditioned tuners can be purchased but the expense is rarely justified in a secondhand set: if the tuner is beyond repair it may be possible to cannibalise another similar set as many sets use similar tuners.

A useful modification to tuners using removable biscuits is to put the biscuits for the local channels alongside each other, thus avoiding having to swing the tuner right round every time channels are changed.

When reassembling the tuner take care that no leads are trapped under the covers. A completely reconditioned tuner should give a smooth channel change over with no trace of intermittency if the set is tapped smartly.

It is worthwhile peaking the aerial coils for maximum output when the set is connected to its final aerial: this can in particular make a difference in areas of low signal strength.

IF and Detector Circuits

From the electrical point of view the i.f. circuits are very lightly loaded. They work with comparatively strong signal and do not need to provide high power outputs. They are lazy circuits, and lazy circuits are reliable. In fact the i.f. stages are possibly the most reliable part of a television set.

Tap all the valves gently to check for intermittent valves and valve bases. An intermittent valve must be replaced. The contacts of an intermittent valve base can be closed up so as to grip the valve pins by using a fine-pointed tool. Very stubborn cases

BASIC ACTION SUMMARY

Tuner: Clean contacts, grease and retension if desired; grease moving parts; change valves; change oscillator anode supply resistor(s); check for intermittencies; move local channel biscuits together (where applicable); peak aerial coils.

I.F.s and detectors: Check sound trap; clean valve bases; change detector diode.

Video circuit: Change valve if not new; renew bias stabilising resistor if fitted; check resistor values and condition of any electrolytics in the stage.

Power—mains and h.t.: Check electrolytic(s); change selenium rectifier if fitted for silicon diode plus protective components; use bolts to secure any replacement dropper sections necessary, heat-insulating sleeving on dropper section connecting wires and scrape away open-circuit sections on the original dropper; check mains tap setting; remove capacitor across mains.

Field timebase: Replace all capacitors; change output valve; change output valve cathode resistor; change high-value resistors; check that controls are approximately centralized.

Line and e.h.t. circuits: Check e.h.t. rectifier; eliminate arcing; check output and boost valves; change boost capacitor; check output valve screen feed resistor; centralize line hold control; check c.r.t. earthing spring contact.

Sound circuits: Replace output valve if necessary; change output valve cathode resistor and decoupling capacitor; repair or replace noisy volume control.

General: Clean cabinet and surround not forgetting knobs and escutcheons; polish tube face and implosion screen (both sides); clean valve bases; check system switching on dual-standard sets; centralize fine tuner setting and adjust oscillator cores on all channels used; check that there is no shock hazard through exposed metal work; expect a little teething trouble at first!

will require replacement. This is not a job to be undertaken lightly as it is very fiddly: replacement however is the only complete cure.

Sound-on-vision is quite common and is characterised by the picture jumping in time with the sound. This may also be caused by off tuning so the fine tuner setting should be checked first. Another possibility is microphony in one or more valves. If neither of these is the cause the sound rejector coil must be adjusted. Ascertain its position from the circuit and adjust the core with an insulated trimmer until the sound-on-vision effect disappears.

It is not advisable to attempt realigning the i.f. chains without the correct equipment and experience. Setting the correct bandwidths without unwanted peaks or dips is very difficult without a signal generator and a sweep generator. The author has seen alignment set up by eye by a very experienced engineer but it is not a feat he would care to try.

Most sets use a semiconductor video detector diode, usually tucked away inside the aluminium screening can of the final i.f. transformer. An improvement in detector output can be obtained by replacing the existing diode with a modern miniature small-signal one. These have improved front-to-back resistance ratio and smaller inherent capacitance, thus leading to smaller losses.

If the contrast control has little effect check the value of the high-value resistor connected to its slider.

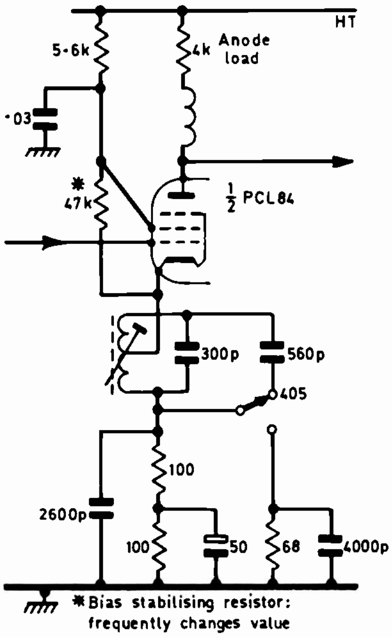
Video Circuits

Unlike the i.f. valves the video pentode has to cope with considerable voltage swings. A replacement can often improve performance, especially when an r.f. pentode such as the EF80 is used. Take a good look to see whether any of the resistors in the stage are discoloured and in need of replacement. In some chassis the anode load resistor is inclined to change value. The cathode components—bias resistor and electrolytic decoupler if fitted—are also suspect. A particular offender is the bias stabilising resistor connected (Fig. 1) between h.t. and the cathode in many video amplifier circuits. If the video biasing is incorrect the sync performance will be poor. An electrolytic decoupler is sometimes used in the screen feed and may require renewal. Check the continuity of peaking coils (the connections are sometimes defective). An old PCL84 should be replaced as this type of valve is prone to internal shorts which often result in associated components getting cooked.

Power Supply Circuits

Most sets are of the a.c./d.c. type using a mains dropper resistor. This is not done to provide for the very, very small minority who are still on d.c. mains but to save the cost and weight of a mains transformer. The chief drawback is that the chassis may be live and while this practice continues there is no doubt that television will claim its quota of deaths each year. It is important to remember that due to their much higher current supplying capabilities the mains and h.t. supplies are more lethal than the much higher voltages generated in the line output stage. Thus every precaution must be taken to avoid shock. An old dodge is to keep one hand firmly in a pocket while working on live chassis. On older sets one pole of the mains switch may have failed at one time and rather than replacing the whole control the faulty pole may have been bridged over. If the mains plug is the wrong way round then the chassis may be live even if the set is not switched on. Always have an insulating cover on the bench—a sheet of sponge rubber will protect the set and prevent it slipping about. Capacitors, both h.t. and e.h.t., hold a charge even when the set is switched off and while such a charge is probably not lethal it can give a nasty and unexpected shock. The resultant involuntary jerk may result in the set being dropped or damaged through a flying tool. Remember that if the tube is hit hard enough it will explode like a grenade and can cause serious damage and injury. When handling tubes it is best to wear a pair of industrial type shatter-proof goggles.

The word explode, applied to tubes, is used deliberately. When a tube is smashed the pressure on the glass of the air outside the tube pushes the glass into the vacuum. The air, being much lighter



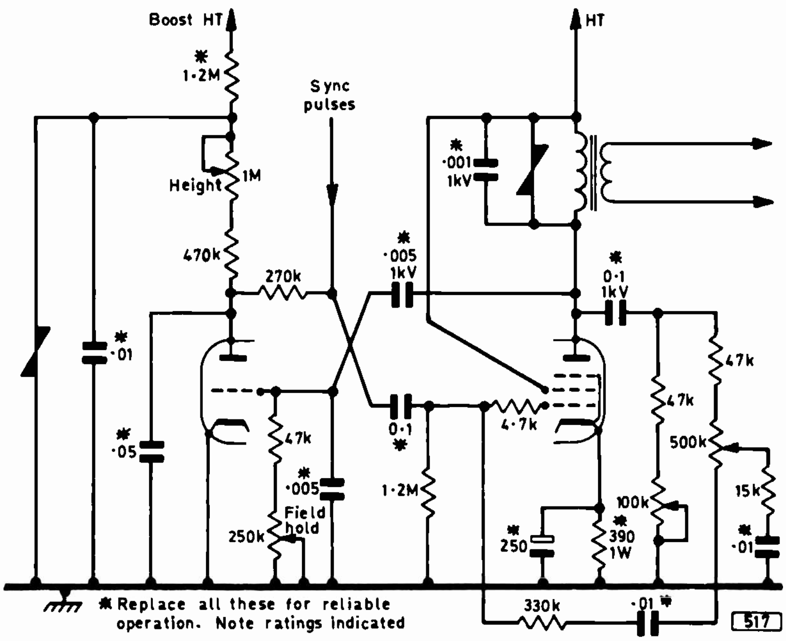


Fig. 1 (left): Many video amplifier circuits, as in this example (BRC 850 chassis), incorporate a bias stabilising resistor which tends to change value.

Fig. 2 (right): Typical field timebase circuit (GEC BT454DST series) using a PCL85/PCL805 valve.

than the glass, rushes into the vacuum much faster. This fast moving air rebounds and the tube explodes throwing the glass outwards with tremendous force.

The mains dropper resistor dissipates a lot of heat and fails fairly frequently due to the stresses and strains set up with the continual heating and cooling cycles as the set is switched on and off. Failure of the mains dropper is the most common cause of a completely dead set. Reference to the circuit diagram will show that the mains dropper is made up of a number of sections which are usually on a common former. Rather than replace the whole dropper when a section goes open-circuit a new section can be wired in. Replacements can be wired directly across the open-circuit section or mounted on the chassis (depending on the type of replacement) and then wired in. The wires should be covered with heat-proof sleeving and the connections made with small nuts and bolts as the heat generated can melt solder. The open-circuit section on the original dropper should be scraped away to avoid any further trouble should the broken wire remake contact.

Some types of replacement dropper sections are in the form of a cylinder with a hole down the middle. Thus in extreme cases of failure a complete new dropper can be made up by threading the appropriate value sections on a piece of brass studding. This makes a very reliable replacement.

Always check that the mains tap setting corresponds to the local mains voltage. The over-run valves which result from a set being operated with the mains selector at a lower voltage than is being supplied to it will give a bright picture for a short time. The valves will then start failing and the only cure is to replace every single one.

Inspect the main electrolytic capacitor. If it shows signs of bulging under the top or leaking electrolyte (white stains round the edges of the rubber seal or round the terminal tags) it should be replaced. Many sets use a selenium h.t. rectifier. This can be replaced by a more efficient and much smaller silicon diode of suitable rating. A 10 or 20Ω resistor must be wired in series with the diode to prevent surges blowing it. A set fitted with a silicon diode should not be switched on and off rapidly as the resulting surges will blow even a diode protected by a limiting resistor. An 0.001μF 1kV working voltage capacitor should be connected across the silicon diode as protection against transient overvoltages.

Most sets have a high working voltage (typically 700V a.c.) capacitor connected across the incoming mains to prevent incoming spikes passing into the set. Its usual action is to dry out and go short-circuit, blowing the fuse. It may safely be cut out.

Timebase Circuits

In reconditioning a set there should be no half measures adopted with the field timebase circuit if trouble is to be avoided in the future. Every single capacitor in the circuit should be changed for a new one. Work from the circuit diagram so that none are missed. Note that the boost feed to the field oscillator is smoothed by a capacitor which is often some distance from the rest of the field timebase circuitry. At the same time change the output valve cathode resistor and any high-value resistors (say over 820kΩ) present in the circuit. Unless the output valve has been obviously recently renewed it too should be replaced. Check that the controls are approximately centralized: that is with a locked and correctly positioned picture of correct linearity (no ellipses when a circle is transmitted) the controls should have movement in both directions to allow for ageing of the components and temperature changes.

Turn up the brilliance control. If the picture gets fainter and expands as if it had been printed on the surface of a balloon being blown up the e.h.t. rectifier is probably failing and should be replaced. If the white areas of the picture take on a silvery appearance and details start to disappear however the tube is probably starting to fail and should be replaced. A regunned tube is a good proposition for a secondhand set and most tube regunners will offer a few shillings refund on the old tube.

All traces or corona arcing must be eliminated by remaking the smooth blobs of solder that are used for connection or if necessary changing the insulated valve holders that are used in some sets. The use of silicone grease to prevent arcing should be regarded as only a temporary measure. Make sure that the c.r.t. earthing spring is making good contact.

The only cure for a faulty line output transformer is to replace it. It is possible to get them rewound but this can be expensive. Tap the line output valve and the boost diode gently with an insulated rod: internal flashing generally means that a replacement will soon be needed.

It is a good idea to replace the boost reservoir capacitor as this is a frequent source of trouble. The line output valve screen feed resistor is also worth replacing in many sets. Take a look at it! Every effort should be made to get the locking range of the line hold control approximately centred to allow for ageing and temperature effects.

Check high-value resistors associated with feedback e.h.t. stabilisation circuits as these tend to change value.

If a harmonic tuning capacitor on the line output transformer shows signs of distress, i.e. bulging, change it. Note that this—also the boost reservoir capacitor—is a high-voltage type. This part of the circuit can be made more reliable by using components with a higher voltage rating than the original, e.g. 1kV working where 600V working components were originally used.

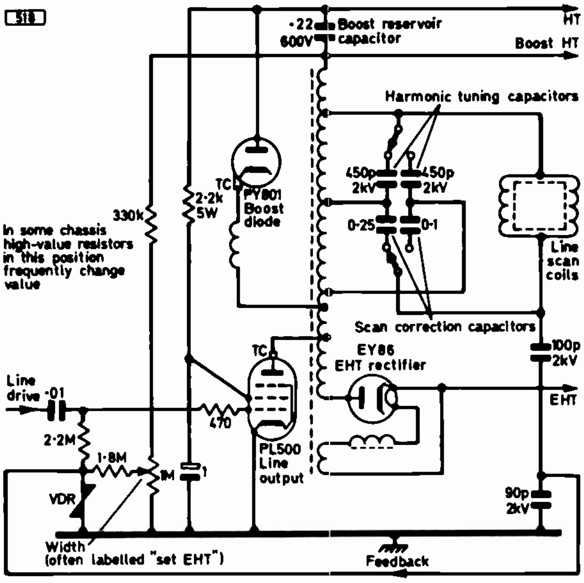


Fig. 3: Typical line output stage circuit (BRC 900 chassis) incorporating e.h.t. stabilisation. In many circuits the boost reservoir capacitor is connected between windings on the transformer.

Sound Circuits

The sound circuits fortunately give little trouble in most sets. It is a good idea to change the output valve cathode resistor and its associated electrolytic decoupling capacitor. These resistors are often run in unventilated conditions below chassis at close to their maximum rating. This can cause value change which upsets the operation of the circuit.

Noisy volume controls should be replaced if a new component is available. If this is not feasible it is often possible to open the control and brush the track with a small paint brush, lightly greasing it with Vaseline petroleum jelly. This dodge can of course be used with most noisy potentiometers.

General

In dual-standard models make sure that the system switch is not likely to cause troubles.

It is important that there is no shock hazard to the user. The fibre backs used on most sets tend to crumble away where the hot air from the mains dropper rises. Cut away the old back in this area and fit a replacement piece cut from another old set by bolting it on. Alternatively use a piece of pegboard. It is also important to maintain ventilation: a set that runs hot will have a shorter life. For this reason sets should be installed away from walls and curtains to allow a free flow of air around them.

A squirt of switch cleaner in each valve base will prevent annoying intermittencies. Watch out for discoloured resistors in any part of the circuit: replace them and any related valves or other components that may be taking excessive currents.

The cabinet should be dusted out. The plastic tube surround, where fitted, may be removed and cleaned with warm water and soap. The implosion screen and the tube should be cleaned with either metal polish or a proprietary window cleaner. Take care to remove every trace of polish: there are few things more annoying than to reassemble a set and find a smear of polish inside the glass. Plastic escutcheons can be cleaned with soap and water. Knobs—particularly the knurled variety—should be scrubbed. Furniture polish can improve the appearance of the outside of the cabinet, with a touch of wood stain for scuffed spots.

When the receiver is reassembled set the fine tuner to its central position and adjust the oscillator cores for optimum results on every channel that will be used. This will avoid constant fiddling with the fine tuner every time the channel is changed.

It is often found that a set after reconditioning with a lot of work and many new components lavished on it fails within the first month or two. This is quite normal and is due to the fact that the higher voltages present because of more efficient working of the power supplies seek out weak points. Just find the faults and be thankful they have shown up early, the set will soon settle down.

Being able to watch a dusty, noisy, flickering television receiver become a gleaming set with crisp pictures and clear sound makes reconditioning a very satisfying occupation. ■

THE 'TELEVISION' COLOUR RECEIVER PART 10
POWER SUPPLIES

Some of the design philosophy behind the power supply unit was mentioned in the first article of the series. Paramount is safety, and a mains transformer for the receiver has been specially commissioned. The main potentials used in the receiver are therefore all isolated and the receiver itself has a proper earth. We would emphasise immediately that although it is of course possible to operate the receiver by dispensing with the transformer and the earth facility we cannot advise this.

A number of varied factors must be taken into account in designing a power supply. First of course are the voltages required by the individual stages of the receiver, and the stability necessary for these different sections. It is also essential that the dropping resistors, rectifiers, etc. are all capable of withstanding the worst circuit conditions. Full circuit protection must in addition be provided.

The mains input is directly applied to the mains transformer primary with a 7A fuse in the line side. Coupled to the primary circuit, and on the fused side, are two feeds: one at 6F goes to the auto-degaussing circuit, the second goes through the valve heater ballast circuitry. Coupled directly across the primary of the mains transformer is the standard mains filter capacitor C501. The voltage rating of this component should be particularly noted.

The heater chain ballast must take account of the current taken by the chain and the voltage drop necessary for operation of the valves used. It has become modern practice to provide a proportion of the voltage drop by using the "wattless" reduction in a diode (D501 here). This avoids the use of a large wattage dropper resistor with its associated heat dissipation problems—and cost!

It has also become the common practice in the last couple of years to dispense with thermistor switch-on protection in a receiver using only a few valves.

The voltage from the diode in the heater chain will be the *average* of the mains voltage. In arithmetical terms this will be $240 \div 2 = 120$V. At 300mA heater current the voltage drop across the three valves, PCF802, PL509 and PY500, will be 9.0, 40 and 42V respectively, a total drop of 91V. Thus a voltage drop of about 150V has to be provided by the ballast circuit and a dropper of about 100Ω is needed in series (R501). 100Ω at 300mA will dissipate 9W so the component is rated at 10W.

As the shadowmask tube is the most expensive component in the colour receiver it is obviously vital to protect it from failure such as might be caused by over-voltage on the heaters. The heaters for the three guns are connected in parallel and are rated individually at 6.3V, 300mA. The power requirement is therefore 6.3V, 900mA.

This is supplied from a 0-24V winding on the mains transformer. The same theory as with the heater chain applies: the diode (D505) provides a wattless voltage reduction, the average voltage being $24 \div 2 = 12$V. At 70°C the resistance of the switch-on protection thermistor (R517 VA1033) is about 1Ω. To get the required voltage drop of 12 − 6.3V (i.e. 5.7V) a 10Ω ballast resistor is fitted, giving allowance for a small variation in the c.r.t. heaters themselves. The rating of R516 must be greater than its 8.1W dissipation—10W is used.

By itself however this is not really sufficient to protect the tube heaters, particularly if a fault such as a short-circuited diode should occur. For this reason a 1A fuse is fitted on the c.r.t. base.

HT Supplies

From the 250-0-250V secondary of the transformer a full-wave rectifier using two BY133 diodes (D502 and D503) provides an average unsmoothed voltage of about 305V. The two diodes are provided with transient protection in the form of C502 and C503 and with a conventional series protection thermistor—the VA1104.

The high-voltage feeds necessary are: to the line timebase at 295V, taking a maximum of about 500mA; to the RGB output module at 230V, taking about 80mA; and to the sync separator at 220V with about 3mA current drain. This is a total possible current requirement of about 583mA.

The common dropper R504 plus R505 (50Ω) provide the 295V h.t. for the line timebase with smoothing provided by R505/C504. The line output stage is separately fused on the timebase board. Because it is a valve stage no excessive supply stability precautions need to be taken.

A 100mA fuse (FS502) protects the feeds to the RGB and sync separator stages, with R506 providing a common dropper resistance—its value is based on the assumption that the RGB module takes an average current of about 60mA rather than the peak 80mA possible. R506/C505 smooth the RGB feed while the spur R507 dropper feeds the sync separator point with additional smoothing from C506.

LT Supplies

An encapsulated full-wave rectifier (D504) supplies from the 0-35V winding the full range of low

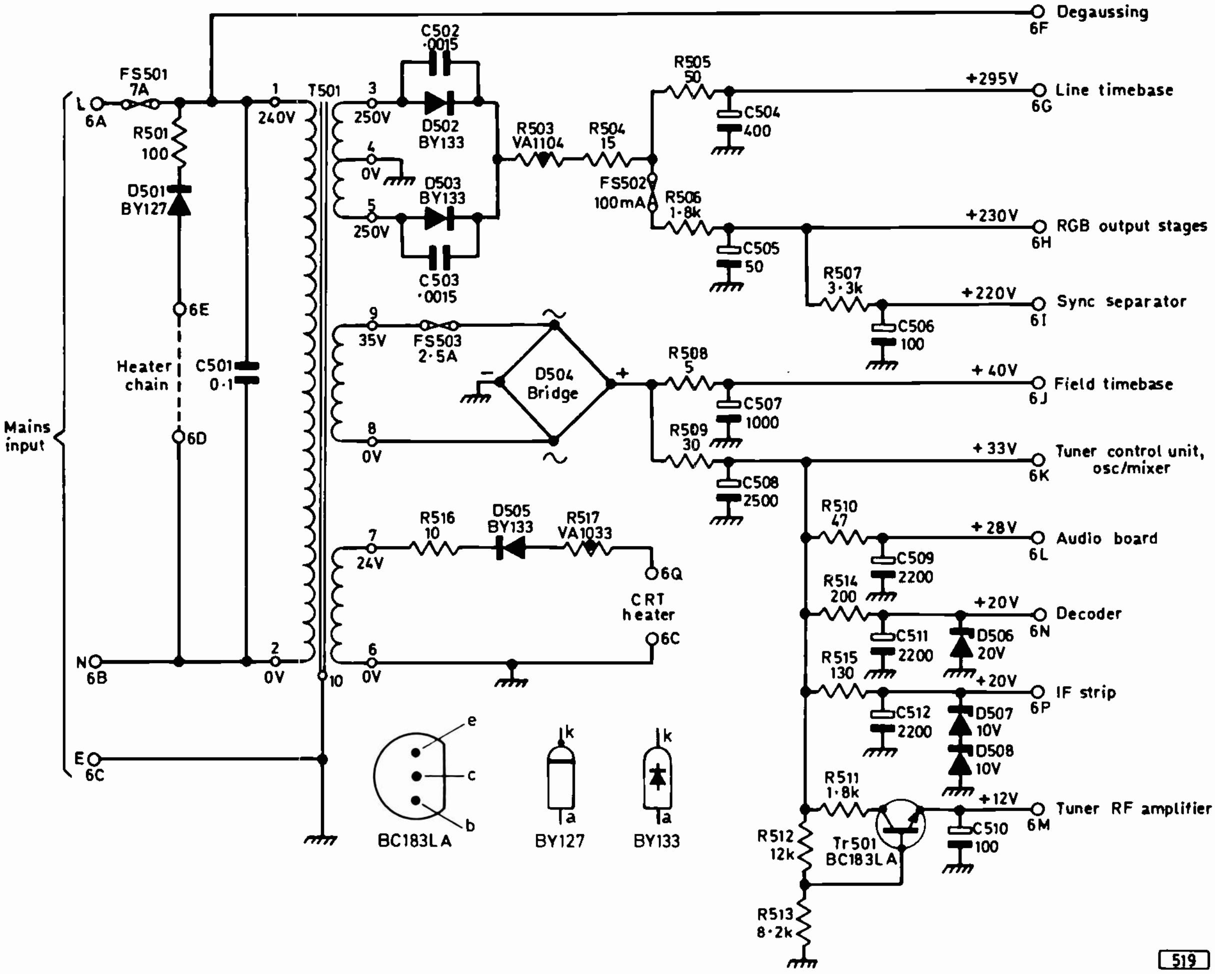


Fig. 1: The power supply circuits. The cathode end of the zeners is marked with a white ring.

voltages for the receiver. The feeds and their voltage/current requirements are:

Field timebase: 40V, approximately 1.25A maximum.

Tuner (control volts and oscillator/mixer): 33V, 0.75mA and 3.6mA.

Audio: 28V, 8mA quiescent, 100mA average peak.

Tuner r.f. amplifier: 12V, 6.5-16mA depending on gain and tuner type.

Decoder: 20V, 60mA approximately.

I.F. strip: 20V, 100mA approximately.

This is a total current requirement of about 1.53A although some transient and high-level signal conditions might raise it to about 1.8A. The secondary winding is fused at 2.5A, the bridge rectifier rating being 2A. A dropper resistance of 5Ω (R508) is required for the 40V field timebase supply, with smoothing provided by C507.

A 30Ω dropper (R509) and smoothing capacitor (C508) provide the 33V supply to the varactor tuner control unit and the tuner oscillator/mixer. Note that a different feed is used for the tuner r.f. amplifier stage which is gain controlled and has a fairly large possible range of current.

A spur from the 33V rail provides the 28V for the audio output stage through a 47Ω dropper (R510). This assumes 100mA being taken. In quiescent conditions the audio rail voltage will rise to a value very close to the 33V rail but this will not harm the audio i.c. At the other end of the range of possibilities is a continuous current drain of more than 120mA—representing a *continuous* audio output of more than 1.5W. The voltage feed to the tuner control unit then falls below the range of the stabilising i.c. (details of this will be given with the tuner board) and the tuning changes. A fault condition in the i.c. or overdriving it therefore gives an instantly noticeable change in receiver tuning.

The decoder and i.f. strip feeds (20V) are both spurred off the same point on the 33V rail. The 60mA current drain of the decoder requires 200Ω ballast and this is smoothed by C511, whilst the 100mA drain of the i.f. strip requires 130Ω and this is smoothed by C512. To reduce the effects of excessive voltage both rails are protected by zener diodes, the ratings giving over-voltage protection to the extent of a further 20V or so. This allows in particular for the possibility of over-voltage during some fault conditions—e.g. if one of the field output power transistors goes open-circuit lifting the voltage rail to about 45V.

Table 1: Components List

Component—Pack 18

R501 100Ω, 10W	R510 47Ω, 1W
R503 VA1104	R511 1.8kΩ, ¼W
R504 15Ω, 6W	R512 12kΩ, ¼W
R505 50Ω, 10W	R513 8.2kΩ, ¼W
R506 1.8kΩ, 15W	R514 200Ω, 2.5W
R507 3.3kΩ, 1W	R515 130Ω, 2W
R508 5Ω, 10W	R516 10Ω, 10W
R509 30Ω, 5W	R517 VA1033
C501 0.1μF, 900V	C508 2500μF, 40V
C502 1.5nF, 1kV	C509 2200μF, 35V
C503 1.5nF, 1kV	C510 100μF, 25V
C504 400μF, 350V	C511 2200μF, 35V
C505 50μF, 350V	C512 2200μF, 35V
C506 100μF, 275V	All above except C501, C502 and C503 are electrolytics.
C507 1000μF, 50V	
D501 BY127	
D502 BY133	D507 10V, 1.3W zener
D503 BY133	D508 10V, 1.3W zener
D504 2A, 100V bridge	Tr501 BC183LA
D505 BY133	FS501 7A "00"
D506 20V, 1.3W zener	FS502 100mA "00"
	FS503 2. 5A "00"

Mains Transformer: Primary 0-240V
Secondaries 250-0-250V
35-0V
24-0V

Printed-circuit mounting fuseholders supplied in earlier packs.

Suppliers

No. 18 Electrokit, 12 Lauderdale Road, London, W9.
Cost: £12.50 including postage.

Printed Circuit Board (⅛in.):

E. J. Papworth & Son Ltd., 80 Merton High Street, London, SW19.
Cost: £2 including postage.

The feed to the varactor tuner r.f. stage must allow for the possible range of quiescent current demand without resulting in excessive voltage. The arrangement uses a BC183LA transistor as a simple series stabiliser. The 13.4V base potential is set up from the 33V rail by the potential divider R512/R513. If the supply voltage to the r.f. amplifier rises above 13.4V—as it will when the stage draws less than 6.5mA—the transistor conducts less thereby limiting the rise.

Constructional Details

It was decided that in order to make the power supply as compact as possible and to minimise the interconnection difficulties between the transformer and the circuit board the board should in fact sit above the transformer itself. The board layout is shown in Fig. 2, where the transformer tag connections indicated on the circuit diagram can also be seen. The system of interconnections between the transformer and the board is by means of 14 or 16 s.w.g. tinned wire. The wire is soldered to the copper side of the circuit board and also to the tags of the transformer. By keeping the leads short a mechanically rigid system will be achieved: we suggest in fact a spacing of about ½in.

The printed circuit drilling is probably the most complicated so far because of the tag connections on the larger electrolytics. Holes should not be drilled to the maximum dimension of the tags because this will make the capacitor mounting mechanically unsure. In the majority of cases it is better to make slits in the board to take the tags. These can usually be formed from $\frac{1}{16}$in. holes drilled in line to the width of the tag, the intervening matter being cleaned out using a needle file.

As far as possible the larger component weights have been centralised over the transformer but in some instances—e.g. C506—the weight falls on the overhang. This makes the actual mounting of the board on the transformer a little tedious. Undoubtedly the best method is to attach the ten lengths of 16 or 14 gauge wire to the transformer tags and then feed them through the board holes. If the wire lengths are made rather longer than is actually required it will be found that the board can be "settled" down towards the transformer and the necessary solder connections made looking up under the circuit board. The excess wire protruding above the board can then be snipped off.

Component Mounting

It is not possible to give a more accurate guide to the board drilling process: the constructor should mark off the hole positions on the etched board using the centre points given as guides. The only component for which these are not given is C506: this is because at the time of publication any one of a number of different components may have to be supplied, the drilling centres of which are all different. The constructor should check the type and the tag spacing on the item supplied.

When mounting the components the following should be particularly noted: the polarity of the electrolytics, the polarity of the diodes, the correct alignment of the bridge rectifier module D504 and the correct location of the BC183LA transistor. The higher dissipation resistors should be mounted about $\frac{3}{16}$in. off the board. When the board has been completed take care to fit the correct fuses in the various fuseholders.

The IF Strip

A number of queries about the stability of the i.f. strip have been raised by readers who have tried to align their own. This was noteworthy in view of the excellent stability of the prototype which although using a hand-made printed-circuit panel was laid out in an almost precisely identical manner. The coils used were hand-made but all the coils made by the suppliers have been tested by us in the prototype on a batch sample basis with no ill effects. We would add that this testing was at the request of the supplier so that he could be sure his standards were being maintained.

Our knowledge of the i.f. strip is rather more intimate than that of the majority of readers because

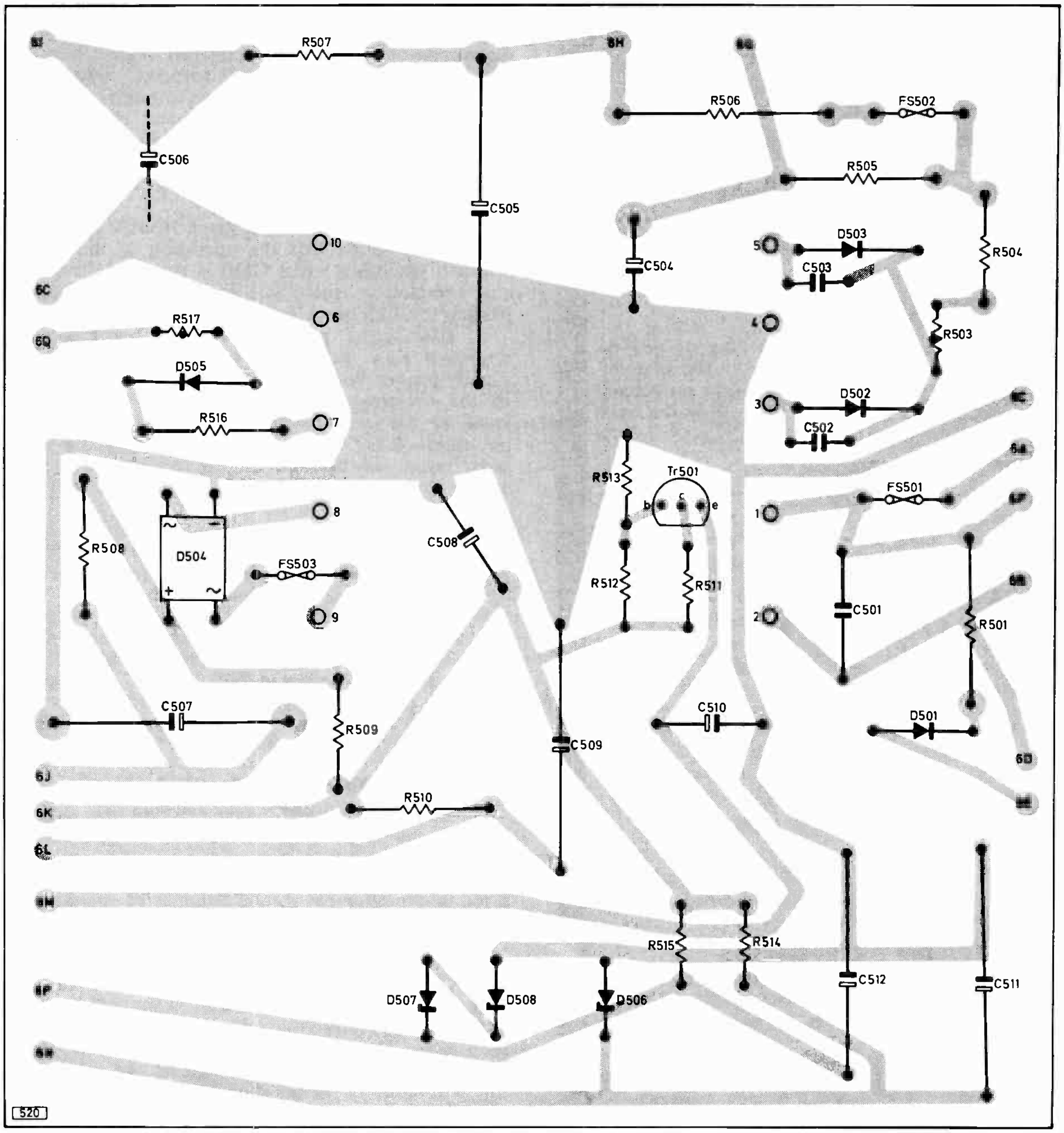


Fig. 2: Layout of the power supply board, viewed from the print side.

we have lived with it rather longer and because now of the "quality-control check" that we have through the Alignment Service. The first batch of i.f. boards received using the commercially made boards, the wound coils and the kit components were grossly unstable when powered. This caused concern and a great deal of time investigating the source of the trouble has been spent by the author and the alignment team—this time has unfortunately affected the author's output and has necessarily delayed the appearance of the tuner panel which was also promised for this month.

It was thought at first—as it has also been by a number of more experienced readers—that the instability was caused by the cascode stage going into self-oscillation, working as it does at high gain, and indeed screening the cascode stage can reduce and in some circumstances eradicate the instability—the latter occurring when the screening earths are correctly connected. Such additional screening would make nonsense however of the intention of the layout to be as uncritical as possible for the home constructor.

Investigation revealed however that the instability was in fact radiation *across* the i.f. strip from the a.f.c. coil tuned to the vision i.f. carrier. It was then found that the level of the signal driving the discriminator circuit was excessively high. Changing the value of R159 from 220Ω to 6.8kΩ reduces the drive sufficiently for the radiation to completely stop whilst the a.f.c. circuit still produces the required output range. This value change will be made to all boards passing through the Alignment Service. Readers not using the Service are advised to change the value themselves.

The a.g.c. circuit has also given trouble again and it has been found that the operation of the circuit is much smoother when C130 is removed from circuit completely. Again this will be done on boards passing through the Alignment Service.

It also seems possible that on many boards improved a.g.c. action can be obtained by using a slightly higher voltage range than on the prototype. In the majority of cases this means reducing the value of the main ballast resistor of the a.g.c. output stage—R130. Values of between 680Ω and 910Ω seem most suitable and an appropriate value will again be inserted on boards passing through the Alignment Service.

One remaining problem on most boards is causing concern. This is a general reduction in design gain particularly when used with earlier types of tuner. Work on this is continuing.

We hope the reader is aware of our concern to sort out these problems. The enormous amount of work that has already been done on the received boards will be continued but there are inevitably going to be some delays in the return of the first batches of i.f. boards. We hope that these delays can be quickly eradicated.

Mounting the Tuner Control Unit

A number of readers have queried the spacing between the vertical ties at the front of the cabinet in view of the dimensions of the push-button selector unit. The fact is that the cabinet was designed prior to the offer by Manor Supplies of the particular push-button unit suggested. If this unit was to be fitted directly between the ties the overall cabinet width would have had to be increased or the width of the ties reduced. Both these solutions were considered undesirable. So the ties were left as they were and to mount the unit a slot must be cut at each side. The small amount of cutting is easily achieved in the completed design of the cabinet. A small amount of wood slicing is also necessary to obtain a large enough aperture for the loudspeaker used in the cabinet. In both cases the small degree of cabinet weakening is more than matched by the mounting bracket used to support the push-button unit and the potentiometer controls. Full details will be given in the relevant article.

Timebase Pack

A few timebase component packs (Component Pack 10) were sent out with a 2W instead of a 6W resistor for R351, the incorrect amount of wire for L301 (15 metres is required) and incorrect heatsinks for the field output transistors. If readers ask Marshalls the correct items will be sent.

Blank boards: Blank $\frac{1}{8}$in. boards for the power supply circuit are available at 87p inc. post and packing from Servitronix Ltd., 26 Killarney Rd., London SW18.

SERVICING television receivers

L. LAWRY-JOHNS

PYE GROUP 368 CHASSIS-cont.

The Line Oscillator

V20 (ECC82) is the line oscillator valve. One section (V20B) acts as a conventional blocking oscillator while the other section (V20A) controls the charging of the capacitor (C109) in the oscillator timing circuit. If the oscillator ceases to operate there will be considerable overheating in the line output stage. This could cause complete failure of the PY800 and of the mains supply fuse. The ECC82 is most often the cause of this trouble.

Other trouble spots are the discriminator diodes (D19 A and B) and the phase splitter (V16B). Unbalanced diodes can cause loss of line hold with the control hard over. If the diodes check out however (i.e. they both have the same back-to-front readings) check the integrator resistor R147 (220kΩ) in the reference signal feed as this can change value. The phase splitter is the awkward one as this uses the triode section of the PCL85 V16 (the pentode section of course is the field output valve). We say awkward because most of us have become used to finding both sections of the PCL85 used in the field timebase and do not normally therefore associate line sync troubles with this valve. Once it is realised however that the field oscillator is an ECC82 (V17) and that the triode section of the PCL85 is in the line circuit everything falls into place and there is no confusion.

Striations down the Left Side

Vertical rulings down the left half of the screen, fading to the centre, can be disturbing. If this is experienced first check the linearity coil damping resistor R159 (1.5kΩ). If this is in order and the rulings are not so obvious check C113 (4μF) which is the PL504 screen decoupler.

The Field Timebase

We have already mentioned that the field output valve is the pentode section of the PCL85 and that the field oscillator is the ECC82 V17. We have also mentioned R109 (1.2MΩ) which usually starts creeping up in value after a couple of years' use. The value is not critical and a 1MΩ resistor can be used, of preferably 1W rating, when replacement becomes necessary due to loss of height.

When there is only a horizontal white line across the screen several points may have to be checked. First try applying a hum test to the PCL85 pentode control grid (pin 9, R104). Whilst a capacitor connected from the heater line is a traditional method remember that in this chassis the heater line is d.c. and furthermore negative. Instead apply the blade of a hand-held screwdriver to pin 9. This will give a little indication of whether the output stage is working (the field should open out a little). If it does check back to the ECC82. If this is in order note that the field hold control is connected across the h.t. line and is not above suspicion therefore.

If however no response is obtained from a tickle on the control grid of the PCL85 check the voltage at pin 8 (cathode). This should be around 17-18V. If this voltage is present the valve is unlikely to be at fault and it can be assumed that h.t. is present at the anode and screen. It then becomes probable that the white line across the screen isn't so straight as you first thought it was. This leaves you with two possibilities. Either one section of the deflection coils is open-circuit or the thermistor R162 is faulty (easily checked by shorting it out). Apart from something daft like a lead off P or Q (or off the output transformer) it then becomes necessary to disconnect either P or Q and check the continuity of the coils. The correct coils must come from C.E.S. Ltd. or be borrowed from a Philips set as the use of coils of any other type will cause severe top compression as well as lack of width.

If the screen is being scanned but there is severe compression at the bottom (with the top also affected but not so much) check C87 which may be open-circuit.

If the field hold control is at the end of its travel the cause is likely to be either the ECC82 or R111 (2.2MΩ). If on the other hand the control is not at the end of its travel but the picture tends to roll up or down with very little lock check the interlace diode D18. This is one of those small rectifiers of the M3 type. It is sometimes only necessary to nip the ends together with a pair of pliers in order to improve the internal contact but as it is a matter of moments to replace the diode this should be done to avoid further trouble. If the diode is not at fault check R120 and C70 in the PFL200 circuit.

Band and Channel Selection

When despatched from the factory the rotary tuner is set so that the two BBC-1 positions can only be tuned to channels 1-5, the two ITA positions to channels 6-13 and the two BBC-2 positions to channels 21-68. The combination can be changed

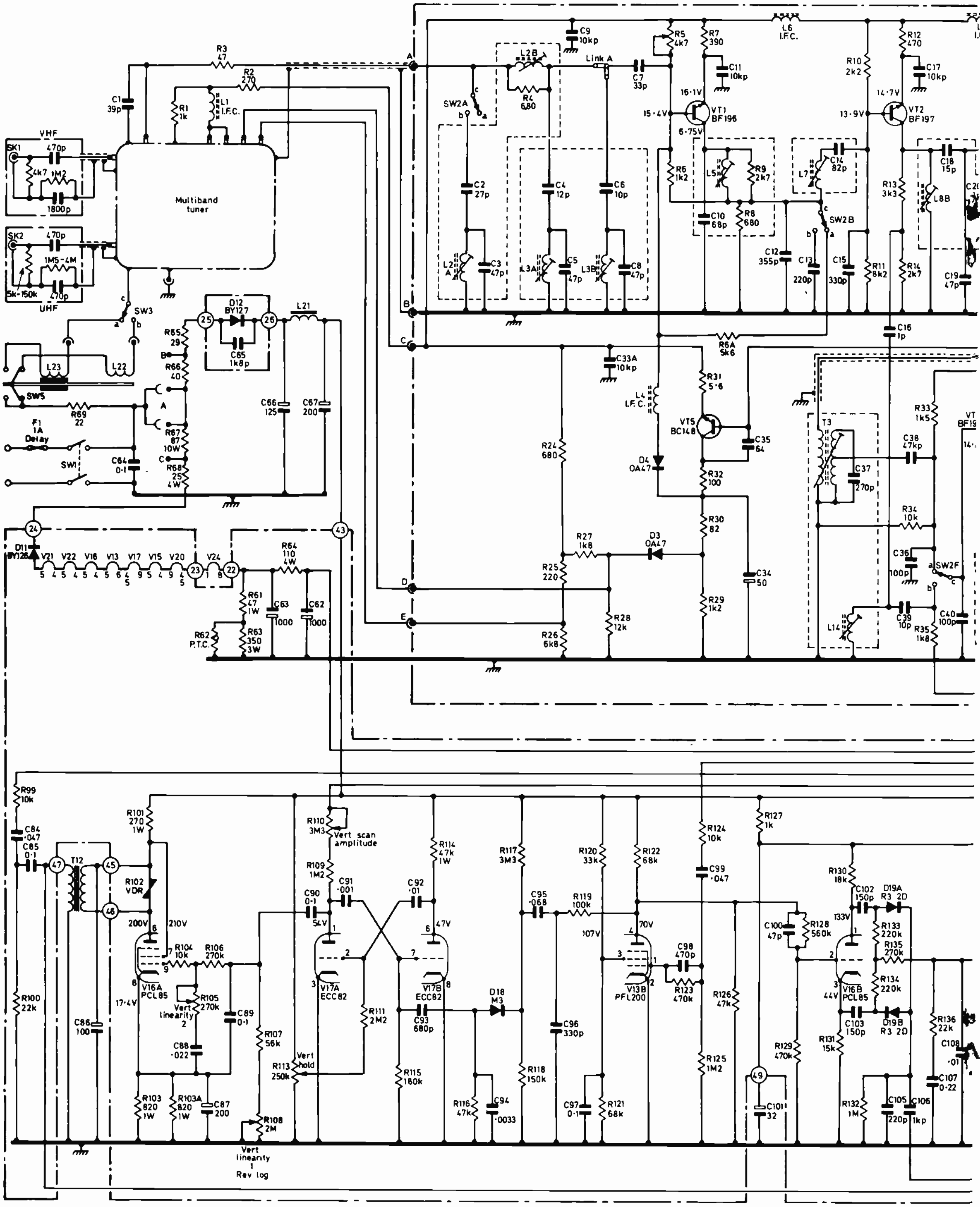
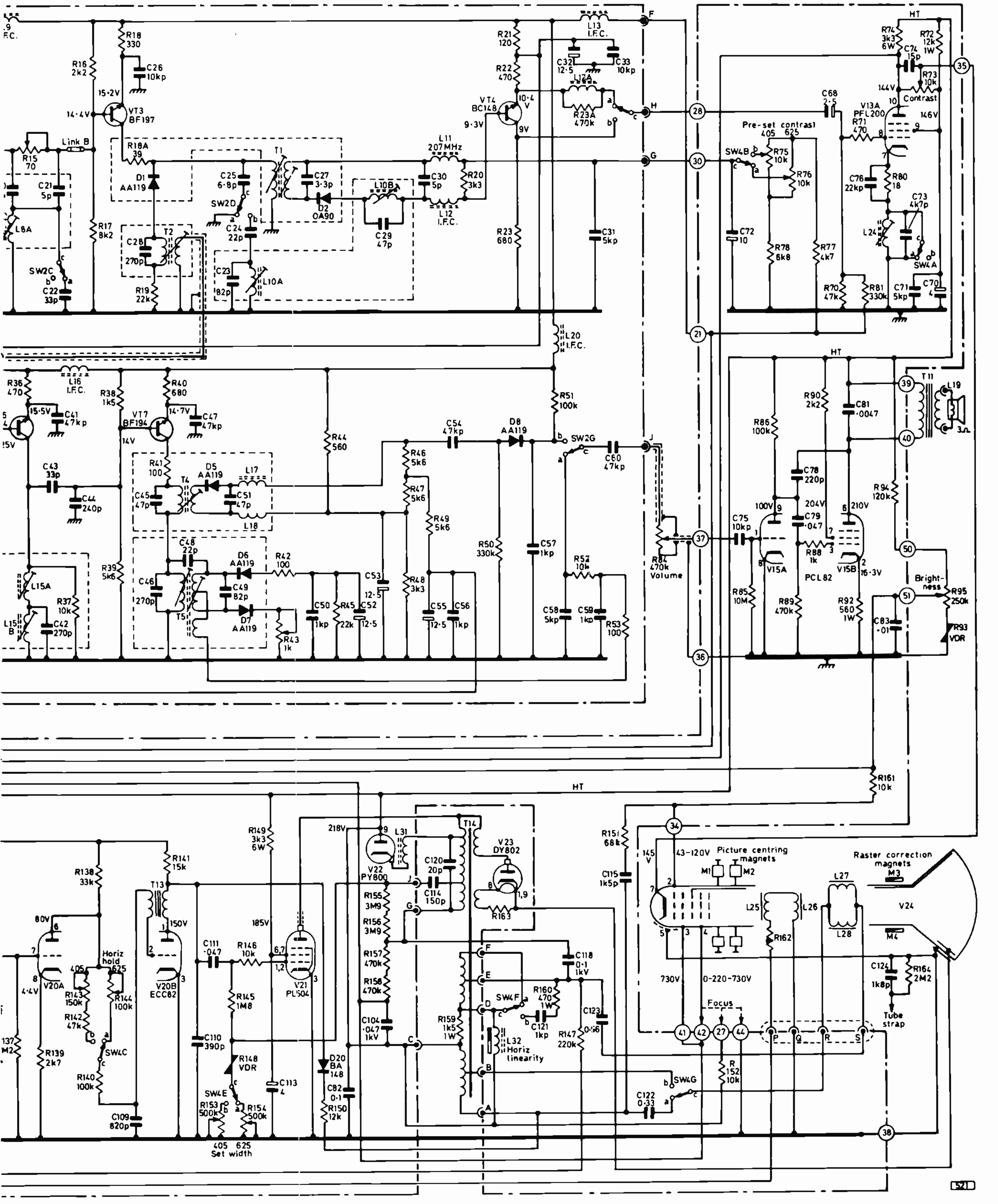


Fig. 4: Circuit diagram of the Pye group 368 hybrid dual-
an AVO Model 8 (20kΩ/V). The readings shown against
controls set for maximum gain and will differ noti



standard chassis. Voltages shown were measured with VT1 and VT4 were measured with the preset contrast ceably with the controls set for minimum gain.

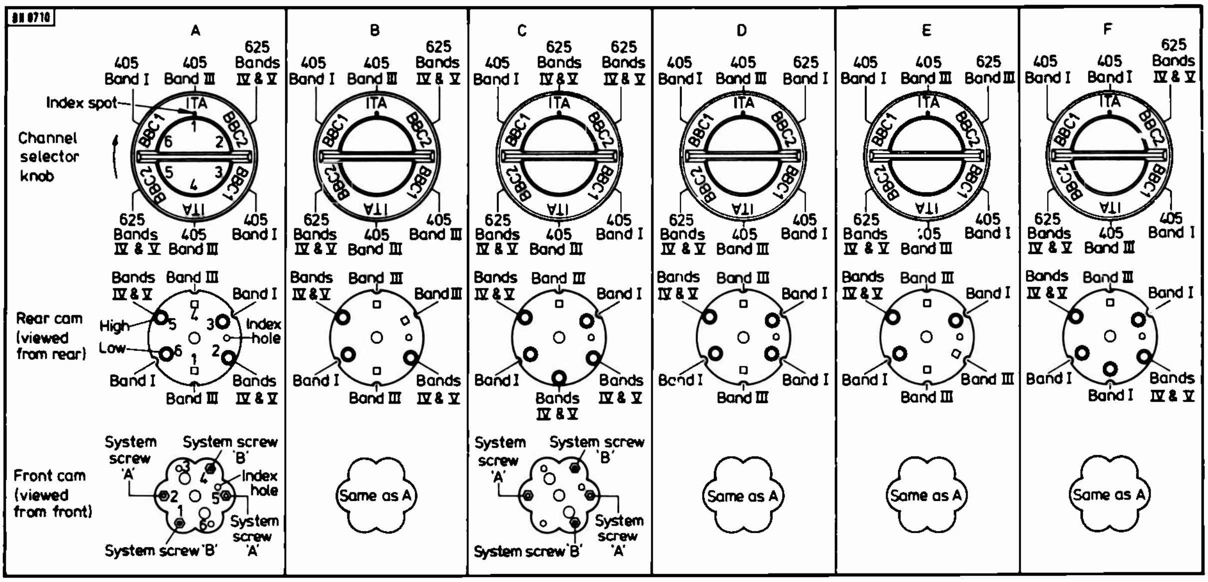


Fig. 5: How to alter the tuner band and channel selection.

quite simply by rotating through 180° or removing one of the cam buttons at the rear of the tuner and/or rearranging the position of the system screws on the tuner front cam. The cam buttons determine the Band coverage and the system screws the line system. A number of variations is shown in Fig. 5: A as despatched from the factory; B with BBC-1 converted to Band III; C with ITA converted to Bands IV/V; D with BBC-2 converted to Band I (625); E with BBC-2 converted to Band III (625); F with ITA converted to Band I. In each case the channel selector knob is viewed with the ITA position such that the small index spot is below the T at top centre and the two cams are in the same relative positions viewed from the rear and front respectively.

The Band range is selected at bottom centre of the rear cam, with the cam button (a) in the low (inner) position for Band I, (b) removed for Band III or (c) in the high (outer) position for Bands IV/V. A parking space is provided on the tuner bracket adjacent to this cam for a button which is out of use.

The line system is operated by screws placed in alternate order behind the front cam (system screw A) or in front of the front cam (system screw B).

To convert A to B: Remove back cover, turn channel selector to ITA (index spot), pull out cam button 3 (from rear cam) and park in square hole adjacent to the fine tuner spindle.

To convert A to C: Remove back cover, turn channel selector so that ITA (index spot) or pointer is at bottom centre then remove knob by depressing the spring-loaded key (accessible from inside the cabinet). With Fig. 5 inverted to correspond with the position of the tuner remove system screw B from position 1 and refit in position 6 through the knob aperture. Replace the channel selector knob and turn ITA (index spot) or pointer to top centre. Insert additional cam button in position 1 (of the rear cam) in the "high" position.

To convert A to D: Remove back cover, turn channel selector to ITA (index spot), pull out cam button 2 (from rear cam), rotate through 180° and replace in "low" position.

To convert A to E: Remove back cover, turn channel selector to ITA (index spot), pull out cam button 2 (from rear cam) and park in square hole adjacent to the fine tuner spindle.

To convert A to F: Remove back cover, turn channel selector to ITA (index spot) and insert additional cam button in position 1 (of the rear cam) in the "low" position.

Modifications

A number of minor component value changes were made during the production of this chassis. The following points are worth noting: In earlier models a 1A fuse is connected in series with R69 which is then 47Ω. A different line blocking oscillator transformer, part number AL22804, is used in some chassis: R140 is then 180kΩ and R142 100kΩ.

VIDEOTAPE: THE US SCENE

The Cartrivision ½in. colour videotape cassette system seems to be rapidly establishing itself as the standard system in the US. This was the first system to be offered to the general public, deliveries starting in mid-June 1972. It is understood that some hundreds of stores throughout the US are now offering blank or prerecorded cartridges to users of Cartrivision players, which provide an output for feeding into the aerial socket of a standard TV set. The system uses inexpensive iron-oxide tape and gives up to 112 minutes playing time per cartridge. Recordings can also be made, off-air or from a separate camera.

The Instavideo domestic videotape system which was to have been offered by Ampex has finally been scrapped. The system was originally announced in 1970 but encountered production difficulties and problems with r.f. radiation: Ampex say the system could not have been profitably introduced in the present state of the market.

COLOUR RECEIVER CIRCUITS

REGULATED POWER SUPPLIES

GORDON J. KING

In the last two articles we looked at basic colour receiver line timebase circuits. The power supply circuitry is determined basically by timebase requirements so it is logical to turn attention next to this section of the colour receiver. Apart from the extra power required for the scanning functions the power supply circuits used in a hybrid chassis are not all that different from the circuits used in monochrome receivers. Valve line output stages employ the well known e.h.t. stabilisation technique with rectified flyback pulses used to obtain a feedback potential which sets the operating point of the output valve, keeping the power supplied in line with the changing requirements of the beams. When a transistor is used as the line output device it is operated as an on/off switch however so this technique cannot be used: the power source to the line output stage must be stabilised instead.

The mains transformer, commonly an autotransformer, has a winding for the picture tube heaters and tappings to supply the various rectifiers and stabilising/regulator circuits. The e.h.t. voltage is nowadays generally obtained from a voltage tripler energised by suitable amplitude pulses from an overwinding on the line output transformer. At least one recent design (BRC 8000 series) however has reverted to the conventional half-wave e.h.t. rectifier (solid state) with third-harmonic tuning to improve the ratio between the peak transistor collector voltage and the e.h.t. pulse.

The power supply stabilisation systems used in the first all-transistor receivers were fairly complicated. The trend now is in favour of thyristor regulation which is neat and less complicated. The first all-transistor colour chassis (BRC 2000) used several separate transistor regulator circuits for the various stages, including zener diode sources and in the line timebase supply regulator circuit a trip overload protection circuit to remove the supply in the event of a fault which increased the load current.

The line timebase regulator and trip circuit are shown in Fig. 1. VT7 is the series regulator transistor which receives a 73V input from a bridge rectifier in the main power supply and delivers a regulated 53V output. The output depends on the conductivity of VT7 and this is controlled by its base current which is established by the settings of the width controls and the action of the control transistor VT6. As either R17 or R20 is adjusted the bias at VT6 base alters. This in turn varies the voltage at VT7 base so that VT7 passes more or less current—depending on the direction of preset adjustment—altering the voltage fed to the line timebase and the picture width. Diodes W1 and W2 ensure that only the appropriate preset introduced by the standards switching affects the bias—they are rather like automatic switches and are biased on by the 68V supply. Feedback from the output to VT6 base-emitter junction adjusts the bias on this transistor in accordance with the load requirements, thereby keeping the voltage constant irrespective of load current.

Transistors VT8 and VT9 comprise the trip circuit. They are normally non-conducting. Should

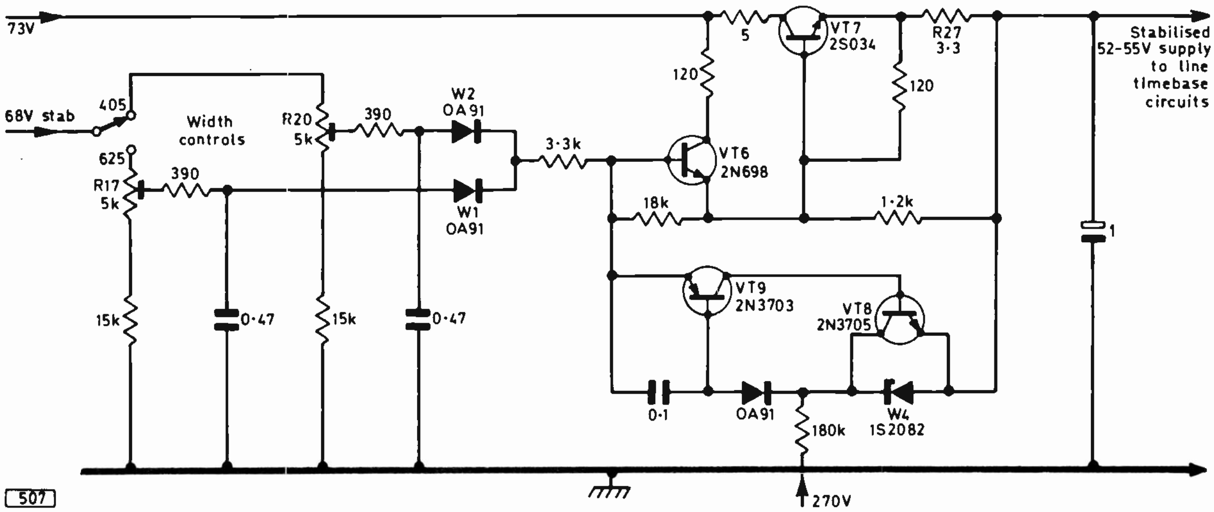


Fig. 1: Transistor series-regulated line timebase supply circuit used in the BRC 2000 chassis.

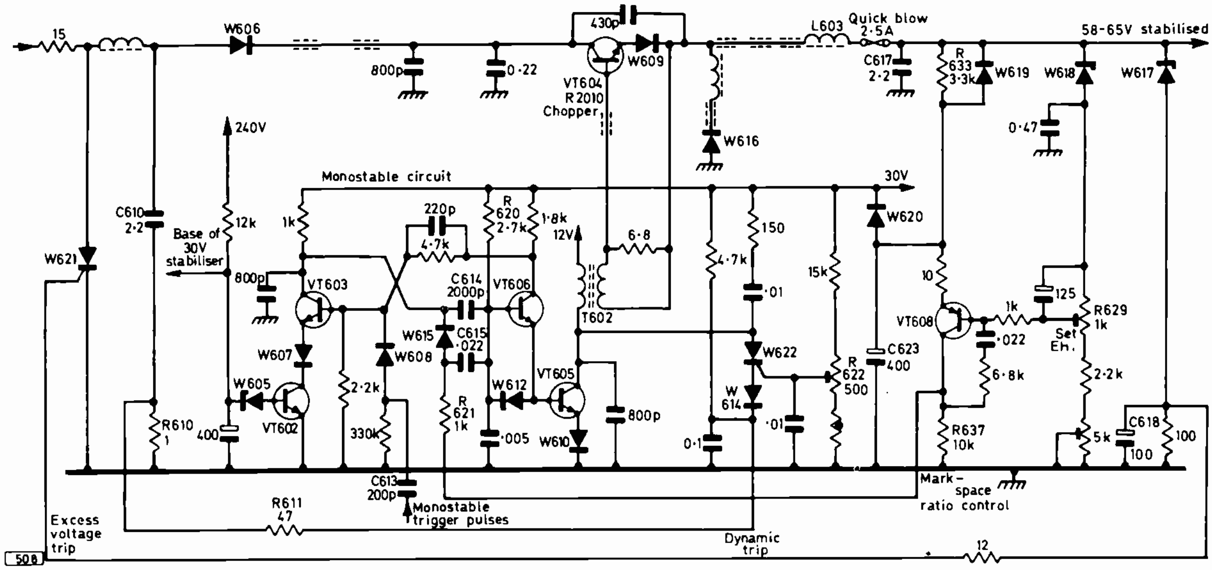


Fig. 2: The chopper-regulated power supply circuit used in the BRC 3000 chassis. The chopper is driven by the monostable which is under the control of the mark-space ratio control circuit.

VT7 pass an abnormally high current however the resulting rise in the voltage across R27 appears across the input of the trip circuit. The effect is that VT9 emitter becomes positive with respect to its base and at a point determined by the reference potential provided by zener diode W4 it will conduct —the zener establishes the trip threshold. When VT9 switches on VT8 also conducts, bypassing the zener diode. Once VT9 and VT8 switch on they remain conducting and short-circuit the base drive to VT6. This effectively cuts both VT6 and VT7 off. The circuit locks in this condition and even with the overload condition removed the set must be switched off and left for some 30 seconds before switching on again to restore normal operation. In the tripped condition the output falls from 53V to about 28V so that damage is avoided in the presence of the circuit fault.

Chopper Regulation

BRC have used a number of regulated power supply techniques in their colour chassis. The 2000 chassis was followed by the 3000 single-standard chassis in which a chopper regulator is employed. Since this is a very widely used chassis we will take a detailed look at the system.

The circuit of the complete chopper system is shown in Fig. 2. VT604 is the chopper "regulator" transistor to the collector of which is applied 200V d.c. from a BY127 rectifier fed from the mains transformer. The output is delivered by the emitter in the usual regulator transistor manner but the control action differs significantly from that of ordinary regulator circuits. VT603 and VT606 comprise a monostable multivibrator, i.e. a multivibrator with one stable and one unstable state so that once triggered from the stable to the unstable condition it then returns automatically after a time set by the time-constant of the cross-coupling components to the stable condition in which it remains until the next trigger pulse arrives. The trigger pulses are obtained from the line timebase and are fed to VT603 base via C613 and W608. VT602 in series with W603 emitter acts as a delay switch, but for the moment let us assume that this is conducting.

Monostable Circuit Action

In the stable condition VT603 is cut off while VT605 and VT606 are conducting. When a positive-going pulse arrives at VT603 base this transistor is driven hard on, its collector voltage falling virtually to chassis potential. C614 and C615, which were previously charged, are quickly discharged and the falling potential at VT606 base switches it off. The resulting negative-going pulse at VT605 base (from VT606 emitter) turns this transistor off also. This is the unstable circuit condition. Just how long VT606 and VT605 remain switched off depends on the time-constant of C614, C615 and R620, i.e. basically on the time taken for C614 and C615 to charge and switch VT606 on again. Clearly by arranging for the capacitor charging time to be adjustable the on/off time ratio (mark-space ratio) of the monostable squarewave output is also made adjustable. This is done by returning one side of C615 to the mark-space ratio control transistor VT608. We will look at this in a moment: for the present let us see how the monostable output is used to regulate the effective conductivity of VT604.

Driving the Chopper

The signal at VT605 collector is developed across the primary of T602, the output across the secondary winding being connected across the base-emitter junction of VT604. The circuit is connected so that when the monostable circuit is in its stable condition VT604 is switched off. Thus VT604 is switched on only during the unstable monostable circuit condition which follows the arrival of a trigger pulse at VT603 base, and the longer the duration of the unstable condition of the monostable circuit the longer the time during each cycle that VT604 remains conducting and the greater the amount of energy conveyed from the 200V source to the load circuits. From this it follows that VT604 output is of a pulsed nature. When VT604 conducts current flows into the inductive reservoir L603. When VT604 cuts off the voltage across L603 reverses switching W616 on. Current continues to flow in L603 and the h.t. circuit, the action of L603/W616 being similar to that of the efficiency diode and line output transformer. C617 removes residual line signal, ensuring that the output, which is determined by the conduction period of VT604, is well smoothed.

The circuit in effect takes up a state of equilibrium, energy taken from the inductive reservoir matching the energy available. Since this depends of course on the load requirement more energy is needed when the load current increases and this is provided by increasing the duration of the conduction time of the chopper transistor VT604. Conversely when the load demand falls the duration of VT604's conduction time decreases.

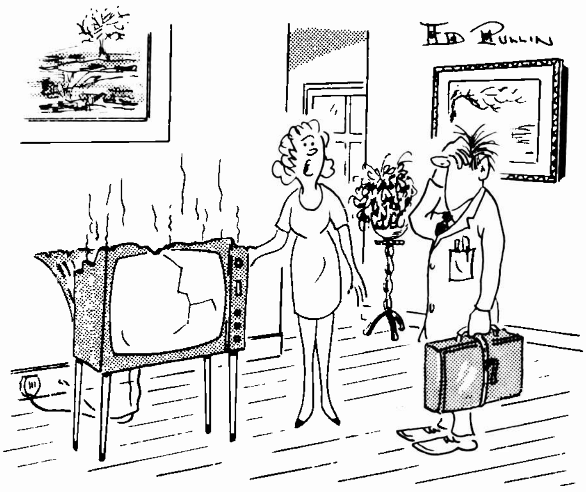
Mark-space Ratio Control

The conduction period of VT604 is set by the mark-space ratio of the output from the monostable circuit and this in turn is determined by the charging of C615. Thus to provide regulation what is wanted is a circuit which monitors the output and automatically adjusts the charging time of C615. This is where VT608 comes in. The output voltage is applied to the base of VT608 via the zener diode W618 and the set e.h.t. potentiometer R629. Thus the conduction of VT608 and the voltage developed across its collector load resistor R637 vary with variations in the output voltage. Now R637 forms part of the time-constant network with C615. In this way the output is monitored and the monostable mark-space ratio varied as necessary.

When the receiver is first switched on VT608 is off and C623 commences to charge through R633. As C623 charges, VT608 gradually turns on. Initially therefore the potential at VT608 collector is small, as also is the charge on C615. The idea is to keep the monostable mark-space ratio at the minimum on switch on so as not to overwork the chopper transistor VT604. As C623 charges so the conduction of VT608 increases and the monostable output mark-space ratio widens. At a certain point W620 conducts and clamps VT608 emitter to the 30V line. The conduction of VT608 is thereafter determined by the setting of R629 and VT604 output voltage. Since the output from VT604 supplies the line timebase which in turn supplies an e.h.t. tripler R629 establishes the e.h.t. voltage. The other preset (5kΩ) is a factory adjustment which sets the upper limit of the e.h.t. voltage. By rapidly discharging C623 on switch off (W619) brief current surges should the supply fail and return quickly or should the receiver be switched off and then on again immediately afterwards are avoided. Thus when the supply is restored there is a gradual build up of chopper output.

Delay Switch

VT602 acts as a delay switch. It conducts, bringing the monostable circuit into action, only after the 30V supply has been established. VT602 base



"The sound's gone too!"

is driven via zener diode W605 which provides the 30V reference.

Circuit Protection

Overload protection for the chopper transistor is provided by the dynamic trip circuit. The chopper switching current is bypassed by C610 and R610, resulting in an a.c. voltage of about 2V across R610. This voltage is applied via R611 and W614 to the cathode of the thyristor W622. If the chopper current is excessive the negative tip of the voltage across R610 will rise above the gate voltage (set by R622) and W622 will fire, shorting VT605 collector to chassis via W614, R611 and R610 and thus removing the drive to the chopper transistor VT604. When VT605 next conducts its collector voltage falls to chassis potential and W622 cuts off. If however the chopper current is still excessive W622 fires once again. This process repeats so long as the overload is present.

There is also an excess voltage trip which comes into operation if the output voltage rises above 72V (or 68V in some models). This can occur if the chopper transistor short-circuits or the control circuit develops a fault. The action of this trip is based on zener diode W617 which fires thyristor W621, short-circuiting the input to VT604, when the output rises above the zener voltage. If W621 fires the mains fuse blows or the overload cut-out (resettable in some models) operates. Short-term flashovers are bypassed by C618.

Thyristor Regulated Supply

The stabilised 180V supply circuit used in the BRC 8000 chassis is shown in Fig. 3. This provides a nominal output of 180V from an input of 240V, with an output current range of 0-600mA from an input current of 1.7A. The source resistance is no higher than 10Ω over the full current range and the stabilisation results in less than 3V change over the range of 200-270V input. The circuit also requires a stabilised 25V input of 1.5mA.

The operation is based on the use of a thyristor (W703) between the input and output. The thyristor

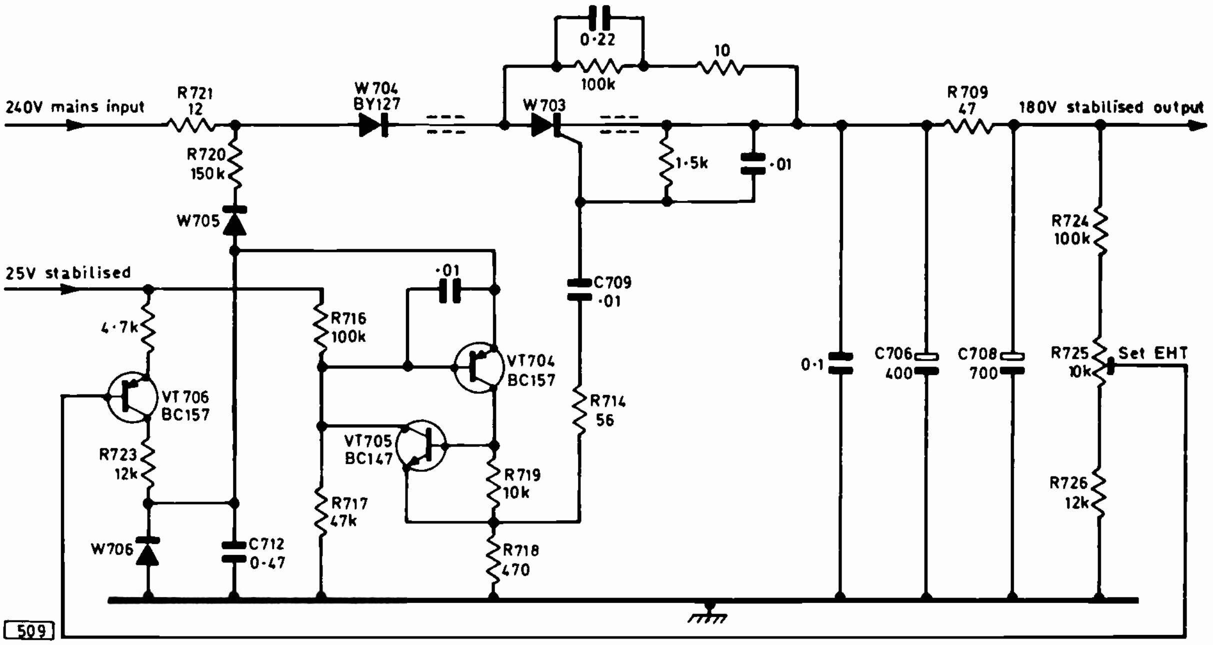


Fig. 3: Thyristor regulated power supply circuit used in the BRC 8000 chassis.

acts as a triggered switch which is triggered on, by applying a positive pulse to its gate, during the positive half cycles of the mains supply for a period determined by the load requirements. Thus the timing of the trigger pulse controls the output. The principle is that the energy removed by the load is balanced by the energy restored to the reservoir capacitor C706 during the periods of thyristor conduction.

It is easiest to start by considering the circuit at the time when the mains input is undergoing a negative half-cycle and the output voltage is at a nominal value. VT706 base voltage is then at a value—determined by the setting of R725 in the divider chain R724/R725/R726—proportional to the output voltage. Since VT706 emitter is connected to the 25V reference source its conduction varies with changes in the output voltage. On the negative half-cycle of the mains input W705 conducts. VT706 collector current and any charge in C712 is returned via R720 to the mains circuit therefore. W706 cathode goes negative so that it conducts and limits C712 voltage to just below zero.

When the mains supply swings positive W705 cuts off and VT706 collector current starts to charge C712, producing a ramp waveform which appears at VT704 emitter. Since VT706 base senses the output voltage, the *rate of rise* of this ramp is governed by the value of the output voltage.

VT704 base is set to about 10V by the potential divider R716/R717 and since this is a pnp device its base-emitter junction is reverse-biased. When the ramp voltage at its emitter exceeds 10V however VT704 begins to conduct. Its collector current, flowing via R719/R718 to chassis, then forward biases VT705 base-emitter junction so that this transistor also conducts. Because of the interconnection of VT704/VT705 the effect is regenerative, the transistor pair quickly turning hard on. This means that once the ramp voltage reaches the level established by R716/R717 the conduction of the transistor pair swiftly discharges C712 through R718. The result is a sharp pulse across R718. This is applied via C709 and the limiting resistor R714 to the thyristor gate, switching this device on.

The reservoir capacitor C706 then charges via the thyristor from the mains supply through the limiting resistor R721 and diode W704. When the mains voltage falls—during the latter part of the positive swing—and meets the rising voltage across the reservoir the thyristor switches off. The ripple on the output voltage is removed by filter R709/C708.

As the mains voltage swings negative again C712 discharges through W705 and R720, VT704 base-emitter junction becoming reverse-biased once more. The circuit is then ready for the next positive mains half-cycle.

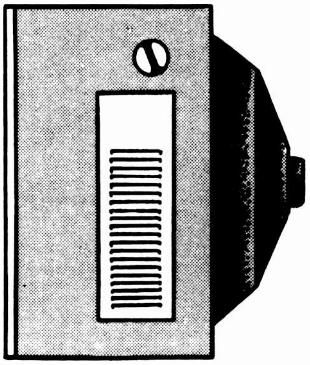
We have seen then that the thyristor firing period is a function of the rate of rise of the ramp voltage across C712 and that this in turn is a function of the output voltage. Thus if the output falls due to an increase in load current the thyristor switches on earlier during the positive mains half-cycles to cater for the heavier load demand. The converse occurs of course when the output voltage rises due to reduced load current.

R723 limits C712 charging current and thus sets the earliest thyristor firing period to just prior to the peak mains voltage thereby ensuring a relatively slow build up of the output voltage after switching on and providing a current limiting characteristic beyond the full load condition. The thyristor is protected on the negative swings of the mains voltage by W704.

Thyristor power supply circuits are now widely used in solid-state colour receiver chassis.

Next month we shall look at e.h.t. supply circuits and their controls.

Renovating the RENTALS



CALEB BRADLEY BSc

⑩ BUSH/MURPHY CTV25/CV2510 contd.

Power Supply

The power supply circuit is shown in Fig. 13. Failure of the neon on the decoder board to glow means no 280V rail and 8F2 will probably be found blown: the offender is likely to be one of the BY127 (BY100 also used) rectifiers. Quite often one of the 7Ω surge limiters 8R3/4 goes open-circuit and the extra current then blows the other one. They are on a common ceramic tube but separate wirewound resistors can be used for replacement. Interesting fireworks result if one is open-circuit and the other is intermittent as 8C5 charges with a violent spark. Extreme hum modulation effects on the picture have been due to parting of the earth (common) connection to 8C1/5—this component is not earthed by its metal clamp. Failure of the l.t. supply bridge 8D3/4/6/7 is not too common but failure of 8D5, giving uncontrollable brightness, is. Plug Z1 can be extremely difficult to remove, due to the locking catches on either side, and rough handling may lead to contact arcing troubles later.

Timebase

The Mk. II timebase can be distinguished from the earlier Mk. I by the use of wire mesh on the top cover and the white line output transformer. The Mk. III uses a solid-state e.h.t. multiplier and has a glass tube around the shunt stabiliser valve. The circuit of the Mk. II is shown in Fig. 14.

The line oscillator is the familiar flywheel-sychronised sinewave type found in many sets these days. To set the line frequency for 625 short the junction 3C3/3D1 to chassis and tune 3L1 until the picture almost locks. The line speed with this type of circuit is so constant that no other line hold control is provided. Naughty components here are

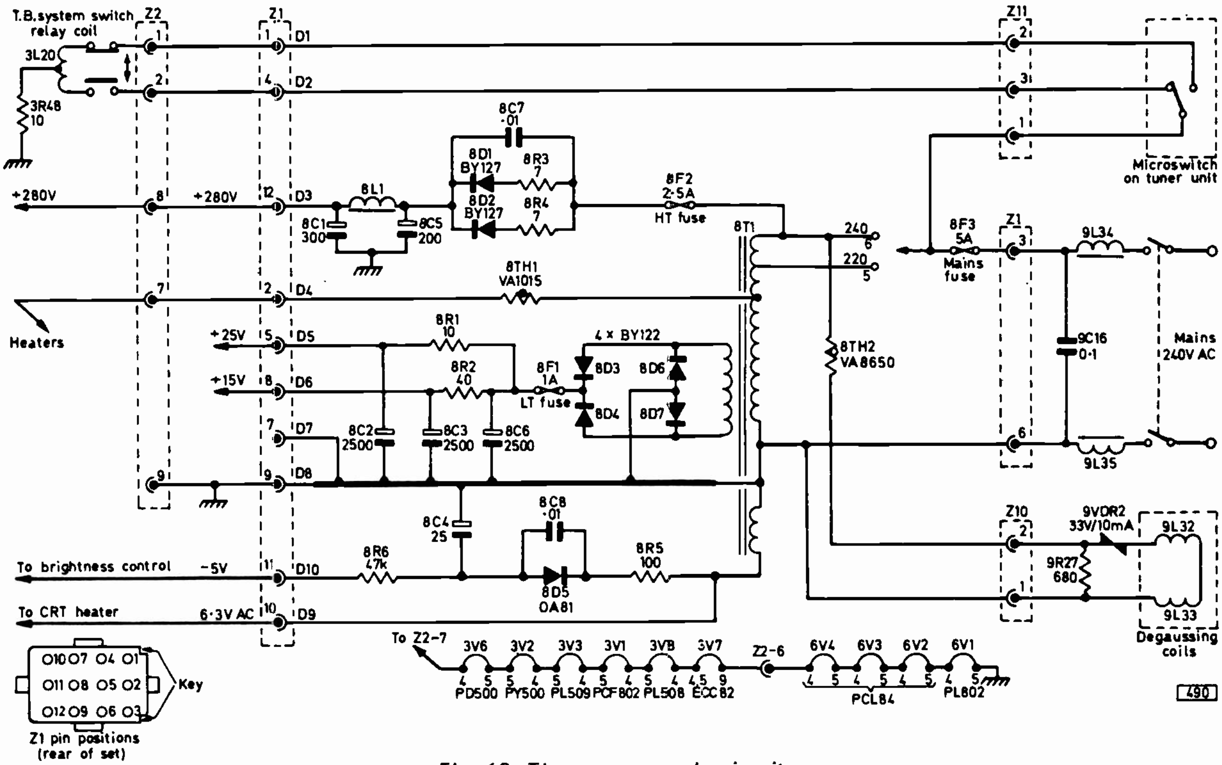


Fig. 13: The power supply circuitry.

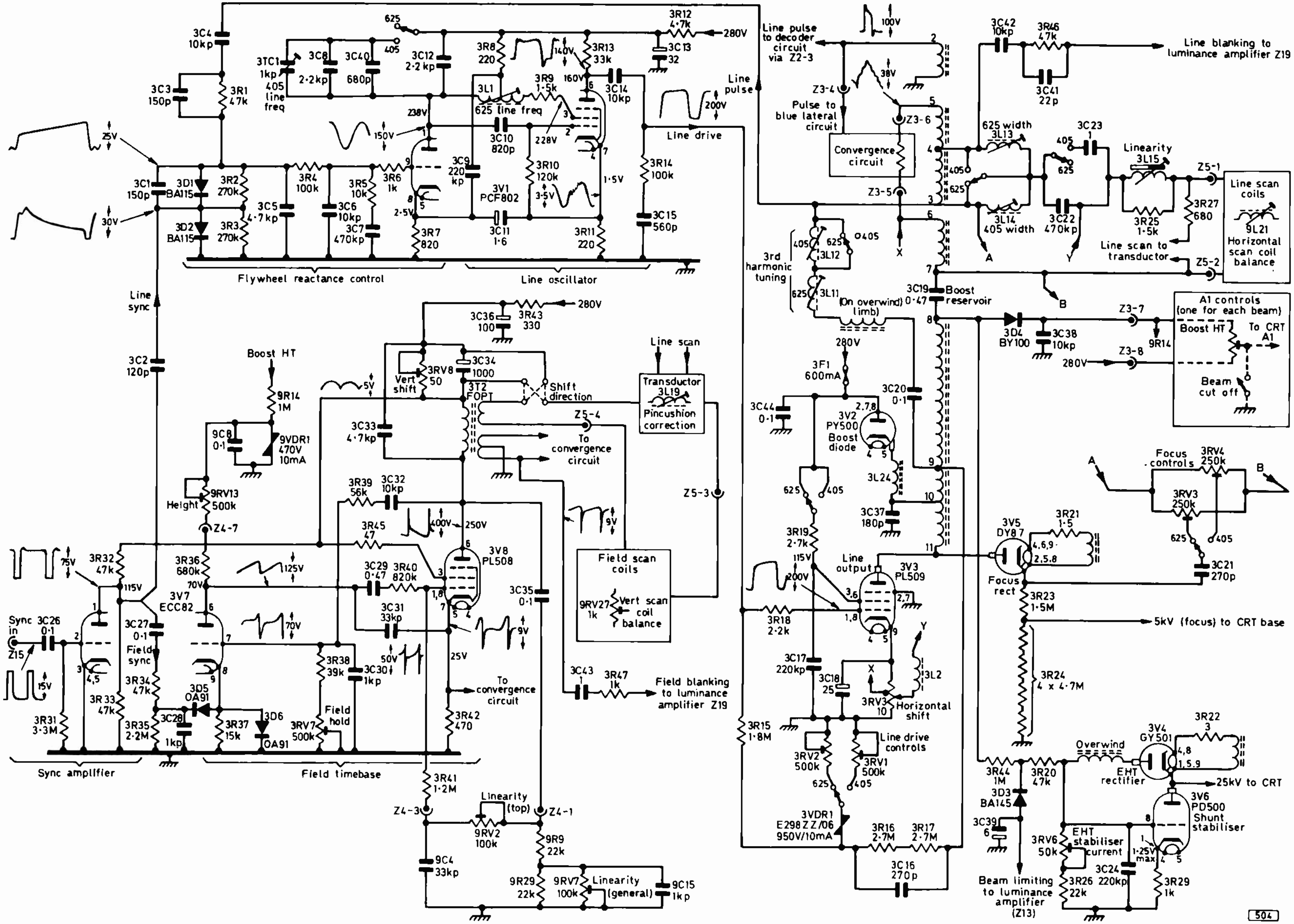


Fig. 14: The field and line timebase circuits.

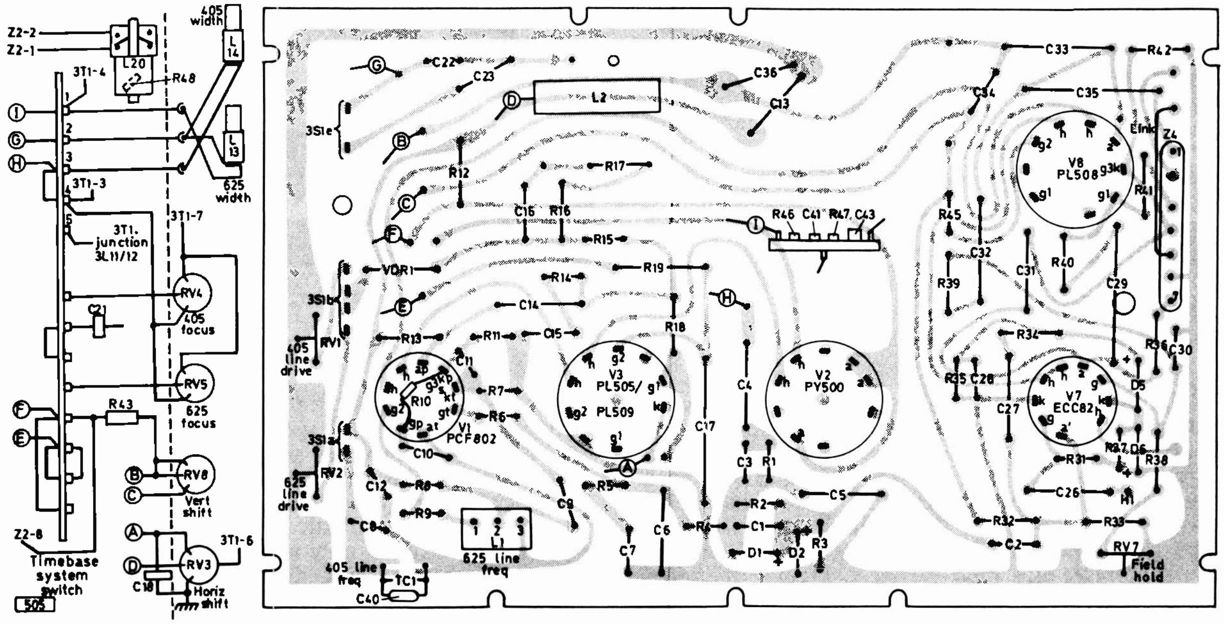


Fig. 15: Timebase board layout, copper side. Connections to the system switch are indicated by the circled letters. All components have the prefix 3.

the line pulse integrator resistor 3R1 (use a 50kΩ wirewound replacement) and 3C11. This is especially naughty since it gives a variety of mysterious line faults including foldovers in the middle of the picture and striations on the left-hand side of the screen. A 2μF electrolytic is a suitable replacement: for reliability mount it on the cool underside of the board.

The basic line output stage is not very different from monochrome circuits since on this one the full d.c. taken by the line output valve flows through the transformer and there are not quite so many feeds to other parts of the set as is sometimes the case. Note how a variable positive or negative voltage is obtained from the decoupled cathode resistor of the line output valve and fed through the line scan coils to give horizontal shift control.

Overheating of the PY500 boost diode is usually due to a short-circuit capacitor—3C19, 3C37, 3C20 or 3C38 in descending order of likelihood. It does not seem a good idea to clamp the boost reservoir capacitor 3C19 too tightly in place.

The voltage-dependent resistor 3VDR1 provides the usual line amplitude stabilisation by rectifying line pulses (from line output transformer tag 9) to give negative grid bias to 3V3. It is vital not to set the line amplitude by 3RV2 any higher than necessary or the life of the line output transformer will be short, especially on the Mk. I version. Start with 3RV2 anticlockwise and advance it only just enough to give adequate width and e.h.t. (i.e. good focus obtainable by 3RV5).

Beam cut off switches on the convergence board (visible on the September cover) allow the screen to be blacked out so that the PD500 e.h.t. stabiliser current can be set to 1.25mA maximum, i.e. 1.25V at 3V6 cathode. *Never run the set with 3V4/3V6 exposed since they both generate harmful quantities of X-rays.* The multiplier used on the Mk. III is fairly reliable apart from brushing (corona) troubles at its connections: if it fails the Remo brand replacement is not too expensive. The faulty rectifier stick can be identified (look for a small burnt spot; the resistance is too high for usual meter testing) and individually replaced but life usually seems too short.

Troubles in the field timebase are fairly mundane. In particular 3R43 gets burnt up if the case of 3C34 touches metalwork, and the tracks on the height and linearity controls burn out with obvious results in use. 3C33 has been known to short-circuit causing of course field collapse.

Important Notes

The address of the official spares and service department is: Rank Bush Murphy, Service Dept., Drayton Road, Boreham Wood, Herts. The timebase mark number (shown on the side of the "tower" facing the back) must be quoted—the Mark I version is unlabelled. Surplus timebase assemblies are available from Manor Supplies, 172 West End Lane, London NW6 who also have other panels available from time to time. Replacement e.h.t. rectifier assemblies for the Mk. III timebase are in stock or can be obtained by Manor Supplies.

The following simple modification will give you a sharper picture with this series of receivers: take the luminance (Y) drive to F2 (see Fig. 3, page 36 November) from 6V1 anode (pin 7) instead of from the junction of 6R12 and 6L5.

A practical suggestion we have received in connection with the crosshatch and dot generator featured in the September issue is to add a LED (light-emitting diode) with series resistor to indicate when the unit is switched on. This involves little extra battery drain.

It has been found that some sets synchronise the generator better than others. An all-round improvement can be obtained by adding a 200pF capacitor between Tr1 base and emitter: later kits from Bi-Pre-Pack include a note about this.

MONOCHROME TUBE TECHNIQUES

TUBE DRIVE

S.GEORGE

If an oscilloscope is applied to the cathode of a cathode-driven c.r.t. will the sync pulse tips or peak white represent the most positive-going signal excursions (a) on 625 lines, (b) on 405 lines? A trick question of course, for on either system increasing the positive voltage at the cathode of a c.r.t. will increase the bias and drive the c.r.t. towards cut-off: the sync pulse tips must be positive-going therefore at the cathode of a cathode-driven c.r.t. The basic bias on a monochrome c.r.t. is set by the brightness control: when this is correctly adjusted the tube beam should just cut off with the signal at black level.

Positive and Negative Vision

But as the vision modulation is positive-going towards peak white on 405 lines and negative-going towards peak white on 625 lines—as shown in Fig. 1 on the left-hand side—how do we ensure that we get in a dual-standard receiver the right conditions at the c.r.t. cathode? As Fig. 1 shows, simply reversing the polarity of the detector diode gives us a signal of the same form on each system: after i.f. filtering the only difference—as shown on the right-hand side of Fig. 1—is that the 405-line signal is positive-going from zero while the 625-line signal is positive-going towards zero. A simple way—used on many Philips group dual-standard chassis—of overcoming this last problem is to a.c. couple the 625-line video signal to the grid of the video amplifier using d.c. restoration so that the signal at the grid is positive-going from the zero line. An alternative and very widely used technique is to adjust the biasing on the video pentode. Fig. 2 shows the idea: the valve is heavily biased on 405 lines, the video signal then driving the grid positively, i.e. up its $-Vg/Ia$ charactertistic towards peak white; on 625 lines the valve is only very lightly biased and the signal adds to this bias, driving the valve down its

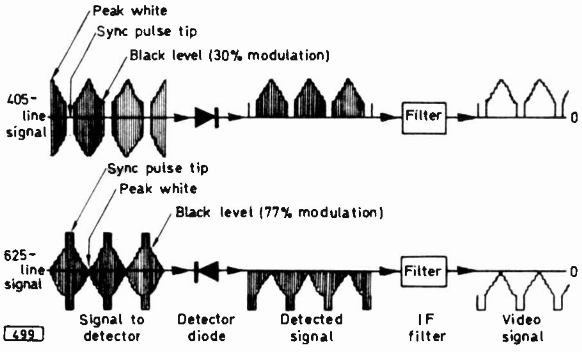


Fig. 1: Although the 405-line signal has positive-going vision modulation and the 625-line signal negative-going vision modulation, by reversing the polarity of the vision detector diode a video signal of the same form is obtained on both systems.

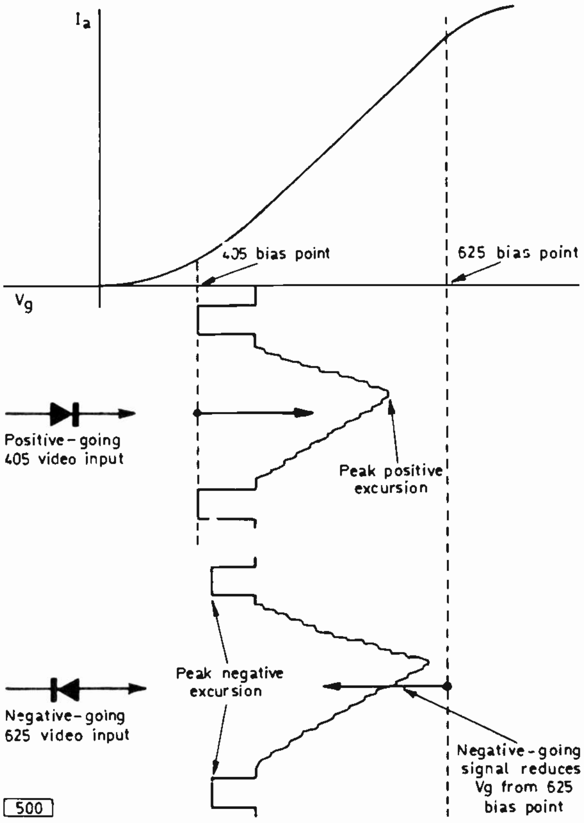


Fig. 2: A common way of overcoming the fact that the resultant signal is positive-going towards peak white on 405 lines but negative-going towards the sync tips on 625 lines is to use different video amplifier biasing points on the two systems, thereby obtaining the same signal on both systems to drive the c.r.t. One snag with this is that the video amplifier and c.r.t. will be drawing maximum current under no-signal conditions on 625 lines. For this reason a.c. coupling with a mid-bias point is generally used on 625 lines.

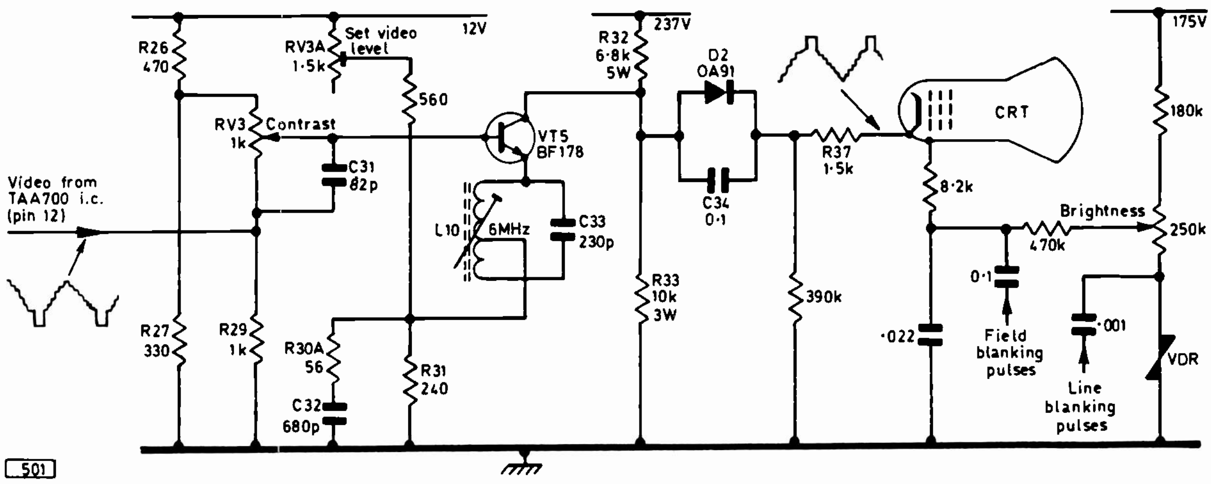


Fig. 3: D.C.-coupled transistor video output stage used in the Pye 169 single-standard chassis, with beam limiting provided by D2/C34.

$-Vg/Ia$ characteristic. A third approach to all this is used in many hybrid dual-standard chassis: the detector diode is left connected the same way round on both systems and a phase splitter stage is used to get the correct signals.

AC Coupling

However the set designer goes about this problem there is one practice always used in dual-standard sets: a.c. signal coupling to the video pentode grid on 625 lines. If a.c. coupling is not used the video pentode will under no-signal conditions be left conducting heavily and as its anode voltage will then be low the c.r.t. (assuming cathode drive) will also be passing maximum current. A.C. coupling on 625 lines has the great advantage that the video pentode anode and c.r.t. beam currents can under no-signal conditions be set at a midway position, the capacitively fed video information then swinging the pentode and c.r.t. positively and negatively with respect to this mid-position.

Single-Standard Circuits

In modern single-standard monochrome models of the full-size—as opposed to the small portable—variety however most setmakers prefer to use d.c. coupling throughout the video circuitry and to adopt solid-state techniques now that suitable output transistors are readily available.

A typical example is the circuit shown in Fig. 3, used in the Pye 169 chassis. The video signal is d.c. coupled from a video preamplifier in a TAA700 i.c. via the contrast control and the video output transistor right through to the c.r.t. cathode. Here the signal must be negative-going (towards peak white) as shown and the signal at the base of the transistor must be positive-going. The biasing under no-signal conditions is such that both the transistor and the c.r.t. are heavily conducting therefore.

The contrast control RV3 has two effects. First it forms in conjunction with the input impedance of VT5 a signal potential-divider: as the resistance in series with the signal path is decreased so a greater proportion of the video signal developed across the external load resistor R29 of the integrated video preamplifier appears across the base-emitter junction of VT5. Secondly at high signal settings RV3 reduces the forward bias applied to VT5. C31 bypasses RV3 so far as high-frequency components of the video signal are concerned so that the h.f. response of the circuit is maintained at all settings of the contrast control. Following conventional practice a 6MHz trap is connected in series with VT5 emitter to prevent intercarrier sound signals reaching the c.r.t., while R30A and C32 are included to provide h.f. compensation: at h.f. R30A is effectively in parallel with R31, reducing the negative feedback and increasing the gain of the stage. RV3A sets the correct bias level for VT5, providing a bleed current through R31. The series collector load resistor is R32: signalwise however R33 is in parallel with R32. Thus the effective load is just over 4kΩ, giving an extremely good h.f. response without the need for peaking coils.

Beam Limiting

The c.r.t. beam current will rise to a peak value if for any reason the input signal to VT5 fails: this condition if prolonged could over-run the e.h.t. system or rectifier. To prevent this a beam limiter arrangement is incorporated. During normal operation D2 is forward biased and has no effect. A small voltage is developed across C34 under these conditions, the plate connected to VT5 collector being positive with respect to the other plate. If under no-signal conditions the voltage at VT5 collector falls below that at D2 cathode then D2 will be reverse biased and the polarity of the voltage developed across C34 will reverse: so far as the c.r.t. cathode is concerned this voltage is in series with the voltage at VT5 collector. The result is a positive potential at the c.r.t. cathode and this of course reduces the c.r.t. beam current. A high beam current will not harm the tube but might exceed the e.h.t. system/rectifier maximum rating.

CRT Drive

It is usual to drive the cathode rather than the

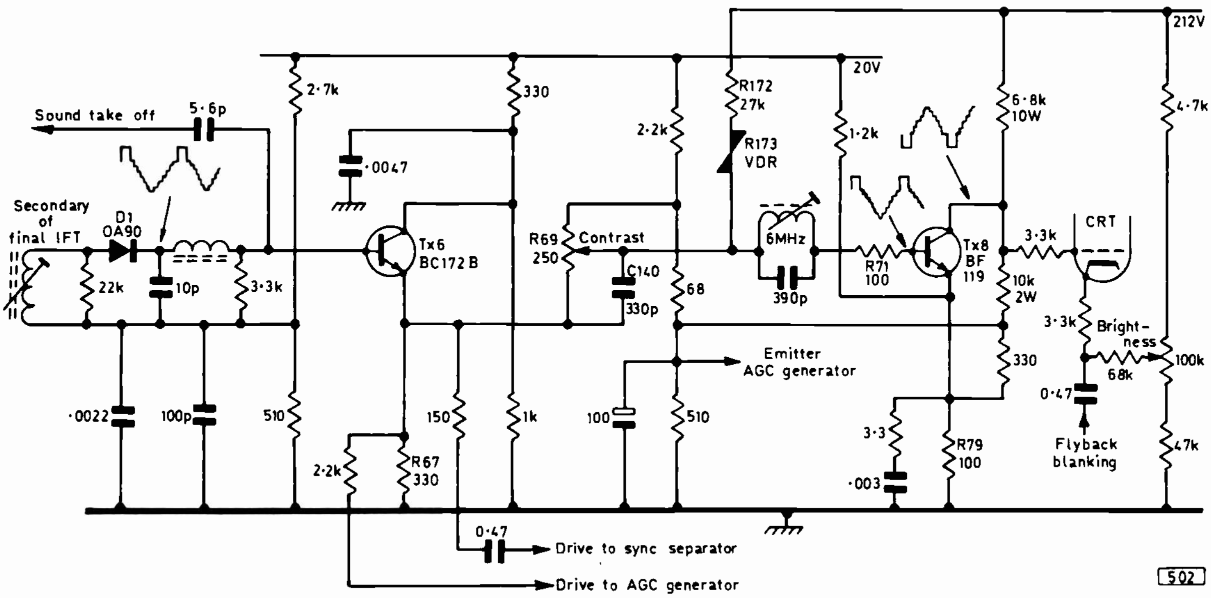


Fig. 4: D.C.-coupled transistor video circuitry used in the ITT-KB VC200 single-standard chassis. As the c.r.t. is grid-driven there is minimum current in the output transistor under no-signal conditions.

grid of a c.r.t. since cathode drive gives a greater change of beam current for a similar voltage change than grid drive does. This is because a change of cathode voltage to increase beam current effectively increases the first anode voltage by the same amount whereas a change of grid voltage to produce the same beam increase effectively reduces the first anode voltage. As with the screen grid of a tetrode or pentode valve the c.r.t. first anode voltage has a great effect on the final anode current. Cathode drive therefore gives a 25-30% increase in tube sensitivity compared to grid drive.

Grid Drive

Grid c.r.t. drive does however have the advantage that a similar type of npn transistor as used for cathode drive can be operated from a minimum current condition with no signal to maximum current (minimum collector voltage) on the sync pulse tips. This is the arrangement adopted by ITT-KB in their VC200 chassis—see Fig. 4. The output from the detector diode is positive-going towards the sync pulse tips and this signal polarity is maintained across the load resistor R67 of the emitter-follower TX6. This signal is then applied via the contrast control, a 6MHz trap and R71 to the base of the video output transistor TX8. This transistor is driven fully on by the sync pulse tips therefore: the collector voltage will then be at minimum and the grid-driven tube cut off.

The d.c. working conditions of TX8 are stabilised by feeding bleed currents from both the 20V and 212V rails through its emitter resistor R79. The collector resistance network also prevents its collector voltage rising above a certain value. R172 with the v.d.r. R173 prevent excessive TX8 collector voltage at switch-on: R173 is of low value if the voltage across it is high, thus the base of TX8 is driven positively and its collector voltage falls to a safe value.

The emitter-follower TX6 also drives the sync separator and the a.g.c. generator stage which, unusually in single-standard models, produces a control potential related to the signal black level rather than the sync pulse tip. With the direct coupling from the vision detector to the c.r.t. grid the picture black level is kept constant. The contrast control acts as a signal potential-divider at l.f. and m.f.: at h.f. the effects of stray capacitance become appreciable, especially at low contrast settings, and this could result in undue h.f. attenuation: C140 therefore provides a constant h.f. feed from TX6 emitter to TX8 base.

Small-Screen Portables

In small-screen portable sets which are often operated under poor lighting conditions maintenance of the picture d.c. level looses much of its importance. In such sets a.c. video coupling is widely used therefore, simplifying design generally and enabling the output transistor and c.r.t. to be biased to a mid-point under no-signal conditions. In most such sets the video circuit consists of an npn emitter-follower driving an npn output transistor, both stages being powered from positive supply rails. As battery operation is called for the h.t. supply for the video output transistor and for the c.r.t. first anode and focus electrodes must be derived from the line output stage, imposing an additional load on an already hard worked section of the receiver. The h.t. for the video output transistor need be no more than 80-100V but the c.r.t. may need upwards of 200V.

Crown Circuit

As an example of the divergency of transistor video circuitry however our final example, the circuit used in the 5in. Crown Model 5TV201 (Fig. 5),

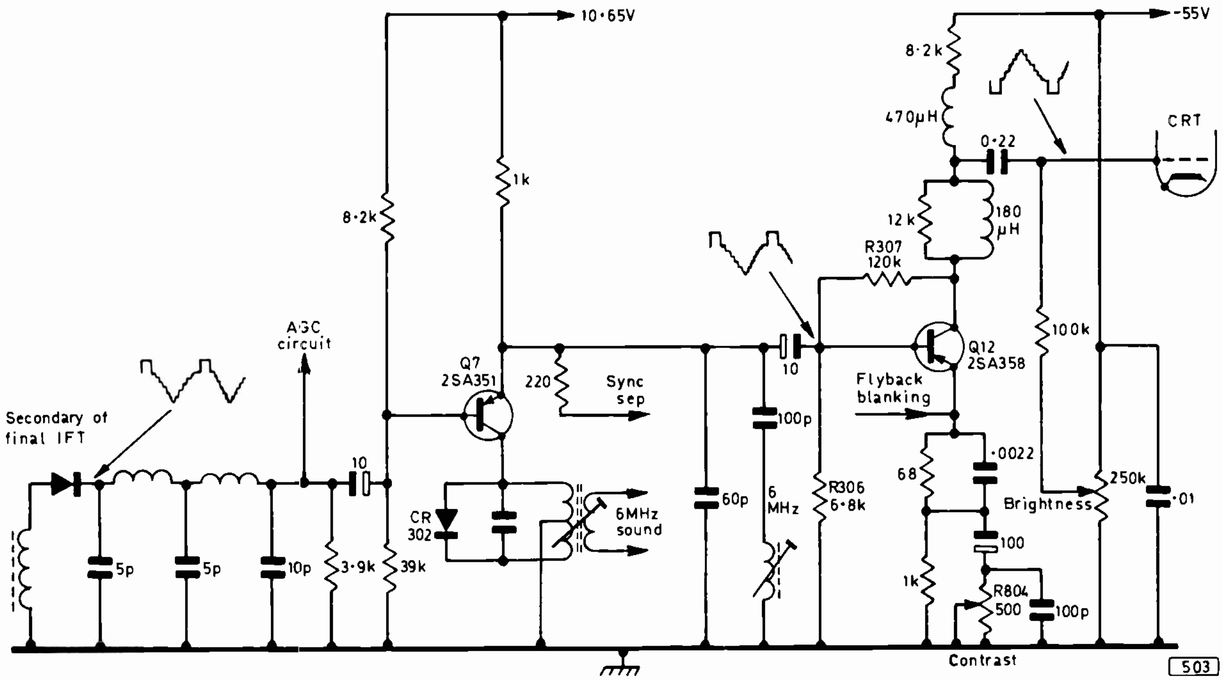


Fig. 5: It is common practice to use a.c. coupling in small-screen portables. This example, with a pnp output transistor operated from a −55V rail and grid drive to the c.r.t., is used in the Crown Model 5TV201.

uses a pnp output transistor powered from a −55V rail which also feeds the brilliance control: this arrangement provides a very worthwhile effective increase in the c.r.t.'s first anode voltage. Both the transistors are pnp types, the emitter-follower Q7 being emitter fed from a 10.65V rail. The video signal is a.c. coupled to the grid of the c.r.t. Thus decreasing the instantaneous c.r.t. grid voltage decreases the beam current and as this condition represents maximum Q12 collector voltage (since it is operated from a negative rail) there is at the same time minimum collector current in the output transistor.

The 6MHz acceptor trap in the emitter circuit of Q7 performs two functions: it prevents the intercarrier signal reaching the video output stage and, by removing negative feedback at this frequency in Q7, enables this transistor to provide maximum amplification at this frequency in its collector circuit from which the sound signal to the intercarrier channel is taken. Diode CR302 assists in a.m. limiting the f.m. signal: as the signal at Q7 collector increases in amplitude so CR302 conducts and increases the loading on the transformer.

Output Stage Conditions

Forward bias for the output transistor is provided by the potential-divider R307/R306 which is connected from the collector of Q12 to chassis instead of from h.t. to chassis: this arrangement helps to stabilise the d.c. working conditions by introducing overall negative feedback. As is almost always done in small-screen portables contrast control is effected by varying the negative feedback introduced in the emitter circuit of the output transistor. The contrast control R804 is a.c. coupled into the emitter circuit by the large-value (100μF) electrolytic: by varying the negative feedback it alters the signal amplification without affecting the d.c. conditions in the stage. This method of contrast control changes the input impedance and bandwidth of the stage as well as its gain but is simple and in practice has much to commend it.

Fault Diagnosis

From the circuit examples we have given it will be clear that depending on transistor type (pnp or npn) and whether grid or cathode c.r.t. drive is employed incorrect output transistor biasing plus a strong input signal will either crush the sync pulse amplitude or the picture highlights. It is important therefore when diagnosing faults in such circuits to be able to establish the signal polarity at each point in the circuit.

When sync pulse crushing occurs in receivers which employ a sync-tip a.g.c. circuit the result may be the development of inadequate a.g.c., leading to cross-modulation due to the i.f. and especially the r.f. stages operating at near maximum gain with a strong signal input: this, in addition to poor line and field sync, could suggest gross misalignment or an open-circuit main decoupling capacitor.

Incorrect Voltages

Where the video output transistor forward bias is adjustable this should be reset in accordance with the manufacturer's instructions. Whether or not such provision is made always remember that in directly-coupled circuits incorrect voltages in the output stage can be the result of incorrect voltages in a preceding stage—or stages. ■

LONG-DISTANCE TELEVISION

ROGER BUNNEY

THE darker days of October are here once again but at least there have been a few brighter days for many of us—certainly as far as long-distance reception is concerned. Tropospherics have been fairly active for part of the time, with slow-moving high-pressure systems over the European area, though conditions didn't quite make the level of "excellent". Reports coming in seem to indicate greater activity in Band III. A number of enthusiasts report signals within the UK from NRK (Norway), SR (Sweden), East and West Germany. Denmark too provided a new country for a number of enthusiasts, with widespread reception of the various Danish Band III transmitters. As an extra bonus for the vigilent there were several lifts with Sporadic E—openings have been reported into Central Europe, one bringing welcome news. Our DX duo at Derby—Messrs Smith and Hamer—report seeing an identification on the PM5544 card as used by ORF (Austria): the 14th brought with it a mid-afternoon opening and this card was noted carrying the identification "ORF FS1". Learned opinion indicates this is an abbreviation for Osterreichischer Rundfunk-Fernsehsender 1. It further suggests that the 2nd ORF chain will carry the test card identification ORF FS2—we await confirmation on this point! Meteor shower/scatter reception has had its moments too with several mornings in the month extremely active. My own log for the period is as follows:

1/10/72 BRT (Belgium) ch.E2—trops.
3/10/72 WG (West Germany) E2—MS. An improvement in tropospherics was noted this day with ORTF (France).
4/10/72 CST (Czechoslovakia) R1; WG E2—both MS.
6/10/72 DFF (East Germany) E4—MS.
7/10/72 CST R1; DFF E4—MS.
9/10/72 WG E2; DFF E4—both MS; BRT E2—trops.
10/10/72 CST R1; WG E2—both MS.
11/10/72 DFF E4; WG E2; CST R1—all MS.
13/10/72 DFF E4—SpE.
14/10/72 BRT E2—trops; SR (Sweden) E2—MS; ORF (Austria) E2a; RAI (Italy) IA, IB; plus unidentified station during an SpE opening.
19/10/72 DFF E4—MS; NOS (Holland) E4—trops.
20/10/72 WG E2—MS; BRT E2—trops.
21/10/72 TVP (Poland) R1; CST R1; Switzerland E2—all MS; BRT E2—trops.
22/10/72 DFF E4—MS; BRT E2—trops.
23/10/72 SR E2—MS.
26/10/72 DFF E4; WG E2—both MS.
27/10/72 DFF E4—MS.
28/10/72 BRT E2—trops.
30/10/72 BRT E2—trops; CST R1; NRK (Norway) E3—both MS.

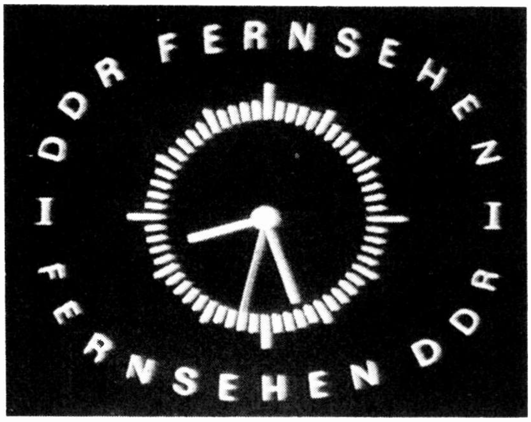
On the whole a rather uninspiring log! The peak time for tropospherics was October 3rd-6th. U.H.F. was rather patchy with nothing that could be called a good opening. Band III however gave extremely good distances with particularly fine reception from Denmark on ch.E5 through to E10 to as far away as the Shetlands.

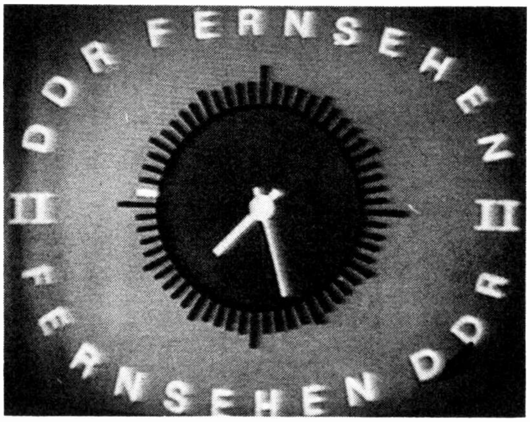
Our recent request to keep observation on ch.E21 with a view to siting the new CLT-Luxembourg transmitter has brought exciting news! Dave Bunyan of Sittingbourne (Kent) tells us that on October 23rd the EBU test pattern was noted floating over Lille. The former pattern carried no identification and was without the circle. Fortunately Lille ORTF-2 was radiating a blank raster at the time. The aerial was in the Lille direction and the reception lasted 1215-1300 (the period the receiver was operating). The following day produced no sign of the new transmitter. We had earlier received news from Holland that CLT was expected to start about the 19th. I feel sure that this was CLT and our congratulations are due to Dave for his vigilance.

Another mystery: ORTF-2 has been noted on ch.F2 using the 819-line sound/vision spacing by Dieter Scheiba, Brussels. The signal is vertically polarised and received almost daily from mid-September.

The PM5544 electronic pattern yet again raises some comments: Iceland has been noted using it at times—received in Holland. Advertisements in the technical press for the PM5544 pattern generator indicate that TVE (Spain) is a user. So far we have not (knowingly) seen this over the air.

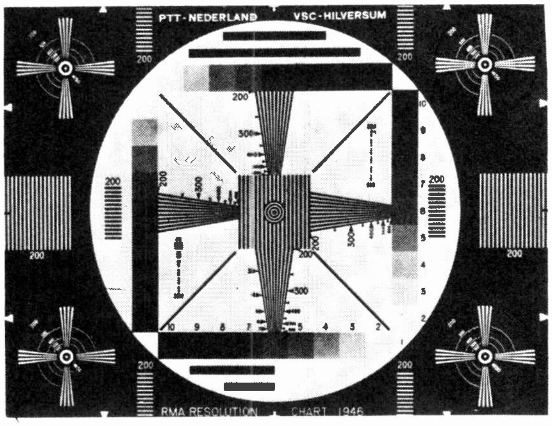
We have received an impressive photograph taken by F. Brancatelli (Sicily) showing a ch.E10 transmission from the Israel Broadcasting Authority transmitter

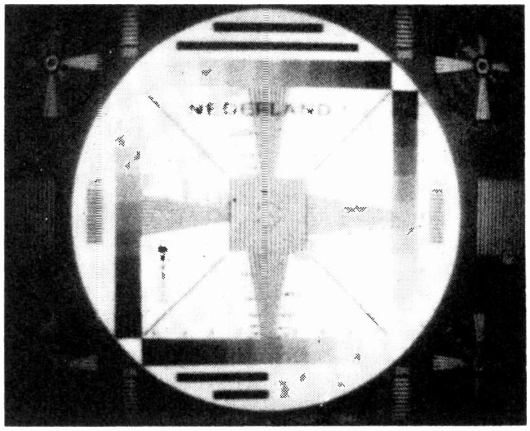




First and second chain DFF (East Germany) clocks: photos courtesy R. Erler.

DATA PANEL 18—2nd series — HOLLAND

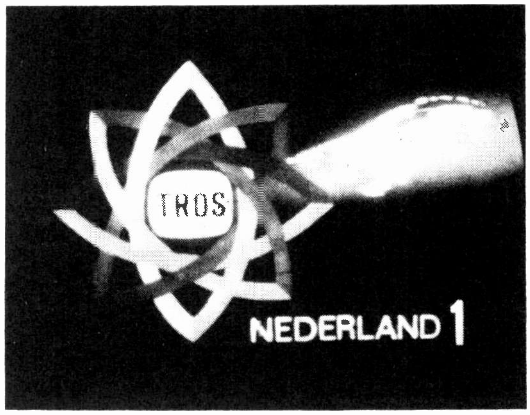




Shown above left and right are the RMA test cards used by the Dutch Television Service—Nederlandse Omroep Stichting (NOS). The card usually carries the inscription for the first or second chain as shown in the right-hand photograph (first chain). The PM5540 electronic test pattern is also in use, as at times is the PM5552. These were shown in the October and November 1971 data panels.

The photograph on the right shows the identification slide used by the TROS organisation.

Photographs courtesy NOS, Hilversum and the Europese Testbeeldjagers.



near Haifa (100kW e.r.p.). The distance of the transmission path is in excess of 1,000 miles—mostly over sea—and the photograph is indicative of the type of reception that can (and often does) occur in such favourable areas. Continuing our series of clocks we must thank Ralf Erler for sending illustrations of both DFF programme chain clocks.

News

Nigeria: A new transmission network is being established in the Midwest State. The studio centre will be at the state capital of Benin and the main transmitter nearby at Uzalla on ch.E7 with 100kW e.r.p. vertically polarised. Another transmitter will operate at Eku with 50kW on ch.E9 (horizontal) and a 3rd at Jattu (near Auchi) with 500 watts on ch.E5 (horizontal). The network should open in January 1973.

France: The ORTF-3 network will begin transmission on December 31st 1972. As with the ORTF-2 network transmission will be on 625 lines with positive-going video and a.m. sound (system L). The SECAM colour system will be used. A list of transmitters has just come to hand with opening dates and *transmitter* powers—not e.r.p. (a 50kW transmitter will have an e.r.p. of up to 1000kW): December 1972 Paris-Tour Eiffel 50kW ch. E28, Lille-Bouvigny 50kW ch.E24, Strasbourg-Nordheim 50kW ch.43, Nancy-Malzeville 20 kW ch.E26; March 1973 Mulhouse-Belvedere 50kW ch. E24; April 1973 Metz-Luttange 50kW ch. E31, Amiens-St. Just 20kW ch.E44; June 1973 Marseille-Grande Etiole 50kW ch.E26, Avignon-Mont Ventoux 20kW ch.E39; September 1973 Lyon-Mont Pilat 50kW ch.E43; October 1973 Bordeaux-Bouliac 50kW ch.E60, Toulouse-Pic du Midi 20kW ch.E27; December 1973 Rennes-St. Pern 50kW ch.E42. A number of lower power relays will also be opened during the period and the network will be further expanded in succeeding years. Our thinks to the EBU for this information.

From our Correspondents . . .

Wallace Roome of Pietersburg South Africa has written to tell us that F2 conditions are on the increase! He mentions that on October 19th both the TVE ch.E2 Madrid and RAI (Italy) ch.IA Cammarata transmitters were received, the latter with good-quality video. Signals were received over the 1500-1900GMT period. We await with interest news of continuing F2/TE activity. Rym Muntjewerff has also been successful with recent reception: from his Beemster, Holland home he has succeeded with Poland (TVP) via tropospherics in Band III. In fact during good conditions in early September he received TVP-1 on ch.R8 (Katowice), R10 (Gdansk) and R12 (either Wrocklaw or Szczecin). Our congratulations on this magnificent reception—which shows what can still be received on Band III!

While at Barmouth earlier this summer A. Trelinski of Rugby noted Dublin ch.B7 in Band III and a number of Band I transmitters including TVE (Spain) and ORTF (France), the latter two via Sporadic E. Further experiments produced West Germany, USSR, Poland and

Hungary on the domestic receiver and aerials. I am sure we all hope Mr. Trelinski will continue his experiments and improve his reception. Another enthusiast new to this column is John Ding of Bushey, Watford: departing from his main f.m. activities and using a Hirschmann FESA 417-U60 u.h.f. array on a rotatable mast he has received various Dutch, Belgian and West German transmitters during the recent tropospheric openings. He notes reception of the NOS EBU bar carrying the identification PTT-NL VSC-HVS (see page 164, February TELEVISION) and adds that as the local early morning fog lifted so the signals deteriorated.

Our final letter this month is from Paul Gardiner at Aldershot: it seems that the 50th Anniversary of the "International Union of Railways" allowed him unlimited travel in Western Europe for one month for only £27.50! His journeying took him from Kiruna (just North of the Arctic Circle) to Central Italy, Berlin and Paris and various points in between. Apart from seeing the sights Paul also viewed the various test cards. He comments on the extensive use of the PM5544 and while in Vienna noted ORF-1 using it without identification and ORF-2 using the TO5-Telefunken card. On his return he was able to view a number of the countries he had visited just a few days earlier thanks to improved trops. He noted Denmark, East and West Germany, Norway and Sweden.

Data Panel

This month we are featuring the Dutch Television Service—NOS. Dutch TV programmes are provided by NOS and certain other organisations. The latter consist of religious and other groups which if above a certain membership are permitted air time. Consequently during programmes certain captions will be seen, indicating the programme source. These are as follows:

AVRO—Algemeene Vereeniging Radio Omroep (Independent).
KRO—Katholieke Radio Omroep (Catholic).
NCRV—Nederlandse Christelijke Radio Vereeniging (Christian).
VARA—Omroepvereeniging VARA (Social Democratic).
TROS—Televisie Radio Omroep Stichting (Independent).
VPRO—Omroepvereeniging VPRO (Social Criticism).
OE—Evangelische Omroep (Evangelical).
NOS—Nederlandse Omroep Stichting.
SER—Stichting Ether Reclame (Television advertising Organisation).

New Series

The terminology necessary to describe long-distance television reception can be confusing to the newcomer to the hobby. To encourage more enthusiasts to take an interest we shall over the next few issues be including each month a section explaining the terms used, the propagation effects to which they refer, reception techniques and so on.

Beginners' Guide—1

The reader of this column will see reports each month of TV reception for varying periods of time from transmitters some hundreds of miles and at times well over a thousand miles distant. Such reception is not unusual and can be achieved by most people provided they have some knowledge, appropriate receiving equipment and, possibly the most important ingredient, patience. The receiving equipment need not be elaborate nor need gigantic, high aerial arrays be used—the reception reported in my personal log these past few months has been obtained using quite simple aerials erected at temporary heights little over 20 ft.!

Whenever the popular press gets on to the reception of TV signals from say the USSR it tends to refer to "freak reception". Such reception can often be obtained *on a daily basis* throughout the summer from stations all over Europe however, signal strengths ranging from weak to extremely high. This may seem a bold statement to the uninitiated but we shall over the course of the next few columns explain the causes of such reception and the action necessary to receive it.

It is well known that the farther one lives from a television transmitter the weaker the signal becomes, necessitating large, elaborate aerial arrays. Those who live in fringe areas find the signals subject to fading and other irregularities. There are times however when the signal in a fringe area increases in strength to give perfect reception: this effect is closely influenced by weather conditions. At such times viewers in both fringe and service areas may notice that channels normally empty are occupied by signals from adjoining areas.

Long-haul tropospheric reception: Israel channel E10 received at over 1,000 miles.

Tropospheric Propagation

Certain weather conditions can produce enhanced signal propagation then. Surrounding the Earth's surface and extending to some 25,000ft. or so is a region called the troposphere: this is "where the weather happens". During periods of anti-cyclonic (high-pressure) weather we often find settled conditions: the daytime usually features clear, cloudless skies and at night the temperature falls sharply at the surface—somewhat more sharply than the air higher up. This produces a temperature inversion which usually gives improved tropospheric propagation, signals being enhanced from late evening to the early morning period when the rising sun heats the troposphere. Fog is also likely to occur during such high-pressure periods.

If you observe the television weather maps you will often get an idea of the direction in which best reception is likely—a path parallel to the isobars is generally best. Tropospherically propagated signals (trops) tend to be stable and slow fading—all television frequencies can be propagated in this way, the best results being on Bands III, IV and V. Reception distances up to 1,000 miles can be achieved at times—in fact it is quite common now to receive u.h.f. transmissions in the UK at distances of around 750 miles. The autumn months often produce excellent tropospheric conditions.

An effect which often accompanies improved tropospheric conditions is ducting. This is at times selective: a particular station or area can be received whereas a transmitter closer but in the same path is bypassed.

We will consider other forms of long-distance television signal propagation next month.

YOUR PROBLEMS SOLVED

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

ULTRA 6621

When the contrast control is advanced to get a properly contrasted picture the picture distorts from left to right, slightly diagonally, and the vertical hold sometimes slips. These conditions occur more often when commercials change or pictures change to captions. If the control is readjusted to give a grey picture the fault clears. The video and vision i.f. valves have been changed but the fault persists.—R. Hawkins (Durham).

We think the trouble will be cleared by replacing the a.g.c. line clamp diode W3. This is a small metal rectifier, type M3.

FERGUSON 3631

The 2MΩ focus present has burnt out twice on this set. Also the line hold on 405 fails after about an hour—first wavy verticals develop then these change to sawtooth verticals. This fault does not occur on 625, and clears itself for a while on 405 after being present for about 10 minutes.—P. Hill (Swanage).

For the focus problem you should check the value of the 820kΩ resistor R125 in series with the focus potentiometer (on the earthy side). As the line hold fault is present on 405 lines only we suggest the 405 line hold control R58 (250kΩ) and the 33kΩ resistor R57 in series with it are checked. Either could be at fault.

PHILIPS 19TG170A

There are alternate light and dark vertical bars from the top to the bottom of the screen (four light and five dark). There are also horizontal bands across the screen—black before and after white and white before and after black. Both symptoms are mainly visible on a blank or near blank mid-grey screen.—T. Imray (Deal).

The vertical striations are most likely to be due to failure of the 1kΩ damping resistor R501 connected across the linearity coil L511. This resistor is mounted on the line output transformer and a replacement should be wired so that there is clearance between it and the transformer windings otherwise transformer breakdown could be caused. Another possible culprit is the PL500 screen grid decoupler C416 (2.5μF electrolytic). The streaking could be caused by incorrect PFL200 video amplifier operating conditions: check the anode and cathode components thoroughly. Alternatively the c.r.t. could be drawing some grid current: try inserting a resistor of about 100kΩ in the supply to pin 2 of the tube base and also check the line flyback suppression components R431 (68kΩ) and C419 1.5kpF.

KB KV003

The fault with this set is that there are four complete pictures side by side across the screen. Checks in the video and sync separator circuits have failed to reveal the cause of the trouble.—J. Walker (Fife).

The first suspect is the line oscillator valve V12 (PCF802). If this is not the cause of the trouble check the 47kΩ resistor R142 which biases the cathode of the PCF802 triode section (pin 8), the 1.2MΩ flywheel filter resistor R141 (pin 9) and the discriminator diodes D8 and D9 (type OA81). Another possibility is that the oscillator coils L74/L75 have slipped down the former so that the tuning is incorrect.

GEC 2047

The width decreased slowly over a few months, the set boost control giving only temporary improvement. The picture has now stopped contracting (it is about 2in. in at each side) but fluctuates sharply. By careful adjustment of the contrast and brightness controls in combination the picture can be made to fill the screen but it is then dark towards the centre and slowly fades, especially with a change of scene. The picture takes a long time to appear when the set is warming up. All line timebase valves have been changed.—P. Middleton (Haverfordwest).

The most likely cause of the trouble is change of value of the 10MΩ resistor R228 in the width circuit. The 2.2MΩ resistor R226 should also be checked. After replacing the faulty component(s) make sure that the set boost control is adjusted so that the boost voltage at tag 6 on the line output transformer is 890V.

GEC 1019

The fault on this set is no sound or picture and uncontrollable brightness. R144 which produces the HT4 feed was found to be badly cracked but replacement has not made any difference.—R. Tothill (Acton).

We suspect that the cause of the trouble is that one of the valves has developed a short-circuit, the most likely one being the PCL84 (V8) which is used as the audio output valve. Check the voltages in this stage. These should be 220V on pin 6 (anode), 230V on pin 9 (screen) and 4V on pin 7 (cathode). If V8 does prove faulty it is advisable while making repairs and testing to insert a 1.5kΩ resistor in the feed to the screen grid (break the print to pin 9). Failure of this valve is likely to have damaged its cathode resistor R96 (150Ω) and could also have damaged the audio output transformer.

QUERIES COUPON

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TELEVISION JANUARY 1973

TEST CASE

121

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

? *The accompanying off-screen photograph shows the symptom which was present on a dual-standard receiver. The video content of the picture was perfectly normal and it was possible to fade the display to zero with the brightness control. It was also possible to adjust the range of contrast on both standards in the normal way. The sound was substantially unaffected.*

During investigation the symptom sometimes disappeared however, the picture then being displayed in correct form, though when this happened vertical interference liness were present on the left-hand side. It was not possible to correct the fault by adjusting the height, width or linearity controls, and even with the width control at maximum setting full horizontal scan at the top of the picture could not be obtained.

Further examination revealed that the line output transformer was running hot and emitting wax while the screen grid of the line output valve was red hot and the screen feed resistor overheating.

A check was first made on the value of the screen feed resistor. This was found to be low in value but replacement made no difference to the symptom. Other smaller components in the line timebase were then tested but no apparent fault could be detected. Owing to the overheating line output transformer and the intermittency accompanied by vertical interference lines it was concluded that the transformer winding insulation was the trouble. This however proved not to be the case as the effect remained after transformer replacement.

Which major component was overlooked that from the symptom would almost certainly be responsible for the trouble? See next month's TELEVISION *for the solution and for a further Test Case item.*

SOLUTION TO TEST CASE 120

Page 91 (last month)

The trouble was caused by low i.f. channel gain. When a picture of low contrast is free from noise one can be pretty sure that the tuner is not responsible. This is because noise on picture or sound arises essentially in the front-end. Since there was no appreciable rise in noise as the input signal was attenuated the signal must have been well above the noise generated in the tuner as an acceptable signal-to-noise ratio was maintained.

Appreciation of this would have avoided tuner replacement and thus saved time in diagnosis. The sound was affected because the i.f. channel of a single-standard receiver handles both the vision and sound signals. Owing to intercarrier limiting etc. the sound may not always be affected to a noticeable degree however.

The trouble was ultimately traced to an open-circuit decoupling capacitor in the i.f. channel but it is worth noting that a fault in the video stages can sometimes produce similar symptoms.

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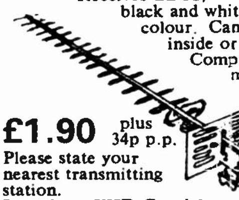

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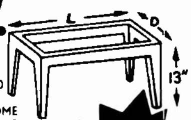

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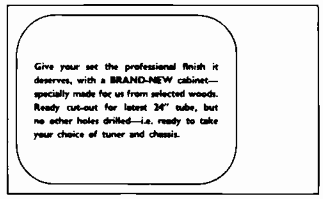

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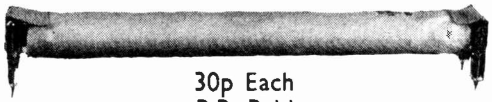

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P.P. Paid

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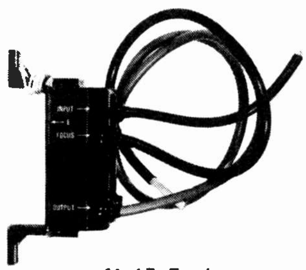
25 KV TRIPLERS



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P.P. Paid

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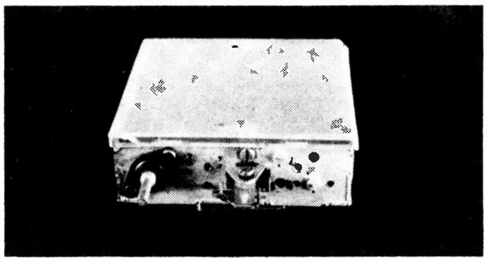

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WITWORTH TRANSFORMERS

TV Line out-put transformers

ALL ONE PRICE £4·50 EACH + 20p P. & P.

ALBA

T1090	T1435
T1095	TD1420
T1135	TD1435
T1195	TD1824
T1235	TS 1320
T1395	TS 1724

BAIRD

600	628	662	674
602	630	663	675
604	632	664	676
606	640	665	677
608	642	666	681
610	644	667	682
612	646	668	683
622	648	669	685
624	652	671	687
625	653	672	688
626	661	673	

Please quote part No. normally found on tx. base plate; 4121, 4123, 4140 or 4142.

COSSOR

CT1700u	CT1975a	CT1962-77*
CT1910a	CT1976a	CT1954-77*
CT1911u	CT2100u	CT1964-78*
CT1921a	CT2310a	
CT1922a	CT2311a	
CT1935a	CT2321a	
CT1937a	CT2331a	
CT1938a	CT2372a	
CT1972a	CT2373a	
CT1973a	CT2375a	
CT1974a	CT2378a	

*Two types fitted one has pitch o/w, the other has plastic moulded overwind—please state which type required as they are not interchangeable.

BUSH

TUG versions	TV125
TV75 or C	TV125U
TV76 or C	TV128
TV77	TV134
TV78	TV135
TV79	TV135R
TV83	TV138
TV84	TV138R
TV85	TV139
TV86	TV141
	TV145
TV91	TV148
TV92	TV161
TV93	TV165
TV94	TV166
TV95 or C	*TV171
TV96 or C	TV175
TV97	TV176
TV98C	TV178
TV99 or C	181S
TV100C	183
TV101C	183D
TV102C	183S
TV103 or D	183SS
TV105 or D or R	185S
TV106	186
TV107	186D
TV108	186S
TV109	186SS
TV112C	191S
TV113	191D
TV115 or C or R	193S
TV118	193D
TV123	
TV124	

From model TV123 to TV139 there have been two types of transformer fitted. One has pitch overwind, the other has plastic moulded overwind.
Please state which type required as they are not interchangeable.

PYE

1
2
3 or u

11u Series
12u
13u — State Pt. No. required— AL21003 or 772494
14u
15u
20u

SP17	62
21f or uf	63
22uf	64
23uf	68
24uf	75
31uf	76
35uf	77
36	80
37	81
40f	83
48	84
49	85
53	86
58	95
59	96
60	
61	

PV110 — State Pt. No. required—
V110 — 771980 or 772013

V210 or A
V220
V410 or A — State Pt. No. required— 771927 or 771920
V420A
V430A
V510
V530

V200 or LB
V300s
V310 or s
V400
V600
V620
V630

V700 or A or D
V710 or A or D — State Pt. No. required— 772444 or 771935
V720
V830A or D or LBA

PHILLIPS

1768u, 1792u, 1796u, 2168u, 2192u, 2196 — Exchange Units

	19TG122a
	19TG123a
	19TG125a
	19TG133a
	19TG142a
	19TG148a
	19TG152a
	19TG153a
17TG100	19TG154a
17TG102	19TG155a
17TG106	19TG156a
17TG200	19TG158a
17TG306	19TG164a
19TG108u	19TG170a
19TG111a	19TG171a
19TG112u	19TG172a
19TG114u	19TG173a
19TG116u	19TG175a
19TG121a	19TG176a
19TG178	19TG177a
19TG179	

21TG100u	G19T210	G23T210
21TG102u	G19T211	G23T211
21TG106u	G19T212	G23T212
21TG109u	G19T213	G24T230
23TG107u	G19T214	G24T232
23TG111a	G19T215	G24T236
23TG113a	G20T230	G24T238
23TG121a	G20T232	G24T300
23TG122a	G20T236	G24T301
23TG131a	G20T238	G24T302
23TG142a	G20T300	G24T306
23TG152a	G20T301	G24T307
23TG153a	G20T302	G24T308
23TG156a	G20T306	
23TG164a	G20T307	
23TG170a	G20T308	
23TG171a		
23TG173a		
23TG175a		
23TG176a		
23FG632		

ALL MAKES OF COLOUR TRANSFORMERS IN STOCK

KB

PVP20	QV30 (90°)	WV90	SV20	KV055	KV136
WV05	QV30FM (110°)	MV100/1	SV30	056	138
KV001	QV30-1	OF100	SV042	065	155
KV002	30	PV100	SV048	066	156
KV005	NV40	KV101	SV054	113	165
KV006	NF60	KV105	SV142	114	166
RV10	RV60	KV107	SV143	124	
O15	WV60	115	SV148	125	
TV15	XV60	117	MV818	126	
O17	NF70 or FM	119	MV819	127	
QV20	PV70	KT400A } VC1 or VC2	MV903	134	
WV20-1	QV70				
RV20	RV70	KT405A }			
TV20	VV70	by chassis No.—			
WV20	WV70	VC1 VC4 VC52	VC200		
QVP20	WV75	VC2 VC5 VC53			
OV30	QF80	VC3 VC51 VC100			

GEC

BT302	BT314	BT321	BT336	BT449	2000	2015	2022	2043	2064
BT303	BT315	BT322	BT337	BT450	2001	2017	2023	2044	2065
BT304	BT316	BT324	BT342	BT451	2010	2018	2032	2047	2066
BT305	BT318	BT326	BT346	BT452	2012	2019	2033	2048	2082
BT308	BT319	BT328	BT347	BT455	2013	2020	2038	2063	2083
BT312	BT320	BT329	BT448	BT456	2014	2021	2039		

MURPHY

V310	V430	V520	V879 or C*	V789	V2015SS
V310A	V430C	V530	V923*	V153	V2016S
V310AD	V430D	V530C	V939 or L*	V159	V2017S
V310AL	V430K	V530D	V973C*	V173	V2310
V310CA	V440	V539	V979*	V179	V2311C
V320	V440D	V540	V653X	V1910	V2414D
V330 or D	V440K	V540D	V659	V1913	V2415D
V330F or L	V470	V649D	V683	V1914	V2415S
V410	V480	TM2 Chassis	V739	V2014	V2415SS
V410C	V490	V843*	V753	V2014S	V2416D
V410K	V500	V849*	V783	V2015D	V2416S
V420	V510	V873*	V787	V2015S	V2417S
V420K	V519				

*Two types fitted. One has pitch overwind, the other has plastic moulded overwind. Please state which type required as they are not interchangeable.

DECCA

DR20	DR34	DR71	DR505
DR21	DM35	DR95	DR606
DR23	DM36	DR100	666TV-SRG
DR24	DM39C	DR101	777TV-SRG
DR29	DR41	DR121	
DR30	DM45	DR122	MS1700
DM30	DR49C	DR123	MS2000
DR31	DM55	DR202	MS2001
DR32	DM56	DR303	MS2400
DR33	DR61	DR404	MS2401

SOBELL

T24	ST284 or ds	1010dst	1033
SC24	ST285 or ds	1012	1038
TPS173	ST286 or ds	1013	1039
TPS180	ST287 or ds	1014	1047
ST195 or ds	ST288ds	1018	1048
ST196 or ds	ST290ds	1019	1057
ST197ds	ST291ds	1020	1058
SC270	ST297ds	1021	1063
T278	1000ds	1022	1064
ST282	1002ds	1023	1065
ST283	1005ds	1032	1066

EKCO

TC403	TC437	T513	531
404	T442	514	T532
406	T500	515	533
T418	TC501	520	535
TC419	T502	521	536
T420	503	524	540
TC421	504	525	541
T422	505	526	
433	506	527	
434	510	528	
TC435	511	529	
T436	512	530	

FERRANTI

1075	TC1122	1163	1155	1175
1080	1123	1164	TC1157	1176
1081	1124	1165	1158	T1181
1082	1125	T1174	1159	T1182
1083	TC1126	T1175	TC1160	T1185
1093	1137	TC1135	1162	T1186
1094	T1154	1136	1163	
1095	T1155	1137	T1164	
1096	1157	1138	T1165	
1097	1159	1140	1173	
1121	1160	T1154	1174	

FERGUSON, ULTRA, MARCONI, H.M.V. (BRC. Jellypots).

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Series	Series	Series	1500 Series
850	950 MKII	980	3 stick £3·00 each
900	960	981	5 stick £3·70 each
911	970	982	
950 MKI	1400		When ordering, model number
£3·00 each	£3·70 each	£3·00 each	and series must be quoted.

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Direct BRC replacement, will clip into existing transformer.

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