TELEVISION

20p

SERVICING · CONSTRUCTION · COLOUR · DEVELOPMENTS

JULY 1973

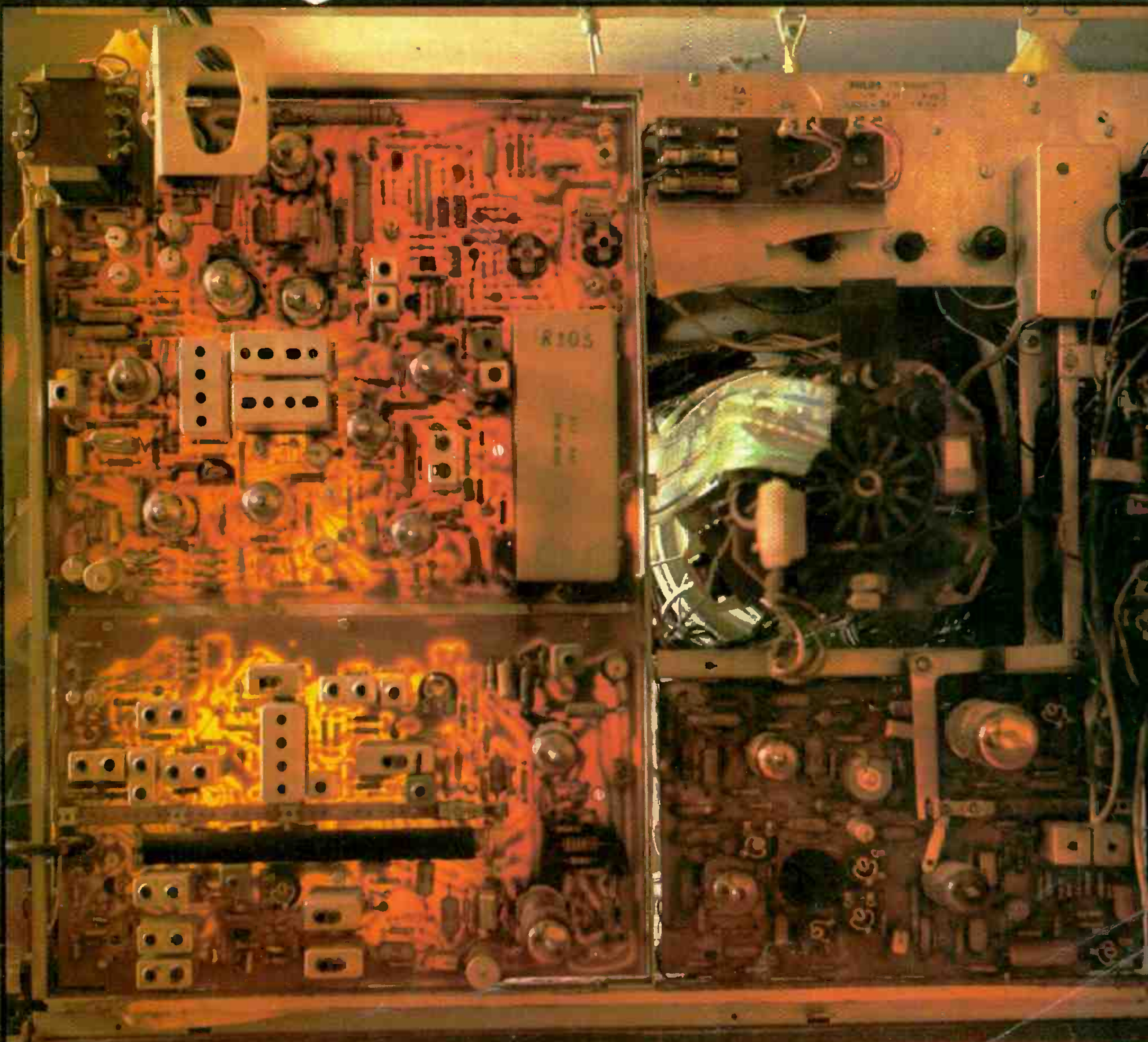
RENOVATING THE PHILIPS G6 COLOUR CHASSIS

ALSO:

DC RESTORATION CIRCUIT

COLOUR RECEIVER INSIGHT

FAULT FINDING - BUSH TV141 IF PANEL



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TELEVISION

SERVICING·CONSTRUCTION·COLOUR·DEVELOPMENTS

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JULY 1973

RTRA's BOURNEMOUTH JAUNT

SEVERAL topics that I have commented on in recent issues inevitably raised their heads at the recent Radio and Television Retailers' Association symposium, conference and exhibition at Bournemouth. From the consumer's angle one of the main problems is ability to receive programmes in difficult areas, and although the rapid erection of some hundreds of main transmitters and relay stations for the u.h.f. bands is providing the predicted coverage this seems as if it will be limited to about 96 per cent of the population. There appears to be some disagreement over the exact proportion of the population that will not be catered for by the present predicted service but at four per cent this amounts to more than two million people and in the region of five million pounds' worth of colour license revenue or three million pounds in monochrome terms. The areas mainly concerned are of course in Scotland, Wales, Northern Ireland and rural England and it is good news that the government has decided to set up a study group to report on this. But it seems rather late in the day to be doing so.

The Conference produced a number of other interesting forecasts. In particular a rapid escalation in the use of i.c.s in colour receivers seems likely in the immediate future, while UK setmakers now seem poised ready to switch over to colour chassis designed around 110° tubes.

The servicing and servicing aids exhibition RadTelDex '73 held in conjunction with the RTRA conference was a worthwhile idea well supported by the industry. It does not however seem to have received the interest expected amongst dealers, which is a pity. Does this mean they don't have any problems, or that they are not interested in them? We hope the latter is not the case.

Perhaps one reason for the lack of support is the number of exhibitions occurring at roughly the same time. Following the RTRA's Bournemouth jaunt we have had the RECMF Components Exhibition and the annual Trade Shows running concurrently in London. All this is a bit much to digest in such a short period and indicates the need for some urgent liaison between conference/exhibition organisers. There is only a limited time that those in the trade can take off to attend these various activities and everyone loses out if they are heaped on top of each other at a busy period of the year.

M. A. COLWELL, *Editor*

THIS MONTH

THE NEXT ISSUE DATED AUGUST WILL BE PUBLISHED JULY 16

Cover: Our cover photograph this month shows a section of the Philips G6 colour chassis, with the decoder board above left and the i.f. board below left.

TELETOPICS

INSTANT NEWS VIA TV

It looks as if the time when the broadcasting authorities will provide an instant news service during their normal TV transmission times may not be far off. This seems to us a most worthwhile extension of the TV service. The basic idea is that information is transmitted in digitally coded form during certain field blanking periods. A receiver attachment decodes and stores the information which consists of a number of pages that can be individually selected and fed to the c.r.t. for display in alphanumeric form on the screen. The viewer can thus at the touch of a button display on his screen a wide selection of news reports which are being continually updated. The first such system to be announced was the BBC's Ceefax system which we mentioned in this column last January. We have now heard that IBA engineers have developed and demonstrated a similar system which they call "Oracle". This system would enable the viewer to receive up to 50 different pages of information, each page containing up to 880 characters or roughly 120 words. When a page is selected by means of a control unit it is automatically "written" on the screen of the receiver. Neither Oracle nor Ceefax affect normal television programme reception.

The IBA has been radiating its Oracle experimental digital data transmissions on line 16 of each field in the London area since early April, and reports that development has now reached the stage of constituting an "experimental working system". This includes a receiver adaptor unit, though it is understood that this would require simplification to become a commercial proposition for mass production. Line 16 of each field should not of course be visible given a correctly adjusted set. Some viewers have however noticed the presence of the data transmissions in the form of twinkling dots, due either to the picture being underscanned so that line 16 is displayed at the top of the screen or to foldover at the top of the picture. Adjusting the appropriate timebase controls should remove the dots.

Oracle draws heavily on the techniques developed by the IBA for its Slice system which enables picture sources to be identified—a problem with complex networking using signals from numerous sources—by inserting identification coding in the field flyback period. The dramatic reduction in recent years in the price of complex digital i.c.s suitable for data storage is the underlying factor that has prompted research—similar work is said to be going on throughout the world by a number of broadcasting authorities—into such public data transmission services.

Since it takes only 1.8 seconds to transmit one Oracle page the entire 50 pages—each possibly providing an entirely different information service—could be rewritten (updated) in less than two minutes.

Two line (64μsec) periods in each period of 625 lines have been set aside by international agreement for data transmission—though not specifically for public data transmission. The Oracle system transmits one "segment" of display information—representing up to ten characters plus the necessary "address code"—during each 64μsec period. The "address" indicates to the receiving unit the particular page and the exact page/screen position of each information segment: it takes the form of a "run-in code" (5 binary digits—i.e. bits), a "start code" (8 bits), a "line number" (5 bits), a "page number" (6 bits) and a screen position indication (8 bits). At the receiver installation the timing sequences necessary to get the information segments displayed at the correct time are controlled by pulses obtained from the line timebase—as with colour decoding this implies the need for stable line timebase operation.

The Oracle adaptor separates the data signal from the television signal and passes the 64μsec information segments into an intermediate store: when the viewer operates his control unit to select one of the pages the address code is used to insert the appropriate information for display at precisely the correct moment into the main store which thus has to hold only one of the 50 complete pages being transmitted. This means that the main store has to be capable of holding 5,280 bits of information—the store consists in practice of a recirculating shift register in i.c. form. When another page is selected the appropriate segments of information are fed into the main store and displayed on the screen, the previous segments being "lost". Each character on the screen is based on a matrix of 7×5 dots.

A computer is used at the studios to code the information available for display and insert it into the television waveform at the appropriate moments. It is intended that the first line of each page would carry an identification, date and time, thus giving the viewer using the service the equivalent of a highly accurate digital clock.

The basic Oracle equipment at the transmission end is said to be likely to cost around £20,000, a modest enough sum for such a useful service. The cost of the receiver adaptor/control unit could lie somewhere in the range £35–£120—current developments in i.c. technology have a considerable bearing on this. Advances in large-scale integration for example could result in the main store consisting of a single i.c., a second i.c. containing most of the control electronics.

VISION MEMORY UNIT

While on the subject of data storage, Hitachi have recently demonstrated a unit which stores TV frames for replay and also by incorporating a continuous recording facility—using a 4in. diameter magnetically-sensitive disc revolving at a speed of 3,600 r.p.m.—enables frames seen up to four minutes previously to be stored for subsequent viewing. The equipment can be used with off-air or CCTV signals, both monochrome and colour, and is called a "Multi-Channel Disc Memory". As new signals are recorded on the continuous recording disc the oldest are automatically erased. A total of 15 magnetic heads pick up the signals from the disc and can be set to automatically store frames at set intervals up to 17 seconds apart.

UHF SERVICE EXTENSIONS

The following two main and three relay stations are now transmitting the BBC-Wales service:
Moel-y-Parc channel 52, receiving aerial group E horizontally polarised.
Llanddona channel 57, receiving aerial group C horizontally polarised.
Bethesda channel 57, receiving aerial group C vertically polarised.
Betws-y-Coed channel 21, receiving aerial group A vertically polarised.
Conway channel 40, receiving aerial group B vertically polarised.

The following IBA transmitters are now in operation:
Blaen Plwyf carrying HTV Wales programmes on channel 24. Receiving aerial group A horizontally polarised.
Blaenavon carrying HTV Wales programmes on channel 60. Receiving aerial group C vertically polarised.
Windermere carrying Granada programmes on channel 41. Receiving aerial group B vertically polarised.

US TV SCENE

The US Electronic Industries Association has announced the figures of TV set deliveries to the US market last year: colour set deliveries were 20% up at nearly 8,850,000 and monochrome deliveries almost 8% up at nearly 8,250,000. These figures include imports, but it's getting hard for the US customer to decide what exactly is and isn't an import. For instance there are no longer *any* monochrome chassis in large-scale production in the USA: those sold under well known US brand names are made mainly in Taiwan, Japan and Mexico. Some US firms are also getting their colour chassis manufactured abroad—for example Admiral in Taiwan. On the other hand several large Japanese setmakers now have plants in the USA. Sony's San Diego plant is expected to be turning out 20,000 colour sets a month by the end of the year, National Panasonic has recently added a colour set production line to its Puerto Rico plant, and Hitachi is producing colour sets near Los Angeles. To further complicate matters what goes into a set wherever it is assembled may today come from here, there or almost anywhere. This latter is increasingly the case in Europe as well—witness TCE's use of a number of Japanese scanning units.

The different timing of the introduction of developments in different countries is interesting. The US were first with 110° colour sets for example, some years ago now, but it is only this year that the all solid-state colour chassis is expected to take a substantial portion of the market. The marketing strategy is also curious. In the UK you wouldn't get away with sticking a higher price on a solid-state chassis, presenting it as a new development worth paying extra for, yet this is exactly the approach being adopted by US setmakers. Some US setmakers claim that solid-state chassis are more expensive to produce and less reliable than hybrid ones, points which have not been borne out by experience on this side of the Atlantic. In fact we wonder whether this late move to the solid-state chassis is more indicative of disarray in the US TV industry which has been under the onslaught of massive cheap imports for several years.

The Federal Communications Commission has set new standards for TV tuner units—these are mandatory upon setmakers. One feature is that all tuners will have to incorporate a.f.c. from July next year. US setmakers are not yet using varicap tuners, because of the problems of operating at both v.h.f. and u.h.f.

THE NEW COLOUR TUBE

Thorn's new precision in-line colour tube which we described in detail last month was officially unveiled at the London Electronic Components Show. The first tube of this type in the Mazda range will be the A51-160X which is expected to be available from setmakers in Autumn 1974. No marketing date for a smaller version, the A42-100X, has been announced. The concept of a colour tube with integral scanning components—as embodied in these new tubes—enables most setting up adjustments to be eliminated, in particular tedious dynamic convergence routines.

UK TRADE SCENE

Some statistics prepared by the EIAJ (Electronics Industry Association of Japan) show that of total UK colour set imports of 334,000 in 1972 (an increase of 3.4 times the 1971 figure) rather less than half, 156,000 (up 3.5 times), came from Japan. It also seems however that towards the end of last year total set imports from Japan, i.e. both colour and monochrome, accounted for some 25% of the UK market. It looks as if Thorn at any rate are making a determined effort to adapt to the way in which the market is fast developing—a mixture primarily of colour sets and monochrome portables. Following their recent announcement of plans to substantially increase colour set production (by "at least 40%") TCE now say they will be increasing the production of monochrome portables at their Gosport plant from 80,000 last year to 200,000 this year. Priority is to be given to exports, and it is interesting that TCE will be introducing shortly in their **Ultra** range a seven-channel 12in. portable designed to operate "in any EEC country"—the price is expected to be about £66.

Decca have announced a new 22in. de luxe colour set, Model CS2233, featuring concealed controls and electronic tuning by means of seven piano keys. **Alba** have announced an 18in. colour set, Model TC2319, fitted with the BRC 8000 chassis. Two monochrome models announced by **Pye** are fitted with a new chassis, the Pye group 173 series chassis: they are the 20in. tube Model 170 with suggested VAT-inclusive price of £72.29 and the 24in. tube Model 171 priced at £80.52—both models are fitted with varicap tuners.

HANDS OFF BBC-1!

We commented in an editorial last January on the campaign being conducted by the Institute of Practicioners in Advertising and others to convert BBC-1 into an advertisement-supported service—"to make the BBC lift its ban on commercials" as the Institute puts it. Since then such suggestions have received a rather dusty answer from the government. The latest development consists of a blatant effort at scaremongering lead by the Institute's president Jack Wynne-Williams who is reported to have said recently that "unless our proposals for financing BBC-1 by advertising are accepted the licence fee could soon double—indeed a 50p a week licence will inevitably be with us". The Institute's attempt to grab BBC-1 is beginning to sound rather desperate.

COLOUR RECEIVER INSIGHT

S.GEORGE

KORTING 51763 SERIES

THE chassis used in the Korting 51763/51765/52665/52666/52865/52866 series of 22 and 26in. models employs four valves and two i.c.s in addition to 36 transistors. The valves are used in the field (PCL805) and line (PCF802, PL509 and PY500A) timebases while the two i.c.s are a TAA640 intercarrier sound amplifier/discriminator and a TAA630 in the decoder to provide chrominance demodulation and burst blanking, PAL switching, G — Y matrixing and colour-difference signal preamplification. In common with most Continental setmakers Korting employ colour-difference tube drive on this chassis.

IF Strip

The signal from the six push-button integrated u.h.f./v.h.f. tuner is fed via a response-shaping bandpass circuit to a three-stage broadband i.f. strip. The use of this shaping at the input enables fixed wideband (approximately 15MHz) tuned coils to be used between the first and second and second and third i.f. stages. The other advantage of this now well-established practice is that the adjacent channel signals are removed whilst at low amplitude, a help since transistors are generally more susceptible than valves to cross-modulation. The final i.f. stage feeds the luminance/chrominance detector via a further bandpass circuit to supress the 33.5MHz sound i.f. signal and thus prevent sound/chrominance beat patterning. A separate shunt detector produces the 6MHz intercarrier sound signal. Forward a.g.c. is applied to the first i.f. stage, the signal coupling to this stage being light (by means of a 10pF capacitor) so that the variations in input impedance produced by changes in the a.g.c. bias do not result in alteration of the response.

Luminance Channel

The complete four-stage luminance channel circuit is shown in Fig. 1. The first stage T105 receives a positive-going (negative video) output from the luminance/chrominance detector and drives the luminance delay line from its collector and the a.g.c. circuit and decoder from its emitter. The base bias of the second stage T201 is set by the "black porch" preset R203. The principle here is that R203/R202/T201/R205 form one side of a bridge with R209/R210 the other side. When R203 is correctly set the voltages at each side of the contrast control R705 are equal. Variations in the contrast control setting do not alter the base bias applied to the d.c. coupled third luminance stage T150 therefore, and in consequence the black level is not affected. On monochrome D201 is non-conductive and L201 is tuned by C203 to 6MHz. On colour reception a positive potential from the colour-killer circuit is applied to D201 anode, switching it on and effectively connecting C202 across the rejector to lower its frequency to 4.43MHz. In this way the subcarrier is removed from the luminance channel on colour while the full video bandwidth is maintained on monochrome.

The high-amplitude luminance signal swing (about 130V peak-to-peak) required to drive the tube cathodes is developed by T150 and applied to the tube via the emitter-follower T151. The use of an emitter-follower in this position gives two advantages. First the tube's capacitive loading—about three times that of a monochrome tube—is removed from the collector circuit of T150, markedly improving the gain/bandwidth performance of this stage, while secondly the low-impedance output provided by T151 prevents interaction between the brightness setting and the luminance signal. As usual the full luminance output is applied to the red cathode of the tube while the green and blue cathodes are fed via presets which with approximately 170V at each side do not affect the d.c. working conditions of the tube.

Beam Limiting

The beam limiting action occurs at T150 emitter. The beam limiter circuit itself is shown in Fig. 2. T205 is linked to the cathode of the line output valve via R224. When the potential at T205 base exceeds that set by the beam current limiter preset R223 at its emitter T205 begins to conduct. The negative-going voltage at its collector in turn increases the conduction of T204 and as a result T204's collector voltage rises. This increased voltage appears at T150 emitter, reducing the conduction of this stage and in consequence the picture brightness. The use of two transistors in the beam limiter circuit ensures a sharp transition into the limiting state so that the beam currents can be allowed to run right up to the maximum permitted values.

Colour-difference Amplifiers

Having examined the luminance drive to the tube cathodes, let's see how the colour-difference signals are applied to the appropriate grids. The three colour-difference output stages are of course almost identical. The R — Y output stage is shown in Fig. 3. The output transistor T728 receives its input from pin 4 of the TAA630 i.c., its output being a.c. coupled via C754 and the *LR* peaking combination to the red grid of the tube. The emitter voltage of T728 is held sensibly constant by the potential divider action of R773 and the emitter resistor R772, while the series connected components C752 and R774 increase the gain at the higher frequencies by eliminating the negative feedback at h.f. across the emitter resistor. As capacitive coupling is used the drive to the tube's grid must be clamped in order to maintain constant black level. This is achieved by the two diodes D724 and D725 which are switched on once each line during the back porch period by pulses from the line output stage, thereby charging the coupling capacitor C754 to the potential set by the brightness control R707. The coupling capacitors in each colour-difference signal feed are charged to an identical potential once each line, establishing a d.c. "base" on which the colour-difference signals are superimposed. The relatively long time-constant of the

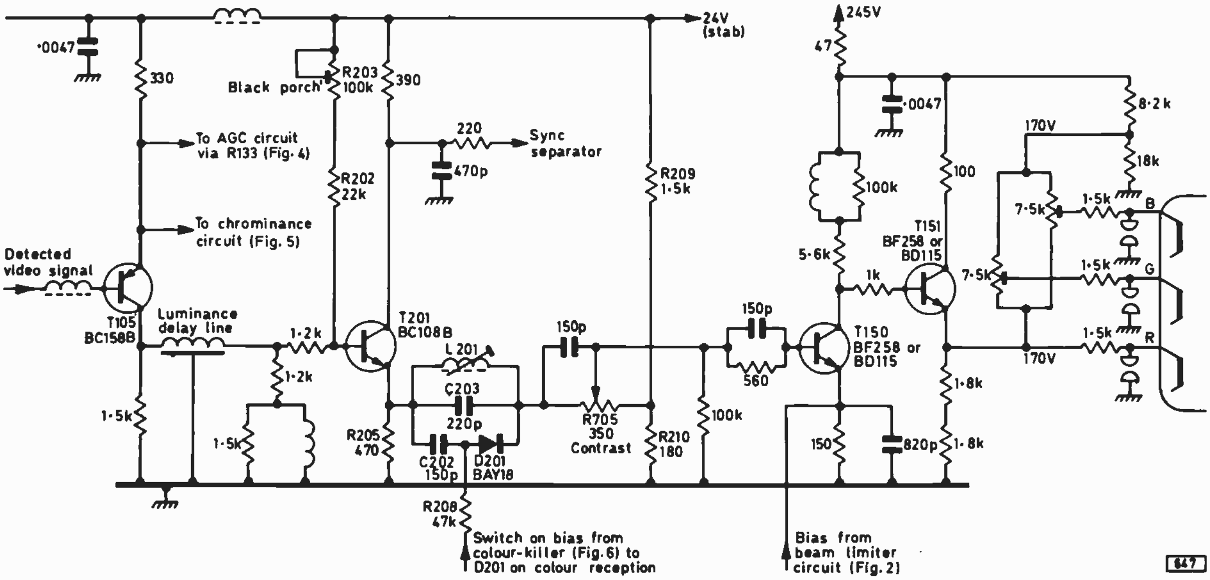


Fig. 1: Complete luminance channel circuit, which is d.c. coupled throughout.

circuit maintains the d.c. level with negligible sag throughout the line period.

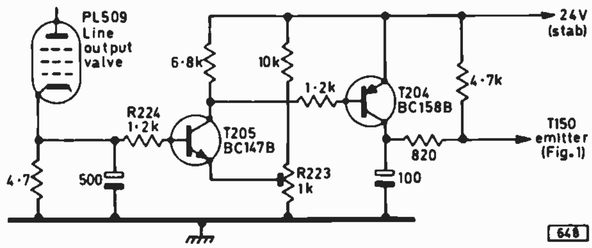


Fig. 2: The beam limiter circuit.

Tint Control

The tint control R711 which is connected in parallel with R794 and the corresponding resistor in the clamp circuit in the B − Y output stage adjusts the relative d.c. voltage at the red and blue grids so that the picture background tint can be varied slightly between reddish and blueish.

Brightness Circuit

As we have seen, the average tube cathode potential is 170V (at T151 emitter). The c.r.t. grids must therefore be at a considerable positive potential to provide the correct working bias. The voltage for the brightness control is obtained, as shown on the right in Fig. 3, by rectifying the field flyback pulses. This provides tube protection since if the field output fails there is no brightness voltage and the screen is blacked out, thereby preventing damage to

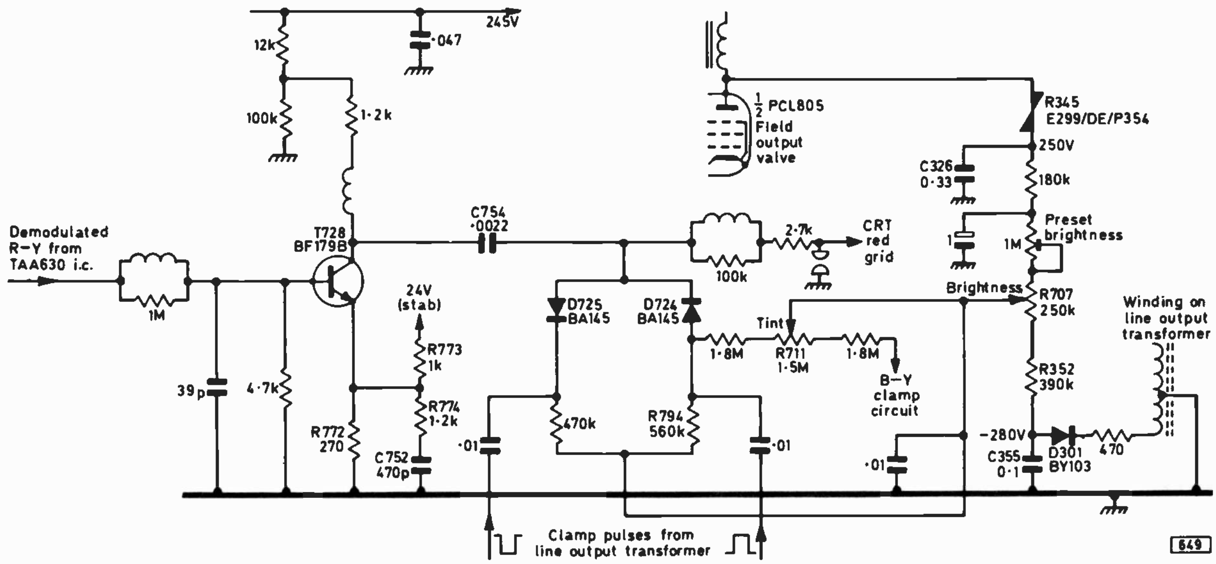


Fig. 3: Circuit of the R-Y colour-difference output stage together with the brightness and tint control arrangements. Tube protection is afforded by deriving the brightness potential from the field output valve.

the tube phosphors. As a result of the non-symmetrical nature of the field output waveform the v.d.r. R345 develops a voltage of 250V across C326. This is then smoothed and applied to the preset and manual brightness controls. The lower end of the brightness control is returned via R352 to C355 which is charged to −280V by D301 which rectifies flyback pulses from the line output transformer. This gives the brightness control a wide control range. The field output pentode anode voltage is negative-going during the forward scan but rises to a high positive value during the flyback: the v.d.r. offers a much lower resistance to the flyback than to the forward sweep, thus producing a high positive mean output. If the waveform applied to the v.d.r. was symmetrical, e.g. a sinewave or squarewave with identical excursions above and below the zero line, the v.d.r. would offer equal resistive values to both and produce zero mean output.

The usual technique with colour-difference tube drive is for the brightness control to vary the voltage at the tube cathodes by acting on the d.c. restorer or clamp in the coupling to the luminance output stage. As reference to Fig. 1 will show however the luminance channel is d.c. coupled throughout. The brightness control acts instead on the tube grids, via the clamps in the colour-difference output stages.

The triode section of the PCL805 field timebase valve is used as a blocking oscillator.

AGC Circuit

Forward a.g.c. is applied to the base of the r.f. amplifier in the tuner and the first i.f. amplifier, a gated a.g.c. circuit being used. As the r.f. amplifier transistor is a pnp type while the first i.f. transistor is an npn type the a.g.c. to the former is negative-going to reduce gain while that to the latter is positive-going. The complete a.g.c. circuit is shown in Fig. 4 and it can be seen that anti-phase a.g.c. feeds are obtained from the collector and emitter of the a.g.c. amplifier T107.

The gated stage is T106: positive-going line-frequency pulses are applied to the collector of this stage and as a result a negative-going potential is developed at the junction of C145/R140 dependent on the amplitude of the signal at T106 base which is d.c. coupled to the emitter of the first luminance stage T105 (Fig. 1). This potential is smoothed and applied to the a.g.c. amplifier T107, progressively reducing its conduction as signal strength rises. This produces the required positive-going a.g.c. voltage for the controlled i.f. stage at T107 collector and the required negative-going a.g.c. voltage for the r.f. stage at T107 emitter. Clamp diodes (D105 and D1) ensure that

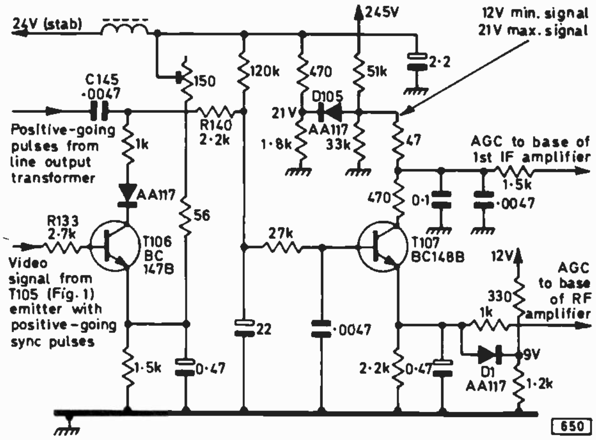


Fig. 4: The a.g.c. circuit.

the a.g.c. voltage applied to the i.f. stage does not exceed 21V on strong signals while the control voltage applied to the r.f. stage does not exceed 9V thus maintaining r.f. gain and good signal-to-noise ratio on weak signals.

Chrominance Channel

Turning now to the decoder, Fig. 5 shows the first chrominance amplifier stage T721 together with the automatic chrominance control circuit. The composite video signal from T105 (Fig. 1) emitter is fed to T721 base: the relatively low-frequency luminance components are removed by the *RC* filters while the fixed tuned circuit BV04677 (tuned to 2.7MHz) limits the response at the lower end and BV04676 (tuned to 7MHz) limits the response at the top end of the passband. The inset response curve shows the net effect of these filters and tuned circuits: further response shaping is provided by the bandpass tuned coils L704 and L703 in T721 collector circuit and a tuned matching transformer in the collector circuit of the second chrominance amplifier stage.

The a.c.c. potential is obtained by rectifying the burst signal appearing at the burst discriminator transformer: a winding coupled to this transformer feeds the rectifier D732 which provides a positive potential dependent on the amplitude of the burst signal to control the conduction of transistor T724—the collector voltage of this transistor thus falls, and with it the base bias applied to T721, as signal strength increases. This is reverse a.g.c. of course. The clamp diode D721 prevents the bias applied to T721

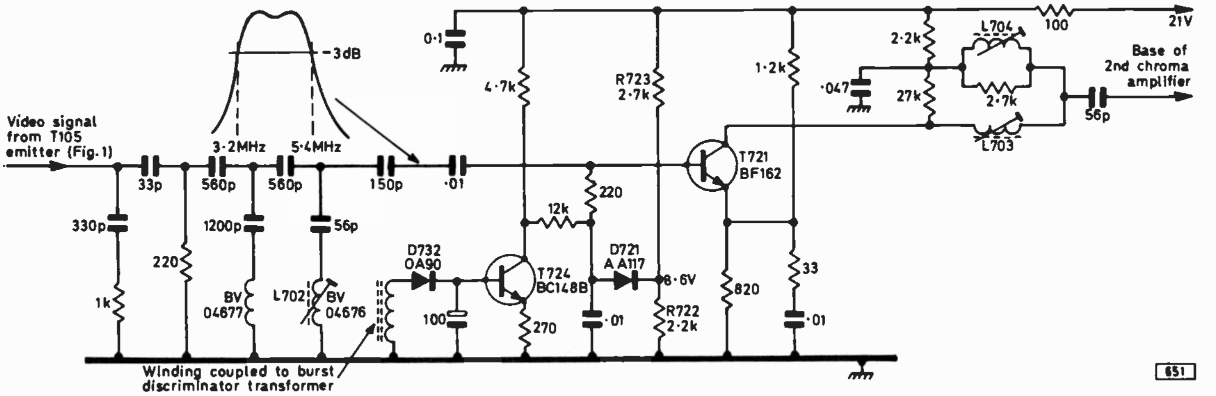


Fig. 5: The first chrominance amplifier and a.c.c. circuit.

rising to too great a value on weak signals by clamping T721 base to the potential (8.6V) at the junction of R723 and R722.

Ident Stage

The heart of any decoder is the ident stage which usually as here controls the colour killer. Instead of the usual *LC* tuned amplifier the ident stage (see Fig. 6) consists of a synchronised *RC* oscillator (T748). This gives improved performance in the presence of noise. Synchronisation is achieved by applying the burst ripple appearing at the burst discriminator output to the base of T748 via C811. The frequency of the oscillator can be adjusted by means of the preset R887 while R883 controls the amplitude of the output. To synchronise the PAL switch the ident signal is fed via C824 and C825 to pin 1 of the TAA630 i.c.

Colour-killer Circuit

The ident sinewave is also fed via C818 to the rectifier D746. This produces a negative bias potential which cuts off the colour-killer transistor T747 (otherwise biased on by the potential tapped from R876). The colour killing action takes place in the TAA630 i.c. The rise in T747's collector voltage when a colour transmission is received is applied to pin 10 of the TAA630 via the potential divider R843/R842. The colour-killer transistor output is used for two other purposes. Its collector is connected via R208 (Fig. 1) to the anode of diode D201 in the luminance channel and this results, as we have previously seen, in the tuning of the filter in the luminance channel being reduced from 6MHz to 4.43MHz on colour. The junction of the potential divider R867/R866 is connected to the anode of diode D745 which connects the earthy end of the *RC* time-constant filter in the decoder reference oscillator control circuit to chassis via C806. As D745 only switches on when the chrominance signal reaches a certain level the effect of this is to remove the time-constant filter from the reference oscillator control circuit when the set is switched on, thereby widening the pull-in range of the control circuit during the warm-up period.

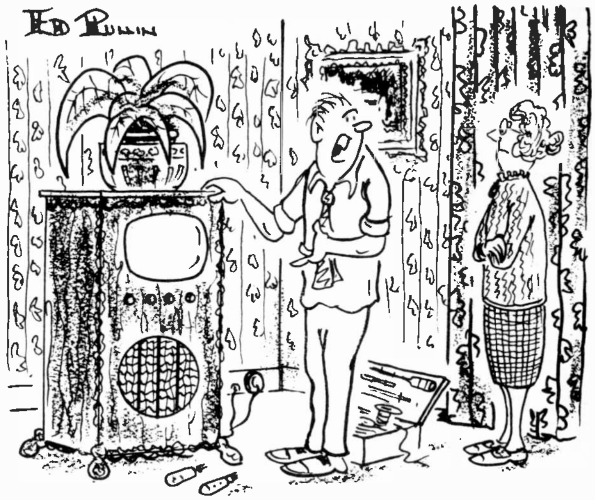
Switch S2 mounted on the front control panel enables the colour to be killed by overriding the negative bias provided by D746 and thus switching T747 on.

Decoder Miscellany

There are two saturation control potentiometers: one is ganged to the contrast control so that the two track together while the other enables the saturation to be adjusted independently. The controls are incorporated in the collector circuit of the second chrominance amplifier stage and set the amount of signal fed to the chrominance delay line/matrix circuit.

The burst take-off is via an emitter-follower buffer stage which is driven by the second chrominance amplifier stage. Both the buffer stage and the burst amplifier stage are gated, the gating pulses being rather ingeniously shaped so as to coincide exactly with the burst period. The technique involves producing a negative-going spike and adding this to the relatively broad positive-going flyback pulse obtained from the line output stage.

The rest of the decoder consists of a conventional crystal/varicap diode controlled reference oscillator and the TAA630 i.c. whose functions were listed at the beginning of this article.



"To be honest Lady, a new tube would kill it!"

Conclusion

D.C. static convergence by means of preset potentiometers is employed—but there are static magnets as well! These latter should be repositioned only if major correction is necessary.

All in all a well made chassis with many interesting circuit features.

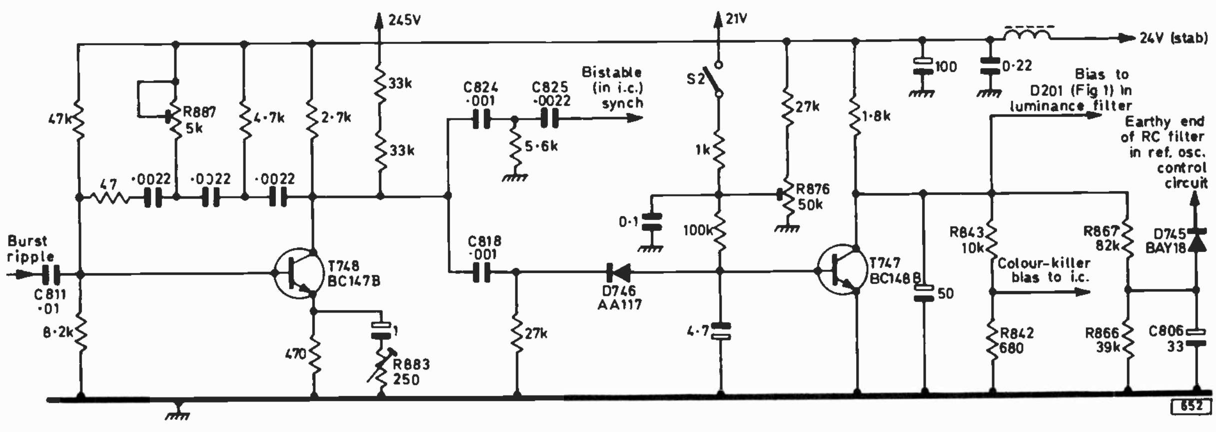


Fig. 6: The RC oscillator ident stage and colour-killer circuitry.

FAULT FINDING GUIDE

5 **John Law**

BUSH TV141 SERIES IF PANEL

In the early 1960s the Bush TV141/Murphy V159 series were among the best selling TV sets available. They are still around in large numbers and are easily recognisable by their rather austere box-like appearance. The main chassis is a vertical frame mounted at the rear of the cabinet: the i.f. panel (left) and timebase panel (right) are screwed to this frame. The panels can be unplugged and removed separately for replacement or repair. For servicing the chassis hinges down on a length of chain after the system switch has been disconnected: most repair work can be readily carried out with the chassis in this position. Separate v.h.f. and u.h.f. tuners are fitted to the side of the cabinet. The system switching, controlled by two push-buttons, operates through a bowden cable and centre-mounted switch lever.

The present article is concerned with faults in the i.f. panel which in addition to the i.f. stages also contains the video and sound output valves and associated components. The circuit is shown in Fig. 2 and the layout in Fig. 1.

The i.f. signal on u.h.f. is passed to the v.h.f. tuner where the mixer stage then operates as an i.f. amplifier. On both systems therefore the input to the i.f. panel is from the v.h.f. tuner. A.G.C. is applied to the first i.f. stage 2V1: the second stage 2V3 feeds the video detector 2MR4 (OA90) which operates on both systems. The detector diode is mounted inside the can with 2L17/18/19 and polarity switching between the two systems is effected by 2S1d and 2S1e—giving a positive-going output on 405 lines and a negative-going output on 625 lines, with "positive video" in both cases of course. The necessary bias adjustment in the video amplifier 2V4a is effected by 2S1f which switches the cathode voltage from 4.3V on 405 lines to 0.5V on 625 lines—it also earths the intercarrier sound take-off capacitor 2C29 on 405 lines. The second section of the PFL200 (2V4b) is the sync separator.

On 405 lines the sound i.f. signal passes from the anode of the common vision and sound i.f. stage 2V1 to the sound only i.f. amplifier 2V2 via 2L6/7. The 405 detector is 2MR1 and the sound signal then passes via the interference limiter diode 2MR6 and the volume control to the triode section of the audio valve 2V5. On 625 lines the inter-carrier sound signal developed by the vision detector is amplified by the video amplifier and passed via 2C29 etc. to 2V2. On this system a ratio detector is used comprising 2MR2/3. Switching between 405- and 625-line operation in the sound channel is effected by 2S11.

The mean-level a.g.c. bias for the controlled i.f. stage and the r.f. amplifier in the v.h.f. tuner is derived from the grid circuit of the sync separator and is backed off by the contrast controls.

Before going on to fault finding mention must be made of the c.r.t. and valve heater protection system. In common with many chassis the heaters are fed with a pulsed d.c. voltage which is obtained from a rectifier (3SR2, BY101) in series with the heaters. This is done to reduce heat dissipation within the cabinet. The screen grid of the sync separator receives its supply via 2R38 from a point along the heater chain. Smoothing is effected by 2C43.

A short-circuit can and sometimes does develop in the rectifier 3SR2, putting a.c. across the heaters. This higher voltage overruns the heaters, with eventual permanent damage if the fault isn't traced quickly. The increased

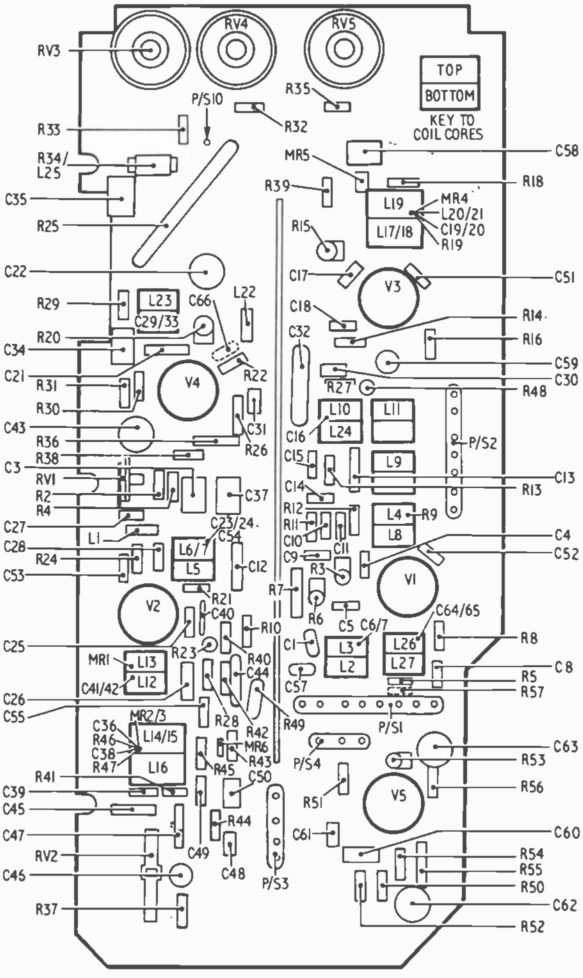


Fig. 1: Layout of the i.f. unit.

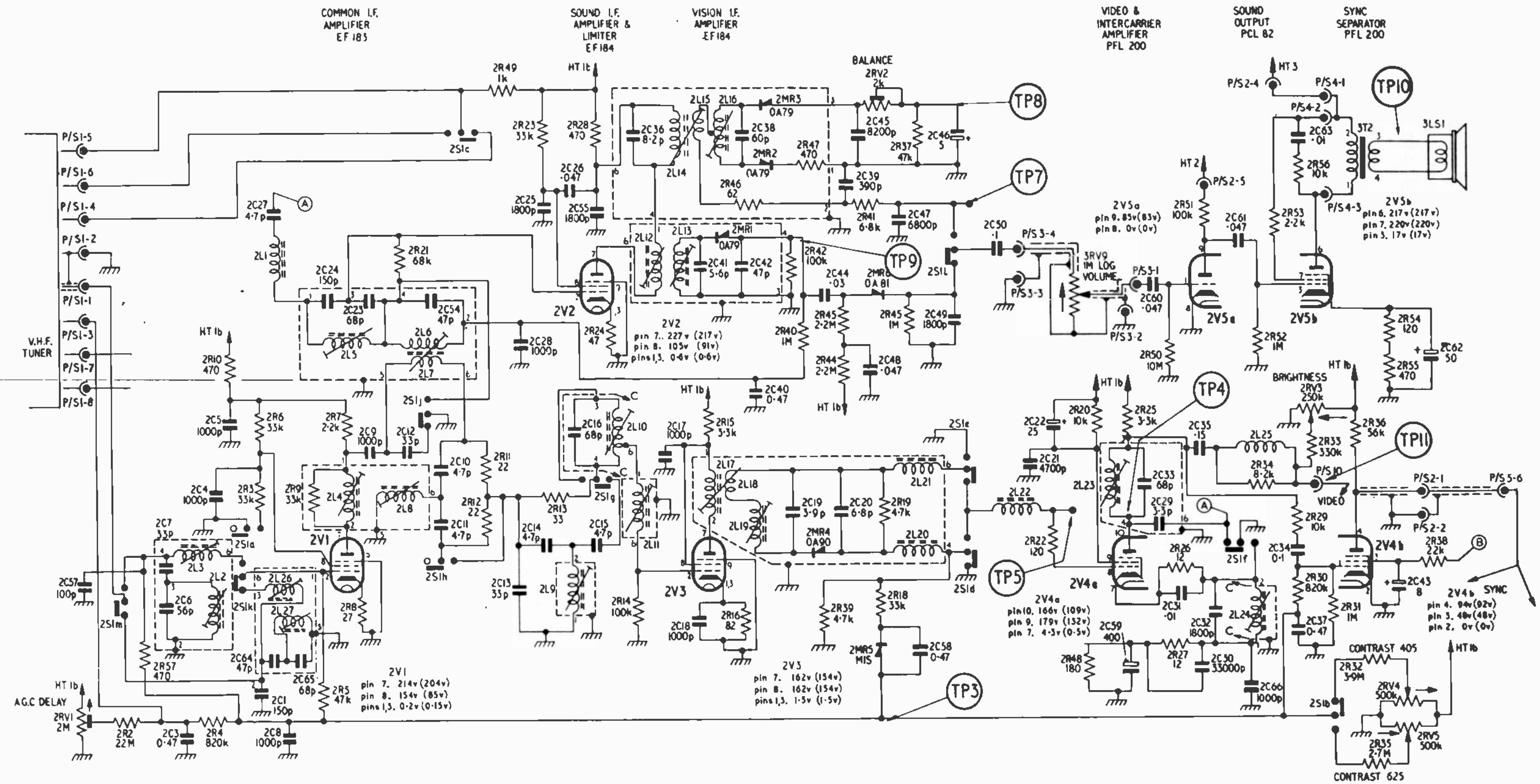


Fig. 2: Circuit diagram of the i.f. unit used in the Bush TV141 and TV148, Murphy V153 and V159 and Defiant 901 and 301. Point B is fed from the heater line.

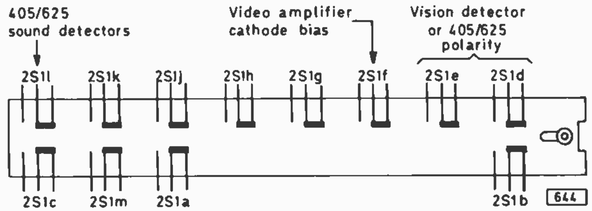


Fig. 3: I.f. panel system switch, shown in 405-line position.

brightness of the valves and c.r.t. can be seen—but the customer is not normally peering into the back of his set! The a.c. will also appear at the screen grid of the sync separator however, resulting in field roll. Thus any suggestion of sync trouble should immediately call attention to the heater rectifier 3SR2: a meter resistance check across it should show about 1kΩ one way and some 100kΩ the other.

Common Faults

The normal fault finding rules—close physical inspection followed by valve replacement and voltage measurements as necessary—apply to the Bush TV141 series as to any other chassis. Seek out particularly discoloured or burnt resistors, leaky electrolytic capacitors or bulging paper capacitors. The printed panels tend to discolour after some years and look burnt, especially under the PFL200. When this happens the print can peel away from the panel and crack, leaving an intermittent or completely broken connection. Always use your eyes before your soldering iron therefore.

In one case in the workshop much time was spent on a Bush chassis changing valves, checking voltages, adjusting rejectors etc., in an effort to trace the source of sound-on-vision. Eventually the cause was traced to the main smoothing electrolytic 3C42. Closer initial inspection would have shown that the can had been leaking excessively over a period and that the capacitor had dried up therefore. A further clue suggesting that the fault was not due to video or rejector trouble was an increase in the severity of the sound-on-vision whenever the volume was turned up. Replacement of the double 300μF can completely cured the fault and gave a crisper picture than before.

The h.t. decoupling resistor 2R15 in the second i.f. stage 2V3 sometimes changes value. This can be due to a fault in the EF184. If a fault is traced to this stage the value of 2R15 (3.3kΩ) should always be checked.

Sync Troubles

True sync faults as distinct from breakdown of the 3SR2 rectifier should be sought in the vicinity of the video section of the PFL200. The valve itself is the first suspect. If the symptoms are confined to 625-line operation suspect the screen decoupling electrolytic 2C22. This is 25μF in some sets, 10μF in others. The higher value is usually found in older receivers. Note that it is connected between the screen grid and h.t. positive, not between screen and earth as is the usual fashion. This means that the negative terminal goes to the screen grid and the positive one to h.t.: connecting the replacement the wrong way round will ruin it. Loss of capacitance in the cathode electrolytic 2C59 (400μF) can also impair the sync signals—this capacitor is shorted out on 625 lines by 2S1f.

The screen grid decoupler 2C43 in the sync section of the PFL200 can also fail: as we have seen this is the reservoir for 3SR2. Leakage in the grid coupling capacitor 2C34 will put a positive potential on the grid, upsetting the valve's operating conditions and altering the shape of the sync pulses. A voltage check at pin 1 of the valve will detect this fault. If an oscilloscope is available the sync pulse distortion can be readily seen.

Blank Raster (405)

Normal sound on 405 lines accompanied by a blank raster suggests absence of the vision signal and often indicates breakdown of the vision detector diode 2MR4. This is mounted in the final i.f. can but can be tested at 2R22 which is adjacent to 2V4. Connect the meter between the junction 2L22/2R22 and chassis: with the leads one way round a reading of less than 500Ω should be obtained while reversing the leads should give a reading in excess of 1MΩ. No reading indicates that the diode is open-circuit, a short-circuit is obvious. Replacement requires removal of the can but this is not a difficult job.

AGC Troubles

A set with a picture on 625 lines accompanied by wavy lines running down the edges was traced to failure of the anti-lockout diode 2MR5. In another case this symptom was caused by breakdown in 2C22—see sync fault above. Loss of emission in either of the i.f. valves 2V1 or 2V3 will cause a reduction of the a.g.c. bias leading to overloading in the early stages. The symptoms will be a combination of sound-on-vision and vision buzz on sound, depending on how seriously the a.g.c. voltage is effected. It can be cancelled completely by grid leak in 2V1.

When checking valves by substitution take care that the EF183 and EF184 valves are not accidentally interchanged: the former is a variable-mu type and the latter a straight pentode and interchanging them can give a picture with symptoms suggesting an a.g.c. fault.

A defective valve can give sound-on-vision. An unusual case with sound-on-vision as the symptom came up recently. Replacement of the first i.f. valve 2V1 brought no improvement but a quick check of the voltages around the base revealed absence of anode voltage. Incidentally the voltages on the bases can be measured without lowering the chassis by replacing the positive test prod with a sewing needle: the fine point will contact the pins where they extend from the steatite base and pass through the printed panel. In the case in question further testing revealed that the anode decoupling resistor 2R7 was open-circuit—replacement cured the fault. One might have expected complete absence of picture with no voltage at the anode but in this case the picture was still viewable.

Sound Faults

Sound troubles are frequently due to the PCL82 valve. Heater-cathode leakage will give distortion accompanied by a higher than normal voltage across the series-connected cathode resistors 2R54/55. Leakage in the grid coupling capacitor 2C61 will also result in distorted sound. Weak sound has been caused by increase in the value of the triode anode load resistor 2R51.

If intercarrier buzz on 625 lines appears check that the discriminator balance potentiometer 2RV2 has not been disturbed.

There is a separate h.t. line to the sound output pentode: where hum on sound is experienced the smoothing electrolytic 3C44—part of the block 3C44/5/6—can be responsible.

Summary

To sum up, faults in the i.f. panel should be no more difficult to trace than defects in the timebase, tuners, etc. Fortunately coils in cans seldom give trouble except for the occasional dry-joint. Inspect carefully for discoloured resistors, leaky or swollen capacitors, cracks in the printed panel and loose or corroded plugs and sockets where the two panels in this chassis are interconnected.

The system switches on both panels have some play which can become excessive. After repairs have been completed check that the central control lever has sufficient throw to ensure solid make and break on both panel switches.

DC RESTORER CIRCUIT

Keith Cummins

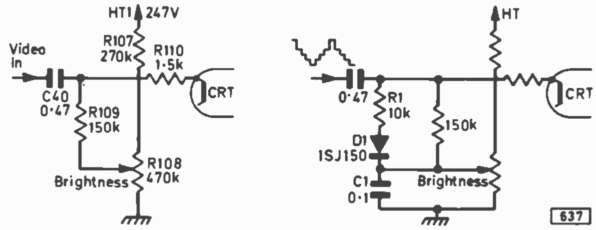


Fig. 1 (left): The video signal is a.c. coupled by C40 to the cathode of the c.r.t. in the BRC 1500 chassis. The two video stages are also a.c. coupled. Since a signal passed through a capacitor loses its reference level, this form of coupling means that the black level of the video signal is no longer stable but varies with alterations in average signal amplitude.

Fig. 2 (right): Simple d.c. restorer diode circuit first tried out. This proved to be only about 50% effective due to the tube cathode current passing through the circuit.

SYNC tip or line-gated automatic gain control circuits are used in most single-standard 625-line receivers. As a result a stable video signal is produced at the video detector, the black level at this point in the receiver being constant.

DC Restoration Techniques

Unfortunately a.c. coupling is then frequently employed in the video stages and in consequence the d.c. level is lost. The d.c. level can be restored however, thereby preserving accurate representation of the grey scale. D.C. restoration can take place before the video output stage, which must then of course be d.c. coupled to the tube, or at the tube itself. This latter approach has been adopted in the circuit to be described. It has the advantage of minimal drift, does not affect the synchronising or intercarrier sound, and can be easily incorporated in almost any receiver which uses an a.g.c. system as specified above.

Prototype Circuit

The prototype circuit was developed using a BRC 1500 chassis. The original tube cathode coupling circuit used in this chassis is shown in Fig. 1 while Fig. 2 shows the basic d.c. restoration circuit first tried—D1 is the d.c. restorer diode. C1 is added from the slider of the brightness control to chassis in order to complete the a.c. path to the diode. The incoming signal is positive-going with the sync pulses representing the maximum positive signal excursion. The sync pulses cause the diode to conduct, thereby setting the video signal on a pedestal voltage set by the brightness control. Since the sync pulse amplitude is constant the picture black level remains at the level set by the brightness control.

The prototype circuit did not operate ideally unfortunately for one simple reason: the tube cathode current flows through the d.c. restorer circuit and the brightness control. This is in effect negative d.c. feedback and offsets the d.c. restoration action so that while the video presentation is improved the d.c. restoration is only about 50% effective.

Final Circuit

The final circuit evolved is shown in Fig. 3. A buffer transistor Tr1 connected as an emitter-follower is interposed between the d.c. restorer and the tube. The tube's cathode current now flows through the emitter resistor R2 instead of through the d.c. restorer circuit. As a result the d.c. restorer's action is affected only by the small base current of the BF179 transistor. The effect of this is very slight and the action of the whole circuit shows a 95% restoration of the d.c. level.

The component values and reference numbers shown on the circuits apply to the BRC 1500 chassis. It will be seen

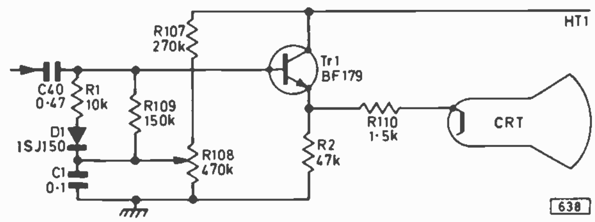


Fig. 3: Circuit finally adopted, with buffer stage Tr1. The diode (D1) is a Radiospares type 1SJ150: a near equivalent is the OA202.

that one diode, one transistor, one capacitor and a couple of resistors are the only extra components required to provide a stable black level. The advantages in picture presentation seem great compared to the cost of these five components.

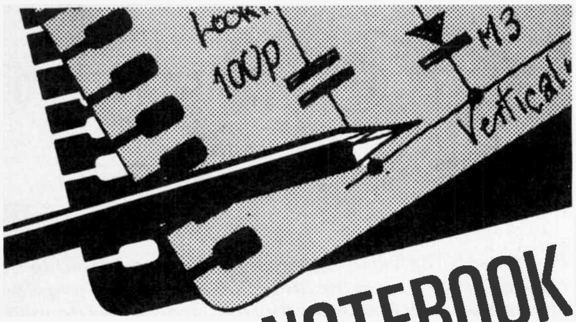
It should be possible to adapt the circuit for use with other receivers, but those that use mean-level a.g.c. are not suitable for this modification.

Assembly Details

The extra components can be easily accommodated on the BRC 1500 chassis. D1 and R1 can be wired in series, sleeved up and soldered on to the printed side of the board across R109. The c.r.t. cathode lead is removed from its tag on the chassis, soldered to the emitter lead of Tr1 and then sleeved up. The base lead of Tr1 is connected to the point vacated by the c.r.t. lead. Tr1 collector is connected to the h.t. line, R2 wired across the tube base panel—between the video lead input point and tag 22 (c.r.t. pin 5 connection)—and finally C1 connected from the slider of the brilliance control to earth, behind the controls.

Results

Altogether the modification is well worth while. For comparison two sets fitted with the 1500 chassis were operated side by side, one as standard production and the other incorporating the modification described. The sets were tuned to the same programme of course. The modified receiver's performance outstripped that of the production model by providing freedom from "milky" scenes, sharp captions against a black background, etc.—thus proving the success of the operation. ■



SERVICE NOTEBOOK

G. R. WILDING

Bottom Cramping

Cramping at the bottom of the picture is generally due to one or more of the following causes: (1) a low-emission output valve; (2) reduced value output valve cathode bias resistor; (3) loss of capacitance in the output valve cathode decoupling electrolytic capacitor. In the case of a 12in. Ferguson portable fitted with the Thorn/BRC 980 chassis that came our way recently however the last two causes had to be immediately ruled out since the field output pentode in this chassis is biased by returning its grid to a suitable voltage point along the negative rectified heater chain. This method of biasing the valve is used as a safety precaution: if the heater chain rectifier goes short-circuit thus greatly over-running the valves and c.r.t. an a.c. voltage will be applied to the field output valve grid constantly tripping the field hold and making viewing impossible.

The circuit is shown in Fig. 1. A new 30PL14 failed to restore a normal raster and it was clear that the cause of the trouble was insufficient grid bias due to a leak in a grid circuit capacitor. This was eventually traced to a leak approaching 2MΩ in C61, the 0.3μF capacitor which smooths the grid bias. On fitting a replacement normal linearity and height were obtained. The leaky capacitor had formed in conjunction with the smoothing resistor R85 a potential divider which reduced the normal grid bias by about a third.

As the rectified heater current is a half-wave supply it might be wondered how a capacitor as small as 0.3μF can remove the a.c. component to leave a pure d.c. voltage as the negative grid bias. The answer of course is the high value of R85: the resistance of this is so very much greater than the reactance of the capacitor (approximately 10kΩ) at 50Hz that virtually the entire a.c. component is developed across R85—with zero d.c. voltage drop across it since there is zero current—leaving the full d.c. voltage across C61 as grid bias.

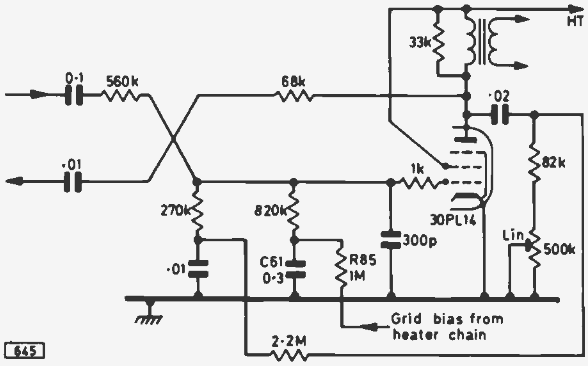


Fig. 1: Field output stage used in the BRC 980 chassis, with grid bias obtained from the heater chain.

Faint Horizontal Line

The complaint with a 19in. dual-standard Defiant receiver (Plessey chassis) was the presence on the screen of only a faint horizontal line. This was obviously due to lack of output from the field timebase but with this fault the line is usually sufficiently bright to cause screen burn if the set is left on long enough. The back of the set was removed and on inspection a charred resistor was seen near the e.h.t. can. This proved to be a decoupling resistor in the boost feed to the tube's first anode, focus electrode, and the triode anode circuit of the PCL85 field timebase valve. There was a dead short from the feed end of this resistor to chassis—thus robbing the tube of first anode voltage and greatly reducing the brightness of the horizontal white line. The associated decoupling capacitor proved to be OK so we concluded that the short must be caused by a breakdown in the printed-circuit panel insulation—this frequency develops in these early dual-standard models.

The printed wiring leading to the height control was then cut; a resistance test proved that the fault was in this part of the circuit but there was no short at the height control h.t. tag. Further investigation then showed that the wiring from the feed resistor had arced over to an earthed point, the resulting burn disconnecting the printed feed to the height control. Normal results were obtained after replacing the resistor, cutting away the charred panel surrounding the shorted print and replacing this with a jumper lead.

When you find a short-circuit in a printed panel it always helps—particularly if you haven't the service sheet to hand—to cut through feeds to narrow down the area for detailed testing. But first make sure that the trouble isn't a valve internal short.

Transposed Reds and Greens

The reds and greens would occasionally be transposed on a 19in. Hitachi colour receiver, clearly indicating that the bistable circuit which drives the PAL switch was not being firmly synchronised. Without synchronisation there is of course on any PAL set only a 50-50 chance that the bistable will operate in the correct phase, but as the fault developed only occasionally on this set it appeared that the ident signal from the second ident stage (Tr1008, Fig. 2) was intermittently missing, greatly attenuated or even phase shifted—misadjusted ident tuning coils frequently produce this last fault in many makes of receiver.

Suspicion was first centred on diode CR1006 which couples the ident signal (and the line-frequency trigger pulses) to Tr1009, one of the bistable transistors, but a resistance test proved it to be OK. There appeared to be no dry-joints in the coupling circuitry and as there was colour with even the weakest signal input it seemed that Tr1008 was developing normal output—as the circuit shows an output is taken from the stage to activate the colour-killer circuit and also the a.c.c. circuit. This supposition was strengthened by the fact that the voltages

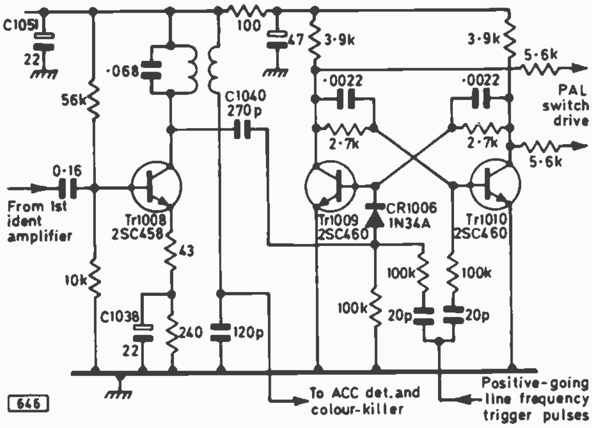


Fig. 2: Second ident stage and bistable circuit used in the decoder section of Hitachi colour sets. Poor bistable synchronisation was due to C1040 being faulty.

everywhere were normal, including those at the a.c.c. detector stage. To be on the safe side as the fault only appeared occasionally and the receiver had had prolonged use we decided to replace the two electrolytic decouplers in the second ident stage—C1038 in the emitter circuit and C1051 in the collector supply line—in case they had to some extent dried up or developed poor power factor.

During a prolonged test run the colours always stayed correct but just as we were about to refit the back the symptom once again appeared. There seemed little else to try but replacement of the ident coupling capacitor C1040 although it appeared to be perfectly all right. This measure resulted in complete removal of the fault symptoms.

Smell of Burning

A smell of burning was the complaint with a Philips Model 23TG132A though the owner said there was a good picture and perfect sound. This was surprising since a smell of burning is usually accompanied by some evidence on the picture or sound. On switching the set on a full-size picture was obtained though it wavered about somewhat, especially at high brilliance settings, in a manner suggesting a faulty e.h.t. rectifier. On removing the back the cause of the trouble was immediately apparent: the lead to the top cap of the DY86 e.h.t. rectifier from the overwinding on the line output transformer had burnt away for almost half an inch, a vivid arc maintaining the a.c. feed to the anode of the rectifier. Yet there were no signs of arcing on the screen! On fitting a short length of e.h.t. cable perfect results were obtained.

TO BE CONTINUED

LATE PUBLICATION

We apologise for the delay in publishing this issue of *Television*, due to printing problems. We hope to be back to normal next month but this cannot at present be guaranteed.

THE 'TELEVISION' COLOUR RECEIVER PART 16 MODULE INTERCONNECTIONS

THE aim this month is to list the module interconnections in detail and indicate the recommended wiring system to be adopted. Also to clarify the line output transformer, e.h.t. tripler and focus unit connections. A component pack of components associated with the line output transformer is being prepared. A warning however: it is most important to get the earthing arrangements around the c.r.t. correct in order to prevent damage due to flashovers —see later.

Wiring

The inter-module wiring of the receiver is listed in Table 1. It is suggested that stranded wire such as 7/0.2mm is used except where detailed below. Wires should be run round the frame of the cabinet after leaving a module and tied into forms to keep them tidy and the receiver uncluttered. 6–9 inches extra length should be allowed on all runs to modules which are movable so that they can be withdrawn with no hinderance. This extra length can be formed into a "hump" at the back of the module. All connections should be taken to one end of each module.

Different coloured sleevings could be used for the numerous wires and it is suggested that the cable ends are marked with their board destination codes (1A, 1B, etc.) as they are placed in position before soldering. This is probably most easily done with a piece of Sellotape wrapped round the wire, with an identifying slip of paper trapped under a Sellotape fold.

The following cables should be screened:

I.F. Module: 2B I.F. input, with screen connected to chassis at 2J.
2D Chroma output with screen connected to chassis at 2J.
2E Luminance output, contrast slider. Screen of both leads to 2J.
2F A.F.C. with screen to 2G.
2H Contrast potentiometer bottom with screen to 2J.
2I Contrast potentiometer top with screen to 2J.
2K Tuner a.g.c. output with screen connected to chassis at 2J.
Pin C of L124/5 assembly with screen to pin E of this assembly.

Audio: 9C Volume control top with screen to 9J.

The following should use twisted wire:

I.F. Module: 2C Audio output—twisted with earth wire from 2J.
Degaussing: 7A and 7B twisted together.
C.R.T. Base Panel: 9D and 9E twisted together.

Standard three-core mains coded cable of 5A r.m.s. capacity should be used into the receiver to the mains switch and thence to the power supply unit. The earth should be looped around the switch. The lead leaving the receiver should be secured at some point to prevent pull on the switch connections.

Line Output Transformer

The line output transformer tags are identified in Fig. 1 this month while Fig. 2 shows all the feeds taken from the transformer. Connections to the e.h.t. tripler unit are shown in Fig. 3: the unit must be mounted a minimum of 20mm clear of any metal work (except of course the fixing bolts). There are three connections to the Erie type focus unit: these are marked A, V and E on the unit itself. A is the input from the e.h.t. tripler (see Fig. 3), V is the output to 9F on the c.r.t. base board and E the chassis connection (to 6C on the power supply unit). There is also a connection point marked B which should be insulated with sleeving. The wires to the focus unit must first be soldered to the Pressac connectors provided and the contacts then pushed on to the focus unit pins: on no account should the wires be soldered directly to the focus unit pins as this will damage the unit.

Arrangements are at present being made for the supply of a component pack (Pack 24) for the components—boost capacitor C602 etc.—associated with the line output transformer. It should meanwhile be noted that the capacitors (C601–3) are either high-voltage or pulse types; R605 is rated at 1W and R606 at 5W. The components can be mounted on the line output transformer itself provided they are ½–1in. clear of the transformer.

CRT Outer Coating

The Aquadag c.r.t. outer coating has to be earthed of course as with a monochrome receiver. This should have been dealt with when we described the degaussing arrangements in Part 11 (February). Two long springs or lengths of braiding with springs at one end to provide tension should be fixed at each side of the c.r.t. magnetic shield on the inside so that when the shield is mounted over the c.r.t. the springs/braiding rest against the c.r.t. bowl. It is important that the springs/braiding make good electrical contact with the magnetic shield which in turn must be earthed by running a lead from the degaussing component tagstrip to 9E on the c.r.t. base panel.

Modifications & Corrections

Flyback Blanking: The flyback blanking circuit has been modified as shown in Fig. 4. The field blanking pulses now come from point 4E on the timebase board as

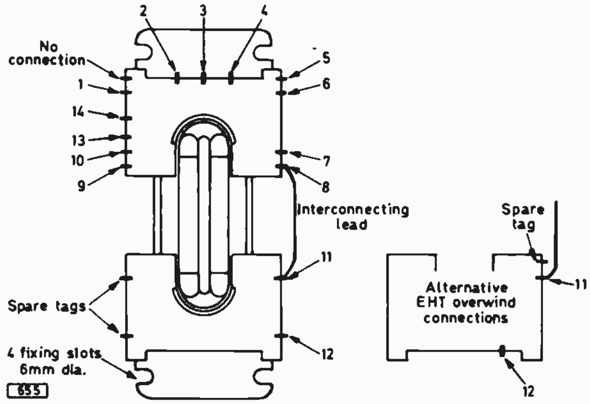


Fig. 1: Line output transformer tag identification.

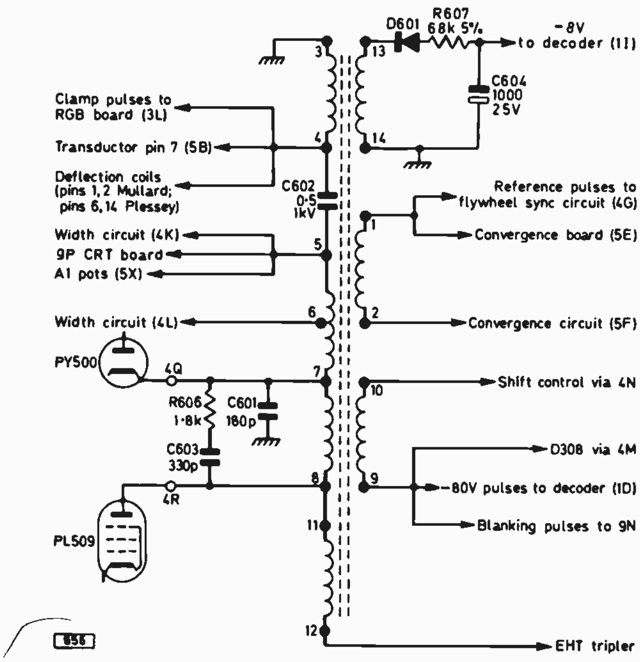


Fig. 2: Line output transformer circuit, showing all feeds to and from the various windings. Connect the earthed pins 3 and 14 to 6C on the power supply board. R605 is connected from the tripler (see Fig. 3 this month and Fig. 3, page 17, November 1972) to either pin 1, pin 3 or pin 4 of the line output transformer, giving e.h.t. level adjustment. Any low-power silicon diode can be used as the −8V rectifier D601, e.g. 1N4148 or 1N914. D601, R605-7 and C601-4 will be in Component Pack 24—details next month.

originally intended. The line blanking pulses are taken from tag 9 on the line output transformer and fed via a new capacitor (C704) and R709 to the junction R712/R708. The c.r.t. base panel arrangements need to be modified as follows: C704 replaces R709 on the board (see Fig. 2, May 1973), R709 being connected instead on the print side of the board from C704 to the junction C703/R712/R708. The print connection on the board between R710 and the original position of R709 must be broken. Despatch of Pack 22 was held up while these modifications were being sorted out and we acknowledge the help given us by Forgestone Components in making these changes.

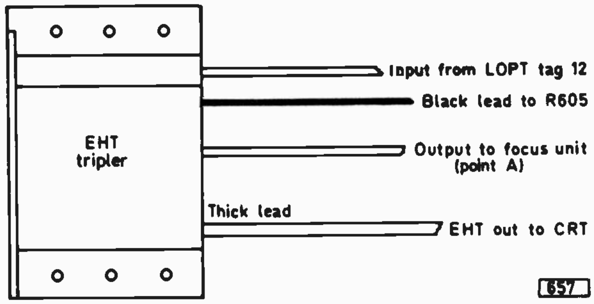


Fig. 3: Connections to the e.h.t. tripler.

Degaussing Coils: Anyone winding their own degaussing coils should note the following correction. The gauge of wire specified in the February issue for use with coils for the smaller sizes of tube (19–22in.) should have been given as 34 s.w.g., not 30 s.w.g. If the wrong wire is used the circuit resistance on switch-on will be too low.

Line Oscillator Tuning: The value of the line oscillator tuning capacitor C322 was incorrectly specified as $0.0033\mu F$. It should be four times greater, i.e. $0.0132\mu F$. To get the line oscillator to operate at the correct frequency an $0.01\mu F$ capacitor should therefore be added in parallel with C322. This capacitor has been given the reference number C332 and will be included in Pack 24. Good oscillator stability is essential in a colour receiver since pulses from the line timebase are used in the decoder and elsewhere and their timing is vital. C332 should therefore be a good quality component, e.g. RS $\pm 2\frac{1}{2}\%$ polystyrene.

V.H.F. Varactor Tuners: Mullard type ELC1042 v.h.f. varactor tuners are available from Forgestone Components, Ketteringham, Wymondham, Norfolk at £4.95 including postage to Eire. Other overseas constructors requiring this tuner should write to Forgestone for a postage quotation.

Convergence Clamping Transistors: There have been several slightly different batches of the NKT279T. In each case however they are coded with a red spot which indicates the collector lead.

Ident Coil: It seems that in a few cases the wrong core has been supplied with the ident coil (L4 on the decoder board). The result is low-amplitude ident output and of course no colour since the ident sinewave is rectified to provide the chrominance channel turn-on bias. Constructors who have reached an advanced stage should bear this in mind. We are seeking information on how this point can be checked. The circuit works perfectly with the correct core.

Line Output Valve Screen Resistor: The 6W line output

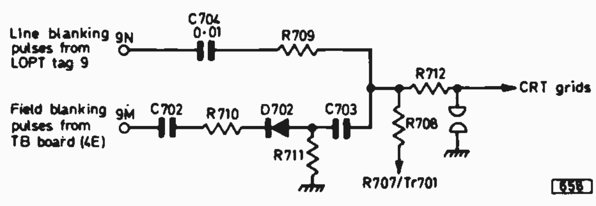


Fig. 4: Modified flyback blanking circuit.

valve screen resistor R351 runs hot and should be mounted off the board therefore, say by 10mm. Those constructors who have mounted this resistor close to the board could insert a small piece of asbestos beneath it. There is otherwise the possibility of damage to the board.

Power Supply: The problem with the mains transformer is being investigated.

We shall be providing a recommended switch-on procedure and clearing up other outstanding matters next month.

Table 1: Module Interconnections.

In the following table the individual module connection points are listed first, followed by the lead destination. The following abbreviations are used: Dec (decoder); IF (i.f. panel); Au (audio module); RGB (RGB board); TB (timebase board); Con (convergence board); PS (power supply unit); Deg (degaussing circuit); Tu (tuner/preamplifier board); CRT (c.r.t. base panel); LOPT (line output transformer).

Decoder

1A	6N (PS)
1B	Saturation control slider
1C	2L (IF)
1D	4M (TB)/LOPT tag 9
1E	3E (RGB)
1F	3D (RGB)
1G	2D (IF)
1H	2M (IF)
1I	R607/C604 (LOPT)
1J	6C (PS), 2J (IF)

IF Panel

2A	6P (PS)
2B	8K (Tu)
2C	9B (Au)
2D	1G (Dec)
2E	3C (RGB), contrast control slider
2F	8F (Tu)
2G	8G (Tu)
2H	Contrast control (bottom)
2I	Contrast control (top)
2J	6C (PS)/9J (Au)/8D (Tu)/1J (Dec)/3J (RGB)/control panel metal
2K	8A (Tu)
2L	1C (Dec)
2M	1H (Dec)
2N	4D (TB)
L124/5 pin C	8L (Tu)
L124/5 pin E	8M (Tu)

RGB Panel

3A	6N (PS)
3B	6H (PS)
3C	2E (IF)
3D	1F (Dec)
3E	1E (Dec)
3F	5BB (Con)
3G	5DD (Con)
3H	5FF (Con)
3J	6C (PS), slider and bottom of brightness control, 2J (IF)
3K	Top of brightness control
3L	LOPT tag 4

Timebase Board

4A	6I (PS)
4B	6J (PS)
4C	6G (PS)
4D	2N (IF)
4E	9M (CRT)
4F	Deflection coils 6 or 3′ (Mullard), 1 or 11 (Plessey)
4G	5E (Con)/LOPT tag 1
4H	9Q (CRT)
4J	6C (PS)
4K	LOPT tag 5
4L	LOPT tag 6
4M	LOPT tag 9, 1D (Dec), 9N (CRT)
4N	LOPT tag 10
4P	5A (Con)
4Q	LOPT tag 7
4R	LOPT tags 8/11
4S	6D (PS)
4U	6E (PS)

Convergence Board

5A	4P (TB)
5B	Deflection coils 1 or 2 (Mullard), 6 or 14 (Plessey)
5C	Deflection coils 1′ (Mullard), 13 (Plessey)
5D	Deflection coils 2′ (Mullard), 7 (Plessey)
5E	LOPT tag 1, 4G (TB)
5F	LOPT tag 2
5G-5K	Line radial dynamic convergence. See November, April and May issues as appropriate
5L	6C (PS)
5M	Deflection coils 6′ (Mullard), 4 (Plessey)
5N	Deflection coils 3 (Mullard), 8 (Plessey)
5P	6J (PS)
5Q-5T	Field dynamic convergence. See November, April and May issues as appropriate.
5U	9C (CRT)
5V	9B (CRT)
5W	9A (CRT)
5X	LOPT pin 5
5AA	6H (PS)
5BB	3F (RGB)
5CC	9L (CRT)
5DD	3G (RGB)
5EE	9K (CRT)
5FF	3H (RGB)
5GG	9H (CRT)

S401/2 L404. See Fig. 7, April 1973

Power Supply

6A	Line (mains) from mains switch
6B	Neutral (mains) from mains switch
6C	Earth (mains), board earths, 9E (CRT), saturation control (bottom)
6D	4S (TB), 7B (Deg)
6E	4U (TB)
6F	7A (Deg)
6G	4C (TB)
6H	3B (RGB), 5AA (Con)
6I	4A (TB)
6J	4B (TB), 5P (Con), 8J (Tu)
6K	8I (Tu)
6L	9A (Au)

6M 8B (Tu)
6N 1A (Dec), 3A (RGB), saturation control (top)
6P 2A (IF)
6Q 9D (CRT)

Degaussing
7A 6F (PS)
7B 6D (PS)

Tuner/Preamplifier Board
8A 2K (IF)
8B 6M (PS)
8C Tuner control unit (see Fig. 6, March 1973)
8D 2J (IF), tuner control unit (see Fig. 6, March 1973)
8E Tuner control unit (see Fig. 6, March 1973)
8F 2F (IF)
8G 2G (IF)
8H Tuner control unit (see Fig. 6, March 1973)
8I 6K (PS)
8J 6J (PS)
8K 2B (IF)
8L Pin C of L124/5 (IF), tuner control unit (see Fig. 6, March 1973)
8M Pin E of L124/5 (IF), tuner control unit (see Fig. 6, March 1973)

Audio Board
9A 6L (PS)
9B 2C (IF)
9C Volume control (top)
9E Loudspeaker (line)
9J 2J (IF), LS (chassis), volume control slider and bottom

CRT Base Panel
9A 5W (Con)
9B 5V (Con)
9C 5U (Con)
9D 6Q (PS)
9E 6C (PS)
9F Focus unit (point V)
9G Solder tag on blue lateral coil clamp
9H 5GG (Con)
9J 6C (PS)
9K 5EE (Con)
9L 5CC (Con)
9M 4E (TB)
9N LOPT tag 9/4M (TB)
9P LOPT tag 5
9Q 4H (TB)

Tuner Control Unit
See Fig. 6, page 232, March 1973.

Line Output Transformer, EHT Tripler and Focus Unit
See diagrams and text this month.

Controls
Volume: top 9C (Au)
slider and bottom 9J (Au)
Brightness: top 3K (RGB)
slider and bottom 3J (RGB)
Saturation: top 6N (PS)
slider 1B (Dec)
bottom 6C (PS)
Contrast: top 2I (IF)
slider 2E (IF)
bottom 2H (IF)
} Connect screens of these leads to metal of control panel.
Mains switch: in, line and neutral from mains,
out, line to 6A (PS) neutral to 6B (PS)
Loop earth lead across switch to 6C (PS)

COLOUR RECEIVER PROJECT: ACKNOWLEDGEMENTS & ADVISORY SERVICE

Referring back to Part I of this series we did point out to readers that to embark on the design, engineering and construction of a colour television receiver is indeed an ambitious project, all the more so when it is carried out on a part-time basis. We have been pleased and flattered therefore at the interest shown in the project—this surpassed all expectations.

We would like to acknowledge the valued assistance and suggestions that have been made from time to time during the series, and in particular the lengthy and helpful discussions that have taken place between our designer, the magazine and the various component suppliers.

In a project of this magnitude it is inevitable that personal circumstances which make it difficult to keep up progress can arise; the pressures on us at this end have been great, but we have done our best to keep the problems to the minimum.

Not the least of our difficulties has been the component supply situation. In a market which has been turned upside down during the past couple of years, with manufacturing and trading policies altered, we have had amongst other things to contend with rapid and substantial price increases. The percentage of imported components in electronic equipment today is not always appreciated and nothing can be done about price rises in this area. We would like to thank those in the component supply trade who have been directly involved in the project for their patience and co-operation in making available as quickly as possible the designer-specified components.

We are grateful for the encouragement given by the many readers who have written to us on this project, especially those who started with a full understanding of the involvement from reading Part I. In several cases it has been possible for us to incorporate constructive suggestions in the articles.

We have received a large number of letters from readers who have presented us with their particular problems and are answering these as fast as we can. Constructors will doubtless welcome the idea of some of the more common problems being answered in the magazine itself, and to this end we are setting up an advisory service. We will be publishing more details of this in the next instalment. Meanwhile we strongly recommend constructors to await the publication of full instructions before writing to us for advice.

RENOVATING the RENTALS

15 PHILIPS G6 CHASSIS

CALEB BRADLEY B Sc

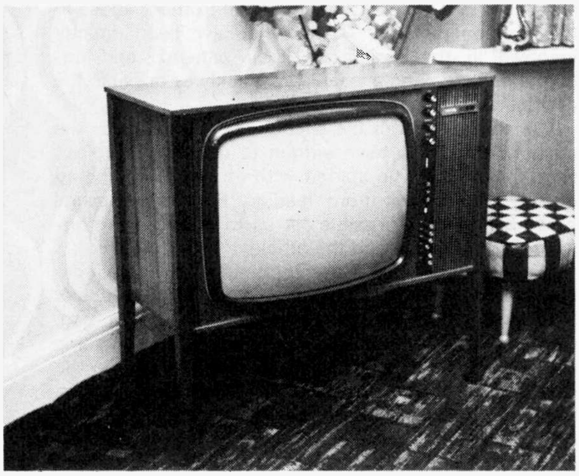
PART 1

ALTHOUGH this colour chassis dates back to the very beginning of colour television in the UK and has passed through many stages of modification including "pruning" from dual- to single-standard operation it has always been noted for its good picture quality when correctly set up. Some work may be needed to achieve this though since the circuit is elaborate—using no less than 21 valves and 17 transistors—and is festooned with far more components per stage than modern designs. Sets are readily available on the ex-rental market at fair prices, almost always in the version shown in the photograph, and are a good prospect for renovating. We are covering the dual-standard version of the G6.

The cabinet is supported on four legs that extend up each corner and are fitted with keyhole plates which hook on to bolts projecting from the cabinet corners. If the set is used without legs it looks rather strange unless the corners are covered in matching veneer. There is usually no knob present on the back where "tint" is stencilled; this control is often cut out as unnecessary on a properly adjusted set. Its function was to vary slightly the relative gains of the R – Y and B – Y output stages.

Access to Chassis

Chassis accessibility is fair, the three printed panels (i.f., decoder and timebase) being mounted in a vertical frame which can be swung out at the top after removing two plastic pegs. This reveals the track sides of the panels, the power supply components at inside bottom and untidy hanks of wire going everywhere. The chassis hinge at bottom left is formed by a bolt which can be removed to allow the frame to be withdrawn from the cabinet—this is the only way to get at some of the line output stage components. The intermittent plug and socket troubles that plague some monochrome sets of this make are mostly avoided on the G6 where the printed panels are wired in, although this increases the possibility of trouble due to dry joints. The convergence and A1 (background colour) controls are mounted on a shallow box which after removing four screws can be slid out of the set and stood on top of the cabinet for adjustment. Take care not to upset all your careful adjustments when sliding it back in!



The Philips Model G25K500, a 25in. receiver fitted with the G6 dual-standard colour chassis.

Tuner

The tuner is an integrated u.h.f./v.h.f. push-button type. The system for each button is set by rotating a slotted knob on the rear of the tuner with the button unlatched. The embossed arrows on these knobs are easier felt than seen. If an explorative child succeeds in latching down all six buttons at once they can be released by pressing the top one farther in.

IF Panel

The circuit of the i.f. panel is shown in Fig. 2 and its layout in Fig. 1. There are so many tuned circuits that it is vital to refrain from twiddling, though it is not difficult to get a single core back to its correct position after a repair. Cores with the original factory sealant (a reddish goo) intact should certainly be left alone.

Weak Contrast/Blank Raster

Weak contrast or a completely blank raster are common fault symptoms on this chassis and the tuner is usually wrongly suspected. Check both the r.f. and oscillator supplies to the tuner (12V 'A' and 'B') since it still works weakly if the former is missing, i.e. the r.f. transistor continues to work with the a.g.c. bias. Check the emitter voltages of the i.f. transistors T2142 and T2143—about 2.4V with no signal. These transistors can be faulty but most stock faults lie around the a.g.c. amplifier.

AGC Circuit

The a.g.c. circuit operates as follows. T2145 is normally held on by bias from R2098 and the tuner a.g.c. voltage across C2040 is low. When a strong signal is received, the negative-going sync tips at T2144 collector draw current via X2153 so that the mean voltage on C2041 is reduced and in consequence T2145 collector voltage becomes more positive. The gains of the tuner and i.f. stages are thus reduced by the increased forward a.g.c. bias. X2151 prevents the i.f. a.g.c. bias rising above the voltage set by the potential divider R2161/2. The a.g.c. control R3485,

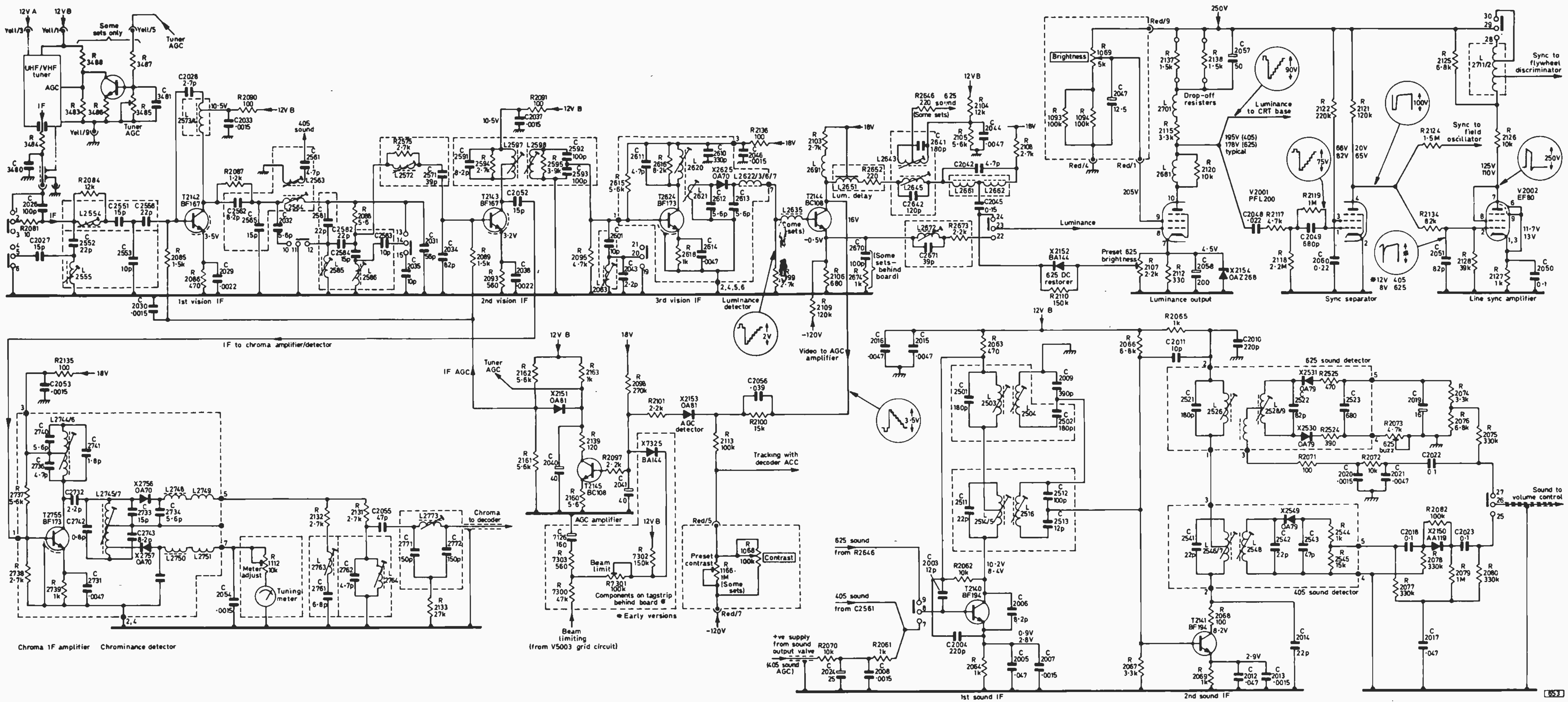


Fig. 2: Circuit diagram of the i.f. panel, which incorporates the luminance channel, sync separator and a.g.c. circuits in addition to the main i.f. channel and the sound and chrominance i.f. sections. The 405/625 system switch is shown in the 625 position. Where two voltage readings are shown the upper one applies on 405 lines and the lower one on 625 lines. During the long life of this chassis a number of modifications were introduced. These were mostly minor component value amendments. Modifications worth noting on the i.f. board are as follows: in later versions T2142 and T2143 are both type BF196, the tuning meter and R1112 are removed, and C2051 is changed to 5.6pF and connected in parallel with R2134 instead of R2128; in earlier versions the screen grid of the sync separator V2001 is fed from a potential divider, R2122 being changed to 33kΩ and R2123 10kΩ occupying the position of C2060. With this latter arrangement the anode voltage of the sync separator is 85V and the screen grid voltage 57V. Also on earlier versions the switching on L2711/2 was omitted.

if fitted on the tuner, can be set as follows: adjust receiver for 0V across X2151 then set R3485 for 4.5V across R3488. Take care not to short-circuit R3488 since T3495 (top left above, marked "some sets only") may suffer.

The signal gain is also reduced by two other means: negative current from the contrast control(s) or conduction of the beam-limiter diode X7325 (X1165 in some circuits). The beam limiting supply is obtained from the grid of the e.h.t. shunt regulator valve and the effect is that if the c.r.t. beam current becomes excessive due to over-advanced contrast and brightness the contrast is reduced by a.g.c. action to prevent tube damage. The onset of limiting is set by R7301 (or R1161) and should only be adjusted *after* the e.h.t. regulator V5003 current has been correctly set. Adjust R7301 so that the regulator cathode voltage (across R5054) cannot be driven below 0.1V by misuse of the viewer controls. A curious result of this arrangement is that incorrect line output stage adjustment can cause apparent i.f. faults due to false beam limiting.

Common faulty parts in this area are X2153, C2041, T2145 and X2151.

In the luminance signal chain, loss of picture can be due to the detector diode X2625 (or the chokes in the same can) going open-circuit, or faulty L2635 or T2144. Note that T2144 and T2145 collectors are connected to their cases, and that the BC109 is a superior replacement. Other blank raster culprits are dry joints on the luminance delay line L2651—this can give double-image effects which look like gross misalignment—and of course the luminance output valve V2001. Two similar looking cases of intermittent luminance were found to be caused by very different things: faulty C2592/3 in one case and a broken pin on V2001 socket in the other. The springs in this socket tend to weaken since V2001 is a tall valve mounted horizontally without support.

Brightness on 625 lines is preset by cathode-to-grid d.c. feedback via R2107 and the d.c. restorer diode X2152 which conducts only on sync tips. A convenient injection point for our crosshatch generator (see TELEVISION September 1972) is at X2152 cathode. Variable brightness level can be due to the zener diode X2154 being open-circuit. The viewer brightness control R1069 varies V2001 screen voltage and has a very restricted range. Thus R2107 must be set carefully. Uncontrollable brightness is caused by R1069 going open-circuit. Smeary luminance with poor field hold can be due to C2047 being faulty: on the single-standard G6 chassis the same symptom can be caused by the black-level clamp transistor T2146 (not shown in Fig. 2).

Intercarrier buzz on 625 sound, most noticeable on pictures with large white content, can be minimised by adjusting R2073. If necessary trim L2526/9 also, using a narrow plastic screwdriver.

The chrominance i.f. amplifier/detector stage T2755 is generally reliable though C2736/C2740 can be responsible for intermittent colour. The vast majority of colour stock faults lie on the decoder panel which will be dealt with in a later part.

CONTINUED NEXT MONTH

Workshop HINTS

by VIVIAN CAPEL

TUNING capacitors in transistor radio receivers tend to be in sealed units a fraction of the size of the older air-spaced gang that was a familiar part of every valve radio receiver. A fault therefore usually means replacing the unit—little can be done in the way of repairs. To offset this snag however the protection provided by the casing means that faults are not all that common. This type of gang has been made possible because of the much lower stray capacitance in the input and oscillator circuits of the miniature layout, and simplified wiring to the wavechange switch.

Shorts

The service engineer still encounters many of the older type sets in the course of a week's work however. A not uncommon fault with these is a short across one section of the gang. The trouble is easily identified because the receiver works at one part of the tuning scale—usually the high-frequency, low gang capacitance end—then as the tuning knob is rotated the stations disappear amid a loud crackling sound. This latter effect indicates that the gang is responsible rather than oscillator cessation which sometimes occurs at different parts of the tuning range.

Clearing the short can be tricky as it is not always possible to see just where it is taking place while there are several possible causes. The most common cause is a bent moving vane, usually one of those on the outside of the assembly. The first step therefore is visual examination of the outside plates, especially at about the place where the crackling starts. The culprit can often be spotted and a cure effected by gently bending it back to the straight position.

Bearing Faults

Sometimes however no deformation of the outer plates can be seen and further examination is necessary. Often the bearings of the moving vanes come loose, resulting in fore-and-aft movement. With the narrow clearances between the fixed and moving vanes shorts then inevitably occur. The fault in this case will be of an intermittent nature: sometimes it will be possible to traverse the whole tuning range without trouble while at other times shorts will occur at different spots on the dial each time the tuning knob is swung through its range. The diagnosis can be confirmed by gently pulling and releasing the tuning spindle: play if present will then be apparent.

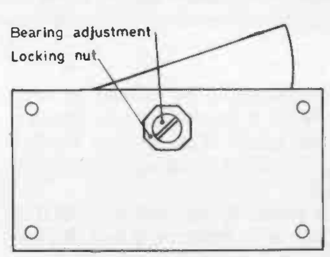
Adjustment is by means of a large screw at the back of the gang in the same plane as the spindle (see Fig. 1). First loosen the locking nut, then screw in the bearing adjustment screw until some resistance is felt. Do not over-tighten as this will make the tuning unduly stiff, causing unnecessary wear, and may push the vanes too far forward causing shorts on the other sides. When you think the adjustment is about right try the spindle for play and undue stiffness: if there is still some play the screw needs a fraction of a turn more but if the spindle is tight to turn the screw needs to come back a shade. Having got the adjustment right keep the screwdriver in the slot to hold the screw in the correct position and then tighten the locking nut. If this procedure is not followed the screw may turn with the nut. Then check again for play and stiffness: sometimes the effect of tightening the locking nut is to pull the adjusting screw back against one wall of its thread, especially if it is rather slack in the housing. This will introduce play again and the only way to overcome the problem is to readjust after once again slackening off the locking nut. This time slightly over-tighten the screw (an eighth of a turn or less is usually sufficient). Then when the locking nut is tightened the adjustment will come right. This incidentally is a ploy that must sometimes be used on bearings other than in the tuning gang.

Fixed Vane Mounting

Another cause of shorting vanes is rather more difficult to put right. The fixed vanes are usually mounted to the metal frame by means of ceramic pillars. If one or more of these breaks the fixed vanes are no longer fixed! This fault is not easy to diagnose unless one is looking for it: I have more than once observed repairmen spending much time and nervous energy trying to clear shorts by bending the moving vanes when it was the fixed ones that were at fault through being loose in this way.

Here again the effect will be intermittent with the shorts appearing at irregular positions and sometimes not at all. Inspection of the ceramic posts will in most cases soon reveal the break, but not always. Sometimes a pillar will shear off where it enters the hole in the frame and everything will look perfectly sound from the outside. The only means of telling where the trouble lies is to gently move the terminal tag of each set of fixed vanes in turn. It will then be seen if and where the vanes move as well. If the problem is a broken pillar and it is not obvious from a visual examination which one is faulty further gentle movement of the vanes will reveal the offending one. A pair of tweezers is useful for doing this. They can grip various parts of the vane assembly and also prevent too much force being used and one of the sound pillars being broken as well.

After identifying the broken pillar we must effect a repair: this is best done with one of the epoxy-resin



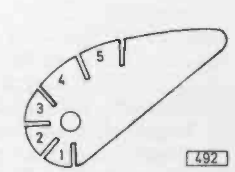


Fig. 1 (left): Gang capacitor rear view, showing the bearing adjustment screw and locking nut.

Fig. 2 (right): End plate of moving vane, showing slots which enable sections to be bent for optimum alignment over the whole tuning range. The correct order of adjustment is as shown (1–5).

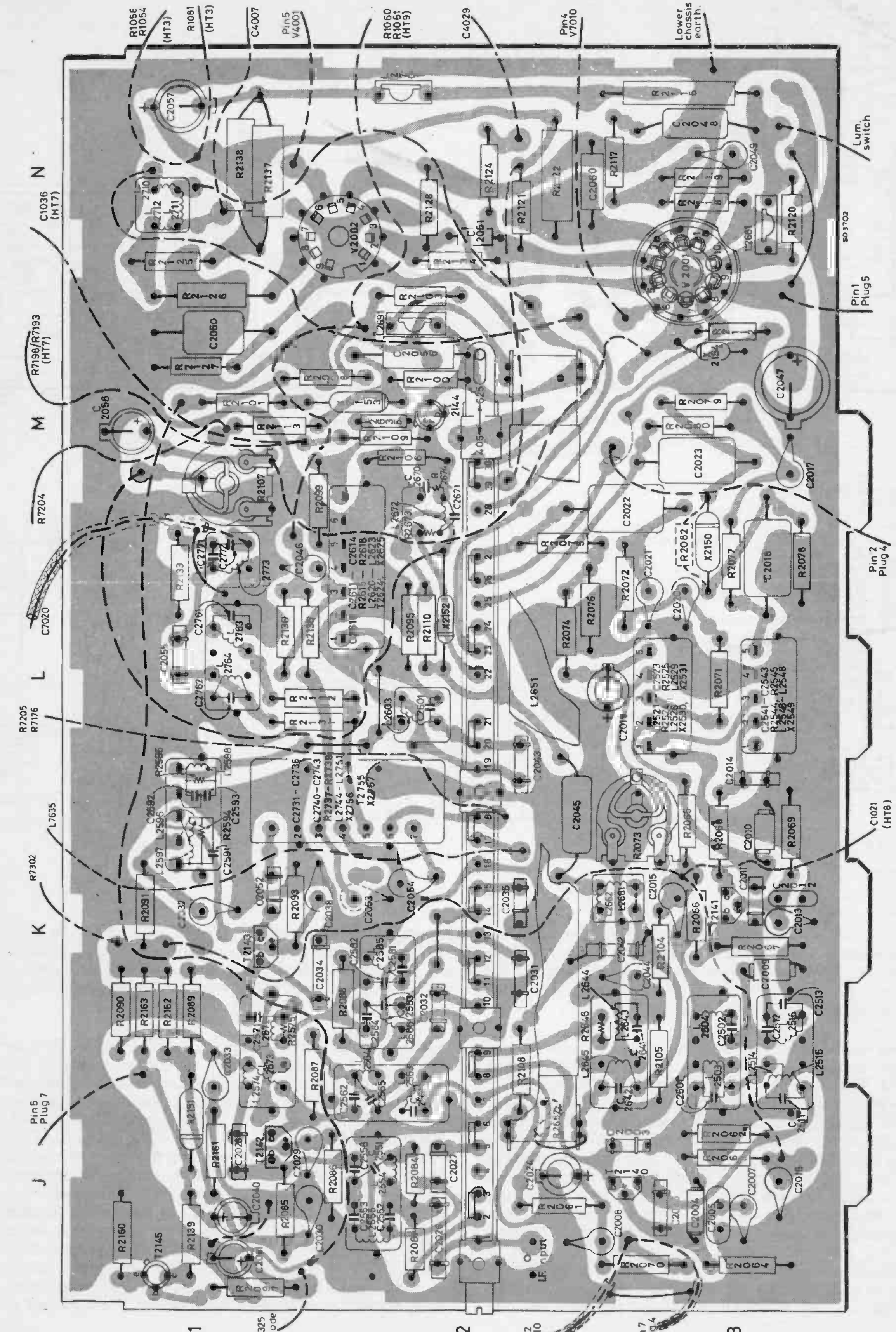


Fig. 1: Layout of the i.f. printed board.

adhesives such as Araldite as this will surround the break and strengthen the actual pillar. It may not be possible to use a conventional adhesive as these need application to the broken faces. Also it may not be possible to force the pillar apart without breaking the others in order to do so. The use of epoxy-resin adhesives makes a longer job of it as they take a number of hours to set—though the process (and the strength) can be increased by application of heat. The main thing to watch out for is that the vanes set in the right position. This means not only putting them so to start with but also ensuring that any vibration or jolt while they are setting does not displace them. To prevent this happening the gang can be fully closed and a few strips of thin card placed between the vanes to hold them in the central position. It may be that the gap is too small even for thin card in which case feeler gauges should do the trick.

Deformed Inner Plates

Especially with older receivers shorts on the gang are sometimes traceable to deformed inner plates among the moving or even the fixed vanes. It is not always possible to examine these and as a result identification of the offending one can be difficult. First we must establish which set of plates is giving the trouble, the oscillator or the r.f. ones. A meter switched to the lowest resistance range will usually identify the faulty set. In some cases there will be a parallel resistance consisting of the oscillator or r.f. coils. This can be low but in most cases will exceed several ohms. When the vanes are rotated the short will be observed as a lower reading. If in doubt or if the available meter does not read low enough to distinguish between a short and the low coil reading the lead to the gang can be unsoldered and a reading taken without the external circuit.

Having decided which set of vanes is at fault the next thing is to locate the offending one. This may be easier said than done. Look down from the top as the vanes enmesh: if this does not reveal the trouble look along the side with the gang at eye level and note whether all the vanes are parallel. Finally if all else fails make up a test circuit consisting of a battery and a suitable lamp and connect it in series with the gang, disconnecting the receiver lead. As the vanes enmesh the lamp will light when the short appears; but, more helpfully, there will be a minute spark between the shorting vanes. If one looks down or along the vanes viewed in subdued light this spark will be visible and indicate immediately which vane is responsible and where. All that then remains is to bend or prise the vane as appropriate.

After bending any of the vanes leave the gang for a short while before completing the job. Sometimes if the metal is at all springy the vane will return to its former position or something near it and the short will recur. In this case it may be necessary to bend the vane beyond the correct position so that it ends up where it should.

Alignment

Having dealt with the gang check the alignment and ganging over the tuning range as good alignment may not now be present over the whole scale. Tracking can be restored by bending the split end-plates of the r.f. moving vanes (see Fig. 2).

This is a problem that sometimes occurs with u.h.f. television tuners, especially in areas that can receive two groups of transmissions. Normally the three u.h.f. stations are close together on the scale so that the tuner does not have to operate over a wide range. Hence any alignment that may be required can be carried out on the frequencies of the local stations. Where two groups of channels can be received it is a different matter: alignment must then be at an optimum at least over the range covered by the two groups.

U.H.F. tuner gangs being small and rigid rarely suffer from shorts but sometimes the tracking over the tuning range is not as good as it could be and it is found that when alignment is carried out around the frequencies of one group of channels it is poor on the other and vice versa.

As with radio tuning gangs split end plates are usually provided to take care of these problems. In either case it is essential to start at the high-frequency end of the scale, that is with the gang fully out. Align by bending the plates for optimum results. Then proceed by meshing the gang and lowering the frequency, bending the sections that have just come into mesh if the alignment of the channels at that point is not at optimum. If you start at the lower-frequency end, with the gang meshed, any alterations subsequently made to the high-frequency channels with the gang partially disengaged will affect what has been done before because retuning to the lower frequencies will bring in the same vane portions that have been bent to affect the higher frequencies. Going the other way, from high to low, does not have this effect because the vane portions bent to align the lower frequencies do not have any effect on the high ones which have already been aligned.

The actual bending is not as precise a method of alignment as could be desired since the capacitance of the bending tool will obviously have a major effect. A long insulated object such as the ubiquitous knitting needle can be used to push the plate inward. If the alignment becomes worse obviously the plate needs to be bent outwards to reduce the capacitance but if it improves then some idea of the amount can be obtained by pushing harder until the gain goes beyond optimum and starts to fall again. The optimum position can be noted and the vane permanently bent to it. If an optimum setting cannot be obtained then other alignment factors must be investigated. The split plates have only a limited capacitance variation and are not a substitute for external trimmers and core tuning. These should be tried first in the normal alignment proceedure: only if optimum ganging cannot be obtained should the split vanes be adjusted.

It is not unknown for shorts in radio receiver tuning capacitors to be caused by conductive material between the plates. Lumps can sometimes be seen adhering to the inner surfaces. If this is the case do not try to flush them out with cleaning fluid as the alignment will be upset and the fluid will take a long time to dry out. If realignment is attempted in these conditions it will drift off as the gang dries. Instead dry clean with card strips passed down between the vanes. It is not necessary for the gang to be meshed to do this; in fact it is easier to do if the gang is not meshed.

Finally while on this subject it is worth mentioning a fault that although not common can be extremely baffling. This is an open-circuit earth to the gang. The chassis connection is one of those things one tends to take for granted, especially after years of servicing wired chassis in which the gang is in physical contact with the chassis. Grommet mounting and printed circuits necessitate a separate earth connection and on at least two occasions I recall being led a merry dance by an open-circuit lead. Now whenever faced with a fault in the r.f. side that doesn't respond to the usual tests I always make a resistance test from the gang frame to earth!

LETTERS

LINE SYNC TROUBLES

With reference to your servicing article on the Bush TV181S/Murphy V2019 series I would like to comment that in 99% of cases where we have experienced line drift, line flicker and the line timebase being right off speed (too fast) in these models the cause has been the 10μF electrolytic 3C31 which smooths the supply to the line oscillator being in various stages of open-circuit.

In *Your Problems Solved* (May) Mr. Cork mentions the problem of three pictures side-by-side following width control trouble (burn up) in a set fitted with the BRC 950 chassis. He will probably find that when the width control burnt out it carbonised the flywheel line sync panel which is situated directly above the width control on this chassis: this gives the effect of three pictures side-by-side, i.e. line right off speed. I have personally experienced this fault and there was much head-scratching before I realised what had happened!—**R. Bettison** *(Boston)*.

FIELD SLIP: BRC 1500 CHASSIS

Since the appearance of your article on servicing the BRC 1500 chassis last August we have noticed that a lot of sets fitted with this chassis have been coming in with the complaint that the field keeps slipping. This is associated with a hum bar on the picture, and pulling. The cause has in all cases been the smoothing capacitor C56 (400μF) in the h.t. feed (HT6) to most of the transistor stages being open-circuit.—**P. Parrock** *(Gravesend)*.

BRC 1400 CHASSIS MODIFICATIONS

THERE are a couple of problems that seem to keep coming up on this chassis, picture pulling when changing channels or on peak whites, and buzz on sound. As a TV engineer who is well aware of the problems on this chassis I would like to draw your readers' attention to the following modifications which will solve most of the trouble.

Pulling: Remove the sync coupling components R44 (10kΩ) and C40 (0.1μF) and insert in their place a single 3,000pF capacitor.

Buzzing: Change the video amplifier screen grid resistor R36 from 3kΩ to 8.2kΩ. It is also a help to convert the set to u.h.f. only operation by disconnecting one end of the 405 vision detector diode W4: although a reverse bias is applied to W4 on 625 it nevertheless tends to have a varactor effect on the final vision/sound i.f. circuit on this system. Careful adjustment of the intercarrier sound coil L27 for minimum buzz, also the ratio detector balance control R87, should improve matters. Some buzz is picked up by the coil assembly L27/L28 from the field scan coils and a factory modification is to fit a metal shield over the can. This is usually bolted into the formers but can be soldered to the can.

Another useful modification to this chassis is to add a 100pF capacitor across the line sync pulse coupling capacitor C43: this increases the locking range of the line hold control, a source of trouble in some receivers.

These modifications really work. Unfortunately in some sets the i.f. coils will be found to have been altered as the buzz sounds like an alignment problem. I modify every 1400 that comes my way in this manner and it only takes a minute.—**L. E. Francis** *(Stourport, Worcs.)*

Editorial comment: To counter the effect of the 405 vision detector on 625 lines another modification is to increase the reverse bias applied to it on 625 lines from 12V to 20V. The bias feed resistor R35 is taken to a potential divider connected across the system-switched h.t. line to provide the required 20V. We must apologise for an error in *Your Problems Solved* recently when dealing with the problem of 625 sound buzz on this chassis (see page 330 of the May issue). The local/distant control R11 is of course operative on 405 lines only: it can be used to remove buzz on this system in strong signal areas.

TELEVISION COLOUR RECEIVER

I would be interested to hear from any constructors (preferably residing locally) who are building the "Television" colour receiver, with a view to corresponding in connection with minor constructional problems, most economical sources of components, etc. Would any correspondents be kind enough to enclose a stamped, addressed envelope. Some years ago I offered through your columns to give away old copies of the magazine and ended up with some 400 letters and expenses totalling over £8 for returning POs and buying stamps to reply to those I was unable to help.—**J. F. Hitchcock** *(86 Reigate Avenue, Sutton, Surrey)*.

Editorial note: We would be interested at the magazine in hearing in due course from readers who have successfully completed construction of the set: our main concern at present is to obtain a set of *average* circuit voltages since those obtained from the prototypes known to us could be misleadingly to one side of the tolerance ranges.

TELEVISION AND PRACTICAL WIRELESS AT THE BERLIN RADIO SHOW

Television and **Practical Wireless** are to take part in an overseas exhibition for the first time at the end of August. **The International Radio and TV Exhibition** to be held in Berlin from August 31st to September 9th is one of the largest exhibitions of its kind. Of special significance this year is the celebration of the 50th anniversary of the official commencement of transmissions from the first German radio station. There will be 23 exhibition halls and four pavillions as well as extensive open-air grounds. Over 20 countries are participating.

The displays will cover all types of electronic home entertainment systems and also servicing, studio and transmission equipment. There will be television transmissions from the main hall.

Television and **Practical Wireless** will be participating in the technical press section. Visitors will be able to see much of the recent work published in the two magazines and get an idea of the exciting new projects to be featured in future issues.

If you are in Berlin at the time of the exhibition we recommend a visit.

LONG-DISTANCE TELEVISION

ROGER BUNNEY

APRIL 1973 was a most eventful month. We normally expect an improvement in Sporadic E conditions at this time as a prologue to the main season which starts in May and there have certainly been improving conditions. The spectacular news however revolves around two other events.

On April 1st in the late afternoon a large Aurora was observed producing the usual interference and disturbance throughout Band I and extending into Band III—I noted various effects up to 220MHz. Reports on this particular Aurora have come in from the UK and Europe—all credit is due to those vigilant enthusiasts who were active on what appeared to be just another quiet day. I noted the Auroral effects—rumbling, hum and other noises not unlike short-wave radio—on switching on at 1720 BST and must confess that at first I thought a preamplifier had gone unstable. On changing amplifiers however, there was no result other than a continuation of the interference so the aerials were rapidly turned towards the north, a noticeable peak being found towards the north east. Signals were certainly trying to get in but with the patterning at high levels it was all but impossible to resolve anything. Just after 1800 however there were several short bursts of signal—unfortunately programme material which could not be identified. The interference died down and eventually disappeared at 1930. A check for the second phase of the Aurora revealed very low-level "noises" until just after 2400 so the afternoon phase was certainly the strongest.

The second spectacular news is of reception which may be either 100% F2 propagation or partial F2/SpE occurring in the UK—more on this later!

Several Sporadic E openings have been noted and although they cannot be compared with the big openings of the main season it is certainly a pointer to better things to come. The period around the 19th was particularly active and Graham Deaves noted ORF (Austria), TVP (Poland), and CST (Czechoslovakia). The tropospherics also showed a lift, with u.h.f. active towards the end of the month—specifically the 25–27th. The Lyrids meteor shower was expected to peak on April 22nd and during the morning/evening periods activitv was noted particularly on chs. R1/2

My own log for the period—deleting Belgium ch.E2 (as previously mentioned)—is as follows:

1/4/73	CST (Czechoslovakia) ch.R1—SpE; WG (West Germany) ch.E2—MS; also unidentified signals via Aurora.
5/4/73	CST R1—MS; NOS (Holland) E4—trops.
6/4/73	CST R1—MS.
8/4/73	DFF (East Germany—GDR) E4—MS.
9/4/73	CST R1—MS.
10/4/73	DFF E4—MS.
12/4/73	TVP (Poland) R1—MS; NOS E4—trops.
13/4/73	WG E2—SpE.
14/4/73	SR (Sweden) E2—MS—see later; unidentified programme on ch.R1 0745 SpE.
15/4/73	WG E2—MS; unidentified sports programme ch.E2 1800—suspect TVE (Spain).
16/4/63	NOS E4—trops.
18/4/73	NOS E4—trops.
19/4/73	CST R1; RAI (Italy) IA, IB; TVE E2. All SpE, opening for 1 hour late morning.
20/4/73	WG E2; CST R1; Switzerland E2; TVP R1—all short SpE; BRT (Belgium) E8, 10—trops.
21/4/73	WG E2; CST R1—both MS.
22/4/73	TVP R1—MS.
23/4/73	NOS E4—trops.
25/4/73	CST R1; SR E2—both MS.
26/4/73	ORTF-2 (French 2nd network at u.h.f.)—various transmitters via trops.
27/4/73	SR E2—MS; NOS E4—trops.
28/4/73	TVP R1—SpE.
29/4/73	RTP (Portugal) E2—SpE.

On April 14th the Swedish TV1 network was received on test card but with a variation—the PM5544 has struck again! Since then other reports which suggest that various identifications are being used have come in. Certainly the lower black rectangle carries the identification "Sverige" while the upper rectangle has "TV1" as an identification with possibly another word.

Over Easter the receiving system was completely changed, from the old Bush TV62s to Murphy types 849/879 (Bush TV125 series). The new receivers have been modified somewhat, the existing tuners being demoted to act as i.f. preamplifiers. Tuning is by means of external varicap units—the frequency is displayed on a 4in. meter. The system gain is extremely high—perhaps too high. Never have I been so well equipped for a coming season! Since this particular chassis (Bush) seems well suited to DX use I shall be preparing an article shortly detailing the modifications and also the varicap tuner arrangements.

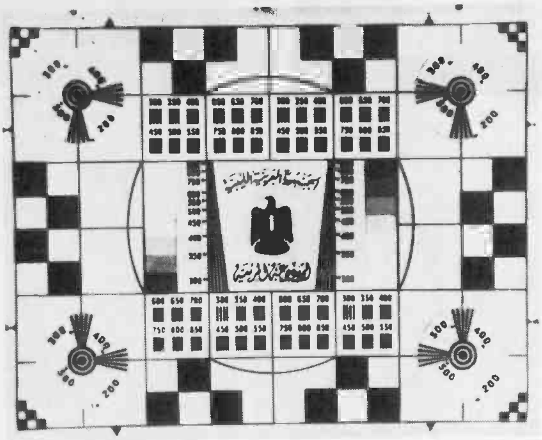
Radio Nordsee International (6205kHz) 0900 GMT Sundays and Radio Nederland (6085, 6020kHz) 1830–1950 GMT Thursdays (DX Jukebox) are both at present running TV DX courses. The latter organisation provides a series of typed lessons. We have seen the first half of the 13-lesson course and can recommend it. The object is to encourage more listeners of course. Unfortunately by the time this appears in print it will probably be over. The address of Radio Nederland however is Radio Nederland Wereldomroep, PO Box 222, Hilversum, Holland—write care of DX Jukebox. The frequencies given are for the 49-metre band in Europe.

Good homes (TV DX homes that is!) are required for the following sets. John Penruddocke of Dean Hill Farm, West Dean, Salisbury, Wilts has a 19in. CCIR system B set with fully loaded tuner (E2-11) and high gain (three vision i.f. stages) made by Westinghouse for export to Africa. This is a modern, compact valved receiver. T. C. Bray of Sparkes Place, Wonersh, Nr. Guildford, Surrey has a Murphy Model 849U (ideal for DX TV) with video detector switching split from main "gang". If anyone is interested in these sets please write to the owners (not to us, please) enclosing a s.a.e. Collection must be arranged.

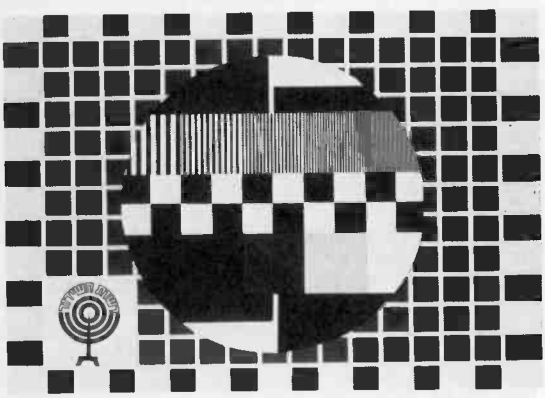
News Items

Jordan: Following recent comments on colour plans we understand that an English company is to install a 15kW (not e.r.p.) transmitter and new aerial system "outside Amman". Our Cyprus friend Mr. Papaeftychiou who has

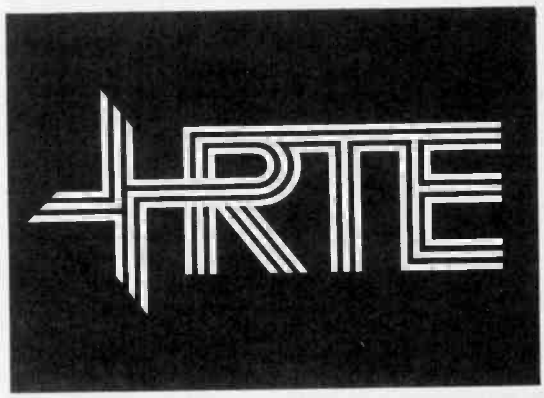
DATA PANEL 24—2nd series



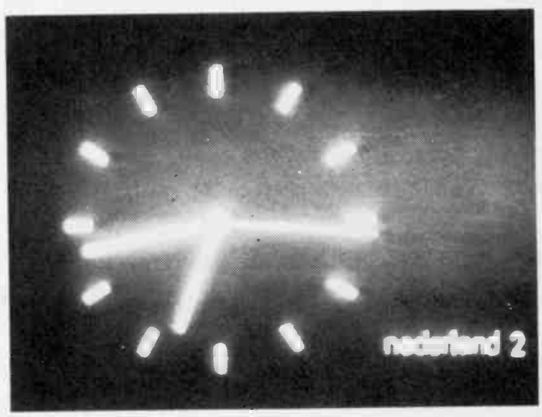
Test cards used by the Libyan Broadcasting and Television Service, courtesy Libyan broadcasting authorities and Michael Dolci. The "official version" is that shown on the left: the eagle appears to be the common factor.



PM5540 test card as used by the Israel Broadcasting Authority. Courtesy the Authority, Jerusalem, and Keith Hamer.



Station identification slide used by Radio Telefis Eireann. Photograph courtesy of Keith Hamer.



Clocks: Czechoslovakian clock left, received by Ryn Muntjewerff in Holland. Right: clock used by NOS (Holland). The NOS-1 one is similar. Courtesy Europese Testbeeldjagers.

been monitoring Amman ch.E3 has noted captions advising viewers to switch to ch.E8 for their foreign programmes. Previously the ch.E6 transmitter carried foreign programmes—there is split programming from Jordan

Television for some hours in the evening.
Greece: Increasing activity at u.h.f. is indicated in the latest World Radio-TV Handbook. The Greek Armed Forces Television Service (YENED) is planning as follows: Thessaloniki ch.E30, Thassos Is. ch.E23 (both 1,000kW) and Thira Is. ch.E29 to be operating in 1973. Several of their lower-powered Band III transmitters are to be increased to 60kW e.r.p.
East Germany—GDR: Our contact here advises that Brocken ch.E34 increased power on April 2nd to possibly 1,500kW (at present listed as 1,000kW). It is indicated that the transmitter is 1190 metres a.s.l. (3,370 feet). Test and programme times are as follows: DFF-1 test transmissions 0700–0745, programmes 0745–2300, weekdays and Saturdays; 0800–0815 and 0815–2300 respectively on Sundays; DFF-2 test transmissions 1300–1845, programmes 1845–2230, daily. (All times GMT.)
Dubai-Trucial States: Keith Hamer tells us that this station is using the Philips PM5540 test card (see column April 1973). We understand that this state/country is called United Arab Emirates.
International Waters: From the Europese Testbeeldjagers we hear rumours about a pirate TV station called "Radio King": radio and TV commercial programmes are said to be about to start.

Exotic Reception

On April 24th I received an urgent 'phone call from Hugh Cocks of Mayfield, Sussex. It seemed that something rather unusual was being received. Hugh had noted the familiar checkerboard on ch.E2 at 1542 (BST) with smeary video—assumed to be RTP (Portugal). At 1600 the RTP ch.E2 signal was covered with a "rumbling effect"—a black bar covered the lower part of the picture. Hugh switched off at 1630, assuming RTP via SpE. When operational again at 1655 a programme was found. At 1700 the same ch.E2 programme was noted carrying the news in *English*. The sound channel was monitored for some time and the accent indicated a similarity to the South African "Dutch type English". The 'phone call to yours truly at 1720 (at my place of work) hurried me to the Eddystone v.h.f. receiver. Certainly on ch.E2 vision (48.25MHz) a weak vision carrier could be heard, fading slowly into the noise. Unfortunately an ever strong ch.B3 local made attempts to resolve the sound channel (53.75 MHz) unsuccessful. By the time I had arrived home some 90 minutes later nothing was left of course!

I feel certain that this was an "exotic", bearing in mind that the signal was from a southerly direction and in the English language. The fact that some four weeks earlier Solar activity was at a high level—resulting in a flare and Aurora—coupled with the 27 days for the Sun's rotation could well mean some form of F2 reception (slightly too early in the day for TE). The sound tape Hugh sent included an Arabic musical programme—probably a harmonic from a radio transmitter—indicating that this too was "picked up" on one of the hops. The point is whether F2 conditions exist sufficiently north of the Equator to propagate a signal into North Africa after which the signal could be propagated into the UK via SpE—hence the arrival of the Arabic harmonic that would have originated in North Africa. We are awaiting word from our Mediterranean friends to check whether anything was noted by them during this period. I feel our congratulations are due to Hugh for this extremely interesting and intriguing reception—certainly this could be one of the longest TV DX hauls for several years.

I regret that space (lack of) means that letters are held over this month.

For the Beginner to DX-TV—concluding instalment

Aerials for Band III and higher frequencies are much more critical than those for Band I regarding bandwidth, matching and gain performance. To obtain the best performance at these frequencies it is unwise to attempt home construction. There are a number of manufacturers who devote considerable finance to aerial research. The outcome is that they have aerials that give excellent performance unlikely to be bettered by a home constructed array.

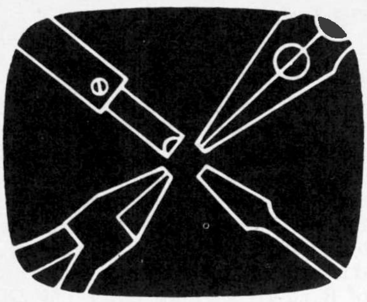
As mentioned last month we have a bandwidth problem—in the case of Band III we must cover 174–220MHz (chs.E5–11 vision) while at u.h.f. the coverage needed is 470–860MHz (chs.E21–68). Fortunately a number of wideband Band III receiving arrays are available, notably the J Beam Astrabeam, in versions with up to 11 elements or more when arrays are stacked. It is also possible to obtain certain West German wideband Band III aerial arrays such as the Fuba ones. The u.h.f. frequencies present a problem in that to obtain full coverage with high gain at least two arrays are required, namely for Band IV (chs. E21–37) and Band V (chs.E39–68). In the UK the use of a group A and a group E array would provide the necessary bandwidth. An alternative approach is to use a lower gain array with an extreme bandwidth—over the whole u.h.f. band—such as a log-periodic aerial. We understand that Fuba market a 27-element wideband u.h.f. array covering both Bands IV and V. There is a considerable number of high-gain u.h.f. arrays available and we suggest that the prospective purchaser investigates the literature available from Aerialite, Antiference, and J Beam Aerials.

Over the past few years a variation of the normal Yagi array featuring a more complicated director structure has appeared. This considerably increases the gain of the aerial system by enlarging the capture area. The structure can be seen in the May column where the J Beam MBM70 was illustrated.

Aerials for tropospheric work should be erected as high as possible and the best quality feeder used to avoid undue loss of the very weak signals that will be encountered. It is advisable to mount aerials at least 3ft apart to minimise unwanted absorption, mismatching and other effects. A slight upward tilt to the array can be beneficial and as with Band I horizontal polarisation is the order of the day.

Aerial preamplifiers are essential for tropospheric reception and in these days of very low-noise transistor preamplifiers it is possible to work down to signals of a few μV at u.h.f. There have been several articles in these pages over the past three years giving details of aerial preamplifiers suitable for DX use at the various TV frequencies. Masthead preamplifiers can be used to advantage, particularly at u.h.f. There are several commercial ones available giving part coverage of the u.h.f. spectrum or indeed the whole u.h.f. bandwidth. These are powered "up the downlead" and are most effective in overcoming cable losses and improving weak signal performance. The one disadvantage is that in the unlikely event of a fault considerable difficulty may be experienced in reaching and repairing the unit.

Tropospheric reception is one of the more difficult modes because of the weaker signals encountered. Great care is required therefore in installing (and selecting) aerials for this work. Provided care is taken the results will justify the effort put in, giving impressive and distant reception at frequencies that would otherwise produce only mediocre signals. Such reception is dependent on tropospheric conditions of course, but given the best aerials optimum results will be obtained.



SERVICING television receivers

L. LAWRY-JOHNS

BRC 1580 CHASSIS—cont.

EHT Tray

The clip-on e.h.t. tray gives little trouble in receivers with low e.h.t. but in the event of one stick becoming defective (symptoms, poor focus and ballooning coupled with lines across the screen when the brilliance is advanced) both should be replaced as a complete tray.

AGC Circuit

Part of the video signal at VT5 emitter is passed to VT8 base via the preset contrast control. VT8 only conducts during the line flyback period when it is switched on by a negative-going pulse of about 30V fed from the line output transformer via C55 and W5. This ensures that VT8 conducts only during the sync pulse part of the video signal, C55 then charging to a level determined by the size of the negative-going sync pulse at VT8 base (the size of the sync pulse depends of course on signal strength and the setting of the preset contrast control). When VT8 is switched off (at the end of the flyback) the positive charge on C55 is fed via a smoothing network to VT2 base. This forward bias *increases* the conduction of VT2 and thus VT1 (since the base of the latter is returned to the emitter of VT2) and the resulting voltage drop at the collectors causes a reduction of gain.

Forward AGC Action

Some may wonder why the control voltage is not negative-going so as to drive the transistors towards cut off—as is done with controlled valves. The answer is that the gain reduction is smoother as the control voltage is increased from the point of maximum gain which is obtained with approximately 6V at VT2 base. Control through decreasing the voltage would cause a more drastic reduction of gain and this is not what is required (what is wanted is a controlled reduction not a switch-like action).

The purpose of W5 is to prevent the a.g.c. transistor being affected by the positive control voltage across C55 (otherwise its collector-base junction would conduct).

Video Channel

The vision detector (W1) output is fed to a buffer stage (VT5) which also acts as an amplifier for the 6MHz sound signals (with prelimiting by W12). The video signals are taken from the emitter (as is the a.g.c. drive) and are capacitively coupled by C32 to the video amplifier VT6, C31 and L10 forming an acceptor filter for the 6MHz component which must be made to feel unwanted in the video stage. We have already mentioned the habit of C32 suddenly becoming open-circuit so we will not labour this point further.

The video amplifier itself (VT6) works hard, being operated from the h.t. line with a nominal voltage of 85V at its collector rising to produce the positive tube drive (towards cut-off at the cathode on the sync pulses) as its base is swung negative by the picture information and sync pulses. This swing at the collector is tapped off by R36 which gives high-level contrast control, the sync pulses being divided by R37-R38 and passed to VT7 which functions as the sync separator with a protection diode (W2) in its emitter lead. A suitable replacement for VT6 is a BF178 and for VT7 a BC117.

Sound Faults

In order to reduce the heat in the cabinet as much as possible a low-dissipation sound output stage is employed drawing only some 10mA or so. With a loudspeaker of the size used the quality isn't too bad until the speech coil starts to rub (as it tends to do after a period) or the PCF80 output valve starts to draw grid current. The difference in the distortion is apparent to the experienced ear but is difficult to describe. If in doubt check the voltages at pins 7 and 1: pin 7 should show about 3V with respect to chassis and pin 1 about 20V. If the pin 7 voltage is higher than say 3.5V either the valve is faulty, R90 is the wrong value or C68 is leaky: if there is a positive voltage at pin 2 suspect the valve or C68. If the pin 1 voltage is low check the value of R83 which should be about 220kΩ. If the resistor is in order check C65 for leakage. If the pin 1 voltage is high, check R82 which can go high-resistance and thus bias off the triode section. If these voltages are correct and the distortion is more obvious at low volume levels suspect the loudspeaker.

Distortion at All Levels

Distortion at all volume levels is more likely to be due to a fault in the ratio detector stage (check W6, W7, R85 setting and C67) or in the alignment of L11-L12.

Tuner Unit

Quite a bit has been written on the subject of the tuner unit employed in this and other BRC chassis such as the 1500 series. It is difficult for us to advise readers whether to service the units themselves or return them to the nearest maker's depot. It all depends upon the aptitude of the

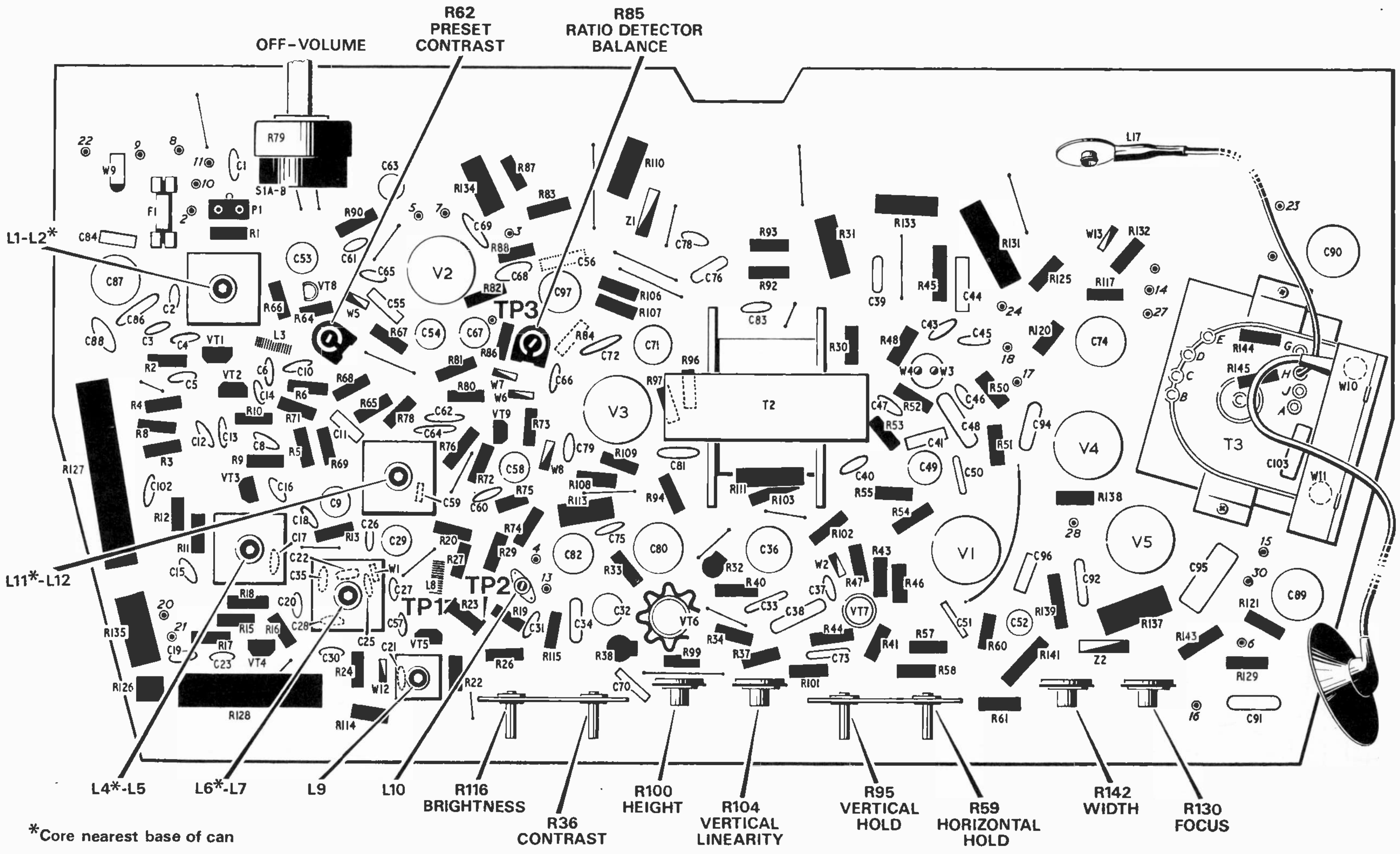


Fig. 2: Component layout on the main chassis assembly.

Suitable semiconductor replacements: VT1 BF196; VT2 BF196; VT3 BF194; VT4 BF197; VT5 BF197; VT6 BF178; VT7 BC117; VT8 BC157; VT9 BF197; W1 OA91; W2 OA90; W3/4 U14710/1; W5 1S44; W6 AA119; W7 AA119; W8 1S44; W9 BY127; W12 OA90; W13 BA148.

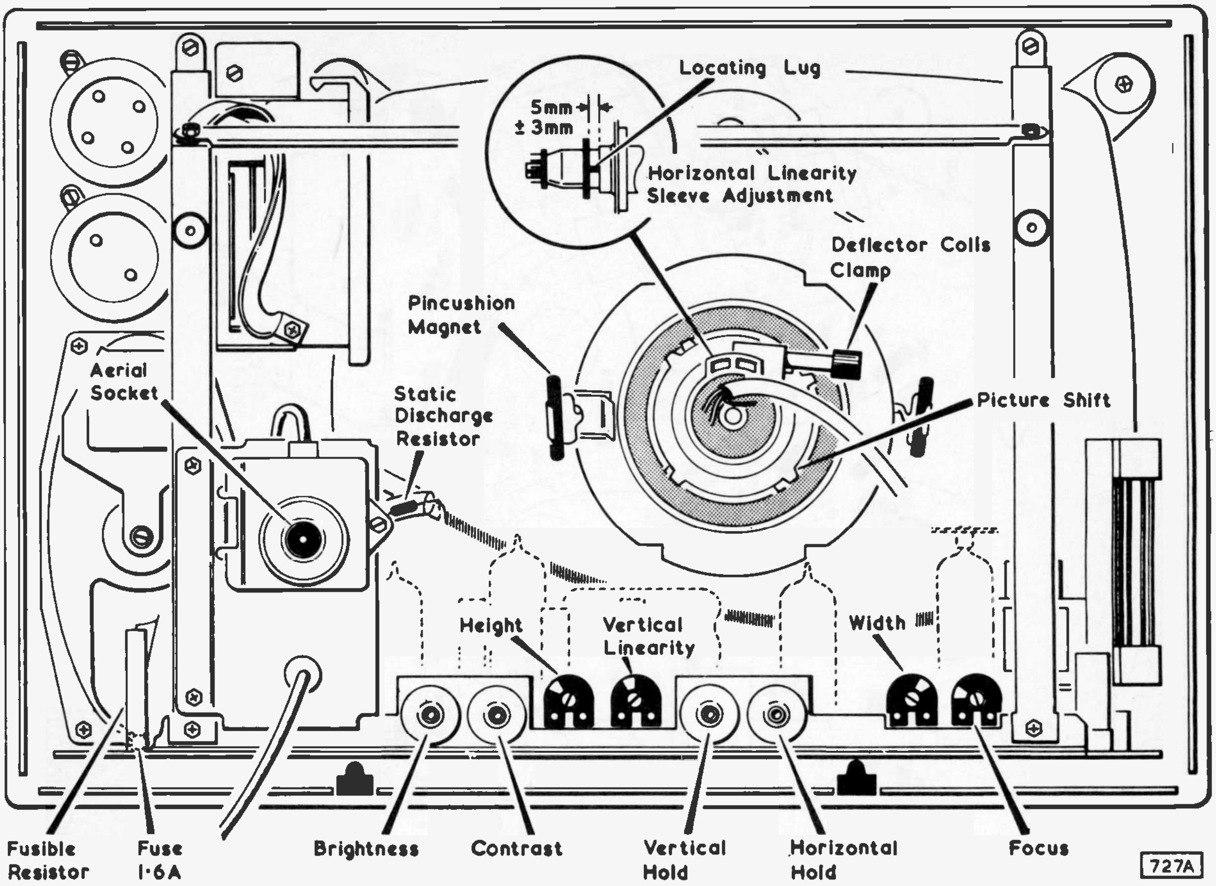


Fig. 3: Rear chassis view showing preset adjustments.

reader. If you don't know exactly what it is all about leave the unit alone and let someone who does know do it. For those who feel quite capable but would like a little guidance we would make the following points.

If the quality of the picture is good but the tuning is inaccurate, the push buttons tending to require frequent resetting, first ensure that the mechanical side is in order. If so it is reasonable to assume that the defect is inside the tuner. The trouble is most likely to be due to surplus grease, which prevents good electrical contact, on the tuning spindle leaf springs. This is not a signal for switch cleaner to be sprayed willy-nilly all over the spindle and tuning vanes: if this is done it will be a considerable time before the tuner will function properly again and the fault will not be removed.

Only the leaf springs require attention. The grease can be removed with a small brush and grease solvent. When the grease has been removed apply switch cleaner lightly to the contact surfaces of the springs. The springs can be removed if desired using a heavy-weight iron or gun—a 15 or 25W iron with a pencil bit is not much use for this job.

Transistor Faults

Low gain, where the picture is very grainy, if not due to a faulty aerial or plug/socket connection is most often due to failure of the first stage transistor in the tuner—type AF239. If the gain is found to be the same or better with the signal applied between the stages it is safe to fit a new transistor. Lack of voltage drop across its 1kΩ emitter resistor is another indication that it is not performing.

The second transistor—type AF139—can well be at fault if one programme can be tuned in but not another (the transistor being reluctant to oscillate at a lower frequency). On more than one occasion we have fitted a new transistor in this position only to find that it is no more willing to oscillate than the one taken out.

Before suspecting any transistor however always make sure the supply line is up to specification—12V at the tuner and 20.5V at HT5. Low voltage could indicate a fault in the field timebase, in a supply resistor, or leakage through a smoothing or decoupling capacitor.

Hum Bars

If the picture is heavily shaded together with loss of field hold suspect C82 and shunt a test electrolytic from the 20.5V line to chassis. The test capacitor should have a capacitance of over 100μF and a rating of 25V or more.

Modifications

C11 may be 0.047μF; C365 in the tuner unit may not be fitted; R102 may be 120kΩ; R111 15kΩ and R355 in the tuner 2.7kΩ (or 2k7 if you like it put that way).

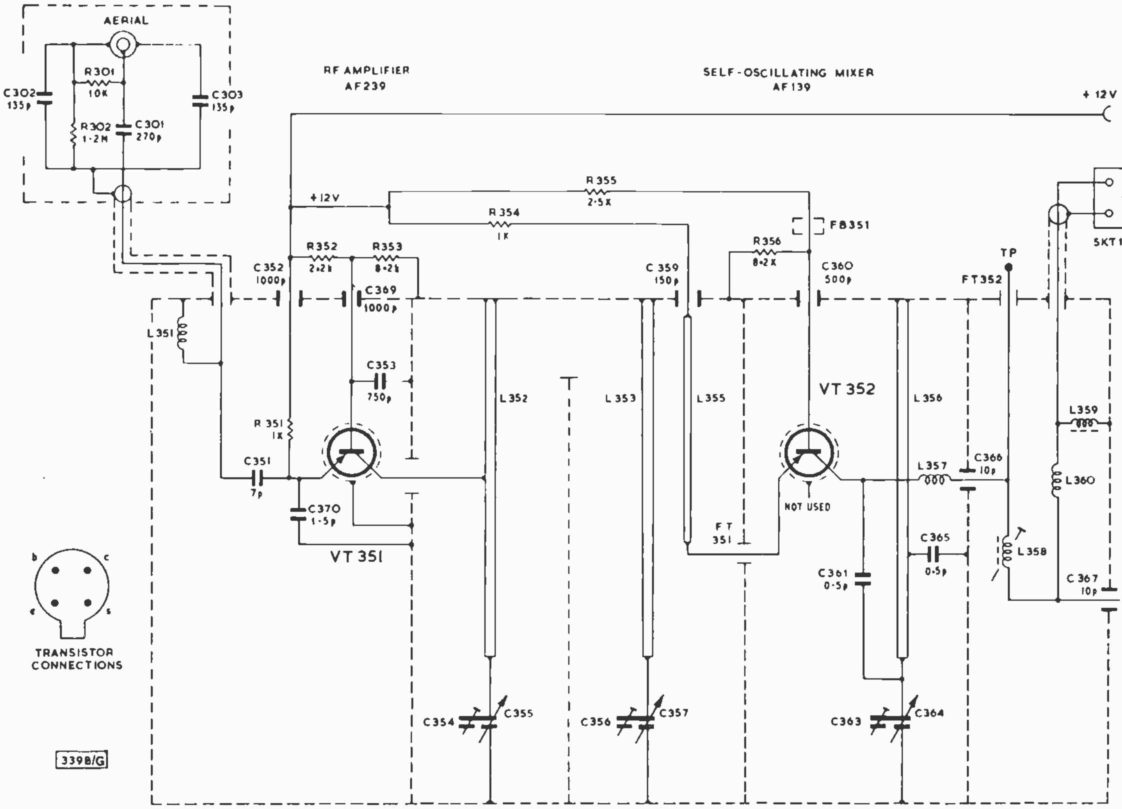
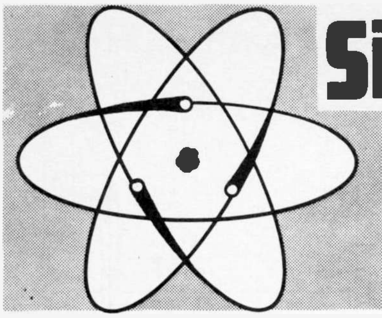


Fig. 4: Tuner type T20 used in the BRC 1580 chassis.



Sizing up the Electron

I.R.SINCLAIR

THE word *electron* entered our language at the end of the last century but has become really well established only in the last fifteen years or so. Nowadays we all use the word and its relation *electronics* as a matter of course, but few know on what evidence we base our ideas of what the electron is and its size.

To the ancient Greeks electron was the word for amber, the first-known substance which, when rubbed with fur, has the power of attracting small particles of insulators. For centuries *electricity* meant the study of these effects which we now group under the heading *electrostatics*. Electrostatics hardly advanced beyond this stage until Coulomb proved that the force of attraction was proportional to the quantity called electric charge and inversely proportional to the square of distance. Soon after this the modern foundations of the subject, now important to the understanding of semiconductors, were laid by the mathematician Gauss. By this time the original word electron had been almost forgotten. The first stage of its recall to active service came as a result of some work by Michael Faraday in the 1830s.

By that time chemists were convinced of the existence of atoms, the basic units of all substances. Faraday was conducting experiments on electrolysis (Fig. 1) to try to find out what amount of electricity was required to deposit unit mass of a material in an electroplating solution. In the course of a series of carefully conducted experiments he found that the mass of the material moved depended on the current and the time for which it was passed. Now the current in amperes multiplied by the time in seconds is the electric charge in coulombs, so Faraday was able to work out the amount of electric charge needed to shift unit mass of any material.

For some time chemists had used the idea of *atomic weights*, the weight of any given atom compared to the weight of the lightest atom, hydrogen, and they had known that in a chemical reaction the weights of substances reacting are in proportion to their atomic weights divided by some whole number (nearly always 1, 2 or 3). These figures of weight put into grams are called gram-equivalent weights, and chemists had a lot of evidence to show that the number of atoms in this weight (32 grams for copper, 108 grams for silver) is the huge figure of 6×10^{23}. Faraday worked out what electric charge would be needed to transfer one gram equivalent of a substance and found that this was the same amount for all the substances which he tried, 96,500 coulombs. This could only mean that a definite quantity of electric charge was needed for each atom, an amount of 1.6×10^{-19} coulombs. He had without realising it measured the charge of the electron.

At that time there was no great interest in this latter measurement. No one was ready for the idea that like matter itself electric charge might exist only in units of definite size. Curiously enough no one ever seems to be ready for such ideas, i.e. the application of accepted ideas to regions where they do not seem relevant, and when Planck seventy years later put forward the idea that all energy, heat, light etc. was also composed of small units of this sort he was met with the same disbelief as had greeted his predecessors. Faraday's discoveries were quickly put to work in the form of the electroplating industry, and no one for some time worried very much about units of electric charge.

From the 1870s onwards physicists became interested in the effects produced when electricity is passed through gases at low pressures. The most interesting parts of these experiments were those produced when the pressure of the gas was very low, as near to a vacuum as could be produced at the time, and the gas had ceased to glow. In these conditions there appeared in the tube a beam of radiation coming from the negative electrode and heading to the positive one; this effect was named *cathode rays*.

Because any gas used in a discharge tube gives rise to similar "cathode rays" but consisting of different and heavier charged particles (ions) and travelling in the opposite direction, the suspicion grew that the cathode rays were particles and a number of ingenious experiments (see *The Discovery of Cathode Rays*, PRACTICAL TELEVISION, March 1969) showed beyond all doubt that they consisted of negatively charged particles travelling at very high speeds. The next step was obvious—to try to measure the charge, mass and speed of these particles. If they were fragments of an atom—as all the evidence suggested—this was going to be a set of measurements unlike any for determining mass, speed and charge ever carried out before. The first honours fell to a physicist working at Cambridge, J. J. Thomson, who measured the speed of the electron and the ratio of its charge to its mass by what must now be described as electronic measurement. Thomson has another claim to fame—he called the particles *electrons*.

To make any sense of the electron we have to assume that it obeys the same laws of physics as any larger particle. We must, for example, assume that a steady force applied

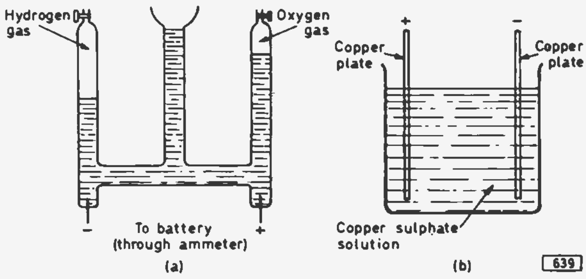


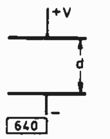
Fig. 1: (a) Electrolysis of water. Water consists of the gases hydrogen and oxygen chemically combined. Electrical energy can be used to separate them, the mass of each gas obtained depending on the amount of electric charge (current × time) passed. (b) Electrolysis of copper sulphate. Copper is dissolved from one plate (the positive or anode plate) and deposited on the other (the negative or cathode) plate. The weight of copper transferred depends on the quantity of electric charge passed.

to an electron will make it accelerate, and that the amount of force needed for its acceleration will depend on its mass and on nothing else. Put in the shorter language of mathematics this comes out as $F = ma$ where the force F is measured in newtons, the mass m in kilograms and the acceleration a in metres per second per second.

Another assumption is that the electron behaves like any other charged particle in an electric field. An electric field exists between any two conductors at different voltages and causes a negative particle to be attracted to the positive conductor. The force of attraction is found by multiplying the charge on the particle q by the size of the electric field E. The size of the electric field is given by the voltage difference divided by the distance between the conductors—V/d, see Fig. 2. The quantity qE, which equals $q \times V/d$, is a force and is again measured in newtons.

This force is steady and does not alter because of the movement of the electron. The effect of the force is to accelerate the electron towards the positive plate (see Fig. 3). If an electron is moving very slowly it might be deflected sufficiently in the time it spent near the plates to land on the positive plate; if it is moving rapidly the time it spends between the deflection plates is very small and the deflecting force acts on it for only a short time thus producing only a small deflection. If a particle is accelerated in a direction in which it was not previously travelling the distance covered in time t (seconds) is given by multiplying the acceleration by half the square of time ($d = \frac{1}{2}at^2$). The three equations we have mentioned can be put together and coupled with the forward movement of the electron to find the velocity from the deflection.

A magnetic field has no effect on a stationary electron but can cause deflection of a moving electron. The force exerted on the electron depends on its speed—the faster it is moving the greater is the force of the magnetic field on it. The important equation here is $F = Bqv$ where F is force, again in newtons, q is the charge on the electron and v the velocity (speed in a specified direction) of the electron at right angles to the magnetic field (Fig. 4): B is the strength of the magnetic field—usually provided by a coil—measured in webers per square metre. This quantity can be calculated with some difficulty from the dimensions of the coils used to create the field and the value of current in amperes passed through the coils. The main difficulty here is to produce a magnetic field which has a constant value



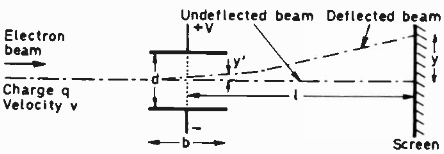


Fig. 2 (left): If V is the voltage between the plates and d the spacing between them, the electric field = V/d volts per meter, e.g. with 300V between plates 1cm (0.01m) apart, field = 300/0.01 = 30,000V/m.

Fig. 3 (right): Electrostatic deflection. Force on an electron during its time between plates = q(V/d) minus electron mass. Force = m × a, thus a = (q/m) × (V/d). Distance sideways = ½at² during time between plates. From the geometry of plates and screen, distance moved sideways between plates = y' = y × (½b/l) = y × (b/2l) where b is plate length and l is plate-to-screen distance. v = forward velocity of electron = b/t where t is time spent between plates. Thus t = b/v, Combining, yb/21 — side distance — = ½ (qV/md) — acceleration — x (b²/v²) — time², Rearranging, v² = (q/m) × (V/d) × (lb/y), or q/m = v² × (d/V) × (y/lb). So q/m can be found if v can be found.

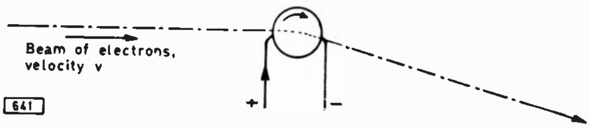


Fig. 4: Magnetic deflection. Deflection force = Bqv. For a simple Bkt coil, B = (6.28/107) × (nl/a) Wb m⁻² where n is the number of turns, l the current in amperes and a the radius of the coil.

over the portion of the tube where measurements will be taken.

The arrangement used by Thomson in his measurements on electrons is shown in Fig. 5. The electrons were generated in a gas-filled tube, accelerated and beamed into a bulb where both electrostatic and magnetic deflection could be applied and the deflection measured. Care was taken that the average potential between the electrostatic plates was the same as the final anode potential in the "electron gun" so that the speed of the electron in the bulb was steady before any deflections were applied. The magnetic deflection coils were arranged so that they deflected the electron beam in the same direction as the electrostatic deflection plates (or, of course, in the opposite direction, depending on the direction of the current in the coils). Before the tube had been assembled the dimensions of the deflection plates were carefully measured and the plates fixed at a known distance from the screen. The deflection coils outside the tube were lined up with their centres in line with the centre of the space between the plates.

The position of the electron beam on the screen with voltages applied to the tube but with both the deflection plates at the same voltage and no current in the deflection coils was first noted. This was not easy: the electron beam was wide—not the finely focused spot with which we are familiar in modern cathode-ray tubes—since no way of effectively focusing an electron beam had at that time been found.

A voltage was then applied between the deflection plates and the deflection at the screen measured. As we saw earlier this enables us to find a value for q/m if the velocity of the electron can be found. It was realised later that the sideways velocity given to the electron in this experiment was at the expense of its forward velocity, making the result slightly inaccurate, but this error is small compared to the errors involved in measuring the deflection of the beam at the screen and so could be neglected. In any case the error is small so long as the deflecting voltage applied to the plates is small compared to the voltage between cathode and anode which gives the electrons their forward velocity.

To find this forward velocity the magnetic field was applied by the coils in such a direction that the electron beam was forced back to the position on the screen where it rested before any deflections were applied. When this

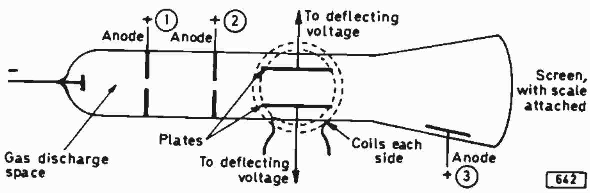


Fig. 5: Thomson's apparatus. The voltages on all anodes are equal. Electric field as before (Fig. 3). Magnetic field added so that beam is deflected back: Bqv = q(V/d). Thus v = (V/dB). Combining, q/m = (V²/d²B²) × (d/V) × (y/lb) = Vy/dB²lb.

happens the deflection caused by the magnetic field, Bqv, must be equal and opposite to the deflection Vq/d caused by the voltage V applied to the deflection plates. When we equate the two the charge q, being on each side of the equation, cancels out and we are left with $v = V/Bd$. We can easily find this value of velocity because we know the values of the magnetic field B, the plate voltage V, and the distance between the plates d. Using this value of velocity and substituting it into the other equation in Fig. 3 enables us to find q/m.

The value found is 1.76×10^{11} coulombs per kilogram, implying that if it were possible to gather together a kilogram of electrons—with nothing else present—the charge would be 176,000,000,000 coulombs, an almost unimaginably large charge. By comparison a 1,000μF capacitor charged to 1,000V stores only 1 coulomb while a 35AH car battery fully charged stores in the form of chemical energy some 1,260,000 coulombs and weighs a darn sight more than 1 kilogram. There seems no doubt that the electron is the "atom" of electricity which Thomson was looking for.

Thomson's experiment not only measured this important quantity but also laid the foundations for the use of magnetic and electrostatic deflection in cathode-ray tubes. Better ways have since been devised to measure the q/m ratio, but Thomson's remains the best-known because it was the first—history has a habit of forgetting the others. Notice incidentally the relation between the beam velocity and the ratio of the electrostatic deflecting voltage to the magnetic field for the same deflection. This accounts for the use of magnetic deflection in tubes using large anode voltages—the voltage required between the deflection plates for electrostatic deflection would be excessive. We can get round this problem nowadays however by deflecting a low-voltage beam and then accelerating it by a high voltage—the technique called *post-deflection acceleration* (p.d.a.).

If the ratio q/m is known we need only find the mass to be able to calculate the charge; or if we can find the charge we can calculate the mass. Since the value of q/m indicates that the charge is large compared to the mass it seems reasonable to expect that the charge of the electron should be easier to measure than its mass. Though there were very good reasons for supposing that the value which Faraday had obtained was in fact the charge of one electron, a direct measurement had to be made to confirm this. This was not achieved for some time after Thomson's experiments, and Faraday's value was used though with a nagging uncertainty.

The idea used by Millikan (who was awarded the Nobel Prize in 1923 for his work) to measure the charge is ingenious and yet startlingly simple. To understand it let us use an analogy. Suppose that we have a set of parcels each containing a different number of identical metal blocks and that we are asked to find the weight of one block without undoing any of the parcels. Suppose that we weigh one parcel and find that its weight is 6kg. Put another parcel on the balance with the first one and we find a weight reading of 10.5kg. Take the first parcel off, and the balance reads 4.5kg. If we know that each block is the same weight and that there are no half blocks we can easily find the weight of a block—it must be the largest number which will divide evenly, with no remainder, into the weight figures we have. Moreover as we have no part blocks it must divide an integral (whole number) number of times.

The largest number suitable in our example is 1.5kg and we could conclude that this is the weight of a block. It could be of course that the weight was 0.75kg and that the blocks go about in twos, but if we did the experiment often enough we should find the weight of the unit block since the pairing would not last forever unless the blocks were welded together—in which case they could not truly be called single blocks. The whole point of this analogy is that the size of a single item can be found without ever seeing a single item so long as the effects can be accurately measured.

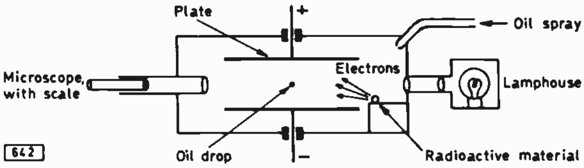


Fig. 6: Millikan's apparatus.

The apparatus used by Millikan was as shown in Fig. 6. Two metal plates are arranged one above and parallel to the other and insulated so that a voltage can be applied between them. The space between the plates is brightly illuminated and contains a scale which can be viewed by a microscope. A nozzle is arranged so that very small drops of oil can be blown into the space between the plates where their movements can be followed by the observer using the microscope. A source of electrons, usually a radioactive metal, is placed in one corner of the space between the plates.

To find the electron's charge we use the principle that a force is exerted on an electron in an electrostatic field. Since the charge of the electron is so large even a comparatively large oil drop will move in an electrostatic field if it has one spare electron on it: the radioactive material will provide electrons to land on the oil drops. The first step is to observe a drop and to measure the time it takes to drop some distance (compared with the scale) with no electrostatic field applied. The time taken depends on the size of the drop and the resistance of the air. We can work out the size of the drop from the speed at which it falls. While the drop remains between the plates however it will be gaining electrons from the radioactive material—and losing them again because of the slight conductivity of the air which is slightly ionised by the electrons.

If a voltage is now applied between the plates, with the top plate positive, the drop may move down much more slowly, may hang suspended or may move upwards according to how many electrons are present on it at the time and on the voltage applied. If the same oil drop is watched over a period, its speed can be seen to change as it gains or loses electrons and its speeds with various numbers of electrons aboard can be measured. We do not know of course how many electrons are on the oil drop at any time, but we can work out how much charge is present because the speed of the drop tells us what force is being applied. The charge can be obtained from the formula $F = q \times V/d$ where F is force, q the total charge, V the voltage between the plates (a few hundred volts) and d the distance between the plates.

As with the problem of the metal blocks we can now find the unit of charge, because the values of charge on the oil drop which we find are whole-number multiples of the electron charge. The quantity which Millikan found by this method was 1.6×10^{-19} coulombs, identical to the value found by Faraday's experiment. Oddly enough the first attempt at this experiment gave a very different answer, not because of the remarkable delicacy of the measurement but because the value of the resistance of the air to a falling drop had never been measured sufficiently accurately.

These then were the two men and the two experiments which changed the world, moving us from the electric into the electronic age. ■

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FERGUSON 3618

We have two of these models each with the same fault. The picture has excessive contrast, as if a preset contrast control has been set too high, while the background is grainy, as if the signal is inadequate. The brilliance control has to be set at maximum and the picture can only be viewed in a darkened room. The i.f. and video valves, the vision detector and the diodes and decoupling capacitors in the a.g.c. line have all been replaced without producing any improvement. —L. Marsh (Rotherham).

The problem is not uncommon with models fitted with this chassis (BRC 850 dual-standard) and is due to C8, a coupling capacitor in the circuit between the tuner unit and the first i.f. amplifier, being leaky. This cancels the a.g.c. at the first vision i.f. stage and leads to excessive a.g.c. being applied to the tuner unit.

REGENTONE TEN-4

The set works normally when switched on. However if, after it has warmed up, it is switched off and then while still hot switched on again only the sound comes on. If it is allowed to cool down it will work normally again when switched on. I suspect a capacitor in the line output stage going short-circuit after being in operation for a while as the line output valve gets very hot and the e.h.t. rectifier heater does not light up when the fault condition is present.—T. Oliver (Barnet).

The trouble you are experiencing is quite common on these sets. It is due to the fact that the line output stage also forms one half of the line multivibrator. The other section of the multivibrator consists of the triode half of V5 (PCF80). We suggest you replace this PCF80 and then if necessary try another PL81 line output valve. The cross-coupling capacitors could be faulty: they are C42 (0.001uF) and C45 (10pF, 6kV). C40 (40pF, 750V) is another suspect component.

FERGUSON 725T

To improve results on this old set the tuner valves were replaced but then after about a quarter of an hour R47 associated with the vision i.f. stage V4 burnt out. A picture was obtained by replacing R47 but we were unable to check the correct value—5.6kΩ was used. Also the sound became distorted. After a further half an hour both the picture and sound went leaving just a bright light on the screen.—T. Upton (Margate).

The correct value for R47 is 1kΩ. This resistor provides the h.t. feed to V4 and if after fitting the correct value you find it overheats then the valve and the associated 1,200pF decoupler C45 (use an 0.002μF replacement if more convenient) should be checked. C45 should be replaced anyway as there appears to be instability—also check the decoupler (C32, 0.001μF) in the common vision and sound i.f. stage V3. Common causes of sound distortion are the PCL82 audio valve and change of value of the sound interference limiter bias resistor R106 (3.9MΩ). If the PCL82 has to be replaced its 470Ω cathode bias resistor R111 should be checked.

KB PVP20 Royal Star

The problems with this set are that the height can't be reduced while the width is in at both sides of the screen. There is also creeping at the bottom of the raster. The line timebase valves have been renewed.—T. Dixon (Ormskirk).

First the line timebase. We suggest you check the value of the line output pentode screen grid feed resistor (R132, 2.2kΩ), the blocking oscillator anode feed resistor (R128, 82kΩ) and the coupling capacitor to the line output pentode (C96, 0.003μF). In the field timebase we suggest you try a new PCL82, check the pentode cathode components (R97 380Ω, C82 50μF) and if necessary the resistors in the height control circuit—in particular R98 1.8MΩ to the slider.

EKCO T407

There is line pairing in this set and I intend to replace the selenium T3/4 interlace diode fitted. These however seem difficult to obtain. Would a Q3/4 selenium rectifier do or possibly a germanium or silicon diode?—K. George (Bangor).

A Q3/4 selenium rectifier could certainly be used. Alternatively a silicon rectifier such as a BA155 could be used.

PYE 36

When the contrast is increased there is motor-boating and flashing on the screen. There is no picture but brilliance is still present. If the contrast control is retarded the picture can be resolved and at very low levels will sometimes remain, though with weak sync. The PFL200 video/sync valve has been replaced and the continuity of the contrast control track checked.—T. Brady (Shoreham).

The symptoms suggest instability due to lack of decoupling somewhere. We suggest you check the following electrolytics: C72 (10μF) on the main panel in the contrast control circuit and C32 (10μF) and C34a (64μF) on the i.f. panel in the a.g.c. circuit.

McMICHAEL M723T

After about half an hour the field linearity alters, the top of the picture stretching while the bottom shrinks by about 1¼in. The picture also looses contrast. All the valves and the main electrolytics have been replaced, also the field output valve bias resistor and the field charging capacitor.—R. Thomson (Bury).

The principal suspect is C73 (0.01μF) in the field linearity feedback loop. However we have also known the v.d.r. wired across the primary of the field output transformer cause this sort of trouble. We presume that the h.t. voltage has been checked, and that it remains steady. The field output pentode cathode decoupling electrolytic and the various coupling and feedback capacitors in the field timebase may have to be checked. Check the 1.8MΩ resistor to the slider of the contrast control.

FERGUSON 3802

The problem with this set is intermittent vision—the sound and raster always remain when the picture goes. Touching the line output valve or boost diode top cap restores the picture. The set runs for several days sometimes without any trouble while on other occasions the picture goes several times in an evening.—J. Middlefield (Manchester).

The cause of the problem follows the video driver stage since the sound take-off is in this stage; the symptoms suggests a faulty capacitor. The electrolytic coupler C37 (64μF) to the video output transistor VT9 should be changed—it is a fairly frequent source of trouble in this chassis. (BRC 1500 chassis.)

COSSOR 1972A

This set has given good service but there is now a strong hissing noise. The effect produces broken vertical lines on the screen slightly off centre to the left. After 2½ hours or so the effect is not so noticeable but is still there in the form of fuzzy edges. The trouble seems to originate from the vicinity of the line output transformer. Removing the aerial connection makes no difference. The interference can however be removed by advancing the contrast control setting but the picture then suffers. There is a faint smell of burning.—G. Wilson (Manchester).

It is essential that the leads and components associated with the line output transformer are kept away from the transformer windings. Check the top cap connections of the valves in the line output stage, including the e.h.t. rectifier. Note whether the hissing effect is still present with the e.h.t. rectifier removed. It should be possible to see some sort of discharge, identifying the source of the trouble, when the line output stage is viewed in a darkened room. (Philips 19TG152A series.)

GEC 2012

There is some sound-on-vision on 405-line operation; it can be reduced but not eliminated by reducing the contrast. Also the sound level can sometimes be increased by switching on the wall lights in another room. On 625 lines reception starts to fade after about ten minutes from cold. The picture can be restored momentarily by increasing the contrast setting but not for long—all that is left is the raster. The transistors in the tuner unit have been replaced without improving matters. The preset contrast control has been replaced by a couple of resistors in parallel—should I restore the circuit to its original condition?—T. Exeter (Bourne).

Replacing the PFL200 video valve will almost certainly cure the 625 signal fade out and will probably reduce the 405 sound-on-vision by ensuring that the full a.g.c. is developed for application to the r.f. amplifier. It would certainly be wise to replace the preset contrast control. Increased volume when lights are switched on usually indicates a dry soldered joint or a badly contacting system switch—also sometimes a faulty coupling capacitor.

BRC 1500 CHASSIS

We have two receivers, a Marconiphone and an Ultra one, fitted with this chassis. Reception is good here but the Marconiphone model gives very poor results on the correct BBC-2 button and also on the spare button when we attempt to tune in on this one.—H. Watkins (London SE1).

You should remove the tuner unit and check the clearance of the tuning vanes as they close towards channel 33. Close inspection may reveal a partial short in one section towards the r.f. end. Clean the spindle washers and reassemble, checking the bar sockets (soldered) and spring tension.

EMERSON E700

This set has been out of use for several years. It appears to be in good condition but we are unable to get a raster. All valves are operating and the h.t. is normal but drops to about 165V after a time. Similar trouble was cured once in the past by replacing the line output transformer.—R. Eves (Stevenage).

Unfortunately the line output transformer was a weak link in this chassis and it is quite likely that the replacement has failed. Before fitting a new one however check the line timebase valves (PCF80, PL36, PY81), the 4.7kΩ PL36 screen grid feed resistor, the boost reservoir capacitor C91 (0.1μF) by removing the PY81 top cap to see whether this restores some life to the line timebase, and the high-voltage 100pF tuning capacitor C93 connected across the line output transformer.

FERGUSON 3618

This set suffers from foldover at the left-hand side of the screen. The line oscillator, line output and boost diode valves have been replaced without improving matters. The line timebase voltages have been checked and are all close to those specified in the manual.—B. Carter (Peterfield).

The thing to ascertain is whether the raster with no picture present folds over or whether the picture folds. If the former is the case the line output stage is at fault and will require further checking. If the foldover occurs only with a picture present the fault is in the flywheel line sync discriminator circuit. (BRC 850 chassis.)

PHILIPS G20T300

This set suddenly developed hum the source of which we are having difficulty tracing. The hum decreases when the volume control is turned up and increases when the volume is reduced.—B. Lane (Stafford).

There are only two likely causes of the hum described. The first is poor contact between the right-side electrolytics and their clip (and earthing wire)—a common fault on this chassis—and the second a faulty PCL82 audio output valve. (Philips 300 series.)

DECCA CTV25

On peak beam current there is severe arcing between the metal shield around the tube and the c.r.t. outer coating. This can be stopped by reducing the setting of the brightness control. There does not appear to be any arcing around the line output transformer but I have been told that this is likely to be the component responsible for the trouble. Another fault is that the verticals are slightly bent. The set is working very well in every other respect.—G. Bishop (Edinburgh).

We suggest you first check the GY501 e.h.t. rectifier by replacement. Then if necessary remove the one turn heater winding on the line output transformer and replace with heavily insulated cable—retaining the 1.5Ω resistor in series with the heater. The transformer itself should not have to be replaced. For the bent verticals check the PCF802 line oscillator valve and the 2μF electrolytic C324 in its cathode circuit—this component is a frequent cause of troubles in the oscillator circuit.

QUERIES COUPON

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TELEVISION JULY 1973

TEST CASE

127

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 complaint with a KB CVC2 colour receiver was intermittent loss of colour which could sometimes be corrected either by rotating the colour control rapidly from minimum to maximum a few times or by switching the receiver off and then on again a few minutes later. On-site examination by the field technician yielded no material clues and although the colour faded once during the examination it reappeared without assistance and did not fade again. Consequently the receiver was brought into the workshop for more detailed investigation.*

A soak test revealed that the complaint was well founded, for after about two hours running the saturation started to "flicker" with the colour disappearing completely at intervals. After the receiver had been allowed to cool right off the soak test was recommenced. As before the colour was unaffected for an hour or so, after which the symptoms recurred. During this time however it was noticed that on a deep saturation fade the colour lock failed, the colour still present forming zig-zag lines across the picture.

To check the signal in the chrominance channel a 'scope was used to monitor the chrominance signal feeds to the synchronous detectors but even when the colour faded these remained essentially constant. The bench technician concluded—correctly—that the fault was temperature sensitive and eventually—after performing one other test with the 'scope—isolated one critical component. What was this most likely to be? See next month's Television *for the solution and for a further item in the Test Case series.*

SOLUTION TO TEST CASE 126
(Page 377 last month)

The disposition of the vision, chrominance and sound carriers relative to the i.f. passband depends on the front-end tuning. The three carriers are always correctly spaced of course, but as the tuning is adjusted they move *en bloc* in the i.f. passband.

Since the various rejectors necessary are located in the i.f. channel the carriers must be correctly placed to ensure correct signal processing—by the rejectors in particular. With the carriers situated too far towards one side of the i.f. passband the definition is impaired while if they are too far towards the other side the definition is enhanced—ultimately leading to beating between the chrominance and sound carriers which causes patterning.

It is clear therefore that in the receiver in question the a.f.c. was pulling the tuning away from the correct carrier placement instead of "locking" the tuning correctly. A Foster-Seeley a.f.c. discriminator fed with a sample i.f. signal via an a.f.c. amplifier stage is used in the Pye Model CT70 to produce a positive- or negative-going output depending on the direction of mistuning. This output adjusts the bias on a varicap diode in the tuner oscillator circuit so as to keep the tuning correct. If the discriminator itself is incorrectly tuned however the phase-lock-loop will stabilise at an off-tune frequency, detuning instead of correctly tuning the front-end.

This in fact was the trouble and was overcome simply by adjusting the core of the a.f.c. transformer secondary—the a.f.c. circuit being situated on the i.f. board. Pye give a special procedure for doing this but tuning the coil for optimum results is almost as good. It should be borne in mind that as in any other i.f. circuit a drift in the value of an associated component could be the cause of the detuning.

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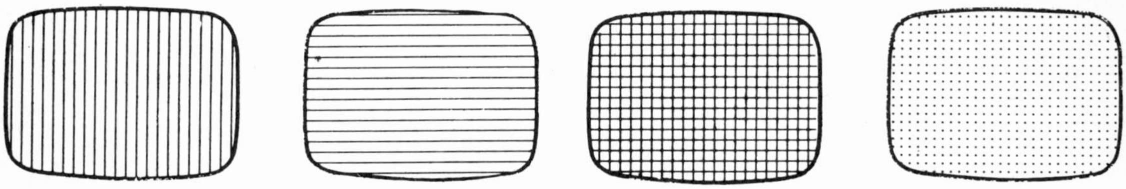

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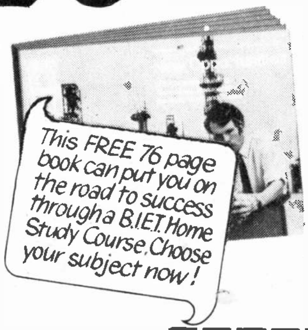

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