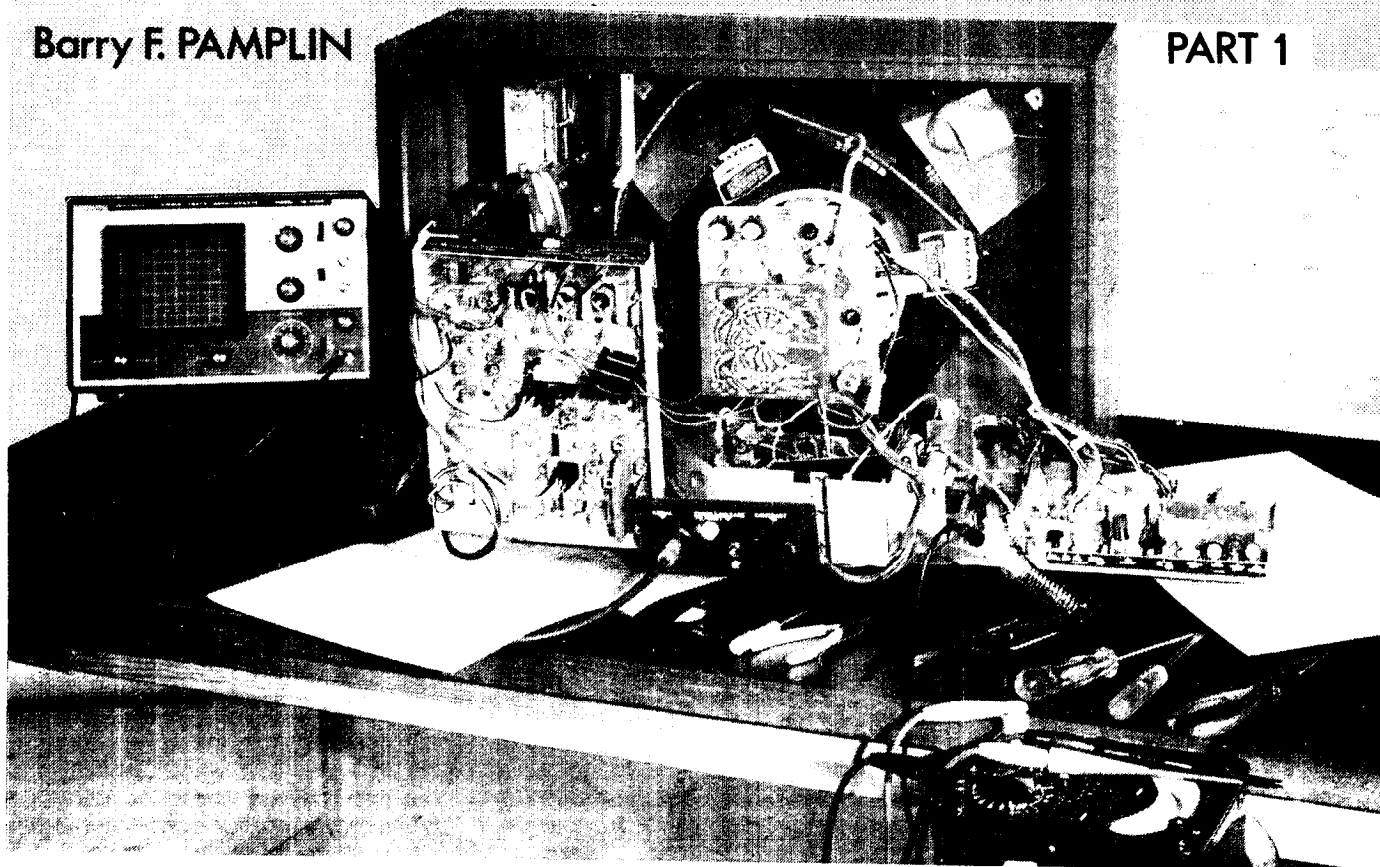# Servicing the THORN 8000 8000A 8500 chassis

Barry F. PAMPLIN

PART 1

JUNE 1971 saw the production of the first British colour chassis aimed at breaking through the £200 barrier — the Thorn 8000 series chassis. With a 17in. A44-271X shadowmask tube and an all solid-state circuit the chassis has, along with its successors the 8000A, 8500 and 8800, proved to be very popular with the viewing public and more reliable than many engineers at first predicted.

Chassis Differences

The differences between the 8000 and 8000A chassis are minimal — the repositioning of some of the h.t. feed resistors from the power board to the mains dropper unit, and minor changes to the power board circuitry. The 8500 chassis, released in July 1972, uses a 19in. tube: the higher scan drive requirements led to a redesigned line output stage and focus circuit and the use of a choke instead of a dropper resistor in series with the live mains input line. This latter modification provides an h.t. rail of about 190V in place of the 170V used on the 8000 series. More recently there has been a redesigned i.f./decoder/video panel (PC651), and the introduction of the 22in. tube 8800 chassis which incorporates pincushion distortion correction and a varicap tuner unit: these later variants are not covered in the present articles.

The circuit is arranged in the form of seven replaceable modules. Accessibility is good, with the exception of the power board on the 8000 version. Originally buried beneath the flare of the tube, it was moved into the open on the 8500.

Outline

The front end consists of a conventional quarter-wave pushbutton tuner covering channels 21-68. There is a grounded-base r.f. amplifier and self-oscillating mixer. A.F.C. is used to prevent drift. Two different types of pushbutton tuner have been used, type 12558 which can be recognised by the presence of a small printed circuit panel at the rear, and type 221 with no such panel. These two units are interchangeable except for the fact that the knobs from one type will not fit the other.

The vision i.f. circuit consists of three broadly tuned stages with a.g.c. applied to the first two, feeding an i.c. low-level synchronous detector (Texas SN76530P or Motorola MC1330PQ). The intercarrier sound channel consists of another i.c. (Texas SN76666, Motorola MC1358PQ, RCA CA3065 or Sprague ULN2165A). The sound output stage is an MJE340 transistor operating in the class A mode with negative feedback. This transistor is
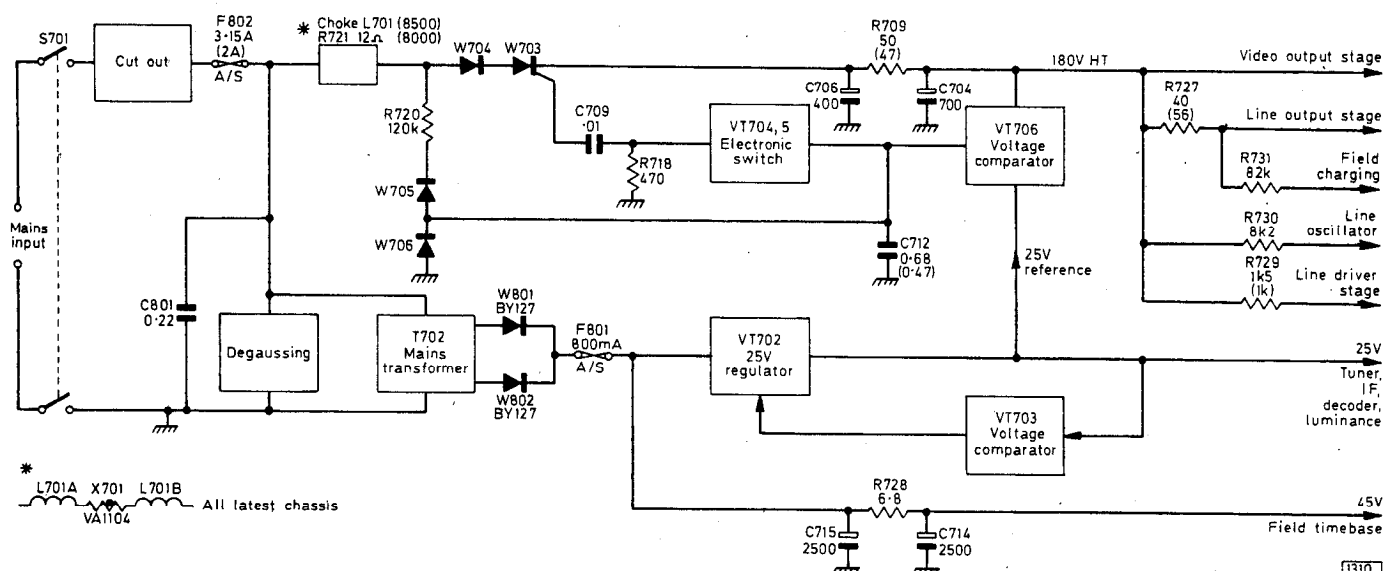
Fig. 1: Overall arrangement of the power supply board. Values in brackets apply to the 8000 and 8000A chassis, though in later 8000A chassis the ramp capacitor C712 which controls the electronic switch is 0·68μF as in the 8500 chassis.

also used to provide a quick path to chassis to ensure that the mains fuse blows under certain fault conditions – more of that later!

The decoder circuitry is fairly conventional (in Thorn terms), using the squared ident signal for R–Y switching and, somewhat unusually, a field effect transistor as a d.c. amplifier in the reference oscillator control loop.

The line and field timebase circuits are also fairly conventional. As mentioned above, the 8500 chassis uses a different line output arrangement based on a 1700V transistor (type BDX32) – the 8000 uses a BU105/02.

Power Unit

Having described the chassis briefly we will now get down to the power unit which is the subject of this first article. Two types of unit are used. The 90V6-644 used on the 8000 and the 90V6-644-101 used on the 8000A and the 8500. To distinguish one type from the other, look at R730 adjacent to the 10-way socket. If R730 is mounted vertically the panel is for the 8000 series, if it is mounted horizontally the panel is the later type for the 8000A/8500 chassis. *These panels are not interchangeable.* If the later type is used in place of the earlier type no damage will occur – the same cannot be said for using the earlier type instead of the later!

Associated with the different power panels are three different types of mains dropper. The original 8000 used a two-section dropper, type 90E5-005, consisting of a 12Ω section and a 47Ω section. The 8000A used a four-section dropper (90E5-006) consisting of a 12Ω section, a 47Ω section (as before) plus a 1kΩ section and a 56Ω section. It will be clear from this that the four section unit may be used in place of the two section one but not the other way round. The 8500 uses a three-section dropper (50Ω+40Ω+1·5kΩ) since a choke (L701) is used in place of the original 12Ω section. This dropper is suitable only for the 8500 series of course.

Overall Arrangement

The overall arrangement of the power board is shown in block schematic form in Fig. 1. From a mains input of 240V 50Hz, three outputs are provided. An h.t. line (referred to as 180V but in fact nearer 170V on the

8000/8000A and 190V on the 8500) which is obtained from a phase-controlled thyristor (W703). This feeds the video output transistors, the line output transistor, the field charging circuit and the line oscillator and driver.

An unstabilised 45V supply for the field timebase is obtained from a step-down transformer (T702), a pair of full-wave rectifiers (W801/2) and a smoothing circuit (C715/R728/C714). This supply is also used to feed the series stabiliser VT702 which provides a regulated 25V supply for the tuner, i.f. strip, decoder and luminance circuits. It is also used as a reference voltage for the thyristor-controlled h.t. line – an arrangement which makes the occurrence of a short-circuit stabiliser transistor a somewhat expensive affair!
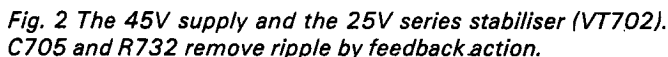
Fig. 1 also shows the effect of the changes in the dropper resistors referred to earlier. In the original 8000 series the resistors feeding h.t. to the line output stage (R727) and line driver (R729) were mounted on the power board. On the later 8000A and 8500 chassis they are mounted on the mains dropper resistor assembly.

Protective Devices

The protection devices used in the circuit are also shown in Fig. 1. A 2A thermal cut-out and a fuse F802 (2A on the 8000/8000A, 3·15A on the 8500, both delay types) are used in the live mains lead while an 800mA delay fuse (F801) is incorporated in the 45V circuit. Whatever the theory may be, in practice – in the writer's experience – the thermal trip opens up only when the line output transistor has decided to shuffle off this mortal coil, the 2A (3·15A) fuse F802 blows only when the thyristor (together with a handful of other bits – more later) goes short-circuit, while the 800mA fuse F801 frequently blows for no obvious reason – unless of course it doesn't like the peak current rushing through it to charge up 2,500 empty microfarads restricted only by the impedance of the BY127s and the transformer secondary! It is not unknown for a defective cut-out to open of its own accord.

25V Stabiliser

The 25V stabiliser circuit is shown in Fig. 2 – the 45V supply has already been described. VT702, connected as an emitter-follower, acts as a series regulator with its emitter
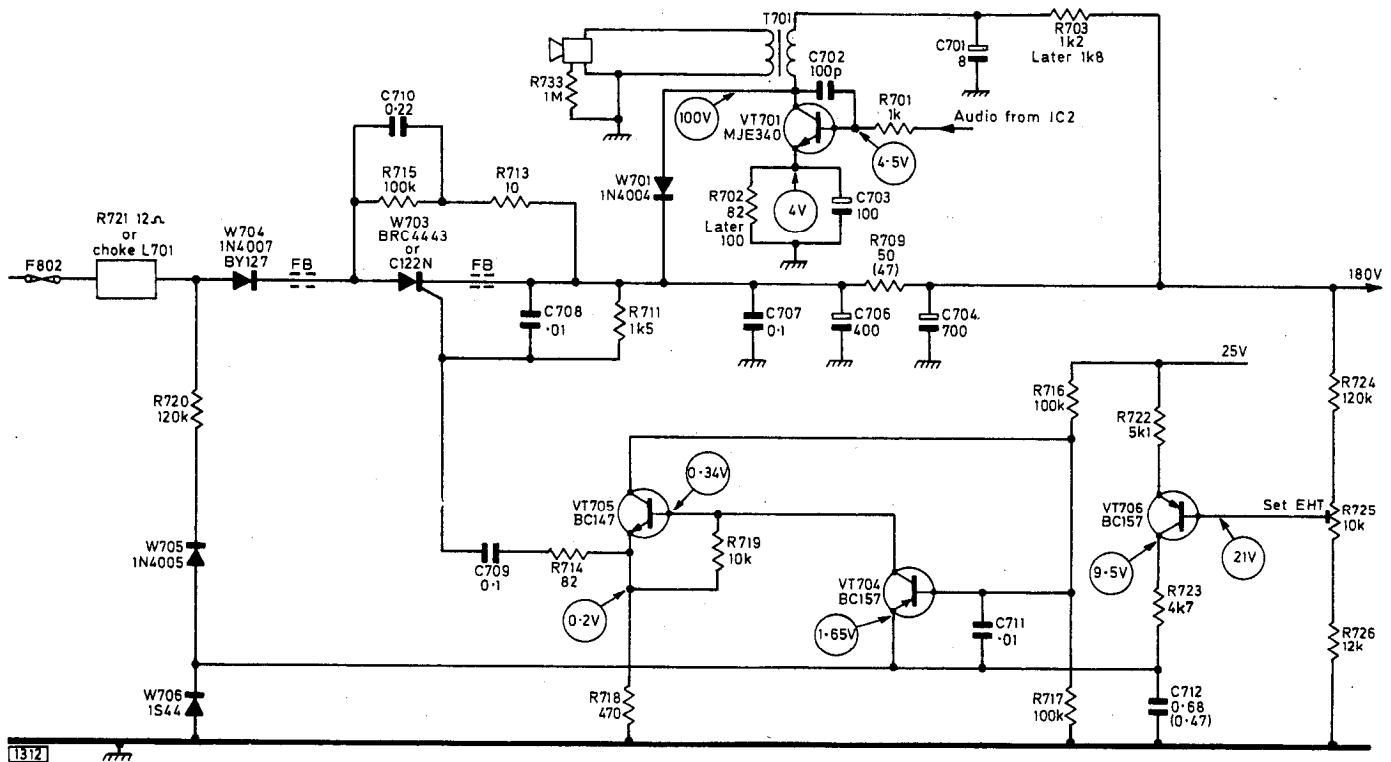
Fig. 2 The 45V supply and the 25V series stabiliser (VT702). C705 and R732 remove ripple by feedback action.

voltage following its base voltage – if the base voltage increases, the emitter voltage increases some 0·5V behind. R706 sets the stabiliser output voltage by altering the base voltage of VT703. Since the emitter of VT703 is tied to 6·2V by the zener diode W702, its collector voltage will alter following variations of its base voltage. Say the 25V line rises. The voltage on the base of VT703 will also increase, and its collector voltage will fall. This fall is coupled to the base of VT702 whose emitter voltage follows thereby counteracting the original increase. C705 and R732 couple the 100Hz ripple present at the output back into the control loop, thus providing effective smoothing.

HT Supply

The control circuitry for the 180V rail is shown in Fig. 3. Although apparently complicated, the operation of the circuit can be easily mastered if taken in small doses.

The mains input is fed via a dropper resistor section or choke to diode W704. This component originally owed its presence to the fact that when designing a set to break through the £200 barrier it is important to keep component costs as low as possible. Without the diode, thyristor W703 has to be able to withstand reverse voltages of the order of 400/500V. Such thyristors exist, but are more expensive than those that don't have such stoutness. Thus it's a case of it being cheaper to use two components rather than one! In some more recent production sets a different thyristor is used, W704 being omitted. More recently still a BY127 returns to the W704 position, and it pays to make sure that the diode is there.

The thyristor is generally faced with only the positive-going portions of the mains supply therefore, and these it conducts to the reservoir capacitor C706 in accordance with the signal at its gate. If more output is required, the gate signal switches it on earlier in each cycle – and vice versa. For those unfamiliar with thyristors it should be explained that once the gate has turned the device on it will remain conducting until the current through it falls to nearly zero – i.e. when its anode and cathode voltages are the same.

So far as the thyristor control circuit is concerned the key component is C712. When the voltage across this capacitor reaches 8V its upper plate is connected via VT704/5 to R714 and the thyristor is fired. The action of VT704/5 we will leave for a moment. Let us consider how C712 charges. It is connected to the stabilised 25V rail via VT706 and resistors R722/723. Thus it commences to charge as soon as the 25V rail has been established. The

rate at which it charges depends upon the base voltage of VT706, which is fed from a potential divider across the 180V rail and chassis. At switch on, the only current available to charge C712 is leakage through VT706. This gives the 8000 series its characteristic delay between switching on and the start up of the line timebase.

C712 must clearly be discharged to some fixed level every cycle, and this is the function of diodes W705 and W706. These conduct on only the negative half cycles of the mains input, pulling the top plate of C712 down to about –0·7V (the drop across W706).

Having sorted out the wood from the trees we can now return to the details of VT704/5. The base of VT704 is held at about 7V by the potential divider R716/R717. Thus when the voltage on C712 reaches 8V the transistor becomes forward biased and starts to conduct. The collector current flowing through R719/R718 causes the base of the npn transistor VT705 to become positive with respect to its emitter with the result that it too turns on. The effect of VT705 drawing current through R716 lowers VT704's base voltage so that this device turns on even harder. This regenerative action results in both transistors turning hard on and C712 being connected across R718. This voltage is fed to the gate of the thyristor via R714 and C709, switching it on.

Components C708 and R711 prevent the thyristor turning on spuriously, i.e. without a proper trigger pulse, especially at higher temperatures. R713/R715/C710 serve to bypass any transients which might tend to switch the thyristor on without a gate signal. C710 has proved to be unnecessary in the 8500 chassis since the transients are stopped by the ballast choke: though fitted to early boards, it should be removed when encountered (this does not apply to the 8000 and 8000A chassis).

Real Life Troubles

So much for the theory of the power board. What actually happens in real life? Without a shadow of doubt the two components that give most trouble are the 12Ω ballast resistor and the thyristor. Especially on the early 8000 models, the 12Ω resistor went open-circuit with alarming frequency. Whether the voltage drop per turn was too high or the ceramic formers were below par is not clear. When the modified resistor for the 8000A became available things got a bit better, but only when the resistor was replaced by a choke on the 8500 did the problem disappear. From a practical point of view the trouble was non-existent if you had a proper replacement to hand, and almost insuperable if you didn't. The classic approach of shunting the broken section with a dropper section was fraught with danger because of the small clearance between the resistor and the plastic cabinet. There was also the small problem of locating a source of 12Ω 50W sections! RS now make a complete dropper (stock number 154-955).

With the appearance of the 8500 chassis it was confidently hoped that dropper troubles would be over. No such luck. Referring to Fig. 1, the connection between R709 and R727 consists of a link of bare wire on the dropper – positioned so that it will readily short out R727 with the consequent demise of the line output transistor!

So much for dropper troubles. The next villain is the thyristor. This can misbehave in three ways. It can go short-circuit, open-circuit or start acting like an ordinary diode (there are other possibilities which are too rare to warrant mention). If it goes short-circuit the cause is often W704 going short-circuit thus subjecting it to high reverse

Fig. 3:Ahe stabilised h.t. supply circuit. Thyristor W703 provides the regulator action. The point at which it conducts during the positive excursion of the mains input waveform is determined by the ramp capacitor C712 whose charging is controlled by VT706. When the voltage across C712 reaches 8V the electronic switch VT704/VT705 operates and fires the thyristor. During the negative half-cycles of the mains input W705 and W706 conduct, discharging C712, and VT704/VT705 switch off.

potentials as mentioned before. When it goes short-circuit it will always take with it the sound output transistor VT701 and diode W701 (see Fig. 3). It is the author's contention, yet to be agreed by any higher authority, that the sole purpose of W701 is to ensure a low-impedance path to chassis via VT701 when the thyristor goes short-circuit and W701's cathode goes negative with respect to chassis. It certainly works, but what a system!

If the thyristor goes open-circuit there is no 180V rail but no damage otherwise. A thyristor acting like a diode will give an h.t. rail of around 280V, with dire consequences for the line output transistor and associated components.

Since the 25V rail is used as a reference point for the 180V supply it follows that a collector-emitter short in the 25V stabiliser transistor VT702 will cause the 180V rail to shoot up – in fact to around 280V. Shorts in VT706 and W705 have a similar effect, and in all these cases it is usually the line output transistor that suffers – and the customer's bank balance when one considers the price of a BDX32. Shorts across the collector-emitter junctions of the switching transistors VT704/705 cause the thyristor to stay off and result in no 180V supply.

Routine Fault Finding

For routine fault finding on the power board the following procedure is suggested.

Check for 45V at F801. If not present check W801/802, the mains transformer, fuses, thermal trip, and the on/off switch. Check for 25V on the emitter of VT702. If necessary adjust to 25V using R706. If no voltage is present here, check VT702/703 and associated components.

If the 25V supply is present but there is no 180V supply check W704, W703, VT704/705 and VT706 for being open-circuit – also check the 12Ω ballast resistor.

If the 180V line is high and uncontrollable the thyristor is the most likely culprit.

Instability of the 180V line is not a common problem, but when it does arise it produces a number of puzzling effects. A series of broad white lines across the screen is one example, another is the whole raster changing size rapidly. In all such cases the thyristor is the first suspect, with the transistors VT704/5/6 next on the list.

Modifications

During the life of the power board a few modifications have been introduced apart from those already mentioned. The three worth mentioning are all concerned with the behaviour of the unit with variations in supply impedance, and can be recommended in all cases where the power unit seems to be temperamental. R720 was changed from 150kΩ to 120kΩ, R723 was changed from 12kΩ to 5·6kΩ and finally to 4·7kΩ, C712 was changed from 0·47μF to 0·68μF.

Setting Up

There are two preset controls on the board. R706 sets up the 25V rail while R725 sets up the 180V rail. The setting up procedure is as follows.

Turn R725 fully anti-clockwise. Connect a meter capable of measuring 25V d.c. ±2 per cent between chassis and the emitter of VT702 and adjust R706 for 25V. The official procedure for setting R725 requires a special diode probe but in practice, and assuming no other fault exists on the receiver, it may be set to obtain the narrowest acceptable picture using the test card – for maximum reliability the h.t. rail should be set as low as possible.

CONTINUED NEXT MONTH

Servicing the THORN 8000 8000A 8500 chassis

Barry F. PAMPLIN

PART 2
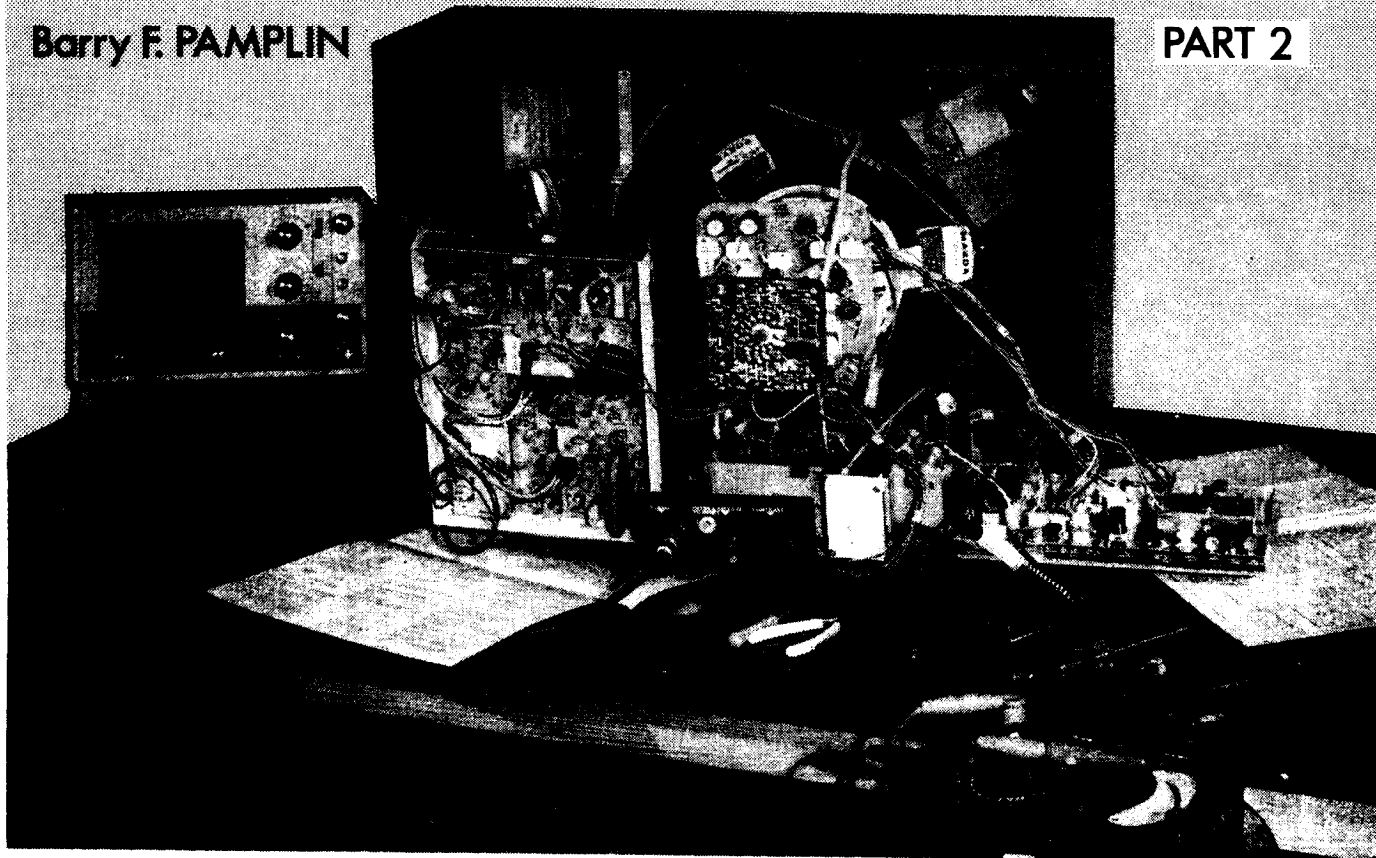
Two types of tuner unit have been fitted to the chassis under discussion, the 12588 variety (incorrectly referred to as 12558 last month) which may be identified by a small printed panel mounted on the rear of the tuner, and the T221 with no external panel. The two types are both physically and electrically interchangeable but use different types of knobs.

The tuner units themselves have proved to be reliable, but the same cannot be said of the earlier versions of the aerial isolator assembly. These separated into two non-repairable halves at the slightest tug on the aerial lead. When faced with this problem there is the understandable temptation to use a pair of coaxial plugs and a coupler as a temporary measure. This must be resisted at all costs as it can easily lead to the outer of the coaxial cable being live if either the mains wiring is reversed or the live side of the mains on/off switch becomes permanently made due to the contacts welding together – a not uncommon experience with the push-push type of switch used on this chassis.

IF/Chroma/RGB Panel

The following notes refer to panel type PC642 which is fitted to the majority of 8000/8500 chassis. It contains the i.f., chroma and video drive circuits and is a large panel mounted on the left-hand side (viewed from rear) of the chassis. The contents of this board are shown in block form in Fig. 1.

Each section shown in Fig. 1 will be dealt with in turn. Note particularly the use of i.c.s for vision and sound detection and for chroma processing. The whole board is powered from the stabilised 25V line – which shoots up to 45V if the stabiliser transistor on the power board goes short-circuit! Fig. 5 shows the position of the various test points. (Our photos show panel PC651.)

The IF Strip

The circuit of the vision i.f. strip is shown in Fig. 2. Most of the i.f. and adjacent channel filtering is carried out in the base circuit of VT101. Specifically, C103/4/L101 form a 41·5MHz adjacent sound channel rejector, C105/L102 reject at the sound carrier frequency (33·5MHz) whilst C106/8/L104 reject the channel 1 vision carrier signal at 45MHz.

The three transistor amplifier stages are tuned to form a broadband amplifier with the appropriate response. L105 is tuned to 38·9MHz, L106 to 34MHz and L107 to 37MHz.

All sections are powered from 25V line
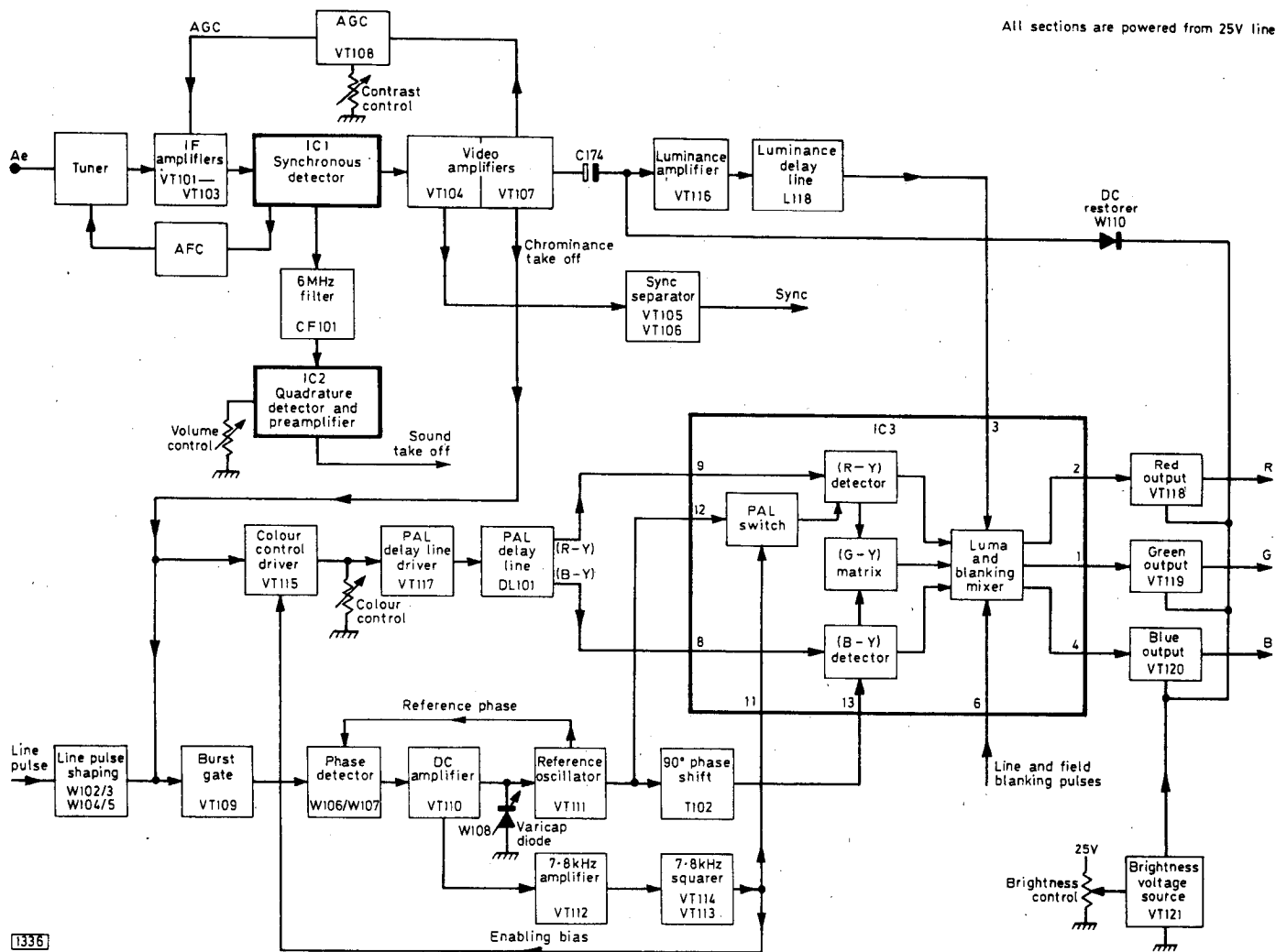
Fig. 1 : Block diagram of the i.f./decoder/RGB output panel.

The vision carrier position is set by fine adjustment of L105 and L103 whilst tilt adjustment can be provided by detuning L107.

A.G.C. is applied directly to the first transistor VT101 and indirectly via VT101 emitter to VT102. The a.g.c. sense is positive-going for reduced gain (forward a.g.c.) and the signal at the i.f. strip output – at TP1 – is of the order of 30-50mV.

Generally speaking the circuit gives little trouble. Most faults seem to be associated with VT101, C110 and C115.
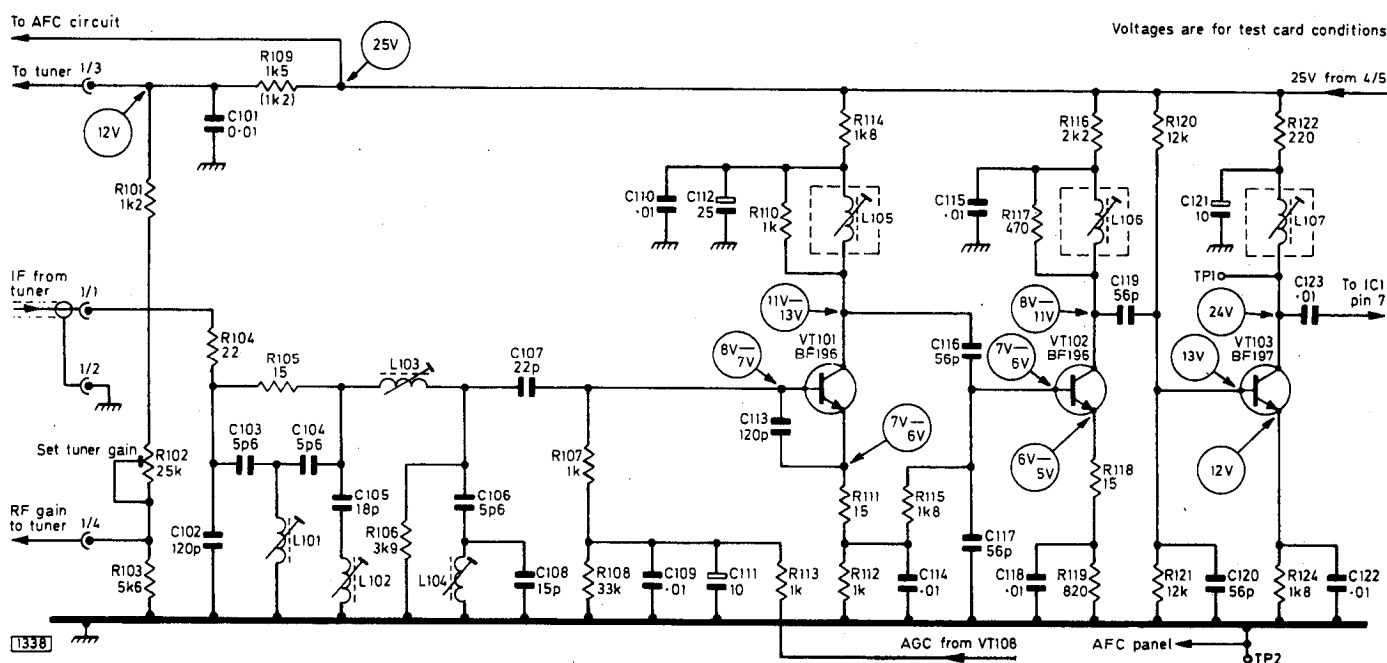
Fig. 2: Circuit of the i.f. amplifier.

Fig. 3: The video detector (IC1), intercarrier sound (IC2), sync separator and a.g.c. circuits. Negative feedback from the secondary of the sound output transformer T701 is fed to pin 7 of IC2 via R148/C141: the tap on T701 was omitted in Fig. 3 last month.
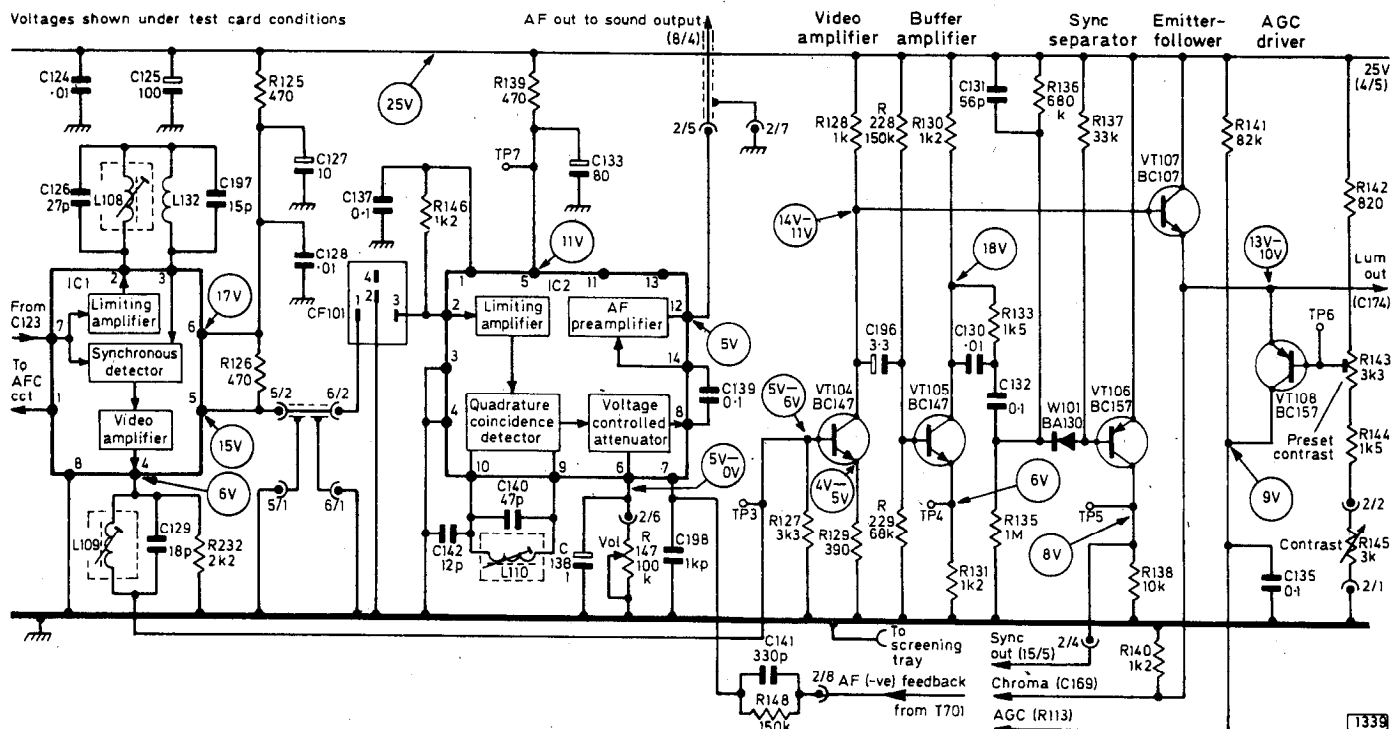
No signal symptoms are more likely to be due to a.g.c. troubles than i.f. troubles. Intermittent contrast changes have been traced to the electrolytic C112.

Detector, Sync Separator & AGC

The output from the i.f. strip is fed to the circuit shown in Fig. 3. IC1 is a low-level video detector providing a negative-going output at pin 4 and a positive-going output at pin 5.

The signal at pin 5 is fed via the 6MHz ceramic filter CF101 to the intercarrier sound channel IC2 which provides from pin 12 an a.f. signal for driving the output stage. Negative feedback is applied to pin 7. The volume control — there have been several different arrangements — is connected between pin 6 and chassis.

The video signal at pin 4 of IC1 is fed via the 6MHz rejector L109/C129 to the video inverter VT104. The forward bias for this transistor is generated within the i.c. The output from the collector of VT104 feeds the sync

Fig. 4: The luminance, RGB output and brightness circuits.
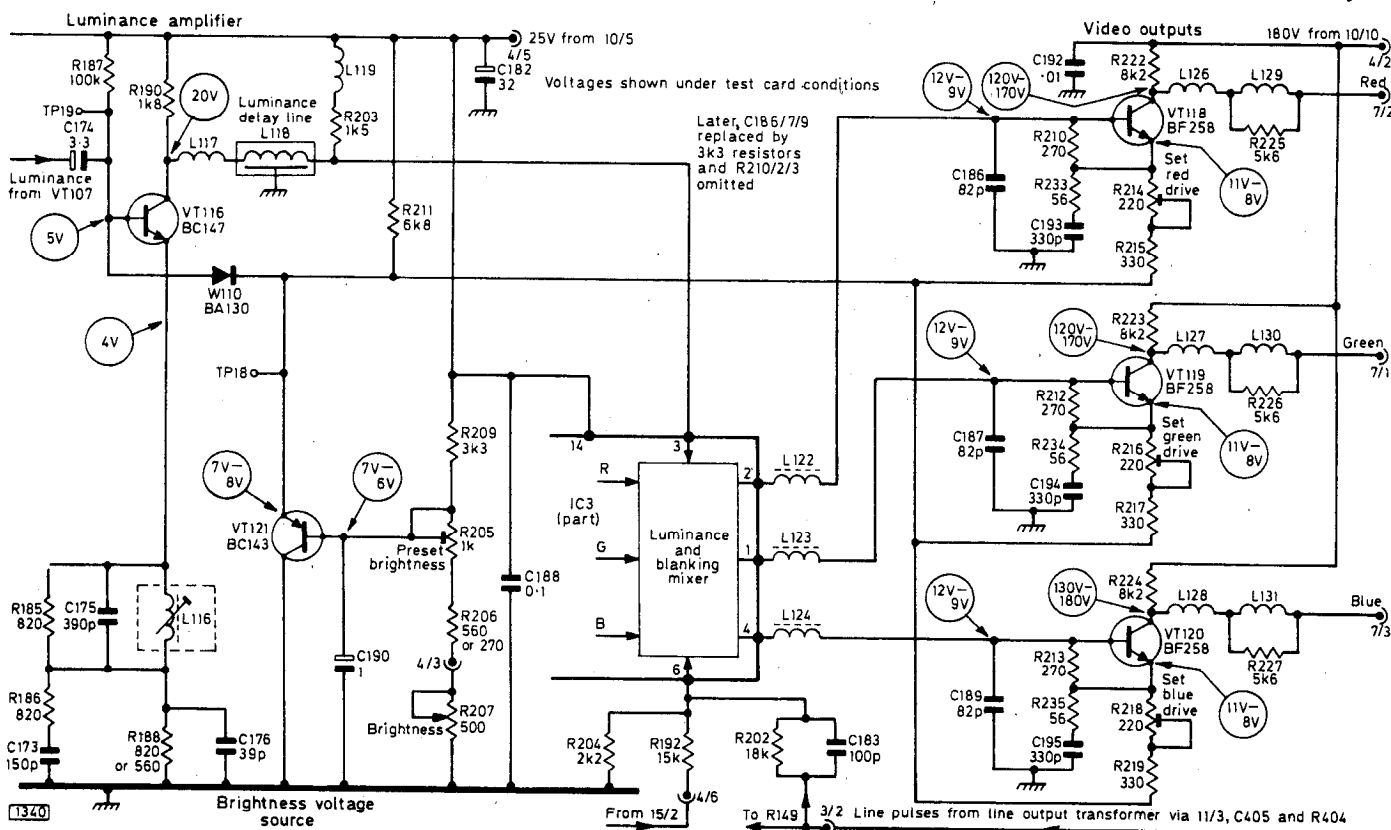
buffer VT105 and the emitter-follower VT107. The output from VT107 consists of a 3V peak-to-peak signal for driving the luminance amplifier.

Also connected to the output of VT107 is the a.g.c. driver VT108. R141 together with R113 and R108 (see Fig. 2) form a potential divider to control the forward bias applied to the first i.f. transistor VT101. With no signal present this stage is biased for maximum gain and VT108 is cut off by the reverse bias from the potential divider R142-R145. With video signals present, the tips of the positive-going sync pulses at the emitter of VT107 cause VT108 to conduct, increasing the charge on C135. The voltage across this capacitor is applied to the first i.f. transistor to reduce its gain. The contrast control R145 together with the preset R143 enable the circuit conditions to be adjusted to suit local reception conditions and customers' preferences.

Returning now to VT104, its output is also coupled via C196 to the inverting amplifier VT105 which reverses the polarity of the signal to make it suitable for driving the sync separator. Negative-going sync pulses at the collector of VT105 cause W101 and VT106 to conduct and positive-going sync pulses appear across R138.

Fault Finding in the Signal Stages

Fault finding in these circuits is simple enough if a logical approach is adopted. Faults can be considered under four headings.

Picture OK, Sound Faulty

Assuming that the sound output stage on the power panel (see first article) has been checked and found to be o.k. the trouble will be due to IC2 or its associated circuit. First check for an 11V supply at pin 5 (TP7). If this is present the voltage on the other pins should be checked and compared with those given in Fig. 9. Any voltage outside the limits shown makes the i.c. suspect. Other components which occasionally give trouble are CF101 and C140. Check also the screened lead and its terminations feeding the filter. In cases of poor sound check that L110 is tuned for optimum results.

No Sound or Vision: Poor Sound, Vision

Assuming that a signal exists at the input, pin 7, of IC1 the first step is to check whether video is present at pin 4. A simple check is to measure the d.c. potential here. If the voltage is about 7V falling to about 5V when the aerial is plugged in it can be assumed that IC1 is o.k. If the i.c. is suspected the voltages on all pins should be checked against those shown in Fig. 9. Assuming that the voltage on supply pin 6 is correct, an incorrect voltage elsewhere on the i.c. will usually mean that it is faulty.

Sound OK, No Vision Signal

This indicates trouble around VT104 or VT107. A check on the transistor voltages will enable the fault to be located.

Sync Troubles

Weak or absent sync is usually the result of a flashover killing VT105 or VT106, or C196 being defective. Video getting into the sync (pulling on captions etc.) is usually the

result of a fault in IC1, especially if accompanied by video smearing. When the circuits are operating correctly the sync output at TP5 consists of positive-going sync pulses of 15-20V amplitude.

RGB Circuits

The video output circuitry is shown in Fig. 4. The signal present at the emitter of VT107 is a.c. coupled via C174 to VT116. The emitter circuit of this transistor includes a subcarrier rejection filter L116/C175 to reduce chroma patterning and to gain compensation at 1·2MHz, needed because of a dip at this frequency in IC3. The output from VT116 passes via the luminance delay line L118 to the chroma processing i.c. IC3 where it is used to provide information for the RGB drive circuits.

Because of the a.c. coupling to VT116 it is necessary to provide d.c. restoration and this is achieved by diode W110 which conducts on the sync pulse tips to restore the charge on C174. The restoring voltage applied to the diode is obtained from the brightness control transistor VT121 which is positioned in the earth return of the three output transistors.

Brightness Circuit

The operation of this circuit is worth considering in some detail since because of the d.c. feedback via W110 a fault developing in any part of the loop will disturb the d.c. levels all round it. The base of the brightness control transistor VT121 is connected to a potential divider network across the 25V supply. The potential applied to its base is controlled by the setting of the brightness control R207 and the preset R205. The base voltage of VT121 determines its emitter voltage, and thus controls the mean collector voltages of the RGB output transistors VT118-VT120. In addition to this however, the setting of the brightness control also affects the drive to the bases of the output
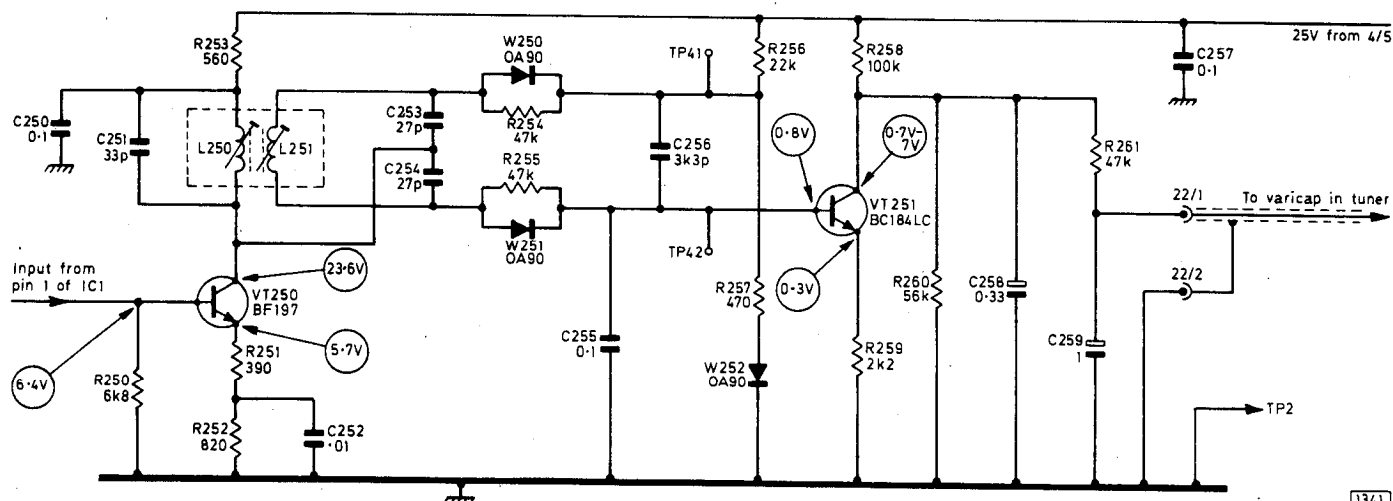

Fig. 5: Positions of the i.f. and decoder test points and preset controls on the panel.
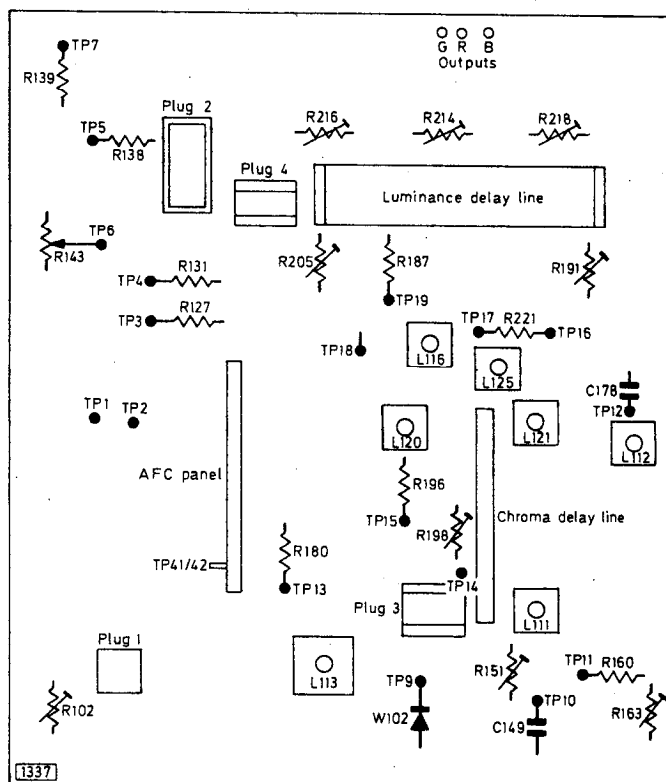
Fig. 6: The a.f.c. subpanel circuit.

transistors because of the d.c. coupling from VT121 emitter via W110, VT116 and IC3.

Luminance and RGB Faults

Fault-finding in any closed loop poses problems. Faults affecting one colour only (absence or excess of a colour in the grey scale) will usually be due to faults in the relevant output transistor or IC3; brightness faults affecting all guns however will usually have their root either in the feedback loop or the flyback blanking circuit. When checking such faults it is worth bearing in mind that anything removing the forward bias from VT121 will tend to cut off all the guns (i.e. no raster). Two common causes are C190 developing a leak or VT121 becoming faulty in some way. W110 going open-circuit would have the same effect, as could a fault in VT116.

Faults in IC3 causing a loss of luminance are rare — as mentioned later, the more usual trouble in this department is loss of one colour. The key to checking the i.c. for proper performance is, as always, to check all the pin voltages — see Fig. 9. A very high voltage on pin 6 of IC3 usually means that W103 in the burst gating circuit has developed a leak.

Video with multiple ghosts usually indicates luminance delay line trouble, although similar troubles can be due to IC1. Absence of the luminance is generally due to VT116 being defective or C174, L117, L118 or L119 being open-circuit.

Automatic Frequency Control

The a.f.c. panel is a separate unit mounted on to the main board. The circuit, shown in Fig. 6, is conventional and consists of an i.f. preamplifier followed by a discriminator and d.c. amplifier to provide a correction signal for the varicap diode in the tuner.

To set the circuit up the discriminator output is removed by shorting together TP41 and TP42, the tuning adjusted for optimum performance, the short-circuit removed and the core of L251 then adjusted to restore optimum performance.

Failure of this circuit is uncommon: most troubles are due to one of the transistors or one of the discriminator diodes.

Burst & Reference Oscillator Circuits

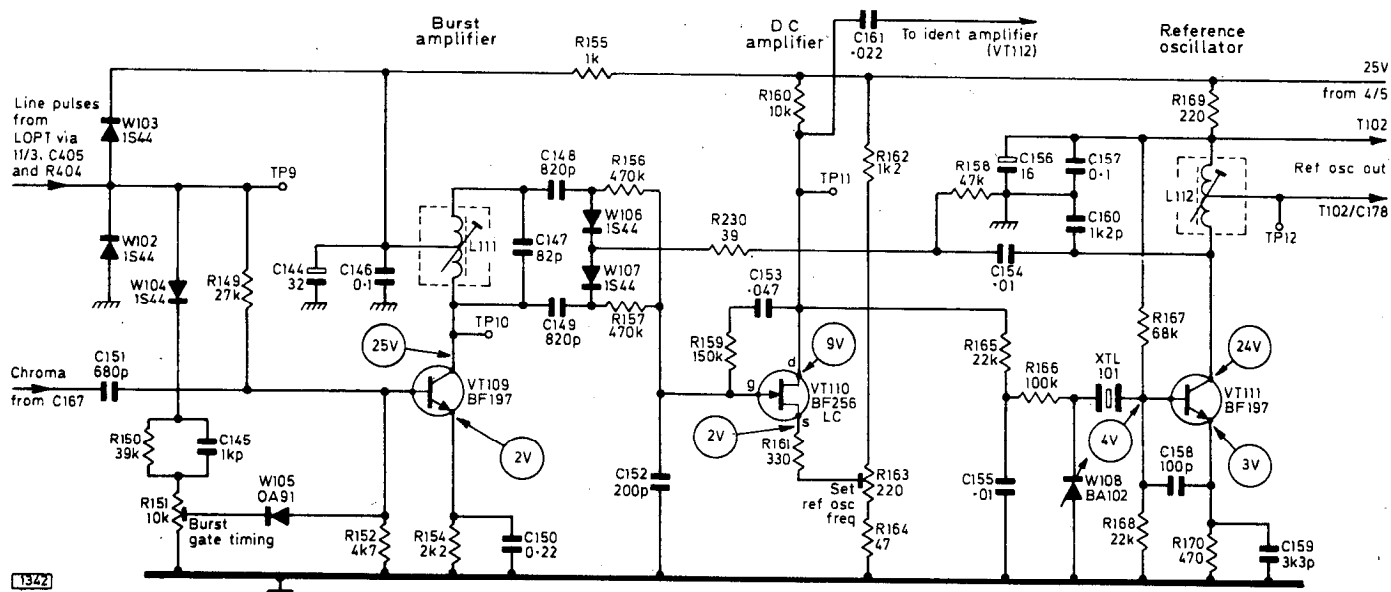The circuit arrangement of the burst channel and reference oscillator is shown in Fig. 7. Chroma and burst

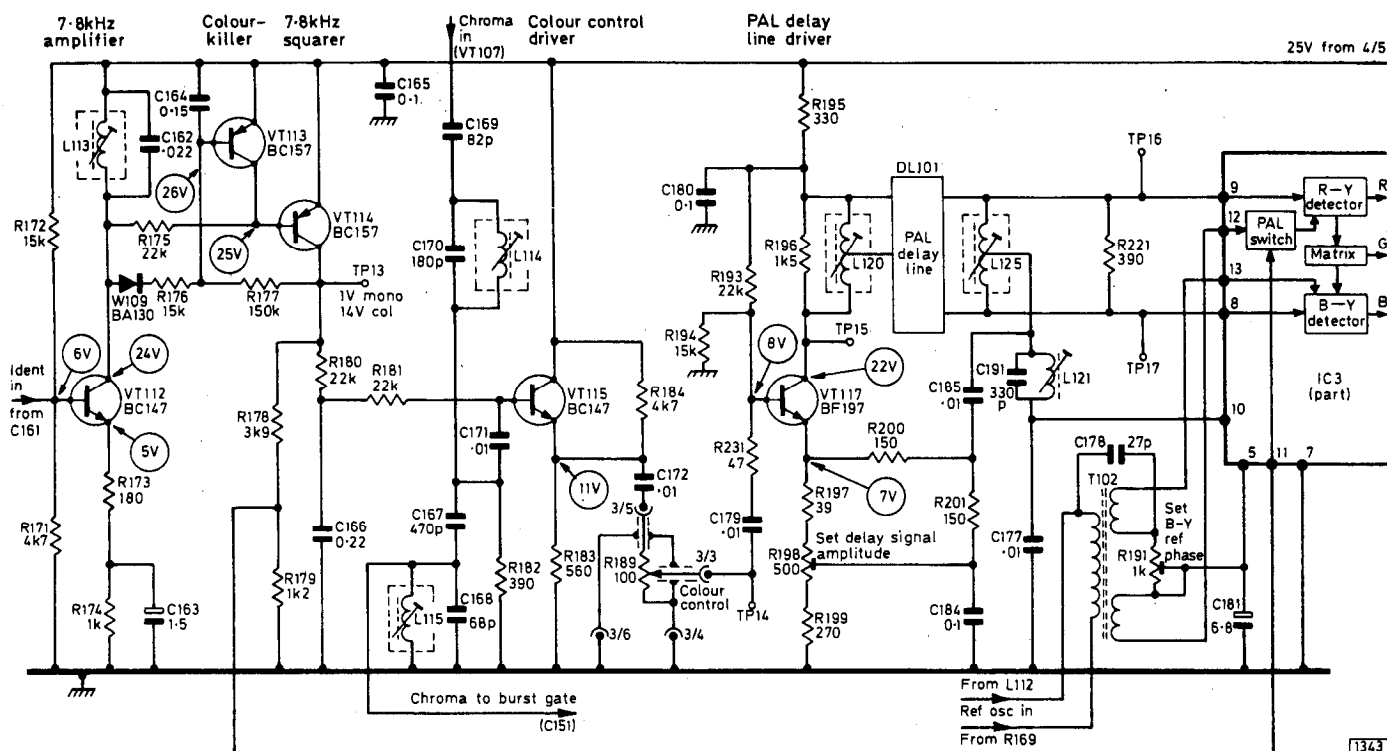*Fig. 7: The burst channel and reference oscillator circuits.*

Fig. 8 The ident and chroma signal stages.

signals are fed to the base of VT109 via C151 while line gating pulses are applied to the same point via a clamping and delay circuit. The positive-going line pulse is clamped between chassis and the 25V line by W102 and W103 and then applied via the potential divider R149/R152 to the base of VT109. It also forward biases W104 and allows C145 to charge via R151. The time-constant of this network is such that the voltage across R151 rises and then falls to a point where its value is lower than that of the line pulse on the base of VT109. The exact timing can be adjusted by R151 to ensure that VT109 cuts off at the end of the burst period. VT109 is held in the cut-off state during the active line period by the charge on C150. This holds the emitter positive until the next gating pulse arrives.

When all is working correctly in this circuit the output at the collector of VT109 is clean bursts of some 20-25V amplitude. These are applied in opposite phase to the two burst discriminator diodes W106 and W107 whose midpoint is fed with a signal from the reference oscillator. The output from the discriminator appears across C152 and consists of a d.c. signal proportional to the difference in phase between the burst and the reference signal plus a "swinging burst" ident signal at 7·8kHz. This combined signal is fed to the high-impedance f.e.t. transistor VT110 which amplifies the d.c. variation and feeds it to the reference oscillator control varicap diode W108 to pull the oscillator into lock with the burst. Resistor R163 feeding VT110 source allows the circuit conditions to be set up for correct operation. The ident signal is extracted from VT110 drain and fed via C161 to the ident amplifier.

The reference oscillator itself is based on VT111 and is quite conventional. The frequency is controlled by the crystal XTL101 and the output is extracted from the collector load coil L112.

Faults

Now for the servicing problems. A complete absence of colour often means a complete absence of line pulses to gate VT109 due to R404 (on the timebase panel) having

cooked and dropped out of the board. R404 can also go high-resistance or even vary in resistance, causing intermittent colour loss. If the fault causing no colour is actually on the decoder panel however it is likely to be due to a defect in the circuits under consideration. Any of the four diodes in the base circuit of VT109 can fail producing, as an alternative to no colour or unlocked colour, such pretty effects as no colour at the start of the scan or random patches of colour which look just like a purity fault.

VT109 has a tendency to go open-circuit as does VT110. Other components with a history of trouble are C144, C154, C160 and R163. The reference oscillator transistor VT111 sometimes fails to "go" for no obvious reason although changing it produces a cure. The other components to suspect are the decouplers C156 and C157, the crystal and the varicap diode W108.

If all these potential troubles seem a nightmare you're quite right, – the more so since many of them show up intermittently rather than as "solid" faults. The author's personal approach is explained later.

Ident and Chroma Circuits

The circuit of the ident and chroma amplifier stages is shown in Fig. 8. The swinging burst ident signal is applied to the base of VT112 whose collector load circuit L113/C162 produces a 30V peak-to-peak 7·8kHz sinewave. This signal is rectified by W109 and applied to the reservoir capacitor C164 to provide a turn off bias for transistor VT113 which otherwise holds VT114 non-conductive.

The amplified ident signal is also applied to the base of VT114 which saturates on the negative half cycles and cuts off on the positive half cycles, producing a squarewave output at its collector. This signal, after attenuation by R178/R179, is used to drive the PAL switch in IC3. It's also applied to the low-pass filter R180/C166 which extracts the d.c. component (about 13V) and uses it as a turn-on bias for the first chroma amplifier VT115.
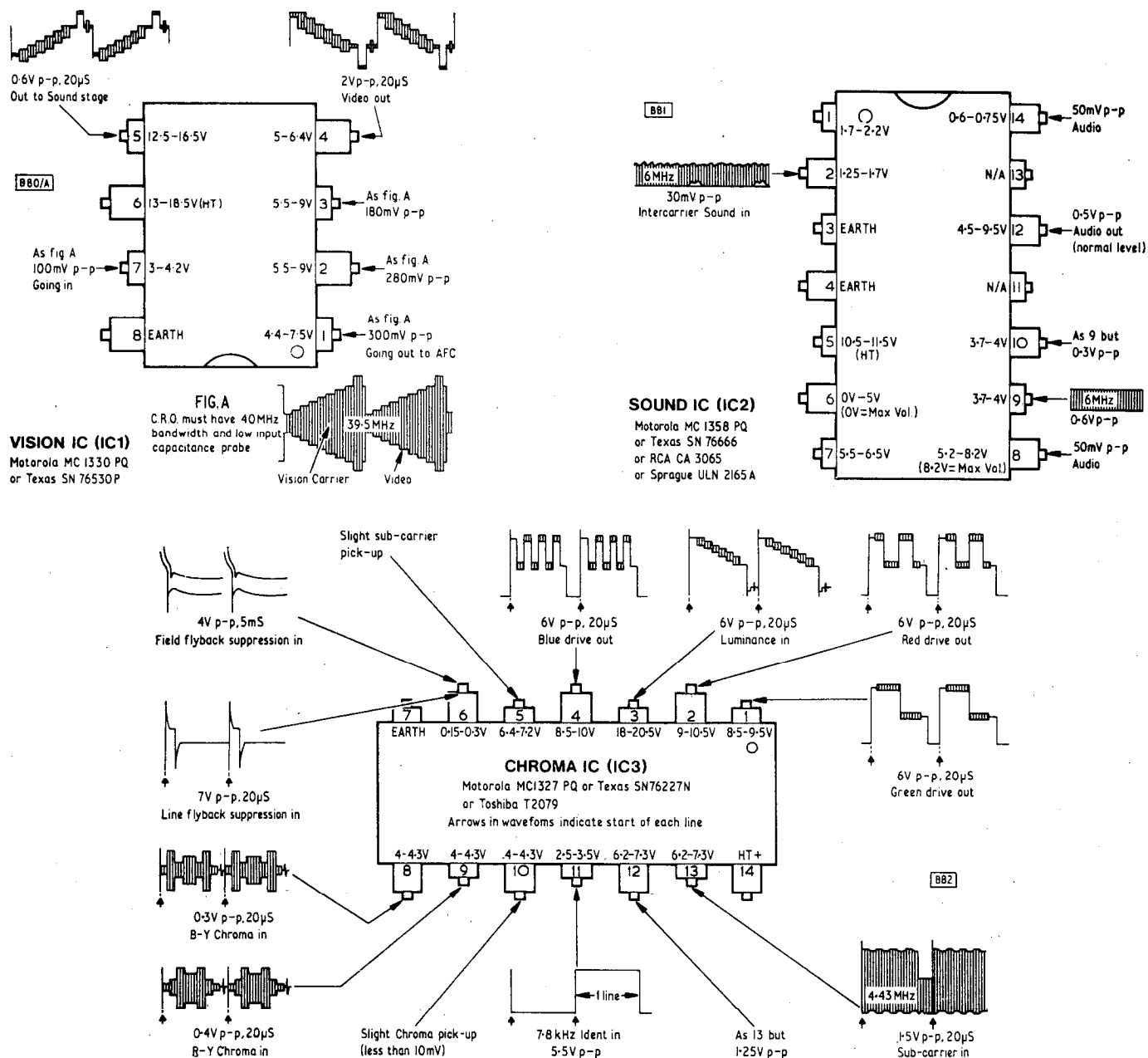
0·6V p-p, 20µS
Out to Sound stage

2Vp-p, 20µS
Video out

[B80/A]

5	12·5-16·5V		5-6·4V	4
6	13-18·5V(HT)		5·5-9V	3	As fig. A 180mV p-p
7	3-4·2V		5·5-9V	2	As fig. A 280mV p-p
8	EARTH		4·4-7·5V	1	As fig. A 300mV p-p Going out to AFC

As fig A
100mV p-p
Going in

VISION IC (IC1)
Motorola MC 1330 PQ
or Texas SN 76530P

FIG. A
C.R.O. must have 40MHz
bandwidth and low input
capacitance probe

39·5MHz

Vision Carrier   Video

[B81]

6MHz
30mV p-p
Intercarrier Sound in

1	1·7-2·2V		0·6-0·75V	14	50mV p-p Audio
2	1·25-1·7V		N/A	13	
3	EARTH		4·5-9·5V	12	0·5V p-p Audio out (normal level)
4	EARTH		N/A	11	
5	10·5-11·5V (HT)		3·7-4V	10	As 9 but 0·3V p-p
6	0V-5V (0V=Max Vol.)		3·7-4V	9	6MHz 0·6V p-p
7	5·5-6·5V		5·2-8·2V (8·2V=Max Vol.)	8	50mV p-p Audio

SOUND IC (IC2)
Motorola MC 1358 PQ
or Texas SN 76666
or RCA CA 3065
or Sprague ULN 2165A

Slight sub-carrier pick-up

4V p-p, 5mS
Field flyback suppression in

6V p-p, 20µS
Blue drive out

6V p-p, 20µS
Luminance in

6V p-p, 20µS
Red drive out

7V p-p, 20µS
Line flyback suppression in

| 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| EARTH | 0·15-0·3V | 6·4-7·2V | 8·5-10V | 18-20·5V | 9-10·5V | 8·5-9·5V |

CHROMA IC (IC3)
Motorola MC1327 PQ or Texas SN76227N
or Toshiba T2079
Arrows in waveforms indicate start of each line

| 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 4-4·3V | 4-4·3V | 4-4·3V | 2·5-3·5V | 6·2-7·3V | 6·2-7·3V | HT+ |

6V p-p, 20µS
Green drive out

[B82]

0·3V p-p, 20µS
B-Y Chroma in

0·4V p-p, 20µS
B-Y Chroma in

Slight Chroma pick-up
(less than 10mV)

1 line

7·8kHz Ident in
5·5V p-p

As 13 but
1·25V p-p

4·43MHz

1·5V p-p, 20µS
Sub-carrier in

Fig. 9: Voltages and waveforms associated with the three i.c.s. Courtesy Thorn Consumer Electronics.

In the absence of the ident signal VT113 is switched on by the bias provided via R177, its collector voltage rising and thus increasing the potential at the base of VT114 so that VT114 turns off. VT114 collector voltage falls to about 3V and there is insufficient bias to turn on VT115 — thus no chroma can be passed on. Obviously W109 is a key component. If it goes open-circuit there is no colour.

From this circuit description it can be seen that the simplest way to override the colour-killer circuit is to short out the base-emitter junction of VT113.

The composite video signal at the emitter of VT107 (Fig. 3) is applied via an intercarrier sound rejector L114/C170 and a chroma acceptor circuit L115/C168 to the base of VT115. This transistor is connected as an emitter-follower, providing a low-impedance signal for feeding the colour saturation control R189. The output from this control feeds the base of the delay line driver VT117. VT115 tends to overheat, causing colour fade out.

The output at the collector of VT117, about half a volt in amplitude, is fed to the PAL delay line. The direct signal

needed for R–Y and B–Y signal separation is taken from the emitter of VT117. The preset resistor R198 controls the stage gain so that the direct and indirect signals can be proportioned correctly. Phase control is provided by L121. The R–Y and B–Y signals appearing at the ends of the termination coil L125 are fed to pins 9 and 8 respectively of IC3. The three colour signals appear at pins 2 (red), 1 (green) and 4 (blue) of IC3.

The reference oscillator signals for IC3 are provided via the transformer T102 whose secondary feeds pin 12 (R – Y detector) and 13 (B–Y detector). Adjustment of the B–Y reference signal 90° phase shift is controlled by R191.

Chroma Section Fault Finding

Without doubt most of the troubles that occur on the composite i.f./chroma/video panel are to be found in the chroma sections, and unless a systematic approach is adopted fault-finding can be very time consuming.

In practice most of the faults are intermittent and since

many of the components are mounted end-on on to the board contact cannot be made from the front of the panel. Although the board hinges out, it cannot in fact be hinged far enough to gain access to the rear because of the length of the three leads feeding the RGB signals to the tube base. Anyone contemplating serious work on this panel should make up extensions for these leads therefore.

Intermittent or No Colour

What is said here applies equally to no colour, intermittent colour and intermittent saturation. Note that when dealing with intermittent faults a lot of time can be saved by judicious use of a freezer aerosol and a hairdryer. The test points are shown in Fig. 5.

(1) Check that you have 25V at pin 5 of socket 4 and check that R404 on the timebase panel is o.k.

(2) Tune in a colour signal and set the preset R163 to obtain 2V at VT110 source. If it won't set to this value, leave it set midway on its track. Set R151 to the middle of its track.

(3) Check the voltage at TP13 (VT114 collector). If less than 2V continue to step (4). If about 14V proceed to step (8).

(4) Using an oscilloscope, check for burst — about 20V amplitude — at TP10 and for reference oscillator signal — about 8V amplitude — at TP12.

(a) *No burst:* Before suspecting the gating circuit, check that gating pulses are present (about 25V amplitude) at TP9 and that chroma is present at the base of VT109. If both these signals are present the fault is in the circuit associated with VT109, with the transistor itself as the most likely suspect.

(b) *No reference signal:* Conventional fault-finding works here. The three most likely culprits are VT111, C160 and the crystal. Crystal failure is not common in modern decoders: the 8000/8500 chassis however seem to be plagued with crystals that go off frequency. The result is that as the reference oscillator control R163 is adjusted the display gets nearer and nearer to the lock-in point and then the colour cuts out. This is because the d.c. correction needed to pull the crystal in is more than the f.e.t. can provide. The author has met this countless times on the 8000/8500 chassis and never encountered it on another chassis.

(5) If the burst and reference oscillator circuits are functioning correctly the next place to check with the 'scope is TP11. This should reveal rather noisy, low-amplitude ident pulses. If these cannot be found check VT110 and the components associated with W106/W107.

(6) Having established the presence of ident pulses at TP11 check that they are arriving at the base of VT112 and then check for a nice clean 30V peak-to-peak sinewave at the anode of W109. An input to VT112 with a poor or absent output usually indicates a dud VT112 or an open-circuit C163. Very occasionally L113 or C162 develop faults. If the signal at the anode of W109 is present but low in amplitude try peaking it up with the core of L113. If all else fails, check that W109 is o.k.

(7) Having obtained a decent ident signal, the next point to check is that there is 14V at TP13. If not, change both VT113 and VT114. They have a nasty tendency to go wrong in unison!

(8) Having got 14V at TP13, no colour symptoms must be due to trouble in the chroma amplifier, the delay line driver, or IC3. A check with the 'scope at each base and collector is the quickest approach, though in practice the culprit is

usually either one of the transistors, R198 open-circuit or troubles with C171 or C180. Complete colour failure caused by IC3 is almost unknown and is always accompanied by obvious video trouble as well.

Having obtained colour on the screen it may be necessary to reset the various preset controls associated with the decoder in order to obtain proper operation. The setting of these is dealt with at the end of this article.

Hanover Bars at Extreme Right or Left

A fault encountered several times is green hanover bars on red areas at the extreme left or right of the picture. This is usually due to the PAL switching taking place during the active line period, and can be overcome by adjusting L113. In some cases however a satisfactory setting cannot be obtained: as soon as the effect is moved off one side of the screen, it appears at the other. This fault is due to a defect in IC3 as a result of which the PAL bistable operates at an uneven mark-space ratio. The only cure is to replace IC3.

Integrated Circuit Trouble Shooting

The three integrated circuits used in the 8000/8500 circuit all cause trouble from time to time. The symptoms are as follows:

IC1 — No sound, no picture; low sound and smeared picture; line sync pulling.

IC2 — No sound; blurred sound; caption buzz; background noises.

IC3 — One or more colours missing or excessive; hanover bars; poor line or field blanking; poor or excessive brightness.

When one of the i.c.s is suspected, it is important to be as sure as possible that it is faulty before removing it from the panel. This is best done by checking the voltage on each pin and comparing it with the data given in Fig. 9. If an incorrect voltage which cannot be accounted for by outside components is found, the i.c. should be changed.

Setting Up the Presets

R102 (tuner gain): Set to give maximum gain without overloading.

R143 (preset contrast): Under normal operating conditions and with the main contrast control at minimum, set for 2·5V across R140 (peak-to-peak measured with a 'scope).

R205 (preset brightness): Connect an 0·1μF capacitor between TP1 and TP2. Turn the main brightness control to minimum. Disconnect the red drive lead to the c.r.t. base and connect meter to the red output pin on the panel. Set R205 for a reading of 125V (if R206 is 560Ω) or 135V (if R206 is 270Ω).

R214, R216, R218 (RGB drive controls): Aim to keep these controls fully anticlockwise, but adjust as necessary to remove colouration from highlights.

R198, L121, L120, L125 (delay line/matrix circuit): Trim to obtain minimum hanover bars on a colour display.

R151 (burst gate timing): With set displaying colour bars, turn control fully clockwise to lose colour. Next rotate slowly until locked colour appears, then turn a further few degrees.

R163 (oscillator frequency): Attenuate aerial signal until picture just fails to lock, then set control for best colour lock under these conditions.

NEXT MONTH: THE LINE TIMEBASE

Servicing the THORN 8000 8000A 8500 chassis

Barry F. PAMPLIN   PART 3

THE field and line timebase circuits are assembled on a single board at the right-hand side of the chassis whilst the convergence circuits are mounted on a printed panel which slips over the neck of the c.r.t. The line output transistor, line output transformer and e.h.t. rectifier are all mounted on the main chassis framework, under the c.r.t. flare.

As in the previous articles each circuit will be described, its operation explained and the stock faults noted, starting this month with the line timebase and concluding next month with the field timebase.

Line Sync and Oscillator Circuits

The circuit of the flywheel sync and line oscillator stages is shown in Fig. 1. Positive-going sync pulses at the base of VT405 are inverted and applied to the flywheel discriminator diodes W405-6 via C424. Reference pulses from the line output transformer are integrated by R411/C426 to produce a sawtooth waveform and fed to the discriminator via the blocking capacitor C425. R418 and C419 provide the necessary reference signal phase shift to ensure that zero output from the discriminator corresponds with a centrally positioned picture. The error

signal at the output is fed via a filter and anti-hunt circuit to the base of the reactance transistor VT404 which is connected in shunt with the oscillator between L405 and C418.

Transistor VT403 is connected in a conventional sinewave oscillator circuit, the frequency being determined by L405/C415/C416/C442 and the inductive reactance of VT404. Capacitor C442 is a NTC type to provide compensation for thermal drift in the other components. The feedback required between the collector and base of VT403 to ensure oscillation is provided by R412 and L405 (which provides the necessary phase reversal) together with the capacitive tap formed by C415/C416. The output from the oscillator transistor is taken from its collector, across R410, and consists of positive-going squarewaves of some 5V amplitude.

Faults in the flywheel sync and line oscillator circuit are not common. Those that do occur give rise to entirely predictable symptoms. Line sync troubles are usually due to diodes W405/6, as also is offset lock — with the picture locked off centre. Complete absence of line sync, with good field lock, is usually due to a fault in VT405 or absence of the reference pulses fed to the discriminator.
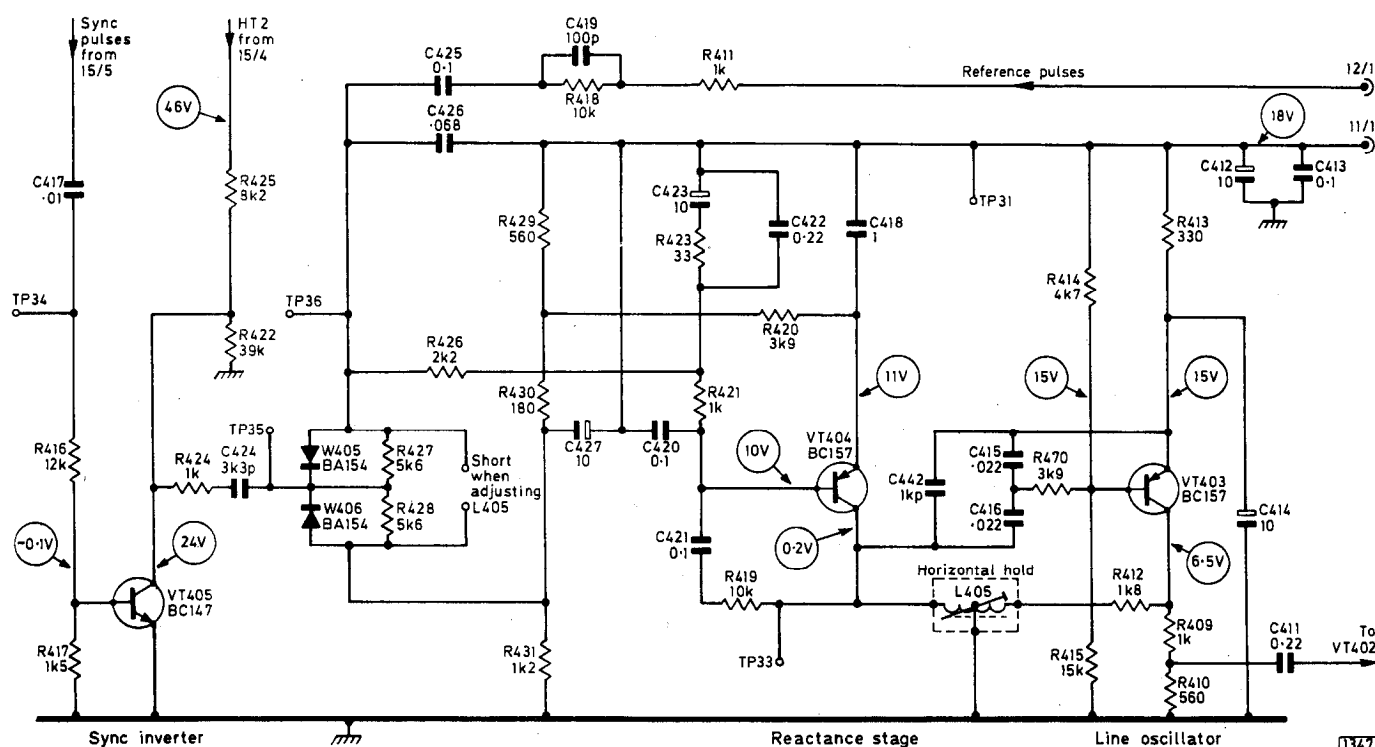

Fig. 1: The flywheel sync and line oscillator circuits. In earlier 8000 chassis C445 (0·001μF) is connected across R470.
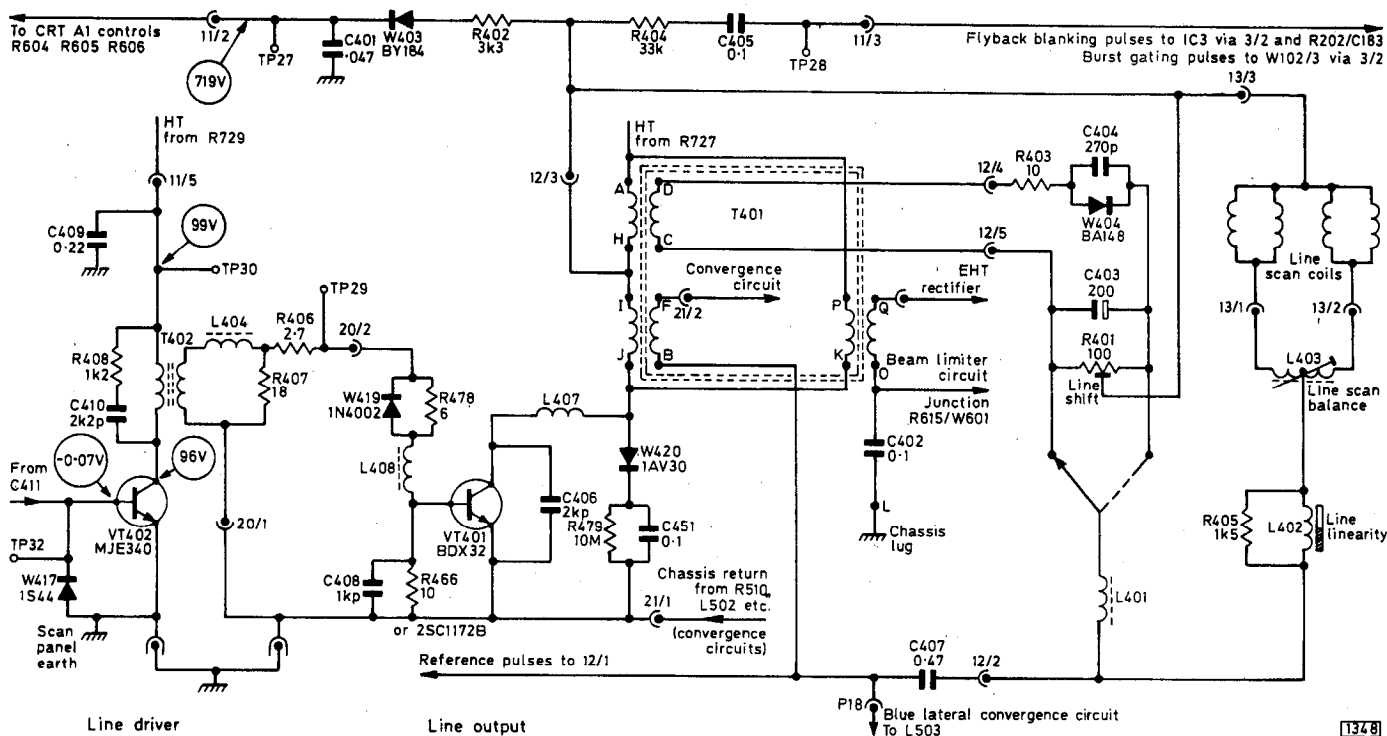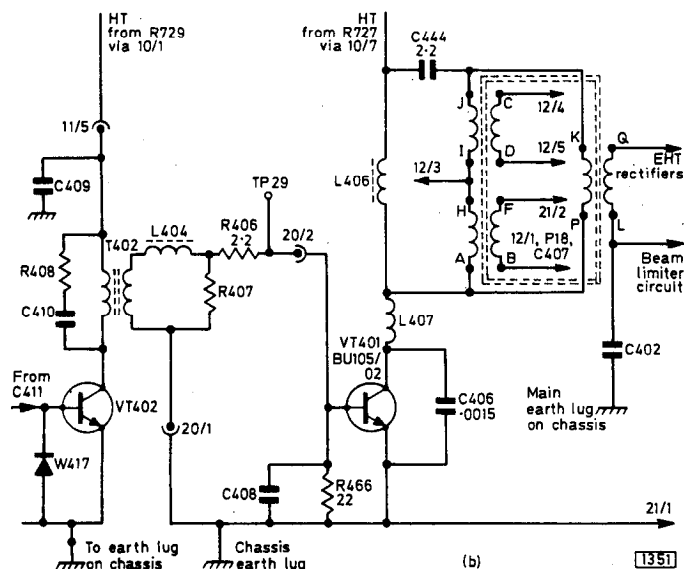
Line driver   Line output

(a)

,Fig. 2: (a) Line driver and output stages, 8500 chassis.
(b) Differences in the 8000/8000A chassis. To improve the
reliability of the BU105/02 line output transistor C444 was
changed from 0·47μF to 2·2μF and R406 from 1Ω to 2·2Ω
or 2·7Ω..C410 changed from 6800pF to 2200pF to improve
the stability of the drive conditions. See also Fig. 5.

R408 and C410 damp out the high-voltage spikes caused
by the collapse of the flux in the transformer. The pulses
appearing across the secondary winding are-fed to the base
of the line output transistor VT401 which is thus switched
on and off at line frequency.

At the end of the forward scan VT401 is. cut off and the
energy stored in the scanning yoke charged C406. This
produces the line flyback pulse. On the negative half cycle
the collector-base junction of VT401 conducts, allowing a
linear decay of current which produces the first part of the
scan – in effect the base collector junction of VT401 acts as
an efficiency diode. Before the current falls to zero, VT401
is switched on to provide the current for the rest of the
scan.

Two secondary windings on the line output transformer
feed the e.h.t. rectifier and the line shift circuits respectively.
The e.h.t. is derived from winding Q-L, using a simple half-
wave rectifier. The "earthy" end of the winding is returned
to chassis via a beam limiter arrangement – see later.
Winding D-C feeds a simple half-wave rectifier (W404)
which· produces the shift potential across C403. Choke
L401 keeps scanning current out of the shift circuit whilst
R401 allows the degree of shift to be adjusted.

S-correction is provided by C407 and line linearity
adjustments can be made with L402. Terminal I on the
transformer provides feeds for the A1/focus diode W403
and also line frequency pulses for the flywheel sync circuit
and the burst/line/field blanking circuits.

Although the circuit description above applies
specifically to the 8000 series chassis, the differences on the
8500 are minor. Instead of a BU105/02 transistor, the
8500 uses a BDX32 (or 2SC1172B) which has a higher
current gain and rating. Some additional components are
introduced in the base circuit to reduce the drive level with

Complete lack of line oscillation is usually either the
oscillator transistor VT403, broken wires on L405, or
C414 leaking. Intermittent frequency changes are best
checked with a freezer spray, but the usual culprits are the
two transistors VT403 and VT404 or one of the capacitors
C423, C421, C416 or C414 in order of suspicion.

Line Oscillator Adjustment

The procedure for setting up the line oscillator is to
connect a shorting link between the test points adjacent to
L405 and adjust the core of L405 for a floating picture. If
the picture sets up correctly but will not lock when the
short is removed the sync diodes should be checked by
substitution.

Drive and Output Circuits

The output from the collector of the line oscillator is a.c.
coupled by C411 to the base of the driver transistor VT402
(see Fig. 2). Diode W417 provides d.c. restoration. The
driver operates from the main 180V h.t. rail and the line
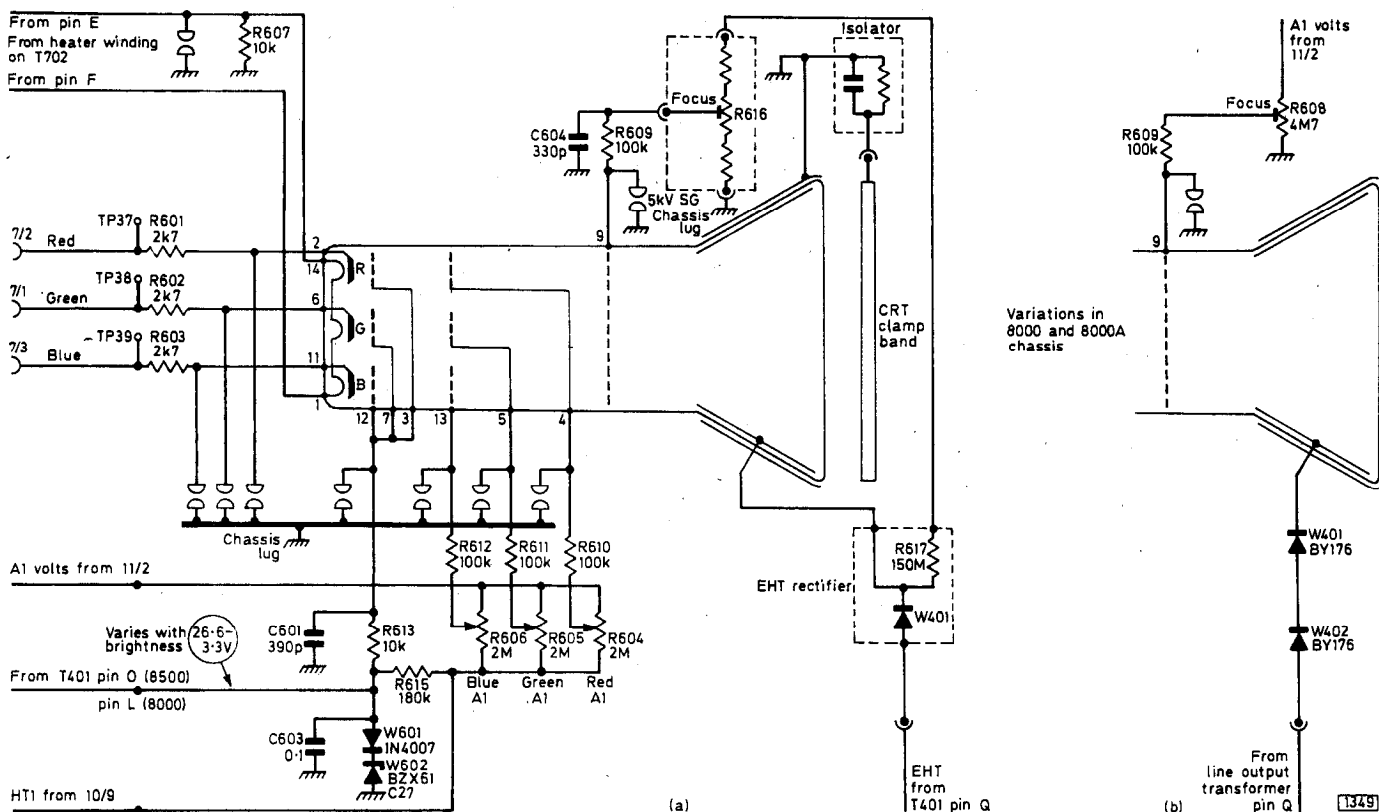drive is developed across the primary of transformer T402.

Fig. 3: (a) The c.r.t., e.h.t. and beam limiter circuits used on the 8500 chassis. (b) Differences on the 8000/8000A chassis.

the transistor on and alter the rate of charge carrier extraction when the transistor is cut off. Some additional transient protection components are added across the line output transistor to protect it from flashovers. All the extra bits are mounted either on the transistor heat sink assembly or the desaturation coil bobbin — the 8500 does not use a desaturation choke (L406). The other main difference between the 8000 and the 8500 is that the focus arrangements are revised. The 8500 uses a thick film focus control connected as a potential divider network across the e.h.t. — this means that the e.h.t. tray used in the 8500 is different from that found in the 8000. The line output transformers are not interchangeable, due to differences in the turns ratios.

Line Output Stage Faults

Faults in the line output stage are frequent — especially failure of the transistor in the 8000 chassis and of the e.h.t. tray in the 8500 chassis. Both these faults usually trip out the thermal switch, giving "dead set" symptoms. A quick check to ascertain whether the trouble is the transistor or the tray is to unplug the tray input lead from the line output transformer: if this action stops the tripping, the tray is faulty.

When faced with a set which has damaged its line output transistor some care is needed to make sure that the replacement transistor is not killed off in the same way. First of all there is the possibility that the failure has occurred because the h.t. rail has gone too high as a result of a fault in the power supply — usually the thyristor W703 going short-circuit. The first check therefore should be a simple resistance check between the anode and cathode of W703. If it reads less than 50kΩ in each direction it should be replaced.

The next check should be a visual one of the mains dropper. A bare wire link on this unit is prone to short out

R727, and this will cause failure of the line output transistor.

If these checks suggest that the trouble is not due to the power supply but to a fault in the line output stage the next step to take is to add some extra resistance in the h.t. feed to keep any fault current to a safe level. For the 8000 chassis a 560Ω 15W resistor is suitable whilst for the 8500 chassis a somewhat lower value, say 220Ω 15W is suitable. As an additional precaution, the set e.h.t. control on the power board should be set fully anti-clockwise before switching on after line output transistor replacement.

Having taken these precautions, switch the set on and check the h.t. voltage across the smoothing block C704. If the voltage here is in excess of 150V there is a fault in the power unit and this must be cleared before proceeding further.

If all is well, adjust the set e.h.t. control to provide an h.t. rail of 170V. The series resistor present will cut down the width of the raster, but it will be possible to see whether things are working properly or not. If a raster is not obtained, check for base drive to VT401, check VT401 and the e.h.t. tray, and finally check for faults in the scan yolk and line output transformer.

Once correct operation has been obtained the limiting resistor can be removed and the set e.h.t. control readjusted. The method of resetting this control recommended by Thorn requires measurement of the peak collector voltage on VT401. The author's pratice is to set the control to get just sufficient width when viewing the test card. This ad hoc approach may offend the purist, but it does minimise the number of call backs!

Having dealt at some length with what is undoubtedly the most common source of "no e.h.t." we will now consider the other stock troubles. Complete lack of drive, or intermittent drive, or lack of width with centre foldover can be caused by that most temperamental of transistors the MJE340, here used as the driver (VT402). No drive can

also be the result of the d.c. restorer diode W417 having an internal short. If absence of drive is due to VT402, W417 or a fault in the line oscillator circuit, the line output transistor will be cold.

Failure of the c.r.t. first anode supply rectifier W403 and its associated series resistor R402 is not uncommon. The rectifier tends to go short-circuit, cooking the series resistor. This event is immediately obvious since a number of components mounted higher up on the board than the resistor get a black coating as a result. A short-circuit reservoir capacitor C401 will have the same effect.

If you find the shift control burnt out, check the a.c. blocking coil L401.

The component which perhaps fails most frequently on the line timebase panel is R404, a 33kΩ, 1W resistor which feeds line-frequency pulses to the decoder. As mentioned last month, the symptom will be no colour or intermittent colour. The resistor is usually found to be on the point of disintegration. Later boards are fitted with a wire-wound resistor in this position, and this type is recommended for replacement purposes on earlier boards.

Beam Current Limiting

The importance of an efficient beam current limiting circuit cannot be over emphasised. Excess beam current drastically reduces tube life and causes e.h.t. tray failures, quite apart from the more obvious picture size regulation problems.

The beam current limiter used in these chassis consists of a circuit connected between the e.h.t. winding "earth" and
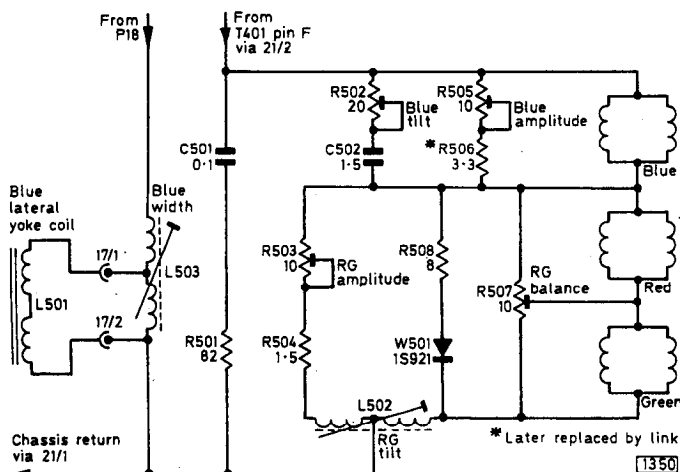

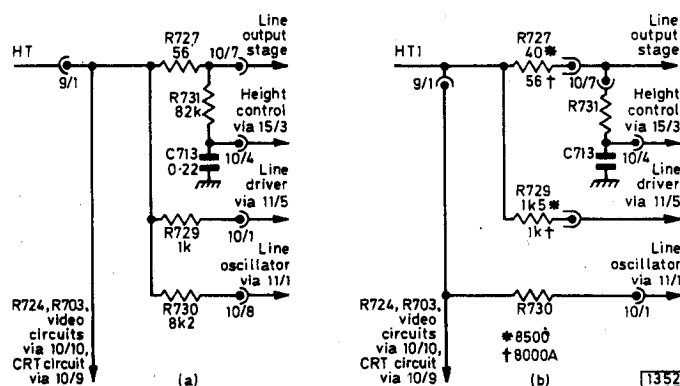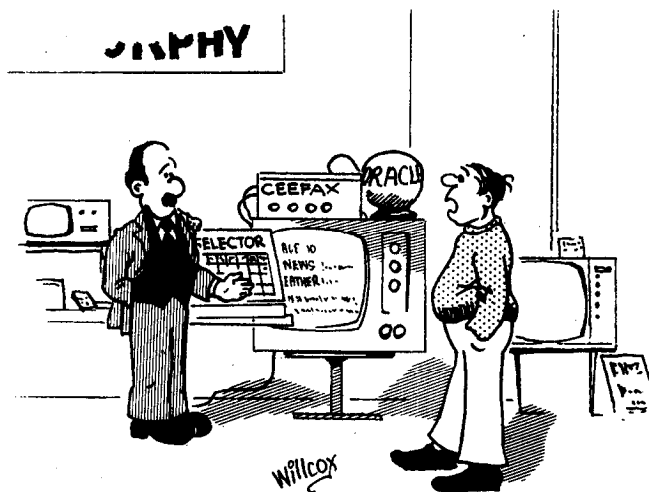Fig. 4: The horizontal convergence circuit.

Fig. 5: Power resistor arrangements. (a) Earlier arrangement used on the 8000 chassis. (b) Arrangement used in the 8000A and 8500 chassis.

"That's all very well, but will I be able to get ITV?"

chassis — see Fig. 3. The two diodes W601 and W602 carry the e.h.t. return current to chassis and are also connected to the h.t. rail via R615. This arrangement generates a nominal 27V bias supply for the c.r.t. grids, corresponding to a current of 1mA through the diodes in opposition to the e.h.t. current. If the beam current increases beyond this figure the bias from the h.t. line is overridden and the c.r.t. grids move negatively, offsetting the beam current change. W601 prevents the grids being clamped to chassis potential when W602 becomes forward biased. C603/R613/C601 form a simple filter network for the grid bias supply. The beam current limiter components are mounted on the c.r.t. base assembly. The circuit has not given us any trouble.

Horizontal Convergence Circuit

The line convergence circuit is shown in Fig. 4 and is connected in series with the scan circuit. Connected in parallel with the convergence circuit is the network C501/R501 which ensures that the convergence circuit appears substantially resistive to the line output stage.

Coil L503 provides a series or shunt inductance with the blue lateral coil L501 to enable the blues at the right and left hand sides of the raster to be adjusted. A two-pin reversal plug allows for correction in either direction.

Line scan current flowing in the R/G amplitude control R503 produces a sawtooth voltage which drives a parabolic correction current through the red and green convergence coils to provide adjustment at the left-hand side of the screen. L502 provides control of the sawtooth component and permits adjustment at the right-hand side of the scan. The R/G difference control R507 adjusts the proportionate level of the parabolic currents whilst L403 (Fig. 2) adjusts the proportionate level of sawtooth — together, these controls enable bowing and crossing to be eliminated along the centre horizontal line. W501 clamps the sawtooth to prevent static shift being caused by dynamic convergence adjustments.

The level of the correction current in the blue radial convergence coils is set by the blue amplitude control R505. The level of parabolic correction is set by R502, the blue tilt control.

Faults in the line convergence circuit are usually caused by intermittent controls. R505 is the main culprit, and should be replaced with a metal case unit. R502 can also give trouble. R506 often goes intermittent and can be safely removed and replaced by a link, as may R504.

Servicing the THORN 8000 8000A 8500 Chassis

Barry F. PAMPLIN

PART 4: FIELD TIMEBASE

THE complete field timebase circuit is shown in Fig. 1.

Field Generator

Transistors VT406 and VT407 are connected as a complementary relaxation oscillator, with the field sync pulses coupled by W407 to the base of VT407. During the scan period both transistors are off since the base voltage of VT406 is held above that of its emitter by the reverse bias on W408 caused by the charge on C430. VT407 stays off since there is no forward bias on its base.

During this scan period the field charging capacitors C433 and C436 charge via the height control R446 to produce a linear scan voltage. VT407 is isolated from the charging circuit by diode W409.

After a period of time determined by the setting of the vertical hold R439, the charge on C430 leaks away and W408 becomes forward biased. This reduces VT406's base voltage and it starts to turn on. Because of the coupling between VT406 collector and VT407 base, VT407 also turns on. Both are rapidly driven into saturation. In the absence of sync pulses the field timebase runs at a frequency determined by the time-constant of C430 and the hold control. With the sync pulses present VT407 is turned on before the "natural" changeover period.

Once VT407 turns on it discharges the field charging capacitors C433 and C436 ready for the start of the next scan. Meanwhile C430 recharges from the supply via R440, the emitter-base junction of VT406, W408, R444 and VT407 until the voltage on the base of VT406 exceeds its emitter voltage and both transistors cut off again.

Driver and Output Stages

From this description it is apparent that at the start of each scan VT408 is switched off – VT409 as well. With VT409 off its collector is at 46V and VT411 is also non-conducting. VT410 is hard on however and driving current through the scan coils to produce the first half of the scanning stroke. This current starts at a high value and decreases as C433 and C436 charge and turn on VT408 and VT409. By the time the middle of the scan is reached VT410 is almost off and VT411 starts conducting to drive a linearly decreasing current in the reverse direction through the scan coils to complete the scan. Diodes W411 and W412 prevent crossover distortion.

Good linearity is achieved by heavy negative feedback from the scan coils to the field current amplifier VT408 via C436. Field scan correction is provided by W410, R449 and C434.

At the end of the scan period, i.e. when VT406/7 turn on, VT408, VT409 and VT411 all turn off and the sudden change in scan coil current gives rise to a back e.m.f. which forward biases W414 to "tip" the surplus energy into the h.t. rail. Capacitor C438 couples this voltage pulse to the base of VT411 to keep it non-conducting: it also provides base current for VT410 which conducts in the reverse direction during the flyback.

Servicing

Apart from output transistor failure the field timebase circuit gives rise to few servicing problems. This is perhaps just as well since fault finding is not easy in this sort of circuit. In difficult cases the following summary may be helpful.

Field collapse:	VT410, VT411, VT408, VT409, R457, R458.
Field jitter:	VT406, W407, C432, C430, W408.
Low height:	VT410, VT411, R447, W410, VT408.
Top foldover:	VT409, W414.
Top cramp:	W411, VT410.
Bottom cramp:	VT410, VT411, C436, C435.
General non-linearity:	VT410, VT411, VT409, W411, W412, C436, C435, C439.
Wrong field frequency:	R438, VT407, C430, C429, W408, R439.
Poor field hold:	W407, C428, C431, C432, W101 (on signal board), W408, VT406, VT407.

When fault finding around the field output stage bear in mind that there are two different varieties of panel, with different copper patterns around the VT410/VT411 area. The variations are shown in Fig. 2 – the general effect is that on later boards the collector and base connections are reversed. This will not produce problems if exact replacement transistors are used, but in any case of doubt the compatability of the transistor type being fitted with the copper pattern should be checked. Amongst the transistor types found on these boards are BD222/BD225, 16599/16600, 2N6178/2N6180, 16199/16120, MPSU05/MPSU55. Keep to these pairings when making replacements.

Field Convergence

The signal for driving the vertical convergence circuits is obtained directly from the scan coil feed. A sawtooth voltage is developed across the sampling resistor R461 and a parabolic voltage across the coupling capacitor C439. These voltages are applied across R514 (tilt) and R513 (amplitude) respectively, the matrixed red and green convergence coils being connected between the sliders of these two controls. Differential drive to the red and green coils is provided by R518 (R/G difference) whilst R460 (R/G balance) provides tilt balance. C503 isolates the d.c. in the scan coils from the convergence coils. W502 (not fitted to later units) acts as a d.c. restorer for the voltage across R512 and R513. R519 and C504 (both not fitted to earlier units) provide improved operation of the tilt control

Fig. 1: Field timebase and vertical convergence circuits. C503 is 150µF on the 8000/8000A chassis. C504/R519 were added and W502 (in parallel with R512 and R513) deleted in later production to give improved convergence.

Fig. 2: Field output stage printed pattern change. Top, up to and including boards marked 643D; bottom, 643E and later boards. The board identification number is adjacent to L404.

R514, especially at the top of the screen.

Blue correction is provided by the blue tilt control R511. This gives correction in both directions and the small parabolic current required is provided via the amplitude control R516.

Some Modifications

The field output transistor emitter resistors R457 and R458 have been reduced in value to 2Ω in recent production to prevent cramping with low-gain transistors. R469 (10Ω) was originally 39Ω – changed to improve top linearity.

The later PC650 timebase panel incorporates an f.e.t. buffer amplifier (VT412, type BF256LC) between the field oscillator and field current amplifier (VT408) stages. This

Fig. 3: Modifications in the 8000/8000A chassis when a BDX32 line output transistor is used.

panel was introduced with the 8800 series chassis and can be used in the 8000, 8500 or 8800 chassis. The earlier panel can be used in only the 8000 and 8500 chassis.

The line output transistor used in the 8000/8000A series chassis varies. Early models were fitted with the BU105/02 which was replaced by the BU206. In some later models a BDX32 is used, as in the 8500 chassis. This is not a direct replacement. Where it is used the base drive circuit is modified as shown in Fig. 3. The extra components are mounted on the transistor heatsink assembly. These components must be fitted when a BDX32 is used, and must be omitted when a BU206 is used (the BU105/02 is now obsolete).

The mains fuse F802 is 3·15A (anti-surge) on all later production chassis. The 25V supply fuse F801 is 1A (anti-surge) in later 8500 series chassis.

Line Output Stage

Finally, a cause of line output transistor failure not mentioned in Part 3 last month – a defective line output stage tuning capacitor (C406). The capacitor can go intermittently open-circuit, killing the line output transistor. This was particularly so in early 8000 series sets. If in doubt, replace both components. ∎