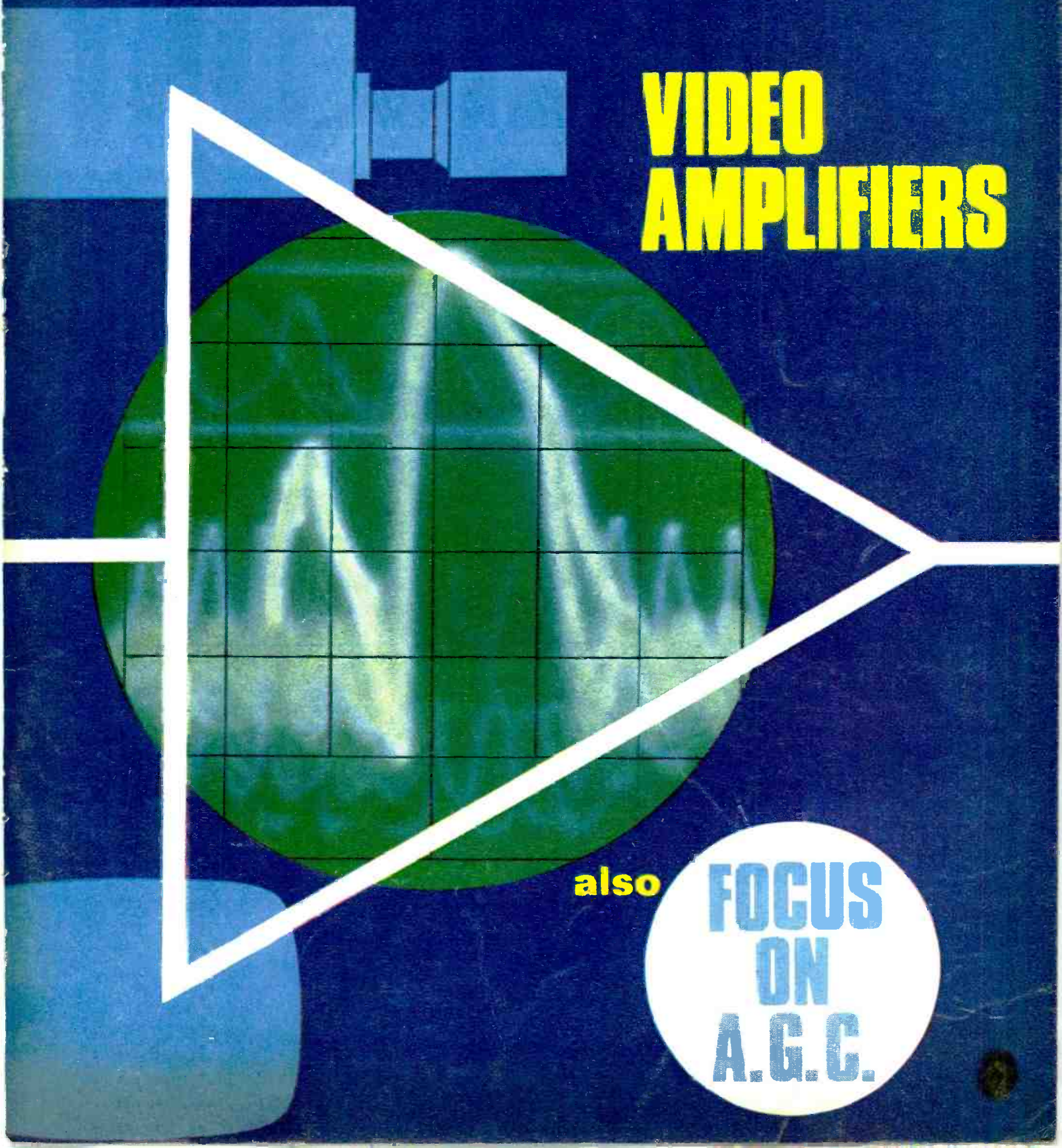
PRACTICAL TELEVISION

3/0

MAY 1969

VIDEO AMPLIFIERS



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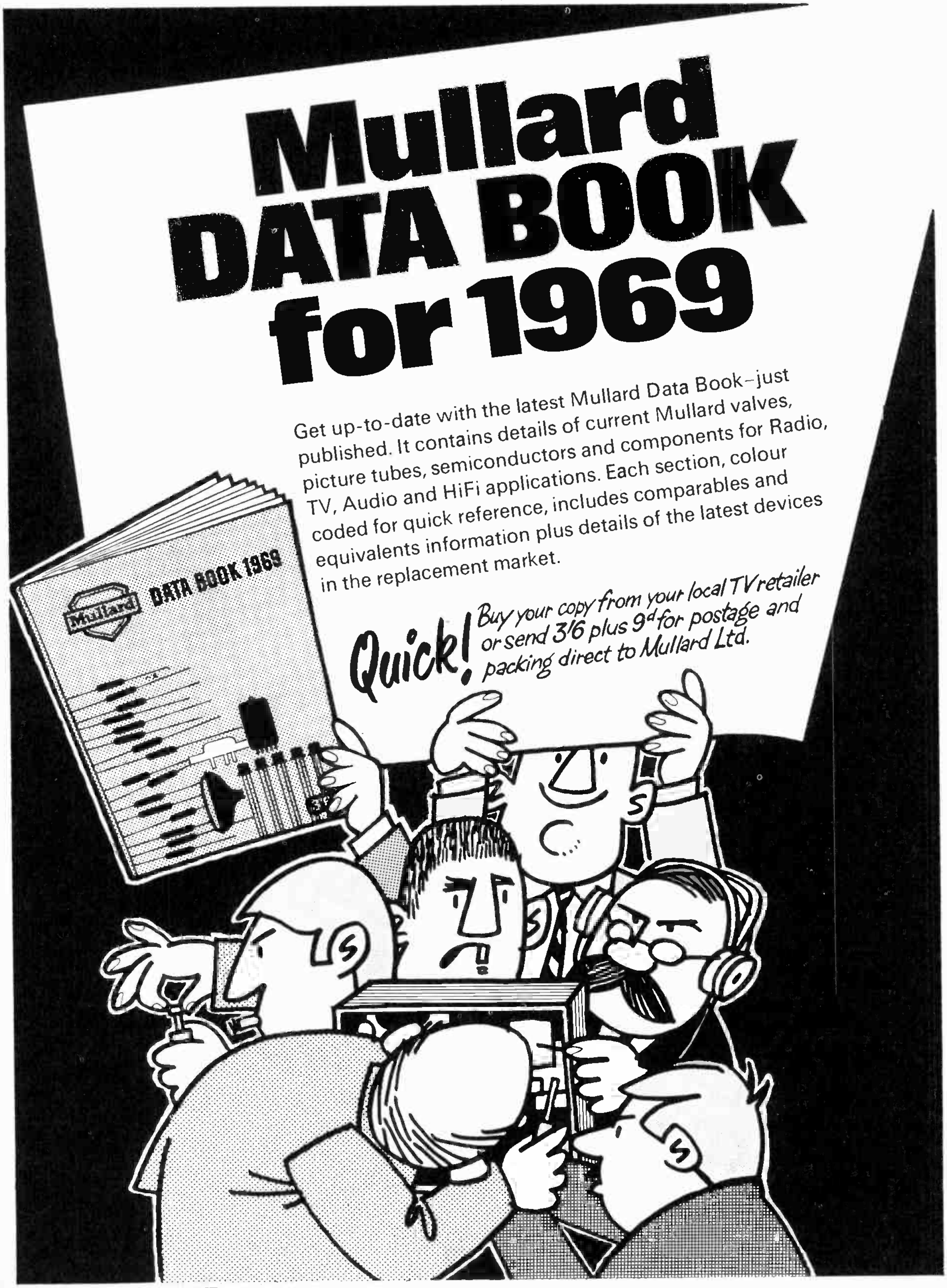


Mullard Mullard Limited, Distributor Sales Division, Mullard House, Torrington Place, London WC1.

CED72

PRACTICAL TELEVISION

VOL 19 No 8
ISSUE 224

MAY 1969

Colour Market

THREE YEARS ago, American TV executives were confidently predicting that sales of colour TV receivers would increase by something like two million per year. They are now sadder and wiser men, faced with the fact that latest estimates are given as an increase of only half-a-million a year, which for 1969 means an 8-10% gain compared with a 12% sales growth in 1968.

One of the chief worries now nagging at the twenty or so American manufacturers is that there might not be sufficient demand for receivers and the matter is more serious for the smaller makers who are finding it a struggle to stay competitive.

Casting around for reasons why this shortfall should occur revealed that with over 19 million colour sets in use, 31% of the market is saturated. It seems that the buyers of these " first generation " receivers were mainly high-income better-educated families, indicating that those most willing to buy have already done so.

But—if the American home produced receivers are losing ground, the importers are leaping in. Japanese manufacturers, marketing directly under their own brand marks, *doubled* their sales in 1969 and are expected to make further gains, especially in the smaller-screen models, for while US manufacturers have introduced smaller-screen sizes the cut in cost has been only marginal.

We hope that our own manufacturers can read the warning in these facts of economic life across the Atlantic. For the same sort of situation could easily develop in the UK, particularly now that single-standard u.h.f. colour TV will be with us within a year.

W. N. STEVENS, *Editor*.

THIS MONTH

THE NEXT ISSUE DATED JUNE WILL BE PUBLISHED MAY 23

TELETOPICS

A FUTURE RIVAL TO THE TRANSISTOR RADIO?

MOTOROLA of Chicago has developed a television set measuring only $3\frac{1}{2} \times 2\frac{1}{4} \times 1\frac{1}{4}$ in. and weighing less than a pound. The set has a one-inch screen and its earphone lead is used as an aerial. Its sensitivity is stated to be comparable with full-size portable television sets and power is derived from four mercury penlight cells.

Revealed as an experimental project to demonstrate the application of advanced semiconductor and engineering techniques, the set is not intended for the commercial market at present.

Most of the total volume of about 13 cubic inches is occupied by the picture tube, power supply and batteries, the actual receiver circuits taking up only one cubic inch. Altogether 43 Motorola transistors and diodes are employed in the receiver which is at present designed for single channel operation. The set has a 3-transistor tuner, 3-stage i.f. amplifier, 2-stage video amplifier, ratio-detector type intercarrier sound demodulator and automatic gain control.

Power consumption is $1\frac{1}{2}$W, about half this being taken by the tube heater. The power supply converts the battery voltage to 11V, 100V, 275V, 1.2kV and 3kV. The sweep circuits provide 200V sawtooth voltages to each of the four electrostatic deflection plates.

GO-AHEAD FOR TV 'VARSITY'

Great Britain's "Open University"—the TV and radio college for home students—is to start in 1971. The university will open for enrolments early in 1970 and more than 150,000 applicants are expected. The university authorities have agreed with the BBC to have 30 hours a week teaching on BBC-2 and 30 hours on radio.

Correspondence courses will also be used by the university, together with programmed learning methods and full-time short residential courses. A general degree in several subjects at ordinary and honours levels will be given.

A BIT BETTER

Soldering iron bits which can last for more than 600,000 joints, and have an estimated life of some 75 times that of copper, are to be put on the market by Litesold. These bits have a 250 micron thick coating of iron, plus protective layers of nickel and chromium, all of which are as thick as practicable without impairing the flow of heat. The bits, made by Philips, will be available in three standard shapes—chisel, screwdriver and conical. The price will be fairly high, but when the length of service is taken into consideration the new bits are claimed to be quite economical.

NEW MODELS INCLUDE 20" SETS

Four 20in. models are amongst the latest releases from the setmakers. The Ferguson 20in. Model 3660 and HMV 20in. Model 2650 are both fitted with the Thorn/BRC 1400 chassis and have the recommended price of £76 10s.

Philips announce the "Super 20" Model 0230, with 20in. type A50-120W/R tube. This is fitted with the Philips group's 210 hybrid chassis and the recommended price is £81 5s. 4d. A new colour set from Philips is the "Super 22" Model 503, fitted with the 22in. type A56-120X shadowmask tube.

The Pye group's first 20in. model is the Ekco T529, at £83 10s. 1d. Also from the group are the Ekco 19in. Europa Model T527 (£77 7s. 10d.) and 23in. models T526 (£85 10s. 10d.) and T528 (£88 11s. 11d.), the Ferranti 19in. Model T1181 (£79 8s. 7d.) and 23in. Model T1182 (£88 11s. 11d.) and the Pye 19in. Olympic Models 77 and 75 (both £77 7s. 10d.) and 23in. Model 76 (£88 11s. 11d.). All these models are fitted with the group's 368 hybrid chassis.

UNDERWATER COMBINED CAMERA AND LIGHTING UNIT

Group 70 Limited of Manchester have developed, in conjunction with Marconi Marine Limited, a new underwater combined camera and lighting unit.

It is possible to operate the unit down to a depth of 350 feet without the slightest fear of water interfering with cables, lights or camera.

The camera is housed in the centre and the lighting arms carry quartz iodine type lights. Reflectors for the lights are adjustable. A feature of the unit is its neutral buoyancy, merely requiring a gentle push to obtain forward or sideways motion as desired.

Another big advantage is in the method of sealing the cable. Even should the underwater cable lead be hacked into two pieces, a bond automatically seals the cable so that the camera is sealed instantaneously and no water penetrates.

IC FILMSTRIP FROM MULLARD

New from the Mullard Educational Service is a 36-frame, 35mm. colour filmstrip entitled "Integrated Circuits". Acting as an introduction to the subject for students of semiconductor technology, the notes provided with the filmstrip can easily be edited to suit varying audience levels.

Also available as a set of slides mounted in 35mm. frames, the film is obtainable from The Slide Centre Ltd., Portman House, 17 Broderick Road, London, S.W.17. The cost is £2 for the filmstrip and £2 10s. for the slides.

ALLOCATION OF ITA UHF TRANSMITTERS

The ITA has now announced the allocation to programme contractors' areas of the first 26 transmitters of its u.h.f. 625-line network. The first four transmitters in the new network will, it is hoped, go into operation towards the end of the year, and the next three are also expected to be in service by the beginning of 1970. All 26 transmitters should be in operation by about the end of 1971.

All transmitters for the u.h.f. network are being co-sited—that is, ITA and BBC will share the same aerial masts and towers. Because u.h.f. service areas are smaller than v.h.f. ones a considerable number of new sites will be needed to provide similar national coverage on u.h.f. This imposes on ITA the problem of allocating transmitters so that the service areas reconcile as far as is practicable with the programme contractors' boundaries. As, however, there is no way in which radio waves can be told to go so far but no further some slight differences in the areas served by the programme contractors on u.h.f. and v.h.f. are inevitable. By careful choice of the allocation of the 625-line transmitters (even where this has meant the provision of additional microwave links) the Authority has endeavoured to keep these discrepancies as small as possible.

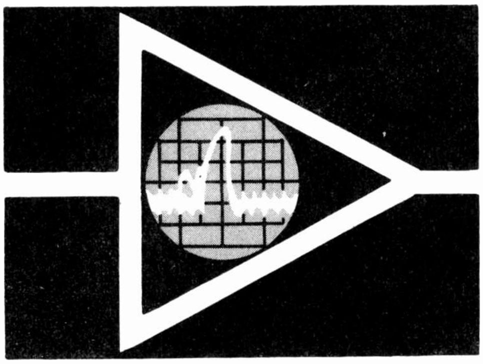
The transmitter allocations are as follows:

Station No.	*Transmitter*	*Programme Company*
101	Crystal Palace (London)	London Companies
102	Sutton Coldfield (Nr. Birmingham)	ATV
103	Winter Hill (Lancashire)	Granada
104	Emley Moor (Yorkshire)	Yorkshire Television
105	Black Hill (Nr. Glasgow)	Scottish Television
106	Wenvoe (Nr. Cardiff)	Harlech
107	Divis (Nr. Belfast)	Ulster Television
108	Rowridge (Isle of Wight)	Southern Television
109	Pontop Pike (Durham)	Tyne Tees Television
110	Mendip (Somerset)	Harlech
111	Waltham (Nr. Melton Mowbray)	ATV
112	Durris (Kincardineshire)	Grampian Television
113	Dover (Kent)	Southern Television
114	Tacolneston (Norfolk)	Anglia Television
115	Sudbury (Suffolk)	Anglia Television
116	Bilsdale (Yorkshire)	Yorkshire Television
117	Beckley (Nr. Oxford)	ATV
120	Belmont (Lincolnshire)	Anglia Television
124	Sandy Heath (Bedfordshire)	Anglia Television
126	Hannington (Hampshire)	Southern Television
131	Caradon Hill (East Cornwall)	Westward Television
137	Caldbeck (Cumberland)	Border Television
139	Heathfield (East Sussex)	Southern Television
141	Redruth (West Cornwall)	Westward Television
147	Craigkelly (Fife)	Scottish Television
161	Selkirk (Selkirkshire)	Border Television

All these u.h.f. stations will carry combined colour and black-and-white programmes from the time they go into service. The programmes transmitted will also be transmitted simultaneously on the 405-line system by the existing network of v.h.f. (Band III) stations in black-and-white only. The v.h.f. transmissions will continue for a number of years so that existing receivers will not be rendered obsolete.

Viewers who can already receive the BBC-2 u.h.f. transmissions (in black-and-white or colour) should be able to receive the ITA u.h.f. transmissions as they become available in their district without any change in receiver or aerial system. When all three British programme services are available in a particular district it will be possible to use a single-standard (625-line only) receiver with a single u.h.f.-only aerial. The most important factor in obtaining good u.h.f. reception is to use a good aerial system—installed in the loft or better still on a high outside mounting

A further announcement is expected shortly giving the programme company allocations of the first batch of relay stations.



K.T. WILSON

VIDEO AMPLIFIERS

Part 1

AT SOME stage in the processing of a signal, whether it be an audio signal from a microphone, a video signal from a TV camera tube or a set of pulses from a sync generator, amplification is necessary. The performance of the amplifier is dictated by the type of signal which is being amplified, so that very considerable differences exist between amplifiers for the three types of signal just mentioned. Comparing audio and video amplifiers, it is instructive to see how the most noticeable difference, that of frequency range, arises.

Frequency Response

The frequency response of an audio amplifier is basically the response of the human ear which extends from about 40Hz to 15kHz. In practice the ear can operate satisfactorily with a much narrower range, and also with considerable variations in amplification over the frequency range, though for good quality sound the graph of amplification against frequency, plotted with the frequency on a logarithmic scale and the amplification in decibels (also a logarithmic scale), should be flat with only a 3dB drop in amplification at the ends of the range.

The logarithmic scale is used for two reasons: since a given distance on the frequency scale represents two frequencies with a definite ratio (for example a scale of equidistant points might have values of 10Hz, 100Hz, 1kHz, 10kHz and 100kHz so that the distance between two adjacent scale marks represents a tenfold increase of frequency), a very large frequency range can be represented with a logarithmic scale. The second reason is linked to human physiology: the ear has itself a logarithmic response. The ratio of the loudest tolerable sounds to the sounds which are just audible is about 10 million *million* times, but as far as the ear is concerned this ratio appears to be about 130 times and for this reason we define a power ratio in decibels as 10 log P2/P1 where P2 and P1 are the two powers being compared, one decibel being the minimum difference which the ear can notice. The response of the eye to light seems to be similar, covering a similar range of brightness.

Video Frequency Range

The frequency range of a video amplifier is determined by the type of picture information which is being amplified. Suppose that a scene consists simply of a landscape, with the upper half of the picture clear sky. Then for half of one field, one hundredth of a second, the signal voltage must be steady if the brightness of the sky or land is to be constant. This requires the response of the video amplifier to extend down to d.c. At the other end of the scale consider a 625-line scan which is completed in $^1/_{25}$ second (remember that scans are interlaced so that only half the lines are scanned in each $^1/_{50}$ second field). 625 lines in 40msec ($^1/_{25}$ sec) means a total line time of 64μsec but we must also fit in the sync pulse with its front porch and back porch (with room for the colour sync burst) occupying a total of about 12μsec thus leaving 52μsec for scanning one line.

Suppose now we wish to examine some fine detail. The finest detail we can see in the vertical direction is set by the number of scanning lines, in this case 625. If we wish to be able to see 625 lines in the horizontal direction, that is in 52μsec, then the voltage of the waveform must go through a cycle of rising and falling 625 times in 52μsec which is 12 million times in 1 sec, i.e., a bandwidth of 12MHz. This is a greater bandwidth than it is possible to transmit, even in Band V, and in practice we aim at rather less than half this, corresponding to the vertical resolution of one field, about 300 lines.

Time Constants and Bandwidth

A time constant occurs in an amplifier wherever a resistor is connected to a capacitor or an inductor, and whether such time constants limit the high or low frequencies depends on the way in which they are connected, as shown in Fig. 1. As frequency is increased a resistor remains of constant resistance, but the *impedance* (the effect of a capacitor or inductor to resist current flowing) of an inductor *increases* while that of a capacitor *decreases*.

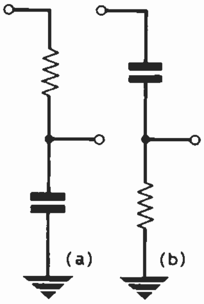


Fig. 1: (a) Limits high-frequency response because the capacitor short-circuits the signal at high frequencies. (b) Limits low-frequency response because the capacitor has a high impedance at low frequencies. The earth connection may be any point which is at a fixed voltage, e.g. the h.t. line.

Low-Frequency Losses

Looking at the simple amplifier shown in Fig. 2(a) we can identify some of the time constants which limit its bandwidth. Fig. 2(b) shows the same circuit redrawn to show how the time constants appear from the point of view of the signal. As far as the

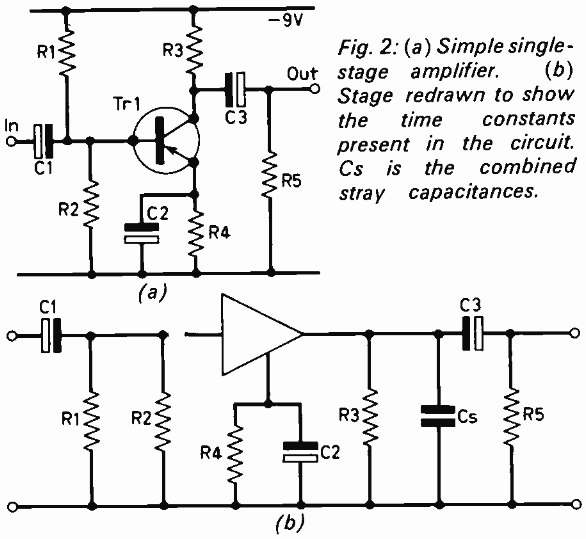


Fig. 2: (a) Simple single-stage amplifier. (b) Stage redrawn to show the time constants present in the circuit. Cs is the combined stray capacitances.

signal is concerned, the negative line is at earth potential (since the power supply has a very large capacitance and low resistance) and all the resistors have stray capacitances across them which have been combined together (*C*s) in Fig. 2(b). Now we can see that C1 and the parallel combination of R1 and R2 [=(R1.R2)/(R1+R2)] form one time constant, which causes a drop in response at low frequencies, while C3 and R5 is another. R4 and C2 form yet another network causing a drop in response at low frequencies, this time because R4 causes negative feedback which is absent at frequencies for which the impedance of C2 is low compared to R4. At low frequencies. when the impedance of even a 100μF capacitor starts to become appreciable (100μF has about 32Ω impedance at 50Hz), the feedback due to R4 starts to contribute to the drop in amplification. At d.c. of course the gain of this amplifier is zero.

High-Frequency Losses

The causes of high-frequency losses are less easy to see. The shunt capacitances which cause the trouble are always either built into the amplifying device (transistor or valve) or into the circuitry in the form of stray capacitances which cannot be removed. As far as transistors are concerned, all transistors working with the signal in at the base and out at the collector (common-emitter circuit) behave as if they generated a signal at the output

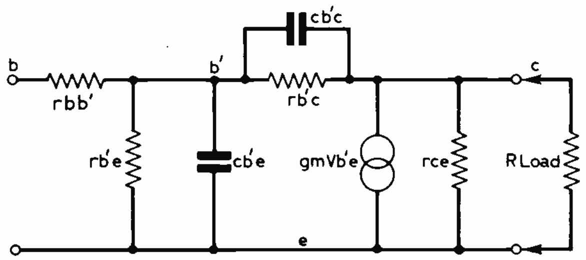
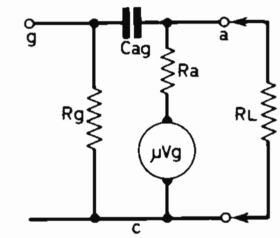


Fig. 3: Equivalent circuit (hybrid-pi) of a common-emitter transistor. The transistor behaves as a current generator of gm milliamperes per volt of base signal. Some of this output flows through rb'c and cb'c, some through rce and some in the output load resistor R-load.

which consists of a current in milliamps roughly 40 times the base *signal* voltage in volts, and this output current depends only on the input voltage. When we wire a resistive load to the collector of a transistor this *signal* current is converted to a *signal* voltage (by Ohms Law, $V=RI$), but the signal current will also take any short circuit path which presents itself. The equivalent circuit (Fig. 3) of a transistor shows what short circuit paths are available. The internal collector-emitter resistance is usually about 250kΩ and causes little bother, but the stray capacitance at the collector will at some frequency have an impedance equal to that of the collector load and will cause a drop in frequency response. Even more serious is the "capacitance", typically 50pF, between collector and base (this varies with applied voltage) causing increasing amounts of negative feedback as the frequency of operation is raised.

When valves are used for amplification, pentodes behave in a manner similar to transistors but with very little feedback (Miller capacitance) while triodes behave as if they generated a voltage μVg (Fig. 4)

Fig. 4: Equivalent circuit of a triode valve (negative bias). RL and any stray capacitance act as a potential divider along with the anode resistance Ra to limit amplification of the voltage μVg.



which is applied to a voltage divider consisting of the internal resistance (*R*a) and the anode load *R*L. Here any stray capacitance reduces the effective value of *R*L at high frequencies and causes a loss in amplification. In the case of triodes there is also a moderately large capacitance between anode and grid which causes feedback.

Returning to transistors, the feedback capacitance causes more trouble at the input than at the output. The charge stored in a capacitor is equal to the voltage swing across it multiplied by its capacitance, so the feedback capacitance has a charge signal of roughly $Ccb \times Vcb$. For a capacitor between base and emitter to equal this its charge signal would be $Cbc \times Vbc = Ceb \times Veb$, giving $Ceb = Ccb \times \frac{Vcb}{Veb} = Ccb \times$ amplification, so that the effect is equal to that of having a much larger capacitance between base and emitter. This Miller capacitance is generally much greater than that due to strays and is the main cause of loss of amplification at high frequencies (assuming that the structure of the transistor permits high frequency amplification).

Extending the LF Response

Since the limits of low-frequency response are caused by the coupling time constants and the emitter-decoupling time constants one obvious method of extending the range is to increase or eliminate these time constants. The emitter time constant can be eliminated by either not decoupling and suffering a loss in gain (though this may be useful as will be seen later) or by using a zener diode as the emitter resistor. Coupling time constants may be extended by using larger coupling capacitors until the d.c. leakage causes bias trouble or by direct coupling. For amplifiers of small gain and few stages direct coupling with zener diodes to preserve the bias voltages (Fig. 5) is very satisfactory, but video amplifiers of high gain and many stages cannot easily use direct coupling because of stability problems.

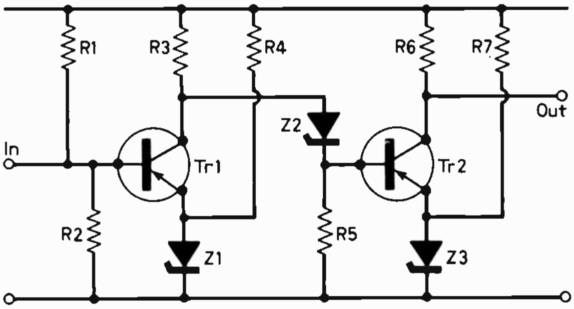


Fig. 5: Direct-coupled amplifier with zener diodes.

The alternative to direct coupling is to devise some scheme for putting back the d.c. and low frequencies which are lost in an amplifier which uses normal a.c. coupling methods. If video waveforms were random in voltage range, like noise, such schemes would be impossible. But video waveforms are not random: there is the sync pulse (or an interval of zero signal) every line and the voltages of black and peak white are fixed. If the voltage of some fixed portion of the signal (white, black or sync pulse tip) is compared to a fixed voltage every line and adjusted to that voltage, then there will be no voltage drift of the video signal and it will appear as if it had been directly coupled through the amplifier, providing that the time constants are not so short that the d.c. voltage changes greatly during the 64μsec of a line.

Clamping Circuits

Two methods of achieving this are clamping and d.c. restoration. A clamping circuit is shown in Fig. 6. Basically it consists of a switch which shorts the video signal to some fixed voltage at some definite time. We might arrange for it to connect the signal to earth during each sync pulse, or to 0.4V during

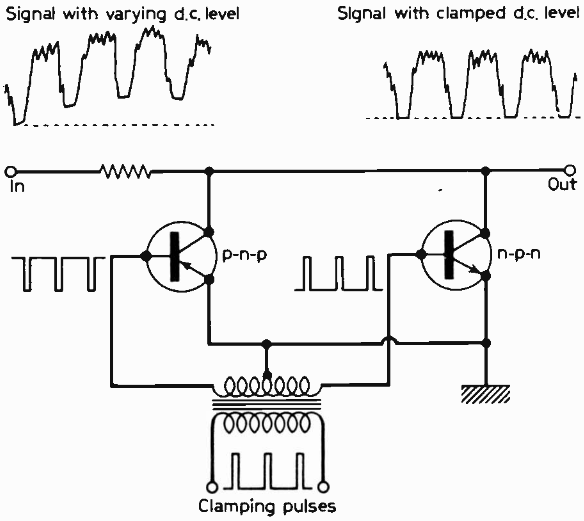


Fig. 6: Driven clamp circuit.

the back porch of the sync pulse or during the whole of the sync period if the video waveform has no sync pulses added (non-composite waveform). Clamping is used extensively in video amplifiers used in TV transmission and camera work and in CCTV cameras. It is more satisfactory than any other method of preserving low frequencies (even direct coupling) and also eliminates hum and any other unwanted low frequencies from the video signal. Note that a clamp circuit must be fed from a high impedance and needs a clamping pulse to operate it.

DC Restoration

D.C. restoration also connects the video signal to a fixed voltage at intervals but the intervals are no longer controlled. A simple d.c. restorer is shown in Fig. 7. Whenever the signal becomes negative to

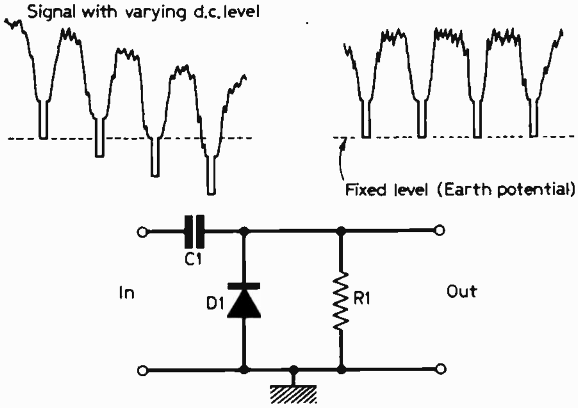


Fig. 7: Simple d.c. restorer.

earth the diode conducts, charging the coupling capacitor positively and restoring the signal to a positive d.c. level. D.C. restoration is one-way only (the circuit shown cannot restore *positive* peaks) and is uncontrolled (it does not restore each line, only when the peak voltage causes the diode to conduct) and is satisfactory only when a video signal contains a " peak block " or sync pulse tip which can be used as a peak to be restored. It does not eliminate hum and does not necessarily assist in the restoration of low-frequency signals.

NEXT MONTH: EXTENDING THE H.F. RESPONSE

DX TV

CHARLES RAFAREL

A MONTHLY FEATURE FOR DX ENTHUSIASTS

It is still a period of awful conditions for both SpE and Trop DX reception; in fact there has been no significant change since my last report. It may be some consolation that we are not alone in our misery: reports indicate that the bad conditions have extended throughout Europe.

The prevailing weather conditions, particularly the snow in February, almost completely prevented any Trop DX. This was brought home to me when I had extreme difficulty in raising even the nearest French locals down here, as happened on many days. For SpE the marginal improvement noted last time has not progressed much; it is still early for this however. Here is the SpE log for the period 1/2/69 to 6/3/69.

1/2/69 Czechoslovakia R1.
3/2/69 Czechoslovakia R1.
4/2/69 Czechoslovakia R1 and USSR R1.
5/2/69 Czechoslovakia R1.
14/2/69 Czechoslovakia R1 and W. Germany E2.
22/2/69 Czechoslovakia R1 and W. Germany E4.
23/2/69 West Germany E2.
4/3/69 USSR R1.

For Trops there was nothing except weak French locals in Bands I/III and u.h.f.

We have received the following list of East German u.h.f. stations from I. C. Beckett

Ch.29 Schwerin (no date of operation yet).
Ch.27 Loba, Nr. Görlitz (operational).
Ch.31 Dequeda (operational).
Ch.31 Inselberg (no date of operation yet).
Ch.33 Blessberg (no date of operation yet).
Ch.34 Brocken (operational).

Ch.27 Berlin seems to have altered its channel but no details of the new one as yet.

Roy Sheppard, a late colleague of R. Bunney at STV, has given us the following news of Amman Ch.E3: "The test card used by Jordan TV is the normal BBC test card C with the word Jordan directly after the letter C. This is transmitted on Ch.E3 and E6 starting at 5p.m. local time and ending at the start of programmes at 6p.m. Local time is G.M.T. plus two hours. The programmes end between 10p.m. and midnight local time, quite a few being in English with Arabic subtitles." Roy should know—he now works for Jordan TV! Amman Ch.E3 should be a possible here under good SpE conditions.

New EBU listings from R. Bunney are as follows:

Austria: Patscherkopfl 2/Innsbruck Ch.23 800kW hor.
Lichtenberg/Linz Ch.43 800kW hor.
Belgium: Genk BRT Ch.44 200kW hor.
Oostvleteren BRT Ch.49 20kW vert.
Rivière RTB Ch.52 200kW hor.
Froidment RTB Ch.57 20kW vert.
Portugal: (1st Chain) Lisbon Ch. 25 420kW hor.
W. Germany: Wesel Ch. 35 500kW hor.
Hessleberg Ch. 32 now up to 250kW hor.
Norway: Bremanger Ch.E4 now up to 80kW and Gülen Ch.E2 up to 30kW.

The new Belgian u.h.f. transmitters are particularly interesting for East Coast DXers.

The USSR Forward Scatter Space Network 35-40MHz was again active here on 5th, 23rd, 24th and 26th February and gave very strong signals. This is a type of F2 I suppose if as seems probable the location is Baikanur, Siberia.

News from Ferdie Dombrowski and Bob Cooper of the World-Wide TV-FM DX Association. I quote Bob Cooper of the Virgin Islands: "The daytime F2 m.u.f. (maximum usable frequency) was heading up at a spectacular rate late in October (1968). Observers in Los Angeles were reporting day-after-day morning reception of BBC-ORTF audio in the 41·5MHz region. An observer in S.W. Africa (a 6MHz Amateur) was logging daily TV broadcasts from over 4,000-6,000 mile paths from England, France and Spain (we have reported this TVE reception in the past), reception extending to the 52-60MHz region. On the USA East Coast reporters were getting traces of 45 and 48MHz BBC transmissions. Apparently things did not improve still further because of Aurora at the end of October; on the 31st this eruption on the sun completely destroyed the conditions that had been building up. The two who recorded reception of BBC-ORTF on the West Coast were Stan Savage and Harley Herndon. It was first heard on 24th October and persisted until the 30th when the flare occurred. This is the first time that these stations have been heard on the West Coast during the present cycle.

"The best times are September to November and March to early May, and the best reception is between 20.00 and 23.00 local time at the mid-point between the transmitter and the receiver, when the maximum m.u.f. seems to be about 1½ that of the normal F2 m.u.f."

There is therefore still hope with a bit of luck for us to get F2 DX up to May 1969, but if there is nothing it looks like a long 11-year wait!

At least one rather more encouraging log from Doug Bowers of Saltash. As has happened before things have been rather better in the West Country than here in the South. There was a good opening for him on 4/2/69 when he logged W. Germany E4, Norway E4, Sweden E3, Switzerland E3 and Belgium E3 SpE. On 7/2/69 he had Norway E4 and Czechoslovakia R2. He comments that the best winter DX/SpE was on E3 which is unusual as in previous years it has been E4. No wonder things have been so poor here in the South—Ch.E3 is almost clobbered for me by my local.

—continued on page 354

fault finding FOCUS

S. GEORGE

AGC CIRCUITS—I

FOR many years a.g.c. in valve receivers has almost exclusively been effected by making use of the negative voltage developed at the sync separator grid to control the vision i.f. and tuner r.f. amplifier stage gain (and sometimes the mixer stage as well). In more recent models the receiver's overall contrast range is extended by means of a preset potentiometer which enables the set user to determine the point at which a.g.c. is applied to the r.f. amplifier stage. Manual contrast control is generally effected by backing-off the negative a.g.c. potential with a slight positive voltage tapped from the contrast potentiometer which is shunted across the h.t. line and chassis.

While this mean-level system has the disadvantage that the a.g.c. depends on signal picture content as well as actual signal strength, in practice it works very well and its simplicity makes it extremely reliable.

The first change away from this basic pattern was the high-level contrast control system introduced by Pye some years ago and later used in several Bush-Murphy models. In these circuits the main contrast control is shunted across the video amplifier load resistor with the slider feeding the c.r.t. cathode so that it can tap off the required level of video drive in the same manner that a volume control taps off the required degree of a.f. signal in a radio receiver. A subsidiary preset is used to determine the signal strength at which a.g.c. is supplied to the r.f. amplifier, but the main user control is the potentiometer shunting the video load.

This arrangement has two main features. First as the vision signal is handled at high amplitude throughout the receiver it swamps valve and circuit noise, while secondly contrast variation produces no change in r.f. or i.f. valve gain and therefore no change in input characteristics to cause slight mistuning. A minor further advantage is that control variation to obtain optimum picture contrast has no effect on sound volume. The only real disadvantage is that if the preset sensitivity control is advanced too far i.f. or video stage overloading can occur causing signal clipping on strong signals, and this cannot be eliminated by reducing the main contrast control setting.

The employment of transistorised i.f. stages has made radical changes necessary in the a.g.c. circuits, although the high-level method of manual control can still be used and in fact has been successfully continued in many hybrid models. Transistor gain is more difficult to control than valve gain since being current and not voltage operated devices each controlled transistor requires a small but appreciable power outlay related to signal strength. Furthermore having a low input impedance transistors cannot be directly controlled by the negative voltage from the high-impedance sync separator grid circuit, even supposing this voltage to be of correct polarity for the type of transistor employed.

This suggests that the source of the control potential must be the video stage, and here we find complications in the fact that in most dual-standard models increasing signal strength on one system produces opposite anode current changes to increasing signal strength on the other. Fortunately this disadvantage can be overcome by using anode voltage change on one system as the control source and cathode voltage change on the other. But there still remains the problem of converting these potential changes to a low-voltage a.g.c. supply of correct polarity for controlling the transistors.

AGC AMPLIFIER STAGE

The usual linking stage is a further transistor generally termed the a.g.c. amplifier although this description is something of a misnomer. Such transistor a.g.c. amplifiers are used in various ways to control receiver gain from a potential that varies with the mean-level signal strength. Figure 1 shows how they can be driven from the cathode of a video pentode on 405 and from the anode on 625, as in many Bush-Murphy receivers which also employ the high-level contrast control technique.

Although for simplicity not shown in the illustration, a single vision detector diode is used d.c. coupled to the video grid on both systems but with its output polarity reversed. On 405 its output is positive-going so the PFL200 video amplifier is biased back to 9·3V by the three series-connected cathode resistors. On 625 its output is negative-going and valve bias is reduced to only 0·5V by short-circuiting the 150Ω and 100Ω cathode resistors. As valve cathode potential follows grid potential while the anode potential is 180° in opposition the net result is that on both systems drive to the base of the

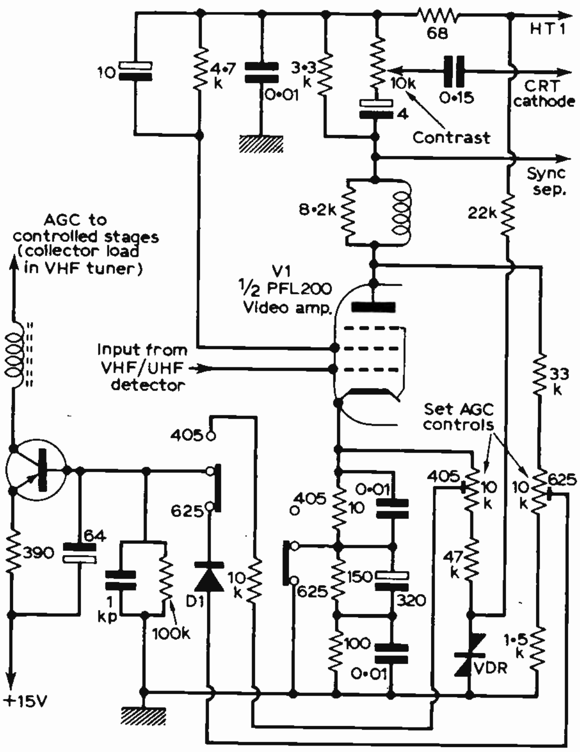


Fig. 1: High-level contrast control system used in many Bush-Murphy hybrid receivers, with OC45 a.g.c. amplifier driven from the video amplifier anode on 625 lines via peak detector D1 and from its cathode on 405 lines.

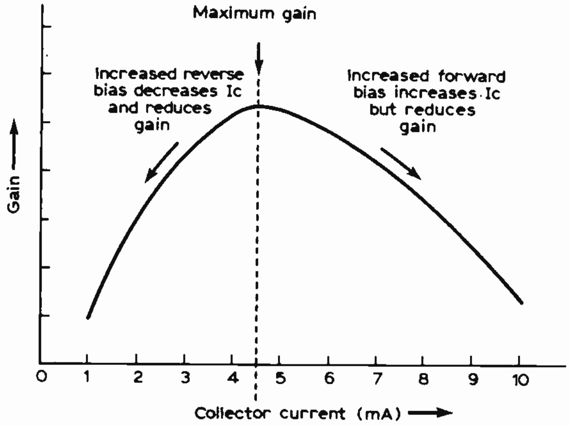


Fig. 2: With forward a.g.c. transistors are biased for maximum gain on no-signal: rising signal strength increases the forward bias thereby increasing collector current and reducing stage gain. With reverse a.g.c. increase in signal strength increases the reverse bias, decreasing collector current and stage gain.

a.g.c. amplifier similarly changes with changing signal strength.

The a.g.c. amplifier together with the other transistors is fed from a positive l.t. rail and the ultimate effect is that increasing signal strength increases the emitter currents of the controlled transistors above their optimum no-signal values (see Fig. 2) and thereby decreases their gain (since a series resistor is included in the collector lead so that the collector voltage falls with increase in collector current).

Whereas reverse a.g.c. is almost universally used in transistor radio receivers, i.e. with this technique increasing signal strength *reduces* the emitter current of the controlled stage, forward a.g.c. as just described is generally used in TV circuits since the weaker input signals are then handled at minimum emitter current giving best signal-to-noise ratio, control is more gradual and a.g.c. variations produce least input impedance change.

Onset of a.g.c. to the r.f. transistor is delayed by means of a diode, but this action will be fully described later.

To summarise, no-signal fixed bias for the a.g.c. amplifier is determined by the settings of the 405 and 625 set-a.g.c. controls and is then varied by the mean level of the incoming video signal; collector output from the a.g.c. amplifier is then applied to the base connections of the i.f. and r.f. transistors to produce the required control action; and video drive to the c.r.t. is a.c. coupled by means of an 0·15μF capacitor with a 4μF electrolytic in series with the contrast control to prevent d.c. flowing through the track and thereby ensure noise-free operation.

In current Bush-Murphy hybrid models (Fig. 3) the valve sync separator provides the source of a.g.c. but is coupled via an emitter-follower stage (Tr1) which drives the actual a.g.c. amplifier. This use of an emitter-follower is necessary to match the high impedance sync separator grid circuit to the low input impedance of the a.g.c. amplifier.

Manual contrast control is effected by backing off the negative sync separator grid potential with a positive voltage tapped from potentiometers across the l.t. supply in similar fashion to the arrangement used in valved receivers. Bias to the emitter-follower Tr1 is therefore the summation of the negative grid voltage and the positive potential tapped from either of the potentiometers. The collector supply for Tr1 is taken from the emitter of the video phase-splitter Tr3, while its own emitter drives the base of the a.g.c. amplifier Tr2.

AGC DIODES

The degree of conduction of Tr2 determines the potential at point X in its collector lead, and this is the basic control potential. Diodes D1 and D2 control the application of a.g.c. D1 is biased by two resistors in the v.h.f. tuner section and D2 by R1, R2 and the delay control R3. On weak signals when the a.g.c. potential is low only D2 conducts applying a.g.c. to the vision i.f. stage, the r.f. stage remaining at full gain to maintain optimum signal-to-noise ratio. Stronger signals that develop an a.g.c. potential in excess of D1 bias then reduce the r.f. stage gain. At a voltage determined by the setting of the a.g.c. delay control R3 D2 becomes reverse biased and the i.f. stage gain is purely regulated by the setting of this control. However, at very high signal levels and therefore high a.g.c. voltages the v.d.r.

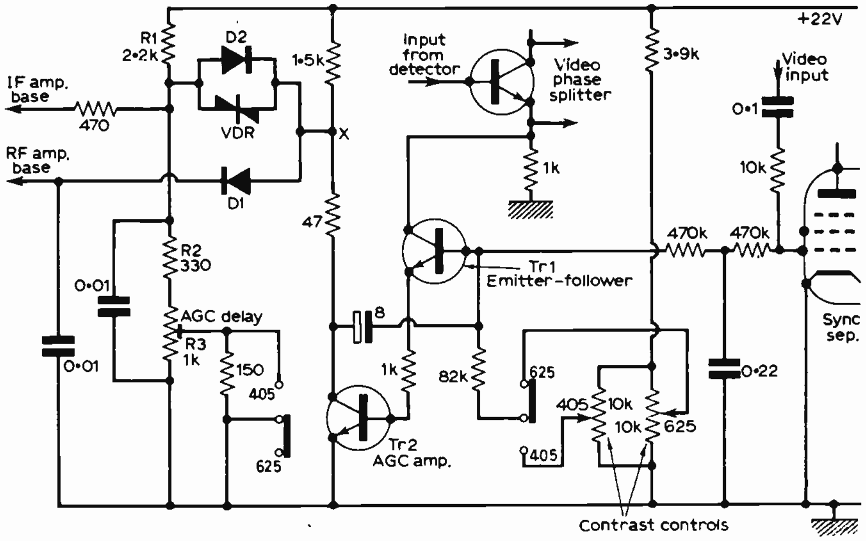


Fig. 3: A.G.C. circuit used on later Bush-Murphy hybrid models, in which the sync separator grid voltage is the control source, applied to the a.g.c. amplifier via the emitter-follower Tr1.

shunting D2 progressively conducts and bypasses the diode so that a.g.c. is again applied to the i.f. amplifier. Both the i.f. and r.f. stages are then under a.g.c.

Both diodes therefore operate as switches routing a.g.c. to the r.f. and i.f. amplifiers according to the level of input signal strength. The system maintains r.f. gain at maximum till signal strength warrants a reduction of front-end amplification to avoid possible cross-modulation and then progressively reduces i.f. gain to ensure freedom from overloading.

The r.f. and i.f. transistors being npn types the a.g.c. potential will be positive-going to increase the emitter currents above their peak gain no-signal values.

The a.g.c. system used in many GEC-Sobell hybrid receivers is illustrated in Fig. 4. This again uses one vision detector diode with polarity reversed on system change. On v.h.f. it is directly coupled to give a positive-going output but on u.h.f. it is a.c. coupled to the video pentode by an 0·1μF capacitor.

An auxiliary diode in circuit on u.h.f. is arranged to provide a d.c. signal component, also positive-going, so that video pentode anode current increases with increasing mean level signal strength on both systems. In the cathode lead of this valve are two series-connected variable resistors, the 200Ω contrast control connected as a potentiometer, and a 1kΩ preset contrast control rheostat connected.

As the video amplifier anode current rises with increasing signal strength so does the potential at the slider of the contrast potentiometer which drives the a.g.c. amplifier. The base potential of this transistor is therefore varied by the signal strength, the contrast control setting and the preset contrast setting.

It should be noted though that although the preset control is connected as a rheostat in the valve's cathode lead it has no effect on valve bias since the control grid is returned to a point above this component and not to chassis. The preset varies both the no-signal transistor bias and the degree to which valve current variations produce cathode voltage variations. The higher its value, the greater its effect.

With low-signal inputs and maximum sensitivity the a.g.c. amplifier is passing maximum collector current so that with its emitter supplied from the 15V positive l.t. rail the collector potential is approximately 13·5V positive to chassis. This potential in this forward a.g.c. system biases back the controlled stages. As signal strength rises the valve cathode potential rises to reduce the a.g.c. transistor's heavy forward bias and lower its conductivity and thus its collector potential. This collector potential is the a.g.c. supply so that what happens is that the positive a.g.c. voltage to chassis in this way reduces with increase in signal strength.

In this range of receivers pnp r.f. and i.f. transistors are used with their emitters fed from a positive l.t. rail and their collectors returned to chassis. When the positive base voltage to chassis is reduced by this a.g.c. variation it is equivalent to *increasing the negative potential of the base with respect to emitter,* the condition we require with forward a.g.c. to increase the collector current (and reduce stage gain) under strong-signal conditions. As an example, normal voltages for the AF181 first i.f. transistor are emitter 13·8V, base 13·5V and collector 4·4V, all positive with respect to chassis. The transistor therefore has a negative base to emitter potential of 0·3V which would increase if base to chassis (collector) voltage was reduced. So although this model employs forward a.g.c. in common with other transistorised receivers it is accomplished by *lowering* the a.g.c. potential with respect to chassis.

It is for this reason that it is essential not to short-circuit the a.g.c. rail to chassis even temporarily since this is equivalent to applying the full l.t. across the transistor base and emitter. In these models, as in many others, the a.g.c. amplifier transistor can be regarded as a low-impedance conductor between the l.t. supply and the a.g.c. rail, its degree of conductivity being regulated by signal strength and contrast control settings.

AGC DELAY DIODE

It will be seen that the a.g.c. rail directly supplies both the r.f. and i.f. transistors, with delay to the

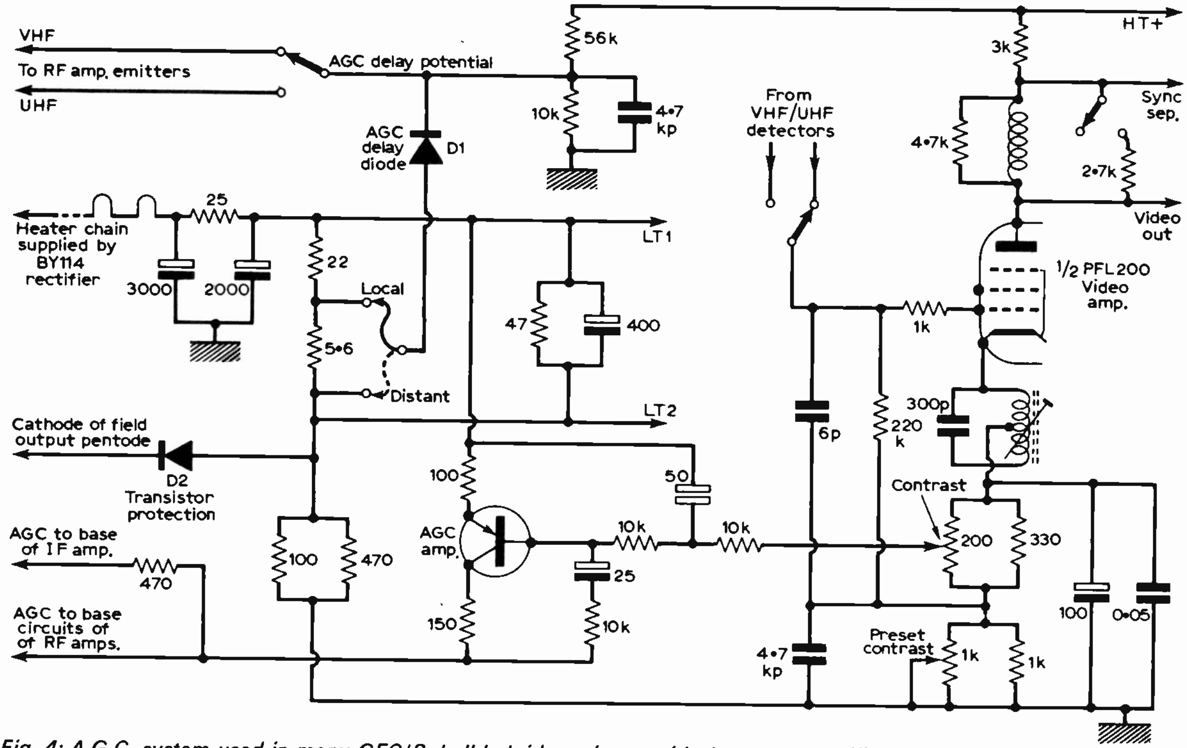


Fig. 4: A.G.C. system used in many GEC/Sobell hybrid receivers, with the a.g.c. amplifier driven from the cathode of the video amplifier. The a.g.c. delay potential biases the emitters of the r.f. amplifiers while the a.g.c. amplifier controls their base biasing.

former being effected by the diode D1. At first glance it may seem difficult to appreciate how this operates till it is noted that while the main receiver section is fed from the 12 or 15V l.t. rails the r.f. transistors in both the v.h.f. and u.h.f. tuners are fed from the h.t. rail via the junction of a 56kΩ and 10kΩ fixed potentiometer. The delay diode D1 is connected with its cathode to this point and its anode to either a "local" or "distant" contact in the l.t. supply network. On weak signals its cathode potential is more positive than its anode potential so that it is reverse biased and non-conductive.

When fed from a low-impedance source or, put another way, with a low-value collector resistor, transistor current is mainly determined by the amount of forward bias. However when fed from a high-impedance source transistor current is limited by the total circuit resistance no matter how great the forward bias. For instance with a series emitter feed of 56kΩ as in this example the r.f. transistors' variation of transistor conductance from minimum to maximum by variation through a.g.c. action of forward bias is small compared to the external resistance. Thus transistor current remains within fairly close limits and although supplied with the same a.g.c. as applied to the i.f. amplifier increasing forward bias produces a much smaller collector current increase in the r.f. transistors.

On low-signal inputs the a.g.c. mainly reduces the i.f. amplification leaving the r.f. stage gain at close to maximum for best signal-to-noise performance. Should signal strength rise the resulting slightly increased current through the 56kΩ resistor develops a greater voltage drop across it which could reduce the delay diode cathode voltage below its anode voltage. The diode would then conduct to supply the r.f. transistors from the low-impedance l.t. rail via the "local-distance" network.

Once conduction occurs through the diode the a.g.c. produces as much effect on the r.f. transistors as it does on the i.f. transistor and the possibility of overloading is thus averted. The "local-distance" flying-lead determines the point at which the diode conducts by varying its anode voltage slightly less from "local" to "distant".

PROTECTION CIRCUIT

There is an interesting transistor protection arrangement in this model which is worthy of note. It will be seen that the transistor l.t. supply is developed across a resistive network at the end of the rectified heater chain supply. At switch-on therefore and until the valve heaters assume their normal working temperature and resistance the heater current will be above normal and could produce an excessive l.t. supply. This is prevented by a diode D2 which is connected with its anode to the 12V l.t. supply and its cathode to the cathode of the PCL85 field output pentode. Immediately after switch-on and until the valve draws anode current its cathode potential will be zero and D2 will effec-

—*continued on page 378*

VIDEOSCOPE MV3

PART 2

MARTIN L. MICHAELIS, M.A.

LAST month we discussed television oscilloscope requirements in general and in relation to the present videoscope design, presenting the full theoretical circuit and parts list for this instrument whose detailed circuitry we will now describe.

Y-AMPLIFIER BANDWIDTH

Purely capacitive means have been adopted to achieve the necessary bandwidth without resorting to any peaking coils. This has led to a cut-off frequency around 5MHz for the Y-amplifier with useful gain up to at least 7MHz. This is adequate for colour television work. In principle peaking inductors could be added in series with R10, R21 and R24 by the conventional method, which would very likely boost the bandwidth to 10MHz. However since it is much easier to obtain small capacitors of known value than small coils of known and readily adjustable inductance it was considered desirable to avoid the latter in order to assist the less experienced constructor.

With the circuit as it stands it was possible to display the carrier wave of a shortwave signal generator tuned to 14MHz, feeding its nominal 1V output signal to the Y-amplifier input at full gain setting normally giving a sensitivity of 100mV/cm. within the nominal bandwidth. The 14MHz display was about 1cm. high, and with a little coaxing properly synchronised, so that the gain seemed to be about 20dB down at this frequency which the sync amplifier was also just still capable of passing. Synchronisation of signal frequencies up to 7MHz sinewave is easy and rigid and at the other extreme equally solid down to a few Hz.

Y-AMPLIFIER SENSITIVITY

The input stage V1 is a cathode-follower capable of handling a large input voltage at high impedance, reproducing this voltage at very low impedance permitting the use of an ordinary potentiometer gain control on the cathode output side without bandwidth restriction due to capacitive loading. V1 will accept a signal of at least 4V peak-to-peak applied to its grid, whereas 0.4V peak-to-peak is required to give full screen excursion with the gain control VR2 set to maximum. Thus VR2 provides an exploitable continuous gain control range of 10:1 and is graduated accordingly on the front panel. R8 has been included to restrict the minimum gain setting of VR2 to one tenth of the maximum gain setting. Without it it is possible to reduce the gain with VR2 to an extent where at full-screen excursion on the c.r.t. there is distortion in V1, a condition which would give very misleading displays.

The gain of V2 and V3 together is such that about 400mV peak-to-peak is required at V2 grid to obtain full-screen excursion defined as 4cm. nominal within the crossgrid scale, i.e. the sensitivity at V2 grid is fixed at about 100mV/cm. Of course V2 grid will accept a signal of 700mV peak-to-peak without distortion to make the spot move right across a geometric diameter of the c.r.t. screen.

This fixed sensitivity at V2 grid means that the manual gain control VR2 varies the sensitivity at V1 grid between approximately 100mV/cm. and 1V/cm. The preset control VR1 has been included to permit adjustment to exactly this sensitivity range for V1 grid.

INPUT ATTENUATOR

The resistance-capacitance network between the input socket P1 and V1 grid comprises a two-position compensated attenuator with a selectable attenuation factor of 1 (straight through) or 10, thus providing two input sensitivity ranges of 0.1-1V/cm. and 1-10V/cm. at P1. The input circuit is normally intended for use in conjunction with a 10:1 attenuator probe consisting of a fixed length of coaxial cable with a 9MΩ resistor in parallel with a 2-6pF trimmer between the center conductor and the prod in the head.

With this probe in use the two sensitivity ranges at its prod become 1-10V/cm. and 10-100V/cm. so that S1 has been labelled ×1 and ×10 for its two settings and VR2 calibrated from 1 to 10. The sensitivity in V/cm. at the prod of the probe is always given by the product of the settings of these two controls. Voltages from 1V up to 500V peak-to-peak can thus be displayed with satisfactory amplitude, using the probe, whilst voltages from 100mV up to 50V maximum peak-to-peak can be displayed without the probe.

The oscilloscope should be operated on direct input without the probe only in special set-ups expressly demanding this mode or if the sensitivity of 100mV/cm. is essential. When using the probe no damage is possible even if a maximum signal of 500V peak sum of a.c. and d.c. components is applied for prolonged periods at full gain, but signals in excess of those required for full-screen deflection may damage the instrument when not using the probe.

ATTENUATOR COMPENSATION

The principle of a compensated attenuator is to give each section the same time-constant, i.e. the same product of resistance and capacitance. The attenuation factor is then theoretically constant from d.c. to infinite frequency whilst the input reaction drops with frequency thus setting a practical limit to the usable frequency range.

A reasonable length of coaxial cable for a probe is about a yard and this together with grid circuit stray capacitances and minimum values of ordinary trimmers fixes the working capacitance at about 40-80pF. Since signal sources to be scoped for television will not tolerate more than 4-8pF capacitive and/or 10MΩ resistive loading without waveform falsification or even ceasing to function it is clear that we must use a 10:1 capacitive division ratio for the probe and hence also a 10:1 resistive division ratio in order to satisfy the constant section time-constant condition.

When using the Y-input P1 directly without the probe remember that this will impose the higher loading of about 40pF in parallel with 1MΩ on the circuitry whose waveforms are being examined so that it must be considered whether this will give rise to any significant falsification, detuning or other disturbances.

The resistors R1, R2, R3 are arranged so that the net resistance is 1MΩ as seen at P1 regardless of the setting of S1. This condition is essential since the network must always provide the same effective bottom section for the probe. The principle of constant section time-constant remains valid as frequency compensation balance criterion for any arbitrary *RC*-attenuator network, so that correct adjustment exists when the product of each resistor and its parallel capacitance is equal to the corresponding product for the probe head.

Since stray capacitances here play an important role it is not possible to achieve balance by selecting fixed capacitors of precalculated values. Trimmers covering the balance values have thus been provided and their method of adjustment will be specified later together with the general alignment instructions for the finished instrument. But the principle must be considered here.

If we apply a squarewave to P1 the flanks, representing a high frequency, will suffer a different attenuation to the roofs, representing a low frequency, if the capacitive and resistive attenuator branches are unbalanced. Accordingly the flanks will overshoot to produce a protruding nose above the roof, or they will rise too slowly so that the squarewave corners are rounded. Only at the correct balance point will the squarewaves appear truly square: the frequency response of the attenuator is then level. The duration of the nose or a retarded flank will be determined by the nominal section time-constant, here 40pF×1MΩ=40μsec. It is convenient to use a squarewave whose repetition period is about five times as long as this in order to display enough of the flat roof too for clear assessment of balance. In other words the squarewave should have a period of about 200μsec corresponding to a frequency of 5kHz. This is the frequency at which severe waveform distortion commences on account of non-level frequency response if the attenuator is not capacitively balanced, so this correction is evidently of paramount importance for this amplifier whose design bandwidth is a thousand times greater.

The self-capacitance of the probe cable is part of

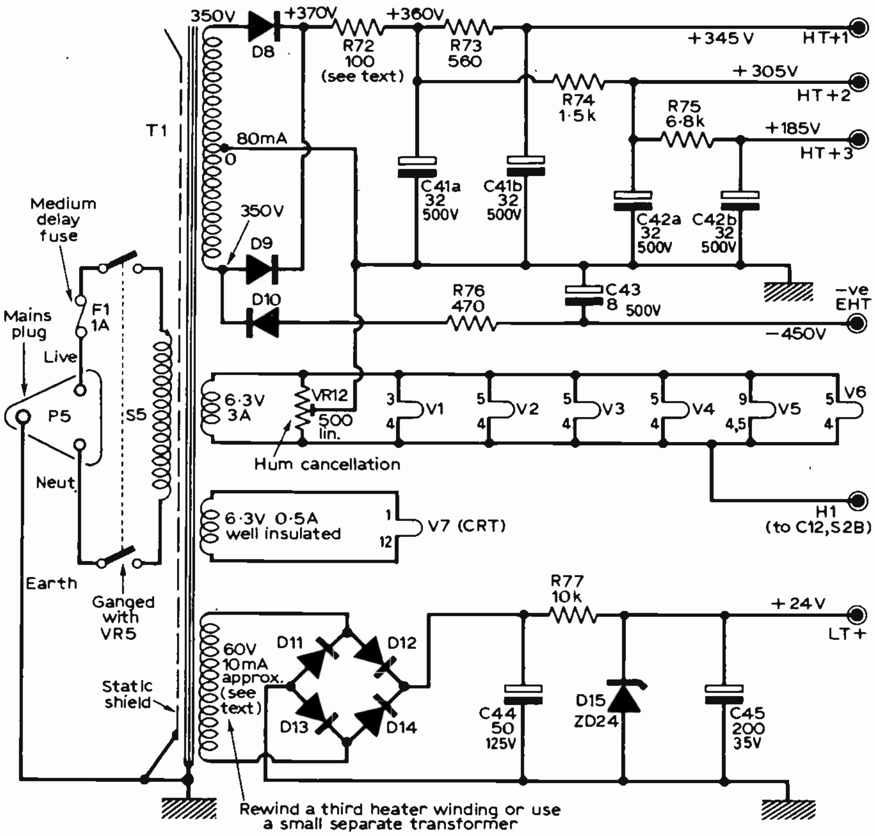


Fig. 3: Power supply circuits of the Videoscope. Voltages shown are measured with respect to chassis using a valve voltmeter, under the following conditions: maximum Y gain, no Y-signal input, timebase speed controls both midway, external sync but no sync input, trace adjusted to 5cm. length (VR8), correct focus (VR4) and centring (VR3, VR6), intensity (VR5) set so that trace is on verge of extinction with d.c. restorer (S4) set to blanking, and VR11 set to zero.

the attenuator capacitance network so that alignment must be with a definite length of probe cable which may be chosen arbitrarily within limits but once determined must be maintained if the alignment is to remain valid. It is important to realise that the balance point is quite critical. The described distortion noses of a squarewave can become three or more times as large as the undistorted rest of the squarewave if the trimmers are set well off balance. Clearly such misadjustments would play havoc with the display of the sync pulses and any other sharp transients of a composite television waveform. These would acquire large spikes, or they would be rounded off beyond recognition, according to the direction of the unbalance.

C2 is selected during alignment since the exact values of the stray capacitances will depend upon actual wiring and components used. It is evident that R3, C1, C2 actually represent a section time-constant nearer 60µsec for the prototype, but it is believed that this was in part due to these capacitors actually having values at the low end of their tolerance range. It is quite uncritical whether 40 or 60 or any other nearby section time-constant is employed as long as it is employed consistently throughout the network. Of course it is undesirable to use excessive values approaching 100µsec, since the capacitive loading imposed by the probe prod on measured circuits will then be intolerable. If it is found that balance can be achieved within the trimmer ranges only for an excessively large value of C2 something is wrong—probably the self-capacitance of S1 is too great or TC1 and TC2 will not reduce to sufficiently small minimum values.

Y-VOLTAGE AMPLIFIER

The Y-voltage amplifier operates with a high-slope valve V2. Substitutes are not permissible; it is imperative to use an EF184. The gain control VR2 is located directly in the grid circuit. It is not possible to place it directly in the cathode circuit of V1 because this would lead to intolerable trace jitter when adjusting gain on account of the d.c. then flowing through the track. Thus C4 is necessary as a d.c. blocking capacitor to prevent every movement of the slider itself amounting to a transient a.c. signal. VR2 must control the oscillogram amplitude smoothly without any jitter of the mean vertical level. If such jitter is found C4 is leaking and must be replaced with a better component.

V2 preserves a large bandwidth by using a low-value load resistor R10 which is insensitive to stray capacitive loading. Gain is preserved at very high frequencies by means of the small capacitor C5 shunting R11 and thus reducing negative feedback in the MHz range. V2 must possess high slope in order to get sufficient gain with the low load resistor R10, hence the unsuitability of substitutes such as an EF80.

VERTICAL AMPLIFIER

We used the Mullard DG7-32 c.r.t. in this design because it is readily available and gives very good performance in a suitably designed circuit. Whilst it is capable of excellent focus at high intensity, thus giving clear oscillograms and surprisingly sharp TV pictures, it does suffer from rather severe deflection defocusing unless properly balanced push-pull deflection is employed. Deflection defocusing is the result of changing the mean potential of the deflector plates with respect to the final anode of the c.r.t. so that the deflector plates then produce additional beam acceleration or deceleration.

Since the focus setting is a function of the total beam acceleration it is clear that the described conditions will call for a different focus setting according to the position of the spot on the screen. It is then impossible to obtain all parts of a displayed waveform sharply in focus simultaneously. If we use single-ended deflection with one plate connected to the final anode and the deflection voltage applied only to the other one the conditions for deflection defocusing are inevitably obtained. Some c.r.t.s are more tolerant than others, especially if the total accelerating voltage is large. However with a low-voltage tube such as the DG7-32 operating at only 500V or thereabouts and requiring deflection voltages which are a large fraction thereof it is evidently inappropriate to employ single-ended deflection.

Instead V3 has been employed to produce a symmetrical push-pull deflection. Equal but antiphase voltage waveforms are applied to the two deflector plates so that their average potential never changes and may be adjusted to a suitable value with respect to the final anode with the help of the astigmatism control VR13. This compensates for another inherent trouble of all c.r.t.s, the reduction of the luminous area to a small ellipse which starts to broaden again in a direction at right angles as the static focus control is turned through its optimum setting, without ever obtaining a true fine spot. The result is that it becomes impossible to focus vertical and horizontal parts of the displayed waveforms simultaneously.

Provided both the Y-deflection and the X-deflection plates maintain constant mean potentials, i.e. push-pull deflection is used for both, we can always find a certain potential for the final anode giving complete compensation for astigmatism. The focus control can then be adjusted to produce an extremely fine, truly circular spot which remains properly in focus without readjustment regardless of the position on the screen to which it is deflected. All parts of an oscillogram or television picture display are then properly in focus simultaneously.

The circuit of V3 is a long-tailed pair phase splitter. The signal from V2 is applied to one grid (pin 7) and thus reproduced across the cathode resistor network by cathode-follower action. Since the other grid (pin 2) is effectively grounded for a.c. signals by C7 this section functions as a cathode-input amplifier. Consequently equal amplitude but antiphase signals appear at the two anodes which are coupled straight to the deflector plates of the c.r.t.

The same methods as for V2 are used to preserve large bandwidth in V3, namely the use here of very small load resistors R21, R24 and negative feedback reduction in the MHz range with C8 and C9 in the cathode network. C9 is selected during final alignment to give a level response up to 5MHz without undue gain peaking in the shortwave band, using the sinewave output of an ordinary r.f. signal generator tuned to its shortwave band. Too high a value for C9 will boost the gain at around 5 to 10MHz to unduly large values compared to lower frequencies but the proper value is not unduly critical.

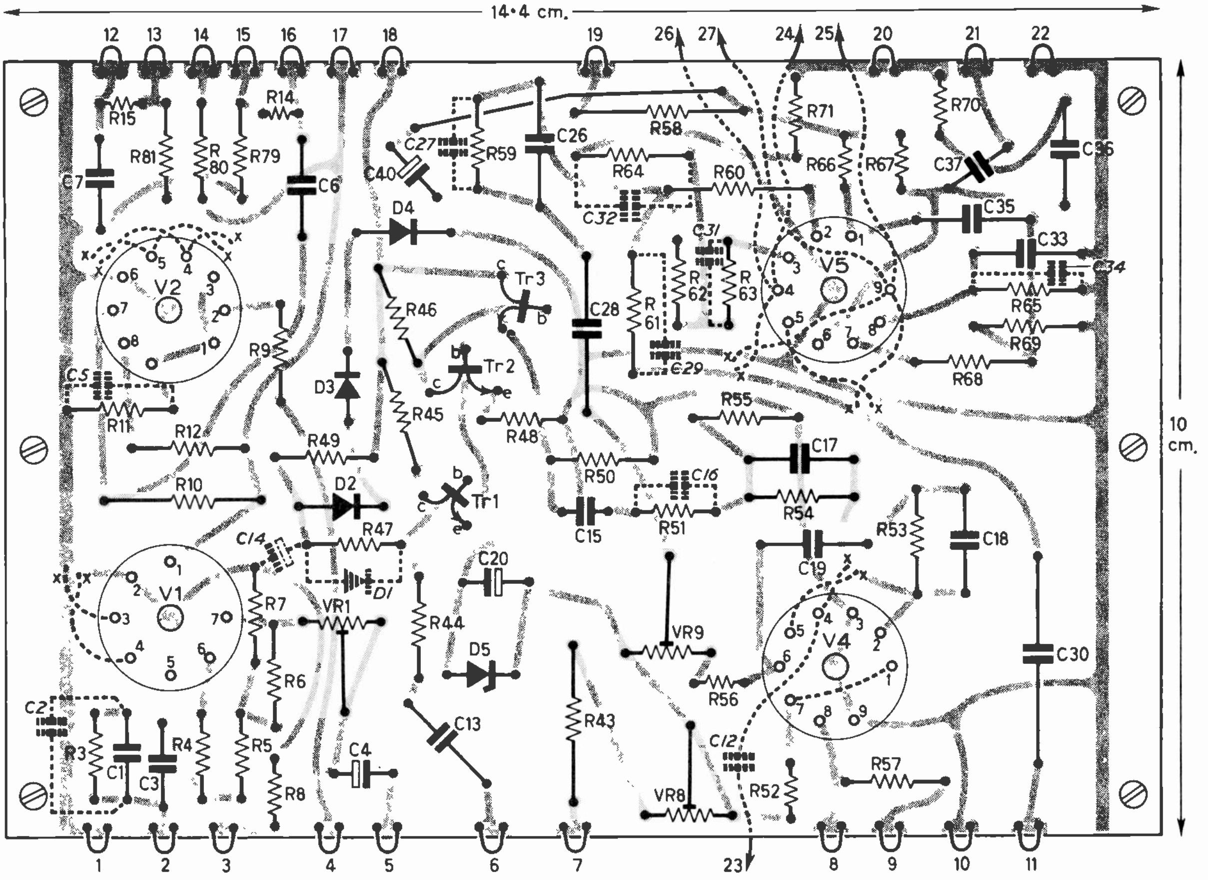


Fig. 4: Layout of printed circuit board, viewed from top. Components mounted on underside are shown broken.

SHIFT CONTROL

V3 at the same time functions as d.c. paraphase amplifier to produce static push-pull shift control without any need to resort to tandem potentiometers ganged in opposition at the c.r.t. deflector plates. Instead VR3 is an ordinary single potentiometer serving as vertical shift control in this circuit. If it is set so that the slider is at the centre of the track both sections of V3 receive the same bias voltage and thus the trace is centred on the screen irrespective of h.t. voltage fluctuations or valve emission changes. In spite of operating via a d.c. amplifier of considerable gain this type of shift control is quite free from short or long term drift.

OPERATING POINTS

Since the anode of V2 and grid pin 7 of V3 normally rest at almost the same d.c. potential when the trace is centred (shift control VR3 midway) one might ask why C6 is not omitted to give d.c. coupling right back to V2 grid. There are two objections to such measures with the circuit as it stands. First the shift control would cease to operate symmetrically. Secondly h.t. fluctuations and emission changes in V2 would be amplified fully, giving intolerable drift of the trace.

To overcome both troubles V2 would have to be duplicated with a blind stage connected to the other grid of V3 and the shift control would have to be taken to the grid circuit of this blind stage. Furthermore a d.c. coupled oscilloscope amplifier is useful only if the d.c. coupling persists right back to the input socket. Thus C4 would have to be removed too, whereupon the arrangement of V1 is not usable. Its cathode potential does not match V2 grid and a continuous gain control is never satisfactory in a d.c. coupled amplifier since it inevitably produces trace flutter instead of smooth control.

Entirely d.c. coupled amplifiers thus have to be fitted with multistep switches for gain control, i.e. VR1 would have to be replaced by a multistage compensated attenuator around a turret switch. So we see that conversion of the amplifier to pass d.c. signals would require radical redesign and greatly increase its complexity. Although a d.c. coupled amplifier is convenient for much work it is essential only for professional purposes where time is money. It is unnecessary for ordinary servicing and most amateur experimenting, provided the a.c. coupled amplifier has a cut-off frequency not greater than a few Hz at the low end so that mains and TV field frequency pulses do not droop unduly in the display.

MEASURING WAVEFORM POTENTIALS

The chief use of a d.c. coupled amplifier in advanced design work is to display not only waveform amplitudes but also the absolute potentials between which the waveform swings. It is little realised that this is equally possible with an a.c. coupled amplifier with the assistance of an ordinary multimeter. First centre the trace properly in the absence of a signal and take a d.c. voltage reading with a multimeter at the point to be scoped. The meter reading is the absolute potential of the centre line on the c.r.t. screen and if the waveform is now applied it will automatically position itself about this centre line so that the true *absolute* potentials of all parts of it are displayed correctly. The ordinary a.c. sensitivity calibration holds true for all excursion distances above or below the centre line.

If most of the trace is to one side of the centre line (sharp positive or negative pulses) it is equally valid to shift the trace statically to some lower or higher graticule line before applying the signal whereupon the absolute potential of the chosen base-line is given by the multimeter reading. Whilst true d.c. coupling is not essential in a TV oscilloscope deflection sensitivity calibration is seen to be vital. It has already been described how this has been effected in the Videoscope MV3.

Another reason ideally calling for a d.c. amplifier in advanced work is to prevent display flutter due to random pile-up of statistical pulse sequences such as are obtained from nuclear radiation detectors. But this trouble can be reduced to negligible proportions too by employing an adequately low bottom-end cut-off frequency for the a.c. coupled amplifier.

HORIZONTAL AMPLIFIER

The horizontal amplifier circuit V6 is identical to the vertical paraphase amplifier V3 but uses different component values. The horizontal deflection bandwidth is only about 1MHz, more being difficult to obtain because the X-deflection plates of the c.r.t. are closer to the screen and thus require a larger deflection voltage obtainable only with larger anode load resistors for V6. Timebase frequencies greater than the TV line frequency are seldom required in TV work so that the horizontal deflection amplifier is never called upon to handle such high frequencies as are contained in the video waveforms applied to the vertical deflection amplifier.

VR6 is the horizontal shift control which functions in the same manner as the vertical shift control. The horizontal deflection signal, whatever its source, is applied to the horizontal paraphase amplifier via C38. Because the X-deflection plates of the c.r.t. are closer to the screen and thus farther from the final anode they produce much less deflection defocusing if single-ended signals are applied to one plate only. Thus a high-level timebase oscillator driving one plate directly would prove reasonably satisfactory with the DG7-32, using a paraphase amplifier only for the vertical deflection. However this arrangement would not permit proper astigmatism correction which depends upon maintaining a constant mean potential of both pairs of deflection plates with respect to the final anode, and it would require unduly large external signal amplitudes for X-deflection in the absence of an amplifier.

CRT NETWORK

The c.r.t. is operated in this circuit with the final anode held at an optimum potential of about +220V determined by the astigmatism correction control and −355V at the cathode. Static intensity control is effected by adjusting the negative potential of the grid with respect to the cathode with the help of VR5. R39 restricts the control range between about −50V and −100V for the grid with respect to the cathode. If necessary select a slightly modified value for R39 if the specified one does not fulfil the condition that VR5 controls beam intensity from *just* cut off at one end to maximum *usable* intensity at the other end.

R41 compensates for voltage shift on the bleeder with increasing cathode current at higher intensities so that the focus setting is independent of the intensity setting. Otherwise it would not be possible to obtain highlights and shadows in focus simultaneously for a TV picture display. This correction functions properly only if the control range of the intensity control VR5 is not excessive, thus it is important to adjust the value of R39 before if necessary adjusting the value of R41. The author tried the circuit with three specimens of the DG7-32, admittedly all from the same maker's batch. The specified values for R39 and R41 proved correct for all three tubes so it is presumed there is nothing critical about these components.

C10 and particularly C11 are necessary to complete the return path of the d.c. restorer network described last month. Do not use any larger values for these capacitors since otherwise the response to adjustments of the static intensity control will be creeping instead of dead-beat.

All other details of the cathode-ray tube circuit have already been discussed in connection with the paraphase deflection amplifiers. The entire circuitry is so well balanced with respect to smoothing and hum—provided the layout and specified component values are maintained—that the trace focuses to a very sharp line devoid of the slightest ripple even when the timebase is locked to the mains frequency and the Y-gain is at maximum. The positioning and orientation of the mains transformer as shown in the drawings and the use of a proper mumetal shield for the c.r.t. are essential requirements in order to realise this low interference level. Neither side of the amplifier heater supply is grounded directly but only via the slider of VR12. During final alignment this preset control is adjusted whilst observing a mains-locked timebase trace with the Y-gain at maximum in order to cancel any residual hum via the amplifier, leaving an absolutely flat trace.

Next month we will continue with the timebase and intensity-modulation circuits and the power supplies.

TO BE CONTINUED

DX-TV

—continued from page 345

I propose in the near future starting a new series of data sheets, this time of outside Europe test cards. Our magazine is widely read throughout the world and in deference to DXers overseas it seems to be a good idea to publish test card and transmitter details for as many countries as possible so that DX in their areas can be identified.

I would therefore ask overseas DXers to help with this project by sending details of their local TV service together with a test card photo for publication.

SERVICING television receivers

L. LAWRY-JOHNS

THORN 950/960 CHASSIS—continued

The original semiportables used a rather strange heater circuit which was later modified to a conventional dropper and diode series chain. However most of the models serviced by the writer have used the original circuit which, unless it is understood, can lead to a lot of time wasting.

The sequence of events from switching on is (or should be) as follows. Eight valves (including the c.r.t. heater) warm up quite quickly through a dropping capacitor C121 (Fig. 9) which has a value of 4·33μF. This means that the screen will light up in the normal time. However there will be no sound and no picture as four valves have their heaters in series with the h.t. return from the chassis to the on/off switch. Thus these valves cannot be heated until the others are drawing current. The high ripple current of the smoothing circuit does not contribute to this as the reservoir 100μF and the 200μF are returned direct to h.t. negative rather than chassis. A shunt circuit of R152 and R153 adjusts the heater current within fine limits and R153 is normally set for a current flow of 300mA when a meter is inserted into the circuit, conveniently at point 24A. on these receivers therefore sound and vision signals cannot be expected until about 45 seconds after the timebases are operative and this period is somewhat longer in some cases.

The awkward bit is when the circuit fails to function. Consider the following actual case. The complaint was small picture, no sound. The customer did not mention that there was no picture. The picture he saw was a small raster which vanished as the brilliance was advanced.

The h.t. voltage was low which accounted for the small raster. V3, V5, V6 and V7 did not light up. R152 and R153 were hot. An open-circuit

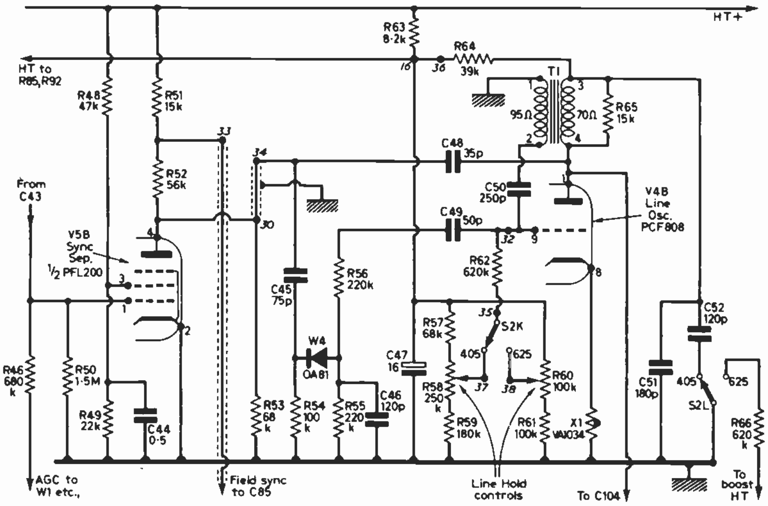


Fig. 5: Line oscillator with direct sync used in some chassis.

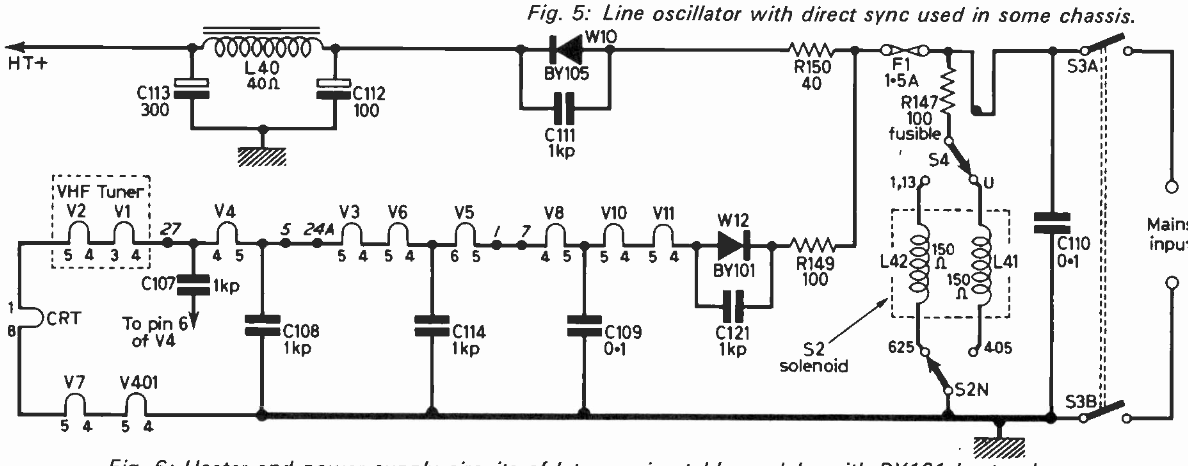


Fig: 6: Heater and power supply circuits of later semiportable models, with BY101 heater dropper.

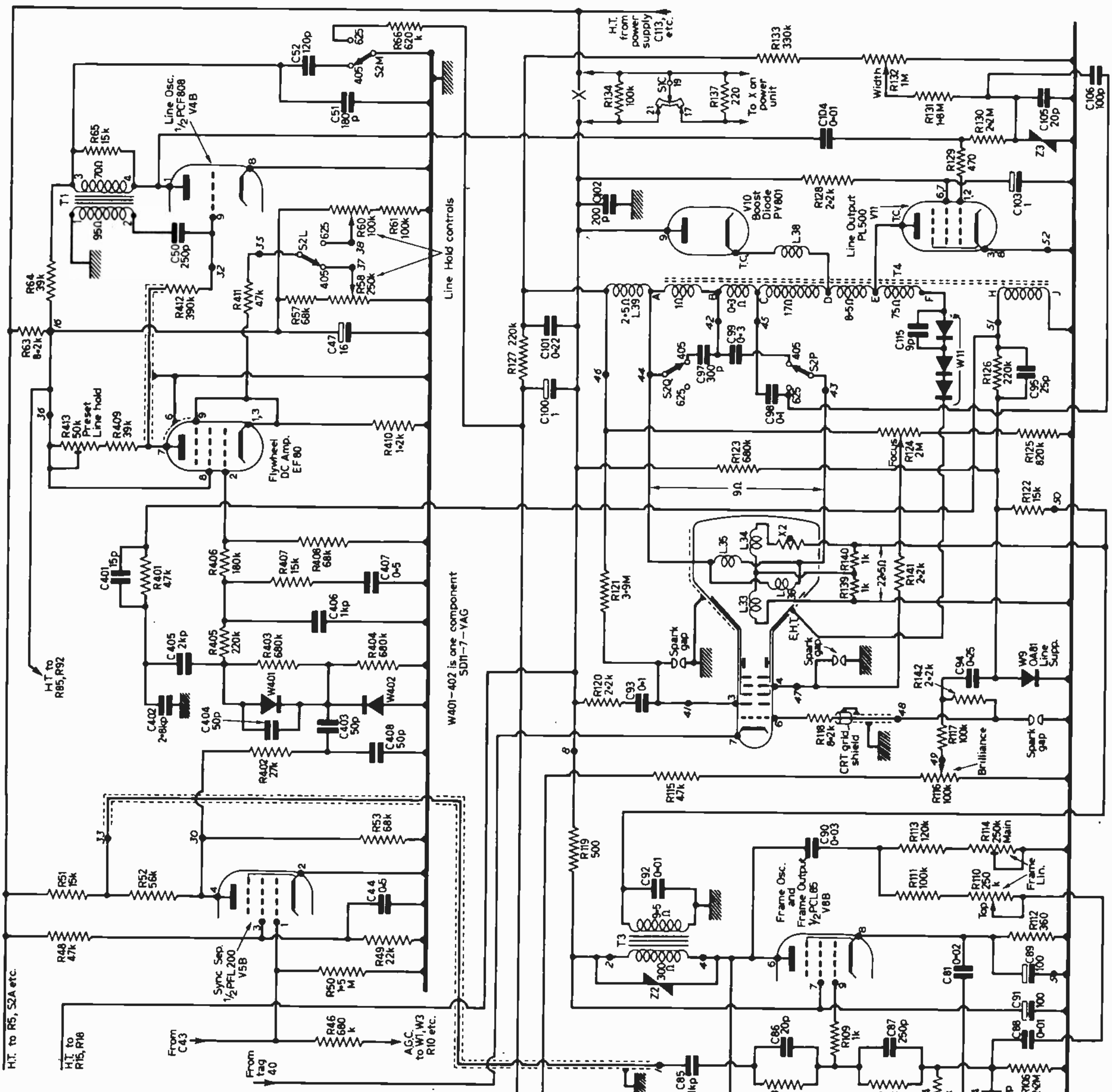
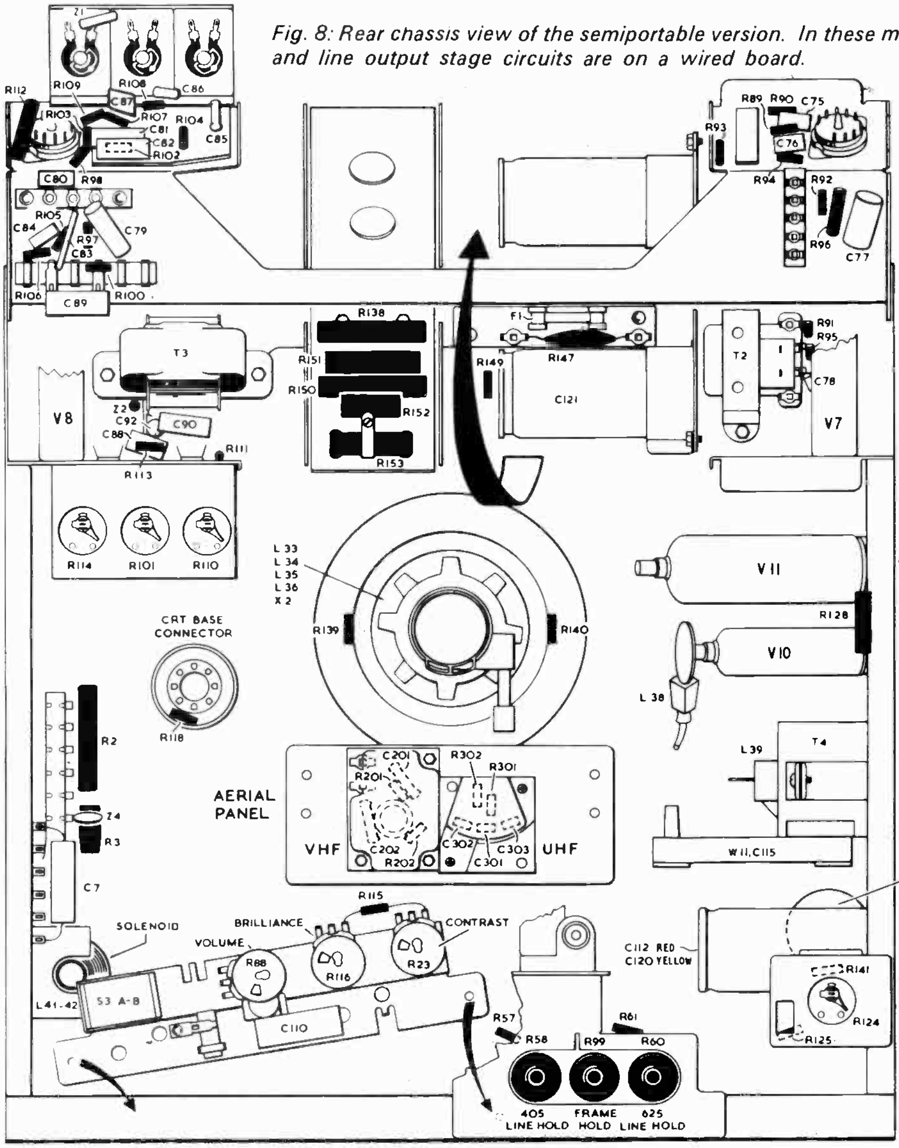


Fig. 7: Circuit diagram of the timebase and tube sections of the Thorn 950 chassis.

heater in one of the four valves was the immediate conclusion. V5, the PFL200, was removed and sure enough the heater was open-circuit. A new valve was fitted and V5 lit up as did V6 but V3 and V7 remained out!

With V7 removed V5 and V6 continued to glow (too bright). It was concluded that V3 or V6 had a heater-cathode short and in fact V6 proved to be the culprit. The heater circuit had in fact become, from chassis, through R69 to the V6 heater. Thus R69 was in fact across the V3 and V7 heaters and having a low value (27Ω) was shunting the current away from them thus causing V5 to fail.

The modified heater circuit (Fig. 6) consists of a BY101 diode in series with a 100Ω dropper. All valve heaters are in a single chain and little trouble is experienced although the diode can short and in so doing will over-run the valve heaters with a heavily shaded raster to call attention to the fault (0·001μF to pin 6 of V4). Unlike the BY130 used in the later 1400 series, which regularly shorts and produces frantic field roll to call attention to it, the BY101 is not so liable to give trouble.



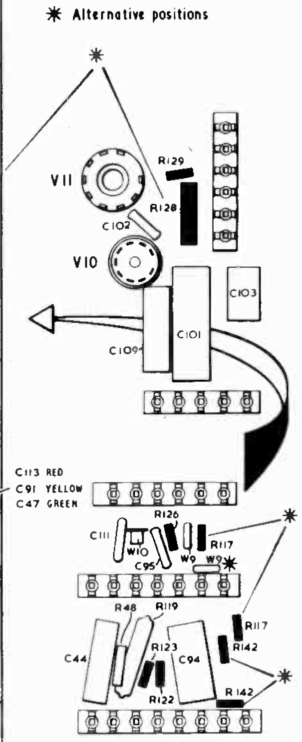


Fig. 8: Rear chassis view of the semiportable version. In these models the audio, field tímebase and line output stage circuits are on a wired board.

VOLTAGES

The voltage readings given on page 547 of the September 1968 "Practical TV" for the 900 chassis also apply to these models. V8B anode voltage on 405 should be 190V. H.T. across C113, 231V on 405, 224V on 625.

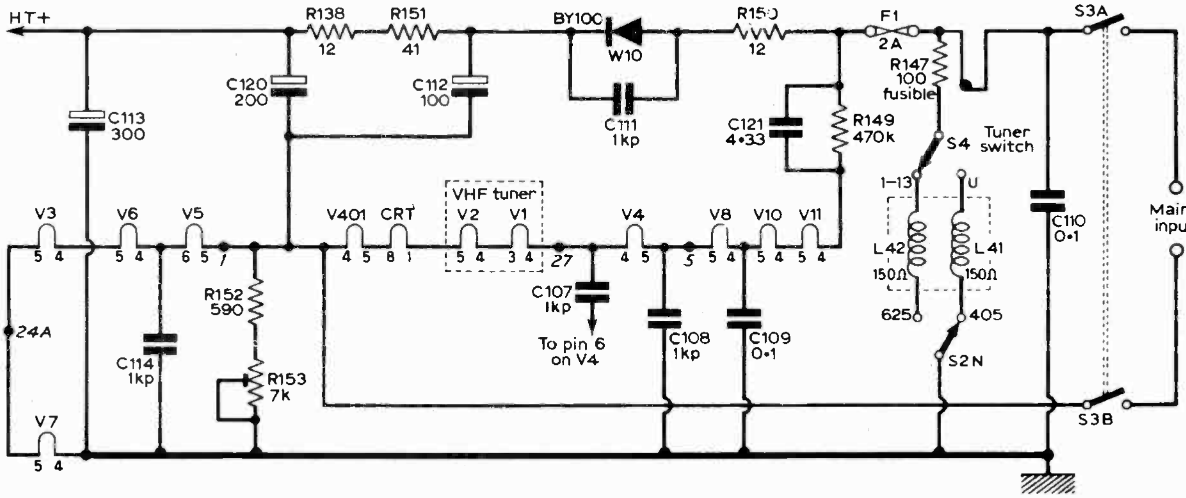
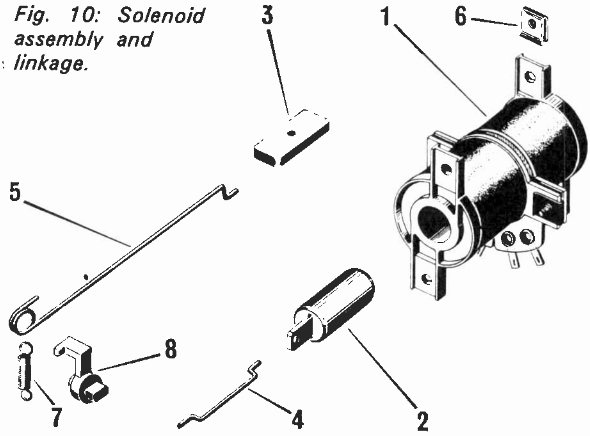


Fig. 9: Heater and power supply circuits used on early semiportable versions. Note heater line dropper C121.

Fig. 10: Solenoid assembly and linkage.



1 Solenoid; 2 slug; 3 TV-radio switch solenoid slug; 4 system switch link; 5 TV-radio switch link; 6 solenoid fixing clip; 7 TV-radio switch spring; 8 TV-radio switch operating arm.

Note that all 16in. models use only one fusible resistor (R147), not two as in the 950 series (R138 in the h.t. line as well as R147).

Additional Versions

To avoid confusion we would point out that there are 16in. versions of the 405-only 11in. portable, e.g. HMV 2643 etc., which have no relation to the 950 or 960 series. For information on these models we would refer readers to the December 1967 and January 1968 issues which dealt with the 980 chassis (Imp, Cub etc.). However, there is a 950 Mk. II with 20kV voltage trebler e.h.t. system etc. and even a 950 Mk. III (36409) which uses a dropper resistor in place of the autotransformer and a slightly different e.h.t. circuit, but we only mention these to avoid confusion.

Tuner Mounting

The standard 950 series models have a v.h.f. tuner which is readily accessible for cleaning. With the channel selector and fine tuner knobs removed a single screw is visible. With this removed, the tuner can be unlatched and moved far enough to remove the cover so that the studs can be cleaned.

The 960 semiportables have no such facility. The chassis must be removed far enough to enable the tuner to be unshipped. This is a matter of releasing screws which secure the tuner knobs, the chassis and the tuner, with a couple in the tuner cover for luck! The channel selector is secured by a screw reached from the inside with the fine tuner rotated to reveal it.

For details of the fine tuner mechanism and slug replacement see the January Philips Servicing Article for diagram and the December 1968 article for description.

NEXT MONTH: THE BUSH-MURPHY TV125/V879 Series.

UNDERNEATH THE DIPOLE

FASHION may be frivolous and capricious, not to say fickle. So it is also with art and even with technology. Many viewers may be attracted by TV cabinets in a tropical olive veneer or hand-polished melamine teak finish (embellished with acrylic-fibre trimmings). But a good-quality colour (or monochrome) picture of a good-quality costume play is now "in," thanks largely to the powerful influence of BBC-2. *The Forsyte Saga* series has shaped the taste of the British viewing public in no uncertain manner. The elegant good taste of its producer Donald Wilson has been a major influence in the scripting, acting and general presentation. And in showmanship!

INDEPENDENT FRAME

It was Donald Wilson who twenty years or so ago introduced a technical film production gimmick which was called "independent frame". This made much use of rear-projection slides and film as a method of putting both interior and exterior backgrounds behind the actors, who played their parts on a mobile stage in a film studio. This stage was twisted to the required angle position in front of the motion-picture camera. The idea was good but complicated in its operation, particularly when matching the foreground perspectives with the perspectives of the background screen. Very fine back-projection scenes were achieved but as a whole the system was technically too advanced for both directors and actors. The best of the independent frame equipment is still in use at Pinewood Studios, where it has been improved and successfully operated (with three matched and interlocked projectors) for colour-film back-projection requiring large and bright illumination. It has also been used for "front projection", helped by highly directional reflective screens together with television aids and videotape when necessary. Another method, known as "travelling matte", photographs the actors in front of a plain blue backing, on the negative of which is processed in the laboratory the scenic background from the separate film. The impressive aerial scenes in the uproarious comedy *Those Magnificent Men in their Flying Machines* were made in this manner.

PROGRAMME MAGAZINES

The BBC and ITV companies now present every evening previews of excerpts from videotaped plays. These are useful if you happen to be switched on: the trailers and announcements amount to self-advertising, like those for the Radio Times which are free. The ITA on the other hand has ruled that the TV Times has to pay high advertising rates. Although this London-based journal features sophisticated presentation it does not carry the local weight and flavour of the individual regional ITV publications. This was one of the biggest policy mistakes ever made by the ITA whose ITV companies, true enough, were naturally not so well equipped technically. The programme magazines are now an essential part of life in Britain, and I would have thought that the characteristics of each region should be preserved, in the arts, sciences and entertainment too.

TV SERIES

A new season of *Dr. Finlay's Casebook* has just started on BBC-1 but seems to have lost its style and appeal. Could this be due to the mod-pop script-writing of what is basically a period piece? Could it be the fall in technical quality, the poor (and inaccurate) sets, the uneven direction or the strained performances of the actors? Perhaps the change of locale from the BBC's Shepherd's Bush TV Centre to their Glasgow studio has proved indigestible to all concerned, however good the Scottish crew may be. The exteriors, handled locally, have always been first class. Perhaps the series will settle down but I have the feeling that the fault lies in the script and in the complete absence of an authentic atmosphere. Something like this has also happened to *The Avengers*, whose style changed in the last series.

FILM '69 AND THE BKSTS

There is no doubt that the beginning of the fusion of the art and technology of films and television will, quite properly, come with the international event of *Film '69*. Delegates from all over the world will attend this convention in June 1969, including large contingents from the USA, principally members of the Society of Motion Picture Engineers. There will also be a considerable representation from the film and television side of the USSR, whose progress in the integration of films and television is much more advanced than in either the UK or the USA. One thing about the USSR can be admired whatever your politics are: the acceptance of technical standards is not retarded by the procrastination and filibustering of the British Standards Institution or any other organisation. *Film '69* is being organised by the British Kinematograph, Sound and Television Society at the Royal Lancaster Hotel, London, and will be reported in due course.

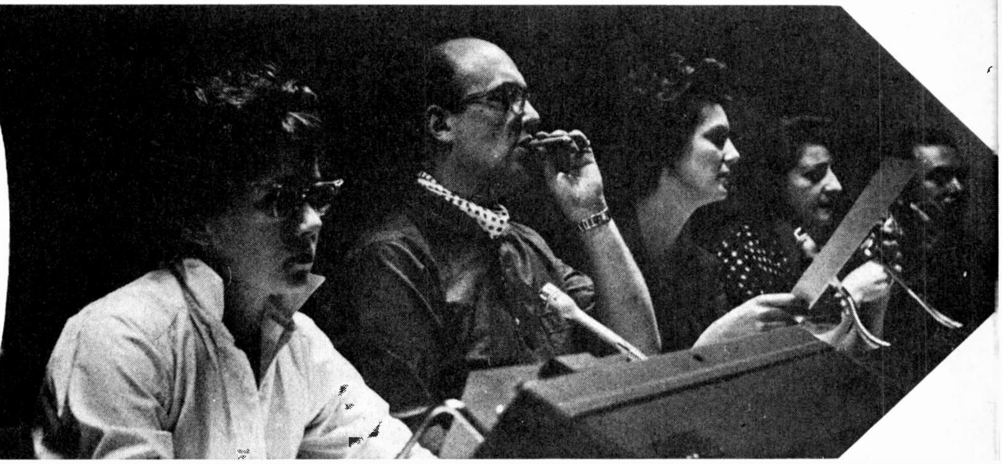
In the meantime a number of interesting BKSTS lectures have already been given in the Spring session by top engineers from the BBC Television Centre, including *Matching Colour Film to the TV Studio* by D. J. Corbett and F. A. Griffiths and *Pulse Code Modulation Sound for TV* by C. J. Dalton. The latter, concerning the insertion of the sound signal into the sync pulse interval of the television waveform, was reported in detail by T. John in the January issue of PRACTICAL TV. This is an immense step forward. Mr. Corbett's instructive paper on matching colour film to taped colour TV of the PAL system revealed the enormous progress made by the BBC.

—continued on page 378

INSIDE TV TODAY

PART 17

M. D. BENEDICT



A FIRST-CLASS broadcasting organisation staffed by the best technicians operating top-quality equipment is only of academic interest unless it uses these facilities to produce programmes to entertain or inform its viewers. Hence production of programmes is the basic aim of all broadcasting organisations. In most organisations programme production breaks down into basic *production units*, each dealing with one programme, and *services* which provide expert and specific aid for the many problems of putting a programme on the air, dealing with each separate production unit and hence with all programmes produced by the broadcasting organisations.

In all larger organisations the programmes are the responsibility of various departments, each making its own type of programme. The head of each department appoints various producers and the producers are made responsible for a given programme or item for a programme.

Production Units

Ideas for programmes come from many sources—most of them from within the department though occasionally outside ideas are used. Senior producers are sometimes in charge of several similar types of programmes and may be called executive producer or editor. To aid the producer a number of assistants are usually appointed to make up the production unit or team. Naturally the exact number and jobs of these assistants will vary with the type of programme presented. For a straightforward programme, a producer may also direct and write the material, as well as do any research work required. In this case a producer's assistant, usually a senior secretary, would look after the organisation and paper work for the actual programme, including typing the script, as well as working on the timing, cueing film and videotape inserts and calling the camera shots in the control room for the actual production. A secretary would assist with the normal day-to-day running of the office.

On the other hand programmes like *Late Night Line Up* and *24 Hours* might have thirty or more assistants all working under the overall control of a very senior producer. Large productions like these would have several producers, each with specific responsibility, then a number of directors to put the programme on the air. Researchers (in ITV) or production assistants (BBC term) would be allocated to a particular item and would then prepare this item for transmission by finding out about the subject, inviting guests, talking to experts, preparing scripts, shooting film if necessary (but only with the BBC—Union restrictions only allow directors to shoot film in ITV), viewing library material, and supervising the editing of film selected so that the item is ready to be transmitted. Researchers are often given responsibility for a given aspect of a complete programme, hence selection of unusual material may well be given over to a researcher.

P.A.s and researchers help with all or any aspects of the production as the situation requires, and naturally they refer to the producers and senior producers for guidance. Producer's assistants working on a rota or working with a particular director perform a similar function to their colleagues on the smaller programmes, but their duties would not include cueing film and videotape (the topicality and lack of rehearsals on such programmes demands the skills of a director for accurate cueing). Last minute changes may cause much confusion and often upset planned timekeeping. Each producer would have a secretary with a number of extra typists to assist with the typing of scripts and other such duties. Drama and light entertainment programmes use writers to prepare the scripts.

Services

All these are part of a production team connected with only one programme or series. Working closely with the team are a number of services. Closest to the team is probably the designer, who is responsible for all design work of the sets and the props. Most programmes require all the designer's time, but a designer might handle two simple programmes at the same time. In a similar position is the costume designer and the graphic designer, each with his own field of interest. If film is going to be used a film editor would be required.

A studio production requires an operations or technical manager to advise on the studio operation and the use of cameras, and he would be consulted at an early stage. Other specialists allocated to the production include make-up specialists; a floor manager who represents the director on the studio floor by relaying all instructions; an assistant floor manager who is concerned with special props, alterations to the script and assisting both director and floor manager, particularly during rehearsal. In large organisations many other specialists are available for

PROGRAMME PRODUCTION

consultation on difficult cases. All liaise through the director, though in most teams, in particular the larger ones, researchers and production assistants cut corners when they feel it necessary. This is possible as the organisation needs to be and usually is sufficiently flexible. In these cases a great deal of intercommunication is needed otherwise chaos ensues. In television, time is usually too short to use the usual systems of office communication to ensure that everyone knows what is going on.

Production meetings are held at regular intervals to bring the members of the team up-to-date with developments. Similarly planning meetings are held to arrange the technical requirements, which may conflict, and these are sorted out as much as possible before going to the studio. It is at this point that the lighting and sound supervisors are brought in. Sound and lighting is a continuous battle where for example a sound supervisor may wish to place his microphone boom for the best sound pickup in line with a very important key light placed for optimum effect by the lighting supervisor. Long experience will allow each to come to a compromise without losing sound or picture quality.

Costs

Thus the producer heads a large number of people many of whom may be solely concerned with his programme. In the BBC the number of people on the team depends on the agreed allocation of facilities and money. Thus *24 Hours* has far more filming and editing effort than say *Jackanory*. Money is allocated to the production and items like artists' fees, special sets and props, film bought from outside the BBC and all expenses incurred with a particular production are charged to this allocation. Many facilities are free to a programme and only need to be booked; others are charged at nominal cost and some at actual cost. For example should an edit be required in a videotape recording the programme must pay for the tape as an old edit cannot be rerecorded with 100% success. Hence subsequent use of the tape is unwise.

Naturally many of the free services cost money in absolute terms. The studio for example may cost several thousand pounds when fully crewed with telecine and videotape recording facilities. However these and other general costs are regarded as being "below the line" so that they do not count when the programme budgets are dealt with. The logic behind this is that all programmes need either a studio or film facilities so that these must be provided to the programme automatically. It is only the extras beyond these basic facilities that need to be budgeted.

Independent companies generally have a different system where every facility and service is charged to the programme budget at a given rate. Even the programme staff such as the director may have their salaries allocated as part of the programme budget. Naturally the basic budget is a lot larger than that for a comparable BBC programme, but even so with basic fees for artists higher than at the BBC and all expenses to pay for the money easily runs out! Where possible, and particularly in the film field, normal commercial rates for the job are applied when budgets are considered. Smaller companies often find it cheaper in the long run to send work to outside companies rather than to maintain expensive cutting rooms and editing facilities which are rarely used to their full capacity. Responsibility for the spending of this money is, of course, the producer's, who must weigh up the pros and cons of the many alternatives available to him. His salary is, however, usually fixed by the programme company!

A clearer idea may be gained of the way these various factors work as a whole if some imaginary programmes are looked at in detail.

Typical Production

Let us consider a prestige drama production. If the BBC accept an idea, the Head of Drama would discuss the idea with a suitable producer. Most producers have their likes and dislikes concerning the type of programme which they wish to do. In ITV the Head of Drama of one of the companies which specialise in this field would similarly select his producer. Then the Head of Drama would put to his controller of programmes the basic idea. It would have to be fitted into an established spot already agreed amongst the companies at their Network Planning Committee. The BBC, too, would likely slot it into a particular place—a Wednesday Play, Theatre 625 or Play of the Month—and this would be agreed with the Controller of BBC-1 or -2. In each case a time and date, a duration and the budget would be agreed and the idea handed over to the producer to bring to the screen.

It is almost certain that the story will have to be rewritten for television and there would be discussions with the original writer, who might handle this, or perhaps another writer who specialises in adapting for television. Plays may be commissioned from a basic idea and plot, particularly if the writer has a good reputation. Little can be done until the writer has handed in his script, but the producer can check on the progress, discuss ideas and start to line up some performers, a director and other members of his team. When he selects the director, he would choose one whose personality suited the style of this particular play and the treatment being used. In consultation with a specialist casting expert the producer and director will check available artists whom they consider to be suitable and then book them through the artists' agents. Often it is a compromise —the leading lady does not know if she will be available, but the number three choice will definitely be available on the recording date. Naturally some artists don't work well with others so these and many other considerations need to be balanced before bookings are completed.

With the cost settled and the script prepared the director can start work. Most writers provide the director with guidance on the treatment envisaged but it is the director's responsibility to instruct and guide the actors, cameras and all others concerned with the final screened production. His first task is to break down the script and determine exactly what is required. Sequences requiring film are usually the first to be dealt with, so the designers and film staff are called in to prepare everything for shooting.

Filming

Filming even the simplest sequence requires a lot of organisation. Permission has to be obtained from the owner of the location or, if public property, the police or local authority. Staff and performers need transportation to and from the location, as do any special props and scenery. If costumes are needed, changing rooms, usually caravans, must be provided, along with make-up facilities.

Food is usually provided by sandwiches for a small unit, but larger units would require specialist location caterers who are able to provide large numbers of cooked meals using portable equipment. Lighting if needed varies from batteries of 10kW lamps and the white reflecting screens to provide a softer reflected light to a battery-operated hand-held quartz-iodide light of about 300W. In the former case special arrangements could be made with the local electricity board to provide enough power, or a mobile generator could be used if the board could not cope with the increased demand for power.

The director usually prepares the points of the script requiring filming by marking the sort of shot that he requires. He might well have rehearsed the performers but if the action is simple he would rehearse before each shot, allowing the camera team some extra practice. When all are at the selected location the equipment is set up for the first shot. This could be any shot that convenience requires, since there is no requirement for film to be shot in any given order. Any other shots from the same position would be done at the same time before the camera and sound equipment are moved to the next position.

When complex shots are required a wide variety of camera mountings can be used, allowing the camera freedom of movement, to elevate and depress. For long-tracking shots special rails might be laid to allow the mounting to move smoothly over the roughest surfaces. Sound requirements for such shots also become more difficult so that a boom might be needed to follow the action. Radio microphones are rarely used as the sound can be added afterwards in a dubbing theatre and exact lip synchronisation achieved by skilful editing. Shooting proceeds until it is too dark, or until the sequence is complete. It is rarely cheaper to return to the location the following day, in spite of heavy overtime rates for artists and crew.

Film editing

The film and sound track are sent off to the laboratories where the film is developed and printed and the ¼ in. tape is transfered to magnetic film. If sufficient time is available the editor uses the clapper-board operated at the beginning or end of each shot to sync the sound and picture before the prints, now referred to as rushes, are shown. This is done as soon as possible, usually the next day. Seeing the results tells the director and others concerned whether any retakes are required and if any sets can be struck. During rushes the director, who may have repeated a shot several times if he is not exactly satisfied with the take, notes which shot is the best one, thus allowing the editor to prepare a rough cut of the sequences.

When shooting is completed the director and his P.A. retire to their editing room where the film editor cuts exactly where required. At the same time he might use two or even three separate sound tracks—one for special effects, one (or more) for dialogue and one for music. The exact position of each is adjusted relative to the other, the cuts may be timed to the music and the effects are exactly synchronised to the action. When all is ready the editor hands over the cut film and sound tracks to a dubbing editor who mixes them at their correct respective levels.

The combined sound track and the cut rushes are then sent to the laboratories or a specialist editor, along with the negatives. Using the cut film as a guide the negative is cut in exactly the same places before being printed to give the final print. Sound may also be added in the form of the optical track, but separate magnetic film is usually preferred. Optical effects such as mixes and fades, frozen frames and wipes are added at the laboratories and the final result is printed to give the show print. Often two prints are made, one for rehearsals, one for transmission only. Each film sequence is then spliced in the required order into one or two reels, depending on the number of telecine machines to be used for the studio recording.

Set design

All other activities do not cease during filming. Consultation between the designer, technical staff and the production staff proceeds. Scenic designers design the sets and supervise their construction and painting. It is their job to capture the atmosphere of the play and translate specific details in terms of rooms, windows, doors and furniture, as well as selecting most of the props and bric-a-brac. The scenic designer chooses the decor of the room, the type of furniture and its layout all to give the required authenticity. However, he must bear in mind the director's requirements for placing his cameras and shooting the action. Costume and make-up departments all work towards this authenticity and atmosphere of the play, but unlike scenic design there are few technicalities to worry about.

At a fairly early stage the designer prepares a floor plan, and occasionally for complex productions a model. The floor plan shows the position of each set in the studio as well as the layout. Furniture, the positions of walls, doors and other salient features are marked in their place. The plan is used by the director, the operation supervisor (technical manager with the BBC), the lighting supervisor and the sound supervisor. It allows them to see what goes where and plan the camera moves, the positions of the lights around the set and the sound coverage and boom positions. All these points are hammered out at the technical planning meetings.

At work in the gallery—an ATV photo.

Rehearsals

In the meantime the director has brought his cast together and rehearsed their moves and speeches in a rehearsal room, often a church hall hired for the purpose. It is at this stage that the assistant floor manager becomes invaluable by marking the positions that the sets will occupy in the studio so that actors moves are realistic. Amendments to scripts are the A.F.M.'s responsibility as well as being general dogsbody, coffee carrier and assistant. During rehearsals the director completes his ideas of what course shots are needed and will often indicate to the performers the type of shot that he envisages. Knowing when they are in close up, when in long shot, etc. helps many performers as they vary their style to suit. When rehearsals are complete the production secretary types out the final camera script with the director's required shots marked in the correct position on the script. It would look something like Fig. 1.

A Typical Sequence

In this sequence the set of a bus stop sets the scene. Lighting and sound effects are used to add authenticity to the atmosphere. This director has placed his cameras and selected his shots revealing the tension between performers. The close-up of Jane would show how she reacts to Barry's words.

Spot sound effects of the car's approach, as well as light from the headlamps, give the impression of a car passing without actually showing it passing (a feat nearly impossible in a studio!). A gramophone record selected by the gramophone operator from a library of sound effects and two spotlights mounted on a horizontal box which is fixed to a swivel allowing the lights to be panned across the set provide these effects.

As soon as Camera 3 has finished its shots the P.A. can "clear it" and allow it to move to its position on the next set to be shown. This becomes very important when cameras have a limited time to move. Timing of critical points, e.g. Jane's walk off the set, is controlled by the director. By arranging to cue her after telecine is running her exit can be timed to coincide exactly with the first frames of the film, making a clean bridge.

Camera Shots

The shot numbers are called by the P.A. and all listening to talkback can hear exactly where they are on the script. The position of each camera is denoted by the letters and refers to the position decided by the director and originally marked on the floor plan. Lens angles are often marked on the script, but with zoom lenses this is not always done.

All the shots for each camera, along with the description of the shot, the positions and lens angles are typed on to cards to be used by the cameramen. A complete script would be too bulky to handle on a camera, as well as being superfluous. Boom operators, sound balancer, vision mixer and occasionally the lighting supervisor use the script for guidance. As rehearsals are usually followed immediately by camera rehearsal in the studio the script is often printed overnight.

Preparing the Sets

Setting up each set and rigging the lights and sets is a very tedious business so that as soon as the studio is cleared of one production work is started on the next. Overnight setting allows the studio to be in use the following day. Floor painting is often used to give the appearance of carpets, floorboards, paths, etc. This demands time and is the first thing to be done in the studio. When the sets are complete and in their marked positions the designer checks on everything, as does the lighting supervisor the positions of the lights. As the crews arrive the cameras are put on their mountings and cabled up to the c.c.u.s, whilst the booms and microphones are cabled up to the sound desk. Camera line-up then commences and the sound crew perform all the checks on the sound equipment, as well as completing the rigging. Finally all is ready for the camera rehearsal to begin.

At this point the production is almost entirely in the hands of the director. He has envisaged the shots that he has indicated on the script. Although each camera position is marked on the floor plan so that an approximation to each shot is easily achieved, this is rarely satisfactory and adjustments are usually made. Alterations for cameras are made via talkback direct to the cameraman but the floor manager (who often uses a miniature radio receiver to receive v.h.f. transmission of talkback without the inconvenience of long cables) is the director's contact with artists, performers, stage hands and other technical personnel on the studio floor. Besides the aesthetic considerations of a given shot the director has often to strike a compromise. Practical considerations such as scenery being in the way, lack of time to change shots, boom being in shot, flares from lights, as well as adjustments for technical reasons—lighting levels wrong—all need to be considered and, if possible, solved as rehearsals proceed.

Rehearsal starts with any convenient point in the script but it is usually the first part to be recorded—either an insert to be prerecorded or the start of the play; the telecine and videotape are not usually used until second or third rehearsals. Since the final rehearsal is usually called the run-through earlier rehearsals are designated walk-through or even stagger-through and these terms give an idea of actual pace. First rehearsals are very slow and each point is often repeated until all major problems are cleared.

Recording the Programme

Much depends on the type of recording used by the director. Normally a programme is recorded in either one continuous take or with short breaks in recording, which are edited out later and allow for extra movement of artists and cameras, costume changes and alterations of the set. Sometimes, particularly in live programmes or those recorded in a continuous take, a prerecorded insert might be required and these are rehearsed first and recorded either the previous day or in the morning, depending on the studio time available.

However sometimes it is advantageous to use the discontinuous stop-start recording technique. This is expensive both in v.t.r. time—a recording machine must be available all the time—and artists' overtime can be very expensive. Artists are paid the normal fee for three times the duration of the programme, starting at the moment recordings start. So with discontinuous recordings lasting all day artists are being paid overtime rates after a couple of hours or so. In spite of this the director may prefer to record in this manner as it has the great advantage of allowing all sequences to be completed and checked before moving on to the next sequence.

Most programmes however are rehearsed through the day, starting at about 10.30 a.m. and recording at around 7 p.m. Naturally the exact sequence and timing depend on the director, who also has to allow for meal breaks, coffee breaks and line-up when working out his schedules. For example, if a continuous recording is being made (or, for that matter, a live performance) it is customary to arrange a break just before videotape recording or transmission. This allows artists, crew and others to relax and often have a meal. Last minute changes to adjust for time are made at this point, the P.A. having carefully timed the last rehearsal to get a pretty good idea of the overall duration of the programme. During the break the studio engineers put in the final adjustments to the cameras and the line-up is completed, as well as making quick checks for videotape and telecine and any outside broadcasts.

About fifteen minutes before transmission or recording all crew and artists return to the studio. If much make-up is used the artists go to have any adjustments or corrections made by the make-up supervisors before this time. Live programmes go out at or very near to a given time as cued by Presentation, but videotape recorders start at the given time if possible in order that optimum use can be made of the booked recording time. Naturally live ITV programmes start at exactly the decided time so that each network control receives the programme at the same time.

Final Adjustments

During recording or transmission the director will often ask for slight adjustments and alterations to camera shots, as well as directing the moves of actors by hand signals from the floor manager who also cues the vital points of each scene.

A well-rehearsed play on the other hand may need no final direction and a few directors actually view the action outside the gallery! All the real work is carried at this point by the P.A. and the vision mixer. Towards the end of a live production the P.A. may ask for the timing to be tightened up and the F.M., using the appropriate signs—a "wind up"—signals the artists to take the appropriate action and adjust their pace. P.A.s are also responsible for the cueing of commercial breaks.

Cueing the Commercials

Cue dots placed at the top right-hand corner of the picture appear at approximately one minute before the break. A black "hole" is electronically switched into the outgoing studio picture and a pattern used to fill the hole, resulting in a mark which can be distinguished from all types of picture. When the dot appears the presentation studio stands by, as does the telecine operator running the commercials. At exactly five seconds to go the P.A. takes the dot away and the telecine operator runs his machine. Both live and recorded programmes use this procedure as it is foolproof and each presentation control room in each area can take the same cues for their commercials. As a check, recorded programmes inform their presentation staff of the timings of the break and live programmes agree each break with presentation as far as possible with the nature of the programme.

Programme Editing

When the recording is complete all but the director and producer can relax. They, however, have to supervise the editing. Editing is usually time consuming and it can be expensive. Often editing is confined to removing the blank parts between various sequences or slotting in a complete scene which was not satisfactory on the original take. Editing videotape demands much care in handling and the cut has to be right first time since it is not possible to remake the tape and move the cut to a different point as one can when editing film.

Copies of the videotape recording may be made in order to see how a particular edit or series of edits works before the master tape is cut, using the copy as a guide. Electronic editing simplifies this procedure

	(SCENE EXTERIOR, NIGHT. BUS STOP IN COUNTRY LANE)	
Fade up 65. 3 Pos. F. 35° 2-S Barry and Jane. (4 next)		CUE FX. NIGHT NOISE
	(JANE STANDING, BARRY SITTING ON A LOG BY ROADSIDE, HEAD IN HANDS) *Jane:* What will happen to us, then? *Barry:* (SULKILY) I dunno. *Jane:* You got us into this, you'd better get us out now, before we're in real trouble./	
66. 4 Pos. L 28° MCU Barry		
Track in to CU STAND BY FX	*Barry:* (SURPRISED) I got us into this! (STANDS UP AND TURNS TO FACE JANE) I suppose that your incompetence as a driver had nothing to do with this; I suppose that my suggestion of telephoning the garage was a bad idea! /	
67. 3 Pos. G. 16° CU Jane STAND BY LIGHTING FX	Don't be ridiculous, woman! It's all down to you but your pride won't let you admit it. Anyhow, the bus has gone and. . . . /	
68. 4 Pos. H 35° 2-S		CUE FX, CAR APPROACH
	Quick! There's a car. Stand in the road and wave it down.	
(CLEAR 3 TO STUDY SET)	(BARRY GRABS JANE BY THE SHOULDER)	
Q LIGHTING FX. HEADLIGHTS PASSING. STAND BY TK 29	*Jane:* Not likely. I'd rather walk than be picked up. (PAUSE)	
		CAR PASSES
RUN TK 29 Q WALK	*Barry:* Well, that's torn it. We'll just have to walk. Come on—that's if you want to come with me. / As far as I am concerned, you can stop here all night. (BARRY WALKS OUT OF SHOT. JANE PAUSES, THEN FOLLOWS HIM) /	
TK 29 On TK for 31″. S.O.F. (3 next)		S.O.F.

Key:

CU	Close Up.
MCU	Medium Close Up.
2-S	A shot just wide enough to contain two performers.
FX	Effects.
S.O.F.	Sound on Film, i.e. sound effects and speech entirely from telecine.
Q and Cue	A signal from Director via floor manager to artists.

Fig. 1: What a typical final TV camera script looks like.

considerably, as modern equipment can simulate a cut before it is actually recorded. Electronic editing however requires two machines and thus more expense to affect the budget.

Having assembled the programme the production team forward details of exact duration, the wording of each title and other relevant details to assist the presentation staff. All that is left is to sort out the finances of the programme, both internal and external—payments to artists, reproduction fees on records used, and many of the extremely costly extras that go into every television programme. And finally to get ready for the next play. Since it is rarely less than three months between starting on this sort of programme to its final completion the following weekly programme would be in the final stages of preparation for the studio, though naturally with a different production team.

TO BE CONTINUED

INSTALLING and SERVICING COLOUR RECEIVERS

PART 8

P. G. ALFRED

LAST month we discussed the general case where both luminance and colour-difference signals are present at the c.r.t. but have been distorted somewhere in the signal processing or amplification circuits. This causes hue distortions on the colour picture of a type which can immediately be diagnosed and ascribed to errors of adjustment or faults in the auxiliary circuits of the decoder to do with PAL switching. Next we have to consider the case where a luminance or colour-difference signal component is actually missing or one gun of the c.r.t. is cut off. These will cause errors of omission on the picture as distinct from simple hue distortions.

Faulty Y Signal

A faulty Y signal can be dealt with fairly quickly because it was checked implicitly during our routine assessment of the monochrome picture. The luminance Y signal should provide a completely normal monochrome picture, and any spurious colour (other than impurity or convergence errors) is usually caused by maladjustment of the grey-scale tracking controls. Occasionally gross errors occur, and these immediately lead us to suspect that one or more guns of the c.r.t. is cut off. Check the d.c. potentials on the electrodes. If no fault is found turn your attention to the cathode feeds from the anode circuit of the luminance output stage.

Faulty Colour-difference Drives

We have already dealt in some detail with the need for careful adjustment of the colour-difference drive ratios. This usually becomes necessary not because of a specific fault but because of a previous maladjustment or component ageing and drift. What we are discussing now is total failure of one or more colour-difference drives, or at least a severe loss of gain in one channel. This leads to the same kind of errors, but in much greater degree. The resulting colour distortions are listed in Table 6 (for the usual BBC colour bars).

Table 6: Colour errors produced by absence of colour-difference drive signal.

Bar	*No R-Y*	*No G-Y*	*No B-Y*
White	White	White	White
Yellow	Yellow	Yellow	Pinky white
Cyan	Pale mauve	Mid blue	Green
Green	Dark lime green	Deep green	Green
Magenta	Blue	Pale magenta	B/Red
Red	Dark	Slight orange red	B/Red
Blue	Blue	Blue	Dark
Black	Black	Black	Black

Certain imported colour bar generators have 75% saturated bars. The hue distortions listed above will still apply, however, but at reduced saturation.

On the face of it this leads to a nice clear-cut diagnosis. If there is a general absence of red, for example, and the monochrome picture is correct, then the R-Y drive is missing or seriously deficient. Unfortunately this does not narrow down the field as much as one would like because the fault can lie anywhere between the output of the delay line/matrix into the R-Y signal channel and the red grid of the c.r.t. There is plenty in between, as shown in Fig. 25.

It would not take long to connect an oscilloscope to each stage in turn to find out at what point the R-Y signal reappears. But why not use a more elegant approach? Connect the scope first to the red grid to confirm that the R-Y signal is indeed missing, and then to the input of the G-Y preamplifier. With a colour-bar signal it will be obvious immediately whether the G-Y signal is correct or not from the shape of the waveform. On a moving picture it will not be so clear and if in doubt put an a.c. short-circuit on the input to the B-Y preamplifier. If there is still a useful G-Y output present then the R-Y circuits are in order up to this point and the fault must lie in the R-Y colour-difference output or clamp stages. If on the other hand no output is seen then the fault must lie *before* this stage, i.e. in the R-Y demodulator or the signal or reference carrier feeds to it.

A very experienced engineer would not need to make this check at all. He would know from the appearance of the picture whether the G-Y signal was correct or not and whether to look downstream or upstream from the G-Y matrix take-off. The snag is that the picture hue differences on colour bars are rather subtle.

Faulty R, G or B Drive Signals at the c.r.t.

To be strictly logical we should point out that any R, G, or B drive fault will have been discovered and diagnosed during the initial check of the monochrome and colour pictures. However, just to emphasise the dual nature of the drives to a colour c.r.t. it is worthwhile discussing matters a little further. R, G and B drives are obtained by adding Y+(R-Y)=R and similarly for G and B. This adding can be carried out either between the

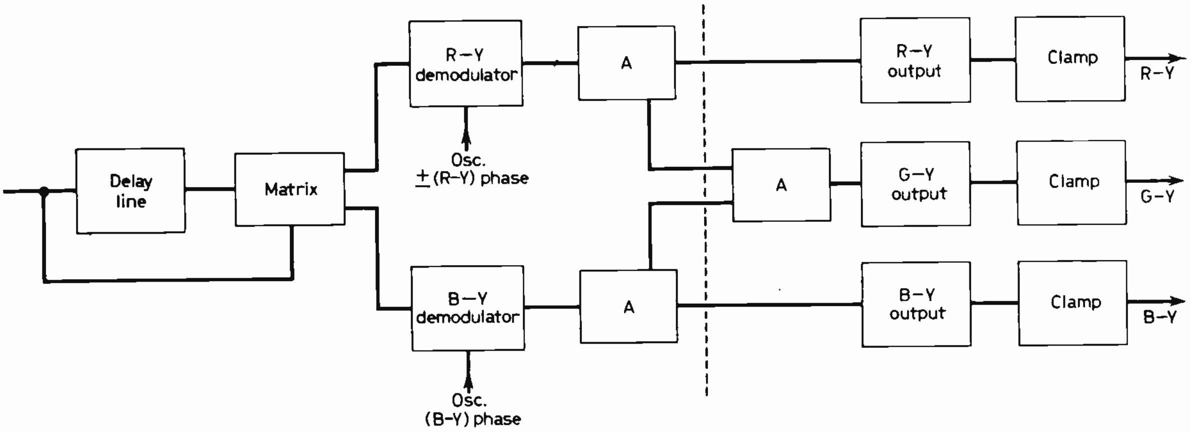


Fig. 25: If a colour-difference output is faulty check the input to the G-Y preamplifier on a colour-bar test pattern. If the G-Y input is correct the fault must lie to the right of the broken line above. If the input is not correct the fault must lie to the left of this line. This is a simple example of how a systematic approach can save time in fault-finding.

cathodes and grids of the c.r.t. itself or in circuits before the c.r.t. in which case R, G and B signals are fed to the three cathodes. This leads us to some basic diagnostic tests and deductions which are worth memorising:

(1) If the monochrome picture is all right then the luminance Y signal is correct;

(2) If the monochrome picture is all right but the colour picture is faulty there is an error in the colour-difference drives;

(3) If both monochrome and colour pictures are faulty then the cause lies in the c.r.t. itself or in the adding network if this is before the c.r.t. (as in BRC receivers and the latest RBM models).

Items (1) and (2) have been covered in previous sections so let us consider item (3). What we are looking for here is a more or less complete absence of red, green or blue in the picture.

In the case of external Y+(R−Y) etc. matrixing as shown in Fig. 21(b) all we have to do is to take an oscilloscope and find out why the signals are not being added together or, if they are, why they are not reaching the cathodes of the c.r.t. It is possible, of course, that the c.r.t. or its electrode potentials are faulty instead. In the more common case of colour-difference drive working shown in Fig. 21(a) the fault can only lie in the immediate environment of the c.r.t. if the luminance and colour-difference drives are correct.

If one gun of the c.r.t. is cut off it must be caused by an incorrect potential on the cathode, grid, or first anode, or a faulty heater. The d.c. error must be large enough for the a.c. drive to be unable to overcome it and this kind of discrepancy is easily tracked down using a multirange meter to compare the d.c. voltages on good and bad guns. In colour-difference drive circuits the drives on the grids are usually clamped to a reference d.c. potential. This potential is generally applied to the cathodes of three triode clamps and is easy to overlook. The clamps are switched or "keyed" on during the blanking period by a line pulse applied to their grids and this too must be checked. The anode circuits commonly have loads of 5-10MΩ, returned to h.t., and meter readings at this point can be inaccurate.

Probably the most common cause of a gun being cut off is a low potential on the first anode electrode caused by a fault in the d.c. feed via the grey-scale tracking potentiometers from the boosted h.t. line.

Tackling the Symptom of No Colour

How many engineers when faced with "no colour" have momentarily experienced that sinking feeling, gazing blankly at the decoder jungle and asking themselves "where do I go from here?" In the opinion of the author however, the task of colour fault-finding is easier and more interesting than, for example, tracing a dud ceramic capacitor hidden away in a coil can in an i.f. strip. Simple logic and a basic understanding of colour is unusually rewarding when faced with decoder problems. Let us try and spread this good news amongst the readers of PRACTICAL TELEVISION!

First of all, *know your receiver.* It is not much use trying to adopt a systematic approach if you do not know the system. So make sure that you have a clear idea of the block diagram of the decoder you are about to tackle. Most designers of the first generation of commercial colour receivers adopted the same basic approach and the block diagram of Fig. 26 is fairly representative of current practice. In order to keep it uncluttered a number of details have been left out such as the odd filter circuit, emitter-followers, the saturation control, etc. The output channels after the two colour-difference demodulators have also been omitted because these were shown in Fig. 25.

Under the heading "no colour" we include the following three basic conditions: (1) No colour—the whole chrominance system (decoder plus output stages) is cut off; (2) Colour is present but completely incoherent—i.e. unsynchronised; (3) No colour but coloured noise is present on the picture.

In all colour fault-finding under the categories we have just listed the one item which has to be checked before all else is the presence or absence of *burst* and the signals and bias voltages derived from it. It is thus the key to several processes of deduction.

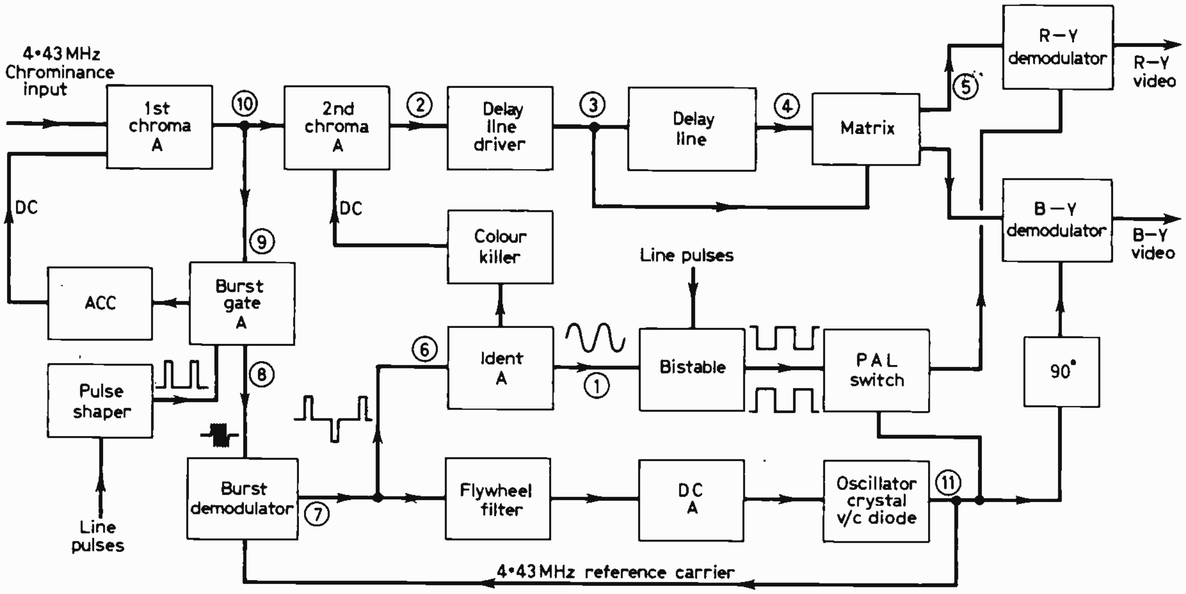


Fig. 26: Simplified block diagram of a typical PAL-D decoder. The numbers refer to the checking points indicated in Table 7. The following stages are as shown in Fig. 25.

The Importance of the Burst Signal

Any PAL decoder can be split up into two groups of circuits—signal carrying and auxiliary. The signal circuits consist of a straight run by the twin R-Y and B-Y signals through the chrominance amplifiers, delay line, matrix, and the two colour-difference signal demodulators. All the other circuits are auxiliary and process, or are controlled by, the burst signal. As can be seen from Fig. 26 the burst signal is used to control the following: (1) the reference oscillator frequency; (2) the phasing of the PAL switch; (3) the colour killer; (4) the a.c.c. circuit—if fitted. These four elements of the burst network should be continually born in mind, and it is important to understand clearly how they are related.

The Burst Gate Amplifier: This circuit amplifies the burst signal but completely suppresses the rest of the chrominance signal. Its output should therefore be pure burst. If the stage is faulty, all four burst-controlled circuits will be put out of action.

The Burst Demodulator: The burst train is converted from ten cycles of sinewave at the subcarrier frequency into a rectangular pulse train whose polarity is inverted from line to line. If this pulse train stops the a.p.c. loop and ident input to the PAL switch will be put out of action and the colour-killer circuit will cut off the signal channel.

The A.P.C. Loop: If the a.p.c. loop has a local fault the burst demodulator gets no coherent reference carrier signal and all burst circuits are affected, together with the R-Y and B-Y demodulators.

The Ident Amplifier: A fault here will cause the polarity of the PAL switch to be uncontrolled (no 7.8kHz ident) and the colour killer will cut off the signal channel. The other burst circuits will be unaffected unless the ident fault puts a load on the a.p.c. loop and makes its pull-in range too small to be effective.

The Colour Killer: This circuit should turn on the chrominance signal channel whenever burst is present, and turn it off when burst is absent. A fault in the colour killer will either leave the chrominance circuits permanently off or permanently on. In the latter case coloured noise and cross-colour (spurious colour components from the luminance signal) will be seen on a monochrome picture.

The A.C.C. Circuit: This controls the gain of the chrominance signal circuits and maintains a constant burst output. It therefore also keeps the saturation of the picture constant provided the signal is correctly balanced at the transmitter and is not distorted during propagation. A fault will alter the saturation of the picture but will not affect other burst circuits unless the change in chroma gain is sufficiently great to overload them or to cause the burst to be too small to be effective.

Having sorted out some of the more important interactions between individual circuit functions, we are now armed with sufficient aids to diagnosis to make fault-finding relatively easy. Easy in principle, that is to say. The real difficulty lies in finding one's way amongst the components on a typical printed decoder board in order to locate a particular point for testing. A combination of experience, setmaker's service data and hard work is the only answer to this one.

Now let us try and establish a systematic fault-finding procedure.

Complete Absence of Colour

When thinking about the reasons for a complete absence of colour from a decoder it is logical to divide the circuits into three broad categories because this helps to make the problem rather more clear. These are: (1) The signal circuits which carry the chrominance signals; (2) The burst circuits which process the burst signal; and (3) The oscillator circuits, including all circuits and feeds generating or carrying the reference subcarrier signal.

A failure in any of these groups of circuits will prevent the chrominance (colour) information being decoded so that no colour picture will be obtained. A single fault in any of the circuits in the right-hand half of the block diagram Fig. 25 will produce all kinds of colour distortions but will *not* by itself produce a complete absence of colour. This point is worth noting because it excludes a large area of the decoder and its output stages on which an inexperienced operator could waste a great deal of time. We have already discussed these circuits in some detail so we must now consider the problems of signal, burst and oscillator faults.

In order to narrow down the field it is convenient to have three master testpoints (which need to be considered in combination) so that we can quickly isolate the group of circuits that is the basic cause of any case of no colour. Consider these:

(1) **Signal:** R-Y and/or B-Y chroma outputs from the delay line/matrix network (point 5 in Fig. 26). These feed the two colour-difference demodulators. Note that the absence of a signal is usually caused by the colour killer which should be biased *on* from an external source.

(2) **Burst:** The output of the gated burst amplifier (point 8) feeding the burst demodulator.

(3) **Oscillator:** The common output (point 11) feeding the burst demodulator, the PAL switch and the 90° phase shift network to the B-Y demodulator.

These three testpoints are largely independent of other groups of circuits except in the unlikely event of some peculiar short-circuit loading the channel being investigated.

Any engineer who prefers to devise his own detailed system of working may find it useful to check these three points first and then to organise a plan of campaign based on the following reasoning.

No Signal: Faulty signal channel, then colour killer may be on or off. No signal or burst, then colour killer off. Reference carrier out of lock, then no demodulated burst and colour killer off.

No Burst: No signal in first chroma amplifier and colour killer off. Faulty burst channel and colour killer off.

No Oscillator Output: No demodulated burst and colour killer off.

These three tests enable you to deduce whether the fault lies in the signal, burst, a.p.c. loop or ident/colour-killer groups of circuits. Although this is useful information, it is clear that there is still quite a long way to go before a logical deduction can be made and in most cases it will be necessary to work backwards from the testpoints down each channel in turn.

Table 7: Flow sequence checking procedure to isolate a faulty stage in a decoder for no colour condition.
(Testpoints are indicated in Fig. 26)

(1) Using an oscilloscope check the output of the ident amplifier

(a) IDENT OK

Check shows OK, deduce	*Check shows fault, action*
(2) Check 2nd chroma amplifier output	
Colour killer OK Query driver stage	Check colour-killer bias *OK* Check 2nd chroma amp. *Faulty* Check colour killer
(3) Check driver stage output	
Direct path OK Query delay line and matrix	Check driver stage
(4) Check delay line output	
Delay line OK Query matrix	Replace line
(5) Check matrix outputs	
It follows from items 1-3 that both outputs must be missing	Check matrix

(b) IDENT FAULTY

Check shows OK, deduce	*Check shows fault, deduce possible causes*
(6) Check at base of ident amplifier	
Ident amplifier faulty Other circuits OK	(1) Base-emitter s/c (2) Ident not reaching base
(7) Check burst demodulator output	
Coupling to ident amplifier faulty	(1) Burst channel (2) Burst demodulator (3) Reference carrier feed to burst demodulator missing or out of sync
(8) Check burst gated amplifier output	
(1) Burst demodulator faulty (2) Reference carrier feed missing or out of sync (see 11 below)	(1) Burst gate amplifier (2) 1st chroma amplifier (3) Burst gating pulse (4) A.C.C. bias
(9) Check burst gated amplifier input	
(1) Burst gated amplifier faulty (2) Burst gating pulse faulty	(1) 1st chroma amplifier (2) A.C.C. bias
(10) Check 1st chroma amplifier output	
Coupling to burst gated amplifier faulty	(1) Amplifier stage (2) A.C.C. bias
(11) Check reference oscillator output	
Carrier present but out of sync, check: (1) D.C. amplifier (2) Varicap diode (3) Burst demodulator	*No reference carrier output, check:* (1) Oscillator stage (2) Crystal

(12) Realign A.P.C. loop

Clues from the Ident Signal

Let us try a different and more systematic approach which may help us to cut a few corners. What we need is a single key point in a decoder which is common to all; easy to measure; easy to locate; which gives the maximum amount of information, and which provides the shortest paths to other key points. The answer is the collector of the ident amplifier. Why?

The ident output consists of a 7.8kHz sinewave of large peak-to-peak amplitude which is easily displayed on any oscilloscope. It tends to be a go/no-go device: i.e. it is either unmistakably present or else it is absent. Furthermore it very quickly tells us whether to investigate the signal channel or the auxiliary circuits. Let us see what we can deduce:

	Assume in order	*Investigate*
Ident Present	(1) 1st chroma amplifier (2) Burst channel (3) A.C.C. loop (4) A.P.C. loop and oscillator	(1) 2nd chroma amplifier and subsequent signal stages (2) Colour killer
Ident Absent (or very small)	(1) 2nd chroma amplifier and subsequent signal stages (2) Colour killer (biased off)	(1) 1st chroma amplifier (2) Burst channel (3) A.P.C. loop and oscillator (4) A.C.C. loop

In either case fault-finding becomes comparatively simple and to the point. Consider the problem where the ident output is normal. All we need to do is to take a fairly sensitive oscilloscope with not more than 10 times attenuation in the probe and start at the output of the first chroma amplifier. We then work steadily along towards the output of the delay line and matrix network until we find the point where the signal disappears. It may be the second chroma amplifier stage due to a faulty colour killer bias but there are several other possibilities.

If however the ident output is absent we have to turn in the other direction. Again using the oscilloscope, work back towards the burst demodulator and, if no fault is found in between, check the input and output. Input present but no output means a fault in the demodulator or no reference carrier feed to it: i.e. an a.p.c. loop fault. No input means that the a.p.c. loop is probably in order but there is a fault in the undemodulated burst channel or in the first chroma amplifier.

By using an oscilloscope and taking the precaution of having the circuit and component layout diagrams on the bench beside you, this sort of investigation becomes a matter of routine and quickly isolates the faulty stage. If your circuit diagram has normal operating voltages and waveforms marked on it there should be no undue difficulty in finding the faulty component as well.

Checking Procedure

In order to keep the general plan of attack as clear as possible we have passed a bit hurriedly over the details and perhaps made things seem rather more easy than they generally turn out to be in practice. The point to be made here is that this kind of approach enables you to know what you ought to be doing at each stage of the fault-finding process and leaves you free to concentrate on the mechanical problem of tracing through the actual circuit. It also tends to remove that slightly helpless feeling that sweeps over even the best of us from time to time when we feel a bit bewildered at the sight of an unfamiliar piece of equipment.

Table 7 shows in diagrammatic form the flow-sequence checking procedure that we have discussed in outline. It can easily be modified in a variety of ways to suit different mental approaches and different measuring techniques. The basic considerations are to avoid missing any vital information or carrying out unnecessary checks which divert your attention and fog the issue.

The procedure shown in Table 7 is based on the block diagram in Fig. 26 and to keep it simple all minor circuits such as coupling networks and the odd d.c. amplifier or emitter-follower have been omitted. When tracing through a decoder it is usually best to ignore them and stick to the key input/output points where other basic networks become involved. Then when a point is found where the signal reappears or disappears, as the case may be, it is time to slow down and check the small stuff. This not only saves time but helps to keep your eye on the ball.

Single Stage Checks

If a signal is not present on the base of a transistor always bear in mind that base-emitter short-circuits are not uncommon and that they will remove a signal just as surely as a fault in an earlier stage.

The purpose of this checking technique is to isolate the fault to a particular circuit. Ordinary methods of fault-finding can then be used to find the dud component. For general tracing purposes you only need one piece of equipment—an oscilloscope. It will not only measure and display all the chroma signals, the burst carrier, burst pulses, reference subcarrier, ident, and gating pulses but will also measure the d.c. bias voltages *at the same time*. Cultivate the habit of always using your oscilloscope d.c. coupled and at least roughly calibrated. (An h.t. or l.t. line is useful for this.) Then when you look at the waveform at the collector of the ident amplifier, for example, and find no output you will see at the same time whether the collector voltage is normal, bottomed (base turned hard on) or up at l.t. (transistor non-conducting). This extra information puts you on the right track immediately. In any case why keep on handling scope probes and meter prods in turn instead of keeping the scope probe comfortably in your hand all the time whilst your mind is busy on the main issue?

All sorts of odd faults of course crop up from time to time which produce peculiar circuit interactions and appear to defy all man-made logic. The logic is merely incomplete, but it is not always easy to extend it to embrace all possible permutations and combinations of dry-joints, short-circuits, misconnected leads and so on. However even the most obstinate of faults will soon give in if the basic plan of attack is right.

The thing to avoid at all costs and in all circumstances is to go scratching around from one idea to another like a wet hen! Every check you carry out must be part of a plan and designed to yield some specific information. This should be collated with the information you already have so that you can come as quickly as possible to a well-founded deduction that you can then proceed to test by measuring a voltage, current, or a component. Cultivate the habit of jotting down the results of each check on a scrap of paper or a spare circuit diagram so that all the information is available at a glance and is also ready for future use on another job.

TO BE CONTINUED

PRACTICAL AERIAL DESIGN PART 3

A. J. WHITTAKER

THIS month we shall discuss television aerials for the reception of Bands IV and V, the u.h.f. channels. Aerials for u.h.f. television reception are further developments of the fundamental Yagi aerial. For instance the u.h.f. system may contain as many as 16 or more director elements in addition to the folded dipole and the reflectors which may be composed of two or more half-wave rods stacked one above the other and usually $\frac{1}{4}$ wave from the folded dipole. The spacing of these reflectors and directors to the main dipole is part of the design of a particular aerial system, the aims being good forward gain, acceptance angle, front-to-back ratio, etc.

The aerial system must have a bandwidth sufficient to cover any of the four channels allocated for each area. Each channel is 8MHz wide and the four channels will occupy a bandwidth of 88MHz. The agreed variation over the band is to be no greater than 3dB. There should be a front-to-back ratio of at least 16dB with minimum side-lobe pick-up. As there are only 44 channels available for national coverage on u.h.f. the directivity performance of the u.h.f. aerial system may prove to be the most important factor in order to maintain selectivity in view of the fact that the 44 channels will have to accommodate well over 1,000 stations. Each of these is to provide four programmes so that each channel will be used many times.

To reduce co-channel interference the transmitting stations are geographically spaced taking advantage of hilly or mountainous terrain to provide as much isolation as possible. The main burden of the selectivity problem falls heavily on the directivity of the aerial and its ability to receive signals from the desired direction and to exclude those arriving from all other directions that may be transmitting on the same channel frequency. Co-channel interference produces some spectacular displays on colour screens whereas on monochrome it only produces a patterning effect on the picture. The u.h.f. aerial must be able to cope with these exacting conditions and aerial manufacturers aim to get the optimum performance from aerials designed for any particular band.

The u.h.f. aerial must remain substantially resistive to the feeder over the channels it is designed to cover. In practice there may be a departure from this ideal state and at the ends of its bandwidth there may be a component of inductance or capacitance which will cause a partial mismatch and an increase in the v.s.w.r. (voltage standing wave ratio) which should not exceed a ratio of 2:1.

UHF YAGI ARRAY

An aerial suitable for use on the Band V channels 44 to 51 may have the dimensions worked out below. The various lengths of aerial rods are calculated from the formulae for a dipole $468/f=$ length in feet where f is in MHz. The aerial is cut for the mid-band frequency which is 686MHz. Thus the dipole length is $468/686=$approximately 0.68ft. or 8.2in. This is the folded length, the total length being 16.4in. end to end. The reflector elements will be of the same length, while the directors will have a length of 0.47λ. The full wavelength is 16.4in. therefore the directors will be $16.4\text{in.}\times 0.47=7.7\text{in.}$ Spacings of the directors will be 0.2λ which is $16.4\text{in.}\times 0.2=3.28\text{in.}$, while the reflector spacing will be 0.25λ and this is $16.4\text{in.}\times 0.25=4.1\text{in.}$ Figure 1 shows the aerial assembly.

The aerial has 11 director elements, a folded

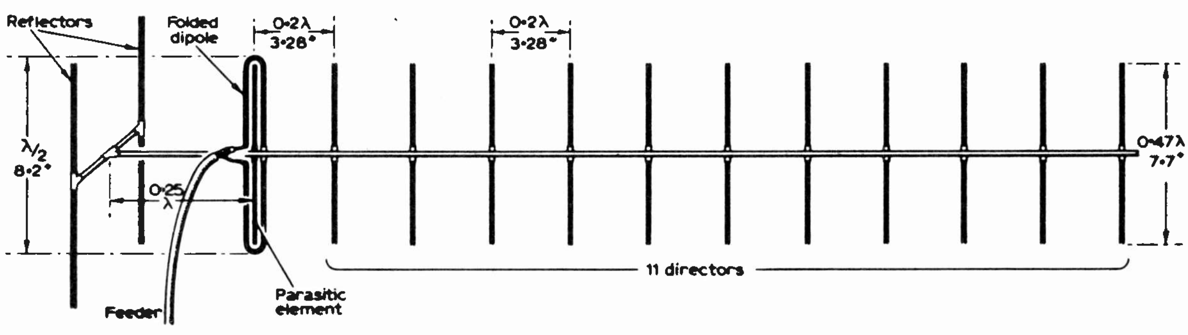


Fig. 1: Practical Band IV/V Yagi aerial array.

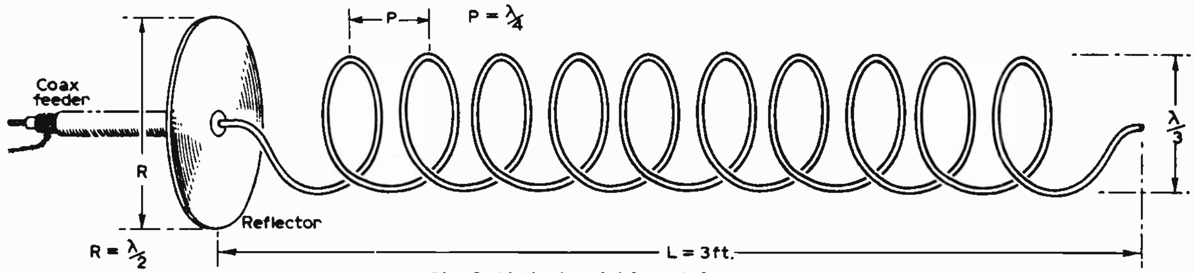


Fig. 2: Helical aerial for u.h.f. use.

dipole, and two reflectors stacked one above the other. The reflectors increase the forward gain by about 5dB. Adding the first director increases this by a further 3dB. The other 10 directors each contribute about 0.5dB making the total gain in the order of 13dB. To facilitate a good match to the feeder a parasitic element is fixed between the dipoles. The reaction of this together with that of the reflectors brings the impedance of the dipole down from about 300Ω to 75Ω. The stacked reflector elements serve to give a good front-to-back pick-up ratio.

HELICAL UHF AERIAL

An unusual form of aerial for u.h.f. reception is the helical aerial. This system accepts horizontally or vertically polarised signals equally well, the signal pick-up being fairly equal in either plane over its bandwidth. A typical helical aerial may have a 10-turn helix, a length of 3ft. and gain of 16dB.

Its principle of operation is based on the fact that a wire in the form of a helix with a circumference =λ (wavelength) will radiate as a beam aerial. The radiation pattern is approximately circular. The helix dimensions are not critical and the gain of the aerial is dependent upon the number of turns in the helix. The diameter of the reflector or ground plane should be λ/2, the diameter of the helix λ/3 and the pitch P about λ/4 (see Fig. 2).

A helical aerial of this type will have a feed impedance between 100 and 150Ω. This may be matched to a 75Ω feeder by means of a quarter-wave transformer.

Table 1: Television channels and frequencies

Channel	Sound (MHz)	Vision (MHz)	Channel	(MHz)
1	41.50	45.00	40	622—630
2	48.25	51.75	41	630—638
3	53.25	56.75	42	638—646
4	58.25	61.75	43	646—654
5	63.25	66.75	44	654—662
6	176.25	179.75	45	662—670
7	181.25	184.75	46	670—678
8	186.25	189.75	47	678—686
9	191.25	194.75	48	686—694
10	196.25	199.75	49	694—702
11	201.25	204.75	50	702—710
12	206.25	209.75	51	710—718
13	211.25	214.75	52	718—726
Channel	**(MHz)**		53	726—734
21	470—478		54	734—742
22	478—486		55	742—750
23	486—494		56	750—758
24	494—502		57	758—766
25	502—510		58	766—774
26	510—518		59	774—782
27	518—526		60	782—790
28	526—534		61	790—798
29	534—542		62	798—806
30	542—550		63	806—814
31	550—558		64	814—822
32	558—566		65	822—830
33	566—574		66	830—838
34	574—582		67	838—846
39	614—622		68	846—854

Band I, channels 1-5; Band III, channels 6-13; Band IV, channels 21-34; Band V, channels 39-68

UHF SET-TOP AERIALS

A portable type of aerial suitable for u.h.f. reception is a development of the bi-square aerial (G2PU S. Kharbanda). This is related to the stacked Yagi and skeleton-slot aerials. As shown in Fig. 3 the active element consists of two stacked dipoles whose ends have been bent round to form a square. The reflector element is formed in the same manner and the spacing between the two squares should be λ/8 to λ/4. The stubs in the reflector element allow the sides of the reflector and dipole arrangements to be made equal in length.

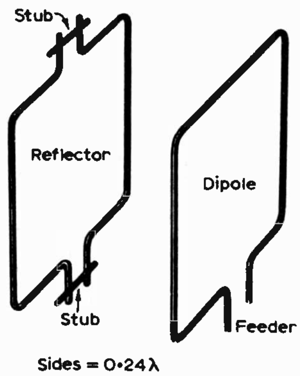


Fig. 3: Basic bi-square u.h.f. aerial.

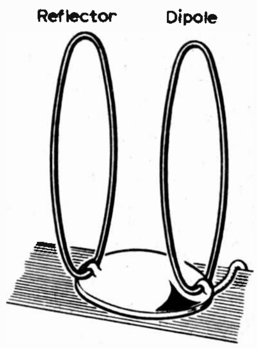


Fig. 4: Labgear set-top bi-square aerial.

A development by Labgear of the bi-square aerial for u.h.f. reception is shown in Fig. 4. In this design the active (dipole) and reflector elements are circular instead of square. The gain is 6.5dB.

For the reception of colour television signals the signal-to-noise ratio should be as high as possible. Interference pick-up by the aerial cannot be entirely eradicated but interference pick-up on the feeder may be minimised by the use of a balun which electrically balances a single screened coaxial feeder to the aerial. An elementary form of balun was described in Part 2.

TO BE CONTINUED

TELEVISION RECEIVER TESTING

Part 11 by Gordon J. King

SOUND CIRCUIT TESTS

ALTHOUGH less complicated than the vision stages the sound stages of a TV set can nevertheless give rise to annoying fault conditions and symptoms which might or might not affect the vision. In this article we shall examine these and suggest the best ways of testing in and around the sound i.f., detector and audio sections.

The sound channel of any TV set has basically the same sort of stages as an ordinary radio set, but some of these are common to both the vision and sound signals. The front-end tuner, for example, handles both signals as does the aerial and generally the first i.f. stage. The transmitter radiates simultaneously the sound and vision signals and these are separated in frequency depending on which transmission standard is being used: on the 405-line standard the separation is 3.5MHz while on 625 lines it is 6MHz, the sound of the former standard being amplitude-modulated and the latter frequency-modulated. On both standards the vision is amplitude-modulated.

The 405-line single-standard set was generally

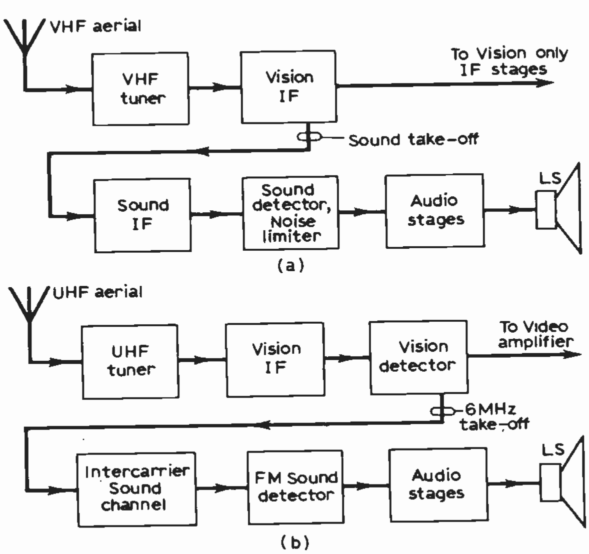


Fig. 1: Sound section block diagrams: (a) 405-line only and (b) 625-line only using intercarrier sound.

designed with a sound channel as depicted in the block diagram of Fig. 1(a)—the alternative being separation of the sound and vision signals at the output of the v.h.f. tuner—while (b) shows a block diagram of the type of single-standard set that is currently on the design engineer's drawing board for 625-line operation only, for before very long all our TV programmes will be accommodated in the u.h.f. channel groups.

In the meantime the dual-standard set will continue to cater for all the programmes, BBC-2 on 625 lines and BBC-1 and ITV-1 on 405 lines. Thus the current dual-standard set has a sound channel which is easily switchable between (a) and (b) in Fig. 1. This is shown in Fig. 2.

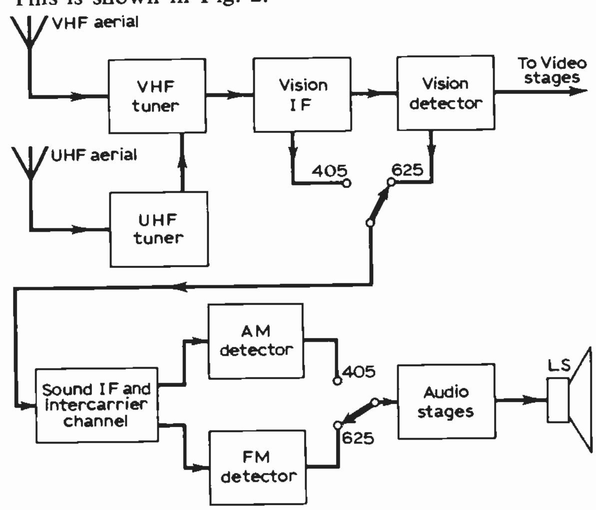


Fig. 2: Block diagram of the sound sections of a dual-standard receiver.

The simplest way of understanding the two sound systems is by considering Fig. 1. At (a) the v.h.f. tuner produces the sound and vision i.f.s with 3.5MHz between them. On most models the sound i.f. is at 38.15MHz so that the vision i.f. (carrier) appears at 34.65MHz. The sound i.f. is taped off in the first vision i.f. stage, a subsequent trap circuit—frequently a bridged-T filter—removing the sound signal from the vision channel. The signal is applied to a sound-only i.f. amplifier stage, the output of this stage feeding the ordinary a.m. sound detector which is generally coupled with an interference limiter. The demodulated signal, now at audio, is coupled to the audio stages proper and thence to the loudspeaker.

At (b) the arrangement is somewhat different. Here the sound and vision i.f.s from the u.h.f. tuner, generally at 33.5MHz sound and 39.5MHz vision, are amplified together in the common vision i.f. channel, the v.h.f. mixer stage generally acting as an additional i.f. stage on this system. They thus appear together at the vision detector and since all detectors are non-linear devices one carrier is modulated upon the other giving a difference-frequency output at 6MHz. This is called the *intercarrier frequency* since it represents the frequency difference between the two i.f. carriers, and upon this signal is carried the sound information—f.m. remember. The intercarrier signal is further amplified at 6MHz and then passed to an f.m. detector the audio output from which is applied to the audio stages.

It is sometimes wondered why the intercarrier technique is used on the 625-line standard when on the face of it the basic sound i.f. scheme as at (a) could just as easily be adopted. It is true that method (a) could be used but method (b) is far better because the effect of frequency drift in the local oscillator of the u.h.f. tuner is avoided. Although u.h.f. tuners are designed to have minimal frequency drift there must be some drift and at 700MHz or so it is bound to be greater than at say 50MHz (Band I) or 200MHz (Band III). Such drift shifts the carrier in the sound i.f. passband and the drift possible at u.h.f. could quickly result in the carrier falling outside the passband or at least well down on the leading or trailing side of the response necessitating frequent readjustment of the u.h.f. tuning to keep the sound channel properly in tune. This is not so important in the vision channel owing to the much wider passband (though with colour it is virtually as important to keep the colour subcarrier at its proper position on the vision response curve. For this reason colour sets sometimes incorporate a circuit providing automatic frequency correction).

Clearly since the spacing between the sound and vision carriers remains constant at 6MHz on the 625-line standard, slight drift in the tuner oscillator will neither alter the frequency—this cannot alter under any conditions, of course—nor affect the amplitude of the intercarrier sound signal drastically. It would not be possible to employ a like technique on the 405-line standard because here the sound is amplitude-modulated. So much then for basic principles; now let us get down to testing procedures.

Since there are still many millions of 405-line-only sets in service testing in this type of set will be considered first; then we can get on to dual-standard sets. There is not much point in dealing specifically with testing in 625-line-only models since not only are such sets not currently available but the tests detailed for the 625-line sound section of dual-standard models are appropriate for 625-line-only sound channels.

Checking Audio Circuits

Let us start with the audio stages themselves. The speediest test for the audio section as a whole, taking in the loudspeaker, consists of nothing more complicated than holding the blade of a screwdriver—with a finger resting on the blade—on the live (to signal) tag of the volume control. This injects a 50Hz mains signal—picked up by the human frame—into the very sensitive audio amplifier control grid input, causing a fairly loud hum from the loudspeaker when the section is working correctly.

Figure 3 shows a typical audio-section circuit. The vast majority of sets employ here a triode-pentode valve, the triode acting as the signal amplifier and the pentode as the output stage. The triode is usually a high-mu type (mu equals about 70) and grid bias is often obtained from the very small flow of grid current in a high-value grid-leak resistor. This is why there is frequently no cathode resistor associated with the triode section. Where a high-value (e.g. 10MΩ) grid-leak resistor is used to obtain so-called grid current bias the resistive element of the volume control cannot be used as the grid resistor, as in some other circuits. Thus the volume control in this arrangement has to be coupled to the grid circuit via a capacitor, which is a point worth bearing in mind.

A PCL82 or PCL86 is commonly adopted, the pentode section of which can yield a little over 3 watts of audio power (but with a rather high level of distortion!). Such power is needed when the loudspeaker is on the small side and not particularly efficient.

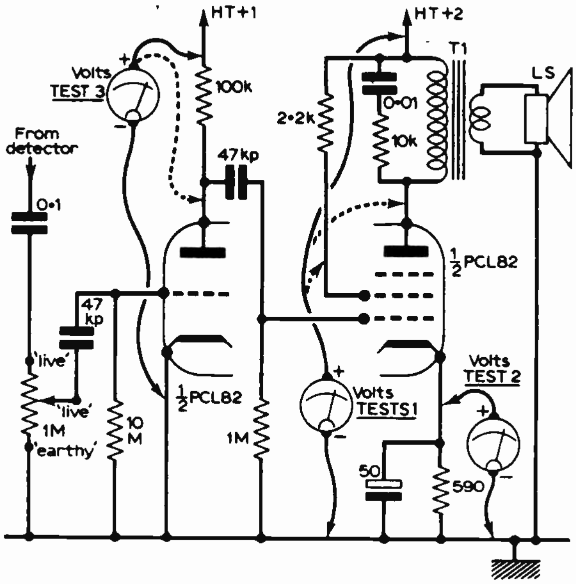


Fig. 3: Audio stages of a typical set of recent design.

The grid hum test just mentioned would be performed initially on a set all right on vision but dead on sound. If a fairly loud hum occurs on touching the live tag (this can be the top or middle one with the volume control turned well up—see Fig. 3), then one can be certain that the trouble lies somewhere before the volume control—in the sound i.f. channel or detector area.

Lack of grid hum would thus indicate conclusively a fault somewhere in the audio section of Fig. 3. The first tests should be those of voltage to the pentode section, first to the h.t. feed at the top of the speaker transformer T1, then to the anode of the valve and finally to the screen grid of the pentode, all shown by Tests 1 in Fig. 3. The voltmeter should be set to a full-scale range of about 250V and the voltage at the valve anode should not be very much less than that at the top of the primary winding of T1. The screen grid voltage will be about the same, or possibly a little lower or higher depending on the particular circuit. In Fig. 3 the anode runs at 220V and the screen grid at 225V, measured on an Avo Model 8 (20,000Ω/volt).

If these voltages are correct then the conductivity of the pentode section can be easily checked by measuring the voltage across the cathode resistor as shown by Test 2. This is normally in the region 5-15V. If all these tests prove positive, then the triode section and the coupling to the pentode should come under scrutiny. Test 3 is the most important to start with, but a meter of at least 20,000Ω/volt is best used for the anode voltage test proper. On such a meter the reading is typically 90V with about 200V or so at the h.t.1 feed, the difference being dropped across the anode load resistor, thereby indicating that the triode is passing anode current. The action of the triode biasing in the type of circuit shown can be tested by measuring the anode voltage as at Test 3 and then shorting the 10MΩ grid-leak resistor.

The anode voltage should normally drop showing that the anode current has risen due to shorting-out the grid bias. If the electrode voltages read fairly normally then the loudspeaker and its coupling to the transformer T1 should be examined. Higher-than-normal electrode voltages could mean that the valve is low emission or defunct, and at that stage it should be checked by substitution.

The insulation resistance of the 0.047μF coupling capacitor between the anode of the triode and the control grid of the pentode can be tested by setting-up as for Test 2, noting the voltage reading and then disconnecting the capacitor either from the triode anode or pentode grid. If the insulation is poor the voltage reading will fall when the capacitor is disconnected. A good replacement should then be fitted.

A leaky coupler would almost certainly result in heavier-than-normal distortion and possibly reduced volume owing to the control grid of the pentode receiving a positive potential from the triode anode. Distortion can also be caused by a faulty valve or a bad electrical (d.c.) leak in the electrolytic capacitor on the pentode cathode. This would show up though on Test 2, the voltage being very low or non-existant; but remember the same conditions would result from an open-circuit or low emission pentode section.

Low sensitivity of the audio section—giving low volume, low hum on the grid hum test and the need for the volume control to be well advanced—can be caused by a low-emission valve, open-circuit of the pentode cathode electrolytic being another cause. Sensitivity testing requires an audio generator delivering a signal at high impedance to the input (at 1kHz), the secondary of T1 loaded with a 3Ω resistor (speaker disconnected) and an audio millivoltmeter connected across this load. The power output in watts (based on r.m.s. voltage) is given by squaring the 1kHz voltage measured across the load and then dividing it by the value of the load in ohms (i.e. by 3). For example if 3V r.m.s. is measured, squaring makes 9 and dividing by 3 makes 3—that is 3 watts. The real input voltage should be around the 300mV mark for this power output. If full power cannot be obtained even with a high input voltage then the speaker transformer would probably have shorting turns, assuming that the valve and associated components are in order. However a check should at this time be made of the R and C across the primary of T1 since a short in C could upset the power yield. These components provide a treble roll-off, reducing the effect of higher-order harmonics.

Basic IF Tests

If the basic grid hum test shows the audio section to be fully active yet sound is still missing tests should be made in the sound i.f. channel and detector. Again there is a very basic test that can be tried. This simply consists of injecting signals from the inner or outer conductor of the TV aerial's coax to the input of the sound i.f. channel (at the control grid via an 0.001μF capacitor). With the volume control turned fully up random signals within the sound i.f. range are normally heard. There is often a powerful French or German station and morse signals! This sort of result proves conclusively that the sound i.f. channel, sound detector and audio stages are all fully active thereby pointing to trouble in the sound take-off from the vision i.f. channel or tuner.

If the set features two sound i.f. stages (most sets have only one stage) the coax can be coupled to the control grid of the second stage. If there is reaction with the input here but not with the input applied to the first stage then the first stage is defunct and normal testing in and around the stage should soon reveal the faulty parts. It is not proposed in this article to detail tests of the i.f. stages; these were considered in various aspects in Parts 3 and 4 of the series, while a.g.c. systems were looked at in Part 2.

So far the points made regarding the sound i.f. stages apply in general to 405-line-only sets but the audio tests apply equally to 405-line-only and dual-standard models. Normally it is not possible to test as just described by connecting the coax to the intercarrier sound channel since the detector at the end of this is f.m. and any 6MHz signals that might be picked up would be amplitude-modulated!

Dual-standard Circuits

We shall now direct our attention more towards dual-standard models. The i.f. stage that responds to the ordinary sound i.f. on the 405 standard is tuned also to respond to the 6MHz intercarrier sound signal on the 625 standard. In other words the one stage (or section when more than one valve is used) serves both signals.

Figure 4 shows the complete circuit of a sound i.f. intercarrier channel with f.m. and a.m. detectors and a.m. noise limiter. This is really less complicated than it seems for only one detector system is working at any one time. The input transformer T1 tunes in the 405 sound i.f. picked up from the common i.f. stage in the vision channel while L1 and associated capacitors tune in the 6MHz intercarrier signal picked up from the vision detector or video amplifier (see Fig. 5, for example). On the 625 standard S1 shorts out T1 leaving only L1 etc. while on the 405 standard the 33pF capacitor completes the earthy signal circuit of T1 primary.

T2 is the f.m. ratio detector transformer fed from the anode of V1 and T3 the a.m. detector transformer. The transformer in circuit which does not correspond to the frequency of the sound signal present effectively acts as a short-circuit thereby rendering switching in this part of the circuit unnecessary. It is necessary to select the audio output though and this is accomplished by S2 which feeds the signal to the audio stages.

Diodes D1 and D2 are part of the f.m. ratio detector; D3 is the a.m. detector and D4 the a.m. sound limiter. The a.g.c. potential picked up from across the a.m. detector load resistor is applied to the control grid of V1 via T1 secondary and the grid resistors and is of course effective on 405 only. Whilst most sets use the ratio detector for 625-line sound detection a few use an EH90 quadrature detector on this system. On 405 lines this acts as an a.f. voltage amplifier.

If sound on one standard is normal but missing or abnormal on the other standard we can be sure that (1) the audio section is active, (2) the i.f. intercarrier valve V1 and basic circuit are correct and (3) the detector system of the correctly working standard is in order. This leaves as the main suspects the detector and the tuned circuits (alignment of coils and transformers) associated with the offending standard. If the alignment has been tampered with the best plan is to acquire a service chart or manual for the set and run through the entire exercise of

LAWSON BRAND NEW TELEVISION TUBES

SPECIFICATION: *The Lawson range of new television tubes are designed to give superb performance, coupled with maximum reliability and very long life. All tubes are the products of Britain's major C.R.T. manufacturers, and each tube is an exact replacement. Tubes are produced to the original specifications but incorporate the very latest design improvements such as: High Brightness Maximum Contrast Silver Activated Screens, Micro-Fine Aluminising, Precision Aligned Gun Jigging, together with Ultra Hard R.F. High Vacuum Techniques.*

DIRECT REPLACEMENTS FOR MULLARD-MAZDA BRIMAR GEC, ETC.

A47-11W (P)	MW53/20	T914	CME1901	21C2P4
A47-13W (T)	MW53/80	C19/10A	CME1902	21DKP4
A47-14W	AW-47-97	C19/10AP (T)	CME1903	23SP4
A47-17W (P)	AW-53-80	C19/AK	CME1905	171K
A47-18W (P)	AW53-88	C21/1A	CME1906 (T)	172K
A59-11W (P)	AW53-89	C21/7A	CME1908	173K
A59-12W (P)	AW59-90	C21/AA	CME2101	212K
A59-13W (T)	AW59-91	C21/AF	CME2104	7205A
A59-14W (T)	C17/1A	C21/KM	CME2301	7405A
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AW47-91	C17/SM	CME1702	CRM211	MW31-74
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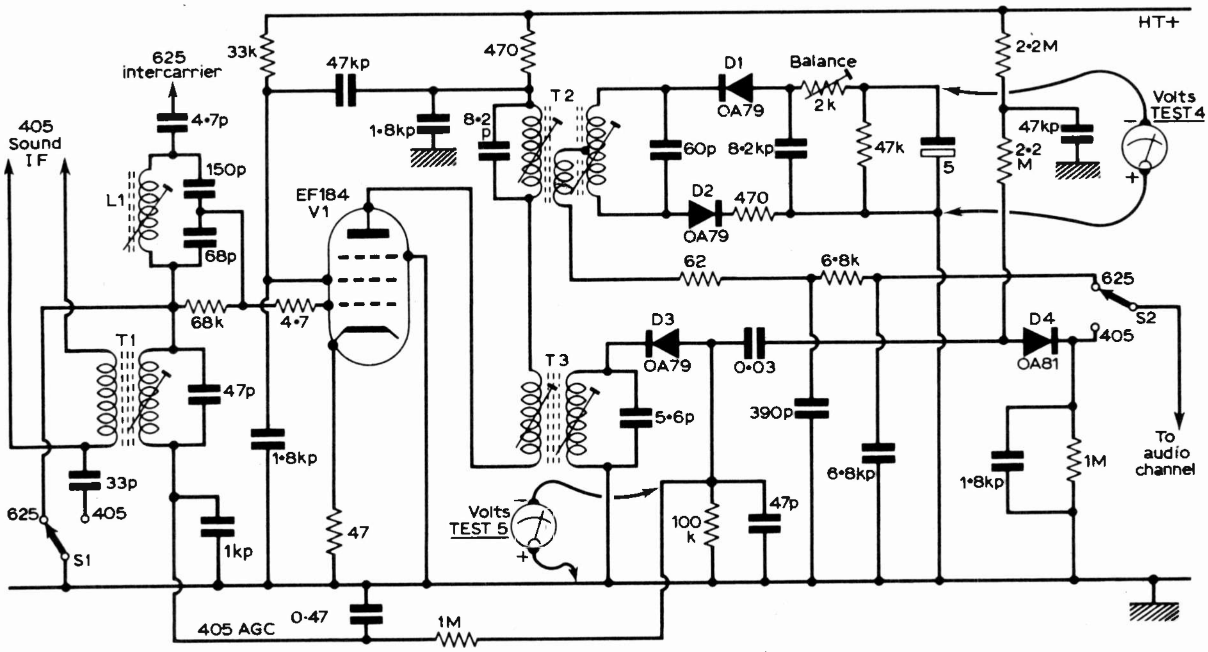

Fig. 4: Sound i.f./intercarrier stage, detectors and a.m. noise limiter of a modern dual-standard set.

alignment which on dual-standard models is very critical.

FM Detector Tests

A common complaint is 405 sound all right but weak and distorted 625 sound. This points to misalignment and/or unbalance in the intercarrier circuit. It is very important for the intercarrier channel to be tuned accurately to 6MHz. A rough and ready test for intercarrier alignment, assuming that the set is otherwise working normally, is to connect a high-resistance voltmeter across the 5μF electrolytic in the ratio detector circuit as shown by Test 4 in Fig. 4. When the set is tuned to a 625 programme a voltage reading will be obtained.

The u.h.f. tuning and the balance preset in the f.m. diode circuit should both be adjusted to give maximum reading and then L1 and T2 primary cores (not the secondary) should be very carefully moved one way and then the other to see whether the reading can be increased. Peaking to maximum reading is not always desirable since this tends to reduce the sound passband and impair the sound quality and encourage frequency drift effects. However the scheme outlined will reveal whether there is a drastic amount of detuning of the tuned circuits. Sometimes it is possible to peak for maximum voltage reading and then detune very slightly each circuit to flatten the top of the response curve; but the only satisfactory method of alignment is by instruments applied in accordance with the service chart or manual.

A crystal-controlled 6MHz signal generator is essential for serious work in this connection but it is possible to get a beat note by lightly coupling-in a 6MHz signal while the set is picking up a 625-line transmission, and to assist the balance preset should be turned to one end of its range to make the f.m. detector responsive to a.m. signals.

Incorrect balance preset adjustment will also encourage distortion and this is best set for minimum a.m. pick-up. Another simple test is to switch on some electrical appliance such as an electric drill and to orientate it near to the aerial input until interference is heard on the 625-standard sound: the preset should then be adjusted for an interference null. More scientific ways of adjusting will however be found in the Manual!

It is possible for one of the f.m. diodes to be short-circuit while still getting a ratio detector voltage reading as in Test 4. However an open-circuit of one diode or a fault in both of them will grossly affect the voltage reading.

On models using an EH90 f.m. detector trouble can arise due to change of value of the associated screen resistors, leading to distortion on f.m., and of course due to a fault in the valve itself.

AM Detector and Noise Limiter

The a.m. detector can be checked on a 405-standard programme simply by measuring the a.g.c. voltage across the load with a high-resistance voltmeter as shown by Test 5. If in doubt it pays to check the suspect diode by substitution or to disconnect one end from the circuit and connect an ohmmeter across it, first one way round and then the other, noting whether in one direction, corresponding to forward current, the resistance value is at least 100 times less

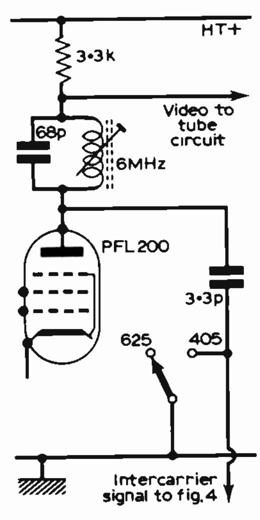

Fig. 5: How the 6MHz intercarrier sound signal is developed across a tuned circuit in the video amplifier anode circuit.

than that in the reverse current direction.

Noise suppressor diode D4 is biased-on by the two series-connected 2.2MΩ resistors from its anode electrode to the h.t. line. Audio is thus conveyed via S2 from the diode when it is conducting. However in the event of a large pulse of interference the diode is momentarily biased-off, since such a pulse from the detector D3 is negative-going at D4 anode. The time-constant formed by the *R* and *C* elements associated with the circuit control the off-state period and yield the best limiting characteristics.

One common fault with this arrangement lies in the high-value anode-to-h.t. resistors going very high in value or even open-circuit. This severely restricts the conduction of the diode causing very bad audio distortion and low volume. A leak in the 0.047μF capacitor in Fig. 3 would give a similar symptom. Diode conductivity should thus always be checked when heavy distortion is present on the 405-standard sound and not on the 625 standard, for the limiter is associated only with the former standard.

Intercarrier Pick-up

Finally a word about the intercarrier signal pick-up. In some models the 6MHz signal is developed across a tuned circuit in the 625-line vision detector stage while in others the intercarrier signal passes through the video amplifier with the video signal and is developed across a tuned circuit in the video amplifier anode circuit as shown in Fig. 5. For the best 625-standard sound this tuned circuit must be peaked to 6MHz. The loading caused by the coupling is very small since it is usually performed by a capacitor of typically 3.3pF.

NEXT MONTH: VIDEO CIRCUIT TESTING

UNDERNEATH THE DIPOLE

—*continued from page 359*

The engineers at present prefer to use 35mm. film for the exteriors, for cutting into videotaped interiors. The qualities of both are acceptable separately but there used to be a startling change of quality on the changeover. This has now been overcome with 35mm. film though not yet with 16mm. film.

ITA's UHF MIX-UP

There will be a tremendous surge forward when there are two more PAL 625-line colour TV services in operation, but there will have to be a rapid sort out of the u.h.f. population coverage before then. This is at present radically different from the v.h.f. coverage and overlaps. The present preliminary (and arbitrary) boundaries of the u.h.f. regions may be fine for the BBC but are not at all satisfactory to regional ITV stations and their viewers. The effort to use high masts with omnidirectional aerials may be acceptable for the BBC, but is in some cases not equitable for neighbouring ITV stations. ITA should have learned the lessons of their early years, when directional transmitter aerials played such an important part in their success. The current thought seems to blame the Pilkington Committee and Professor Hoggart for all the mistakes: which just indicates how powerful hot air can be.

Iconos

FAULT-FINDING FOCUS

—*continued from page 349*

tively shunt the valve's 330Ω cathode resistor across l.t. and chassis.

When the PCL85 is fully warmed up its pentode cathode voltage reaches approximately 18V thus reverse biasing the diode and preventing further conduction through it.

THORN 970 CHASSIS

Most receivers with transistorised i.f. stages broadly follow the lines of the examples outlined. However the Thorn 970 series employs two valves in the vision i.f. strip with a single transistor i.f. " link unit " between the integrated transistor tuner and the main receiver chassis. A.G.C. is applied only to the " link-unit " i.f. amplifier and the r.f. amplifier, the two vision i.f. valves operating at full gain.

Maximum gain reduction of the i.f. amplifier transistor is preset at 23dB and following usual practice the ultimate effect of rising signal strength at the vision detector is rising collector current in the controlled transistors plus in this particular model increased damping of the i.f. collector tuned circuit. Control is first applied to the i.f. transistor and subsequently to the r.f. amplifier if signal strength is sufficient. Two switching diodes and two transistors are employed in the a.g.c. system, one transistor as the a.g.c. amplifier and the other as an emitter-follower to match the a.g.c. source impedance to the input impedance of the former.

TRANSISTOR LT SUPPLIES

While pnp transistors operating from a positive l.t. rail are commonly employed, this is not universally so and in the recent Pye 368 series for instance npn transistors are employed with a negative l.t. rail so that the collectors are still returned to chassis via their respective loads or tuned circuits.

In some models such as the Pye 40F npn types are again used but with a positive l.t. rail which results in the various stages looking more like their valve counterparts, the emitters (cathodes) rising from the main chassis line and the collectors (anodes) rising above the transistor symbol to the l.t. supply rail. This makes it much easier to see what base polarity is required to achieve the required forward bias and to follow through the a.g.c. action.

A.G.C. systems in transistorised TV receivers tend to be complex, including an amplifying stage, one or more switching diodes and frequently an emitter-follower for impedance matching purposes. Manual contrast control is usually an integral part of the a.g.c. arrangement. Faults in both valve and hybrid versions can be many and varied, so we shall cover practical servicing aspects in the following instalment while you become familiar with the basic operation!

TO BE CONTINUED

YOUR PROBLEMS SOLVED

Whilst we are always pleased to assist readers with their technical difficulties, we regret that we are unable to supply service data or provide instructions for modifying equipment. We cannot supply alternative details for constructional articles which appear in these pages. WE CANNOT UNDERTAKE TO ANSWER QUERIES OVER THE TELEPHONE. The coupon from page 380 must be attached to all Queries, and a stamped and addressed envelope must be enclosed.

HMV 1896

There is a persistent hum when on video (not present on f.m. reception). There is line jump and poor interlace, also cramped picture at bottom. The linearity controls will not bring this back to normal. There is also a faint vertical white line but this is not apparent on dark scenes.

I have changed the 100-400-16μF capacitor and substituted the field output valve V13 (PCL82), also V7 (ECC82) V5 (PCL84) V12 (PCL82) in fact nearly all the valves with little or no results or improvement. I have also replaced C98 in V13 circuit with no apparent result.

The hum will vary in frequency when the field hold is turned above or below lock frequency.—D. W. Harris (Middlesex).

Check the volume control wiring and ensure that the screening is bonded. Reroute the wires if necessary.

Also check C97 0·01μF linearity capacitor and check the screening and remove the aerial from the vicinity of the set if it is near it.

FERGUSON 3646

The left-hand side of screen shows upright striations of light and dark bars, more pronounced on BBC-1. They are visible on BBC-2 and ITV. Also uprights and horizontal parts of a picture tend to bow in to the middle.—J. H. Weedon (Essex).

A certain degree of this effect might be normal. However the bowing in the centre could be caused by a defective scan assembly or hum in the vision stages (or field timebase) resulting from a worn electrolytic capacitor. Low voltage and a low-emission line output valve and/or booster diode could aggravate the symtom. Check that the mains tapping is set to suit your local supply voltage.

GEC BT2748

The above mentioned television set has given good service in the past. However after an evening's viewing, on switching the set on the following day there was no sound, vision or raster. All the valves and the tube heaters were alight.

There was complete lack of e.h.t. and the line whistle could not be obtained.—I. Sullivan (Middlesex).

This is the sympton of voltage failure. Check on the h.t. line with a voltmeter. Zero voltage should lead to a check of the rectifier, fuse and a.c. feed to the rectifier. Low voltage could indicate a short leak on the line due for instance to a failing electrolytic smoothing capacitor or an electrical leak in a transformer.

PHILCO 1040

There is a faint raster which can only be seen in a darkened room, but when the set is switched off the screen lights up for a fraction of a second with the scan spot in the centre of the tube.

I have renewed EY86, PL81 and PY81 and can draw a spark from the anode of each valve. The line output whistle can be clearly heard.—M. Hector (Renfrewshire).

Whilst the possibility of a low-emission tube cannot be ignored (and this is probably the cause) you should check the tube base voltages, particularly at pin 3 (first anode) as the C39 (0·25μF) may be leaking to chassis.

KB OV30

There are four vertical dark lines about ¾in. wide separated by about ¾in. on the left side of the picture.

The sound is normal and the picture is good, not being erased by the lines which appear more as shadows.—D. Cook (Wiltshire).

There is an 820kΩ resistor in series with a 120pF capacitor from the line output transformer to the c.r.t. pin 2 circuit. Check these components.

ULTRA V1780

On the above model the test pulse bars are visable approximately ¾in. from the top of the picture. These pulse bars only appear on BBC-1 and were not present when I obtained the set.—C. T. Wood (Northampton).

Try changing the field timebase valve. Low emission or changed characteristics can slow down the retrace, giving pulse display on the picture as described.

PHILIPS 1446U

This set has developed a white line across the centre of the screen. I can see a narrow picture in the middle of this line but cannot make it open out. The sound is quite normal on the two channels and the brightness is OK.—J. Favermere (Birmingham).

You should check the left-side front ECL80 valves. If these are in order, check the h.t. on *both* top front tags of the field oscillator transformer. The h.t. winding often goes o/c.

KB OV30

The fault takes the form of gradual compression about 3 inches from the bottom of the picture. This gradually gets worse.

I have so far replaced the PCL82 with a new valve, but no difference was noted, and have checked the cathode capacitor and cathode resistor and the voltages after reading your article on field faults. The fault cannot be cured by the linearity control on the bridge supporting the tube. The only conclusion I can arrive at is that the linearity circuit is faulty somewhere. I have traced the lead from the linearity control to a tag strip on which there are mounted some large wax capacitors.—J. Bush (Cheshire).

We would advise you to change the 0·4μF capacitor from the linearity control to the junction of a 0·1μF and a 1·8MΩ resistor. Also check the value of this latter resistor.

STELLA ST8721U

The picture has a vertical bar near the centre of the screen and there is also half of another picture present—H. Mather (Lancashire).

Check the line oscillator valve ECL80 and check the 330kΩ resistor to the hold control.

Disconnect the limiter control if the above does not help matters as this control often changes value.

DECCA DM4/C

Two months ago the field transformer became unservicable. The manufacturers could only supply me with a replacement for a 90° tube and my set has a 70° type.—E. Dickinson (Sheffield).

The difference between the two transformers is that the 70° model uses an ECL80 field output valve and the 90° model uses a PCL82. This makes a difference in the characteristics of the transformer.

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This coupon is available until May 23, 1969, and must accompany all Queries sent in accordance with the notice on page 379.

PRACTICAL TELEVISION, MAY 1969

TEST CASE

78

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

? *A set using a Thorn 950 MkII chassis developed a symptom of vertical distortion and lack of height. This would sometimes appear suddenly, the picture beforehand being perfectly normal, or it would gradually occur as the inside temperature of the set rose.*

Of the opinion that the field output valve was responsible, the enthusiast had the valve tested. This was proved to be in good order but still not satisfied a new valve was tried, the symptom still remaining. Attention was next directed to the linearity correcting circuits of the field output stage and then to the field oscillator feed to the boosted h.t. line, but nothing at all could be found wrong in these areas of the set.

The symptom was still present after a new set of scan coils and a new field output transformer had been substituted. What causes other than those directly in the field timebase circuits could have been responsible for this symptom, and how did the enthusiast eventually clear the fault? See next month's PRACTICAL TELEVISION *for the solution and for a further item in the Test Case series.*

SOLUTION TO TEST CASE 77
Page 331 (last month)

Because the phase of the V (weighted R-Y) chroma signal at the transmitter is alternated line-by-line in the PAL colour system the V chroma signal in the set must also be switched in like manner. This is done either by switching the reference oscillator signal to the V detector or the V signal itself on alternate lines. The switching in the receiver must be synchronised with that at the transmitter. In the PAL system the phase of the burst signal is alternated each line and this provides an identification as to the V phase being transmitted. The signal derived in the decoder from the alternating burst signal is called the "ident" signal—short for identification—and this is used to synchronise the V chroma switching in the decoder.

In the Philips chassis a bistable circuit is used to control the switching of the V signal on alternate lines, and this is in turn under the control of a transistor which supplies the ident correction waveform. In the absence of the ident signal the V signal switching in the decoder could easily run in antiphase and this is just what was happening in Test Case 77. The technician soon discovered that the ident transistor was defunct.

Published on or about the 22nd of each month by IPC MAGAZINES LIMITED, Tower House, Southampton Street, London, W.C.2, at the recommended maximum price shown on the cover. Printed in England by Fleetway Printers, 17 Sumner Street, London, S.E.1. Sole Agents for Australia and New Zealand: Gordon & Gotch (A/sia) Ltd. Subscription rate including postage for one year: To any part of the World £2 1s.

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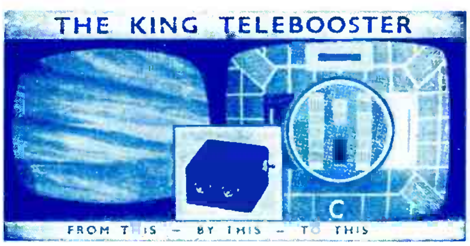

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