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TELEVISION

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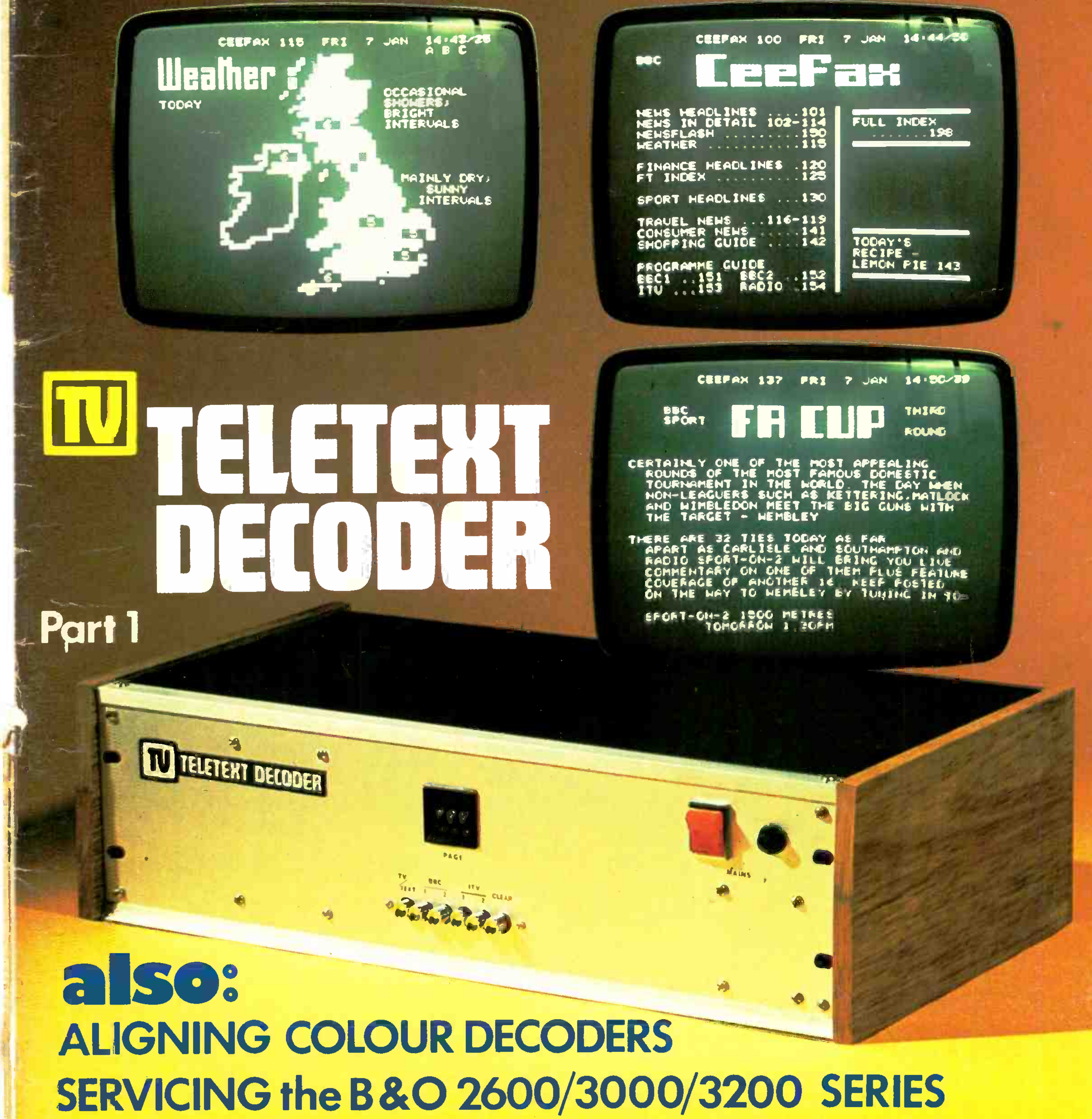

TV TELETEXT DECODER

Part 1

also:

ALIGNING COLOUR DECODERS

SERVICING the B&O 2600/3000/3200 SERIES

TELEVISION

March 1977

Vol. 27, No. 5
Issue 317

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All correspondence regarding advertisements should be addressed to the Advertisement Manager, "Television", Fleetway House, Farringdon Street, London EC4A 4AD. All other correspondence should be addressed to the Editor, "Television", Fleetway House, Farringdon Street, London EC4A 4AD.

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TV 10

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THAT OLD RELIABILITY PROBLEM

It's a well known fact that the reliability of Japanese made TV sets is better than that of European made ones. It works out something like this: for every call to a Japanese set during its first year you'll have to make two-three calls to its European counterpart. It's not quite as bad as that may sound. Call rates tend to lie in the region 0·5-1, which means at one end that half the sets won't require attention while at the other end each set will require one call per year. Then again these are average figures, and while many sets won't require attention at all others will have more than their fair share of breakdowns. Fortunately there has been an improvement in recent years – the situation was rather worse say four years ago. But then for the last couple of years we've been going through a period when the technical situation has remained fairly static. Will the new in-line gun tube chassis using the new ranges of i.c.s prove more or less reliable than their immediate predecessors? Only time will tell of course.

But the unfavourable comparison between the failure rate of Japanese and European sets has been a continuing fact of life for several years. Is it to do with components, assembly methods, or basic design? Well, Japanese sets use much the same components and assembly methods, and the designs are not fundamentally all that different. Perhaps there is some subtler difference somewhere? Recent conversations we've had suggest that this could well be so. We can speak only of the UK industry of course, but feel that the situation is probably much the same with our continental competitors.

The first thing to bear in mind – and this relates to other industries, such as car manufacturers, as well – is the different industrial structures. Like the car industry, UK TV setmakers tend to be assemblers of finished products rather than manufacturers of whole units. They buy in capacitors, resistors, semiconductor devices, many of the wound components, the tubes, probably the tuners and triplers and so on. This is far less the case in Japan, where most of what a setmaker uses comes from "in house" sources.

All right you may say. But UK component manufacturers have been in the game long enough to know what they're about – as long as anyone else for that matter. Furthermore, they've been working in close contact with the same setmakers, both facing and dealing with common problems. Why should this different industrial set-up make any difference?

It's probably not so much the set-up itself so much as the fact that the way the UK industry is organised tends to emphasise certain basic weaknesses. Quite substantial changes have occurred in even the most mundane components in recent years – component manufacturers are producing new types of capacitor and resistor that were simply not known a decade ago for example. But to do this successfully calls for adequate investment and the employment of adequate numbers of properly trained engineers and technical staff. In both these respects, UK industry is notorious. It may well be said that in difficult economic times it's hardly possible to increase investment and take on extra trained staff, which is true enough. But the fact is that we are reaping the results of our past inadequacies, and a start has to be made sometime if the situation is ever to be retrieved.

The main problems seem to relate to know-how and technical liaison. Does the setmaker get a thorough and reliable service from his suppliers – and conversely has he set about ensuring that he does? It's not good enough today to continue on the basis that something worked reasonably well enough last time and the supplier says he hasn't had any particular complaints other than the usual ones. To achieve the degree of reliability required to continue to exist in a highly competitive international industrial climate, it's necessary to know precisely what order of tolerances under various operating conditions the various components offered and bought have. And this calls for adequate technical back-up and investment.

During a recent conversation with a representative of a leading setmaker we were given an alarming number of examples of what may politely be referred to as failure by suppliers to do their technical homework or, more forcefully, as sheer lack of professionalism. These could have led to uncertain performance and unreliability in the finished product – the TV set. The Japanese invest adequately and their engineers can get together within a single organisation to deal with common problems. It's not necessary for the UK industry to be reorganised for the same to be done. What's required is a more powerful voice for the engineer, backed by adequate investment.

CORRECTION

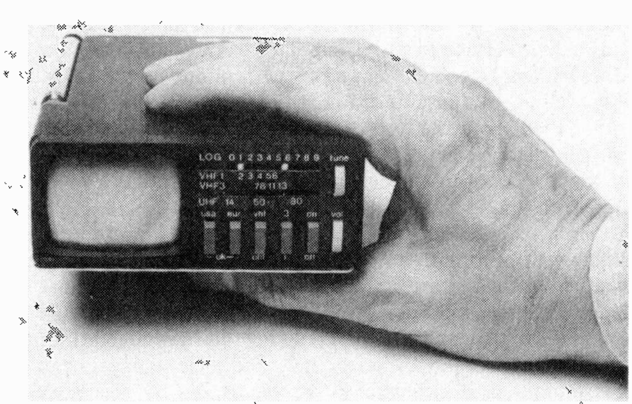
An error occurred in Part 1 of "The Art of Alignment" under the heading "Action of the Tuner". In deriving the sound i.f. the frequencies should have been fundamentals of 573·25MHz (ch. 33 sound carrier) and 606·75MHz (local oscillator), giving sum and difference frequencies of 1180MHz and 33·5MHz respectively. The sum is also incorrectly shown as 1186MHz in Fig. 2.

teletopics

WORLD'S FIRST POCKET TV SET

After various hints and promises over recent years Sinclair have at last launched their pocket TV set – the world's first and a notable achievement. The research and development programme which culminated in this set has been going on for twelve years and has cost some half a million pounds. The set is now in production at Sinclair's new St. Ives assembly plant, and will initially be available in the UK and the USA – where it has already been shown, at the recent Chicago Consumer Electronics Show. The suggested price in the UK is £175 plus VAT, and in the USA $300. By the end of the year it is expected that the set will be available world wide. In case this marketing arrangement should puzzle you, let us immediately point out that one of the most remarkable features of this tiny (6 x 4 x 1½in., and weighing 26½oz) set is that it is fully equipped for multi-standard operation – for operation that is on the UK and Continental 625-line standards and the US 525-line 60Hz standard.

The objectives behind the design are listed as follows: true portability; excellent performance regarding sensitivity and picture and sound quality; multi-standard operation; and a useful internal battery life. The u.h.f./v.h.f. tuner has been designed by Sinclair engineers and uses varicap tuning and pin diodes for band switching. Both a.f.c. and a.g.c. are applied to the tuner. Selection of the UK, Continental or US standards is by means of push-button switches, and separate v.h.f. and u.h.f. aerials are incorporated. The timebases are both dual-standard while the i.f. section is switched between three different sound-vision signal spacings. The main market initially is considered likely to consist of businessmen travelling between different parts of the world and anxious to keep in touch with the news via TV. Hence the concentration on multi-standard operation.



The Sinclair Microvision is the world's first hand-held TV set. It operates on three different standards.

New techniques have been developed to provide the necessary low power consumption – 750mW total. A key factor in reducing the power consumption is the choice of picture tube. This is a neat 2in. (diagonal) screen type using electrostatic deflection. The tube has a very low power heater with a 15 second warm-up time. The screen is slightly curved to maintain the focusing at the edges and the e.h.t. is 2kV.

The bulk of the circuitry is contained in five bipolar-transistor integrated circuits, three of which were specially designed by Sinclair engineers for use in this set. Aims here have been low external component count plus low overall power consumption – measured only in microwatts in some parts of the circuit. Because of the low power dissipation, radiation is much lower than with conventional designs and is further reduced by the metal outer casing.

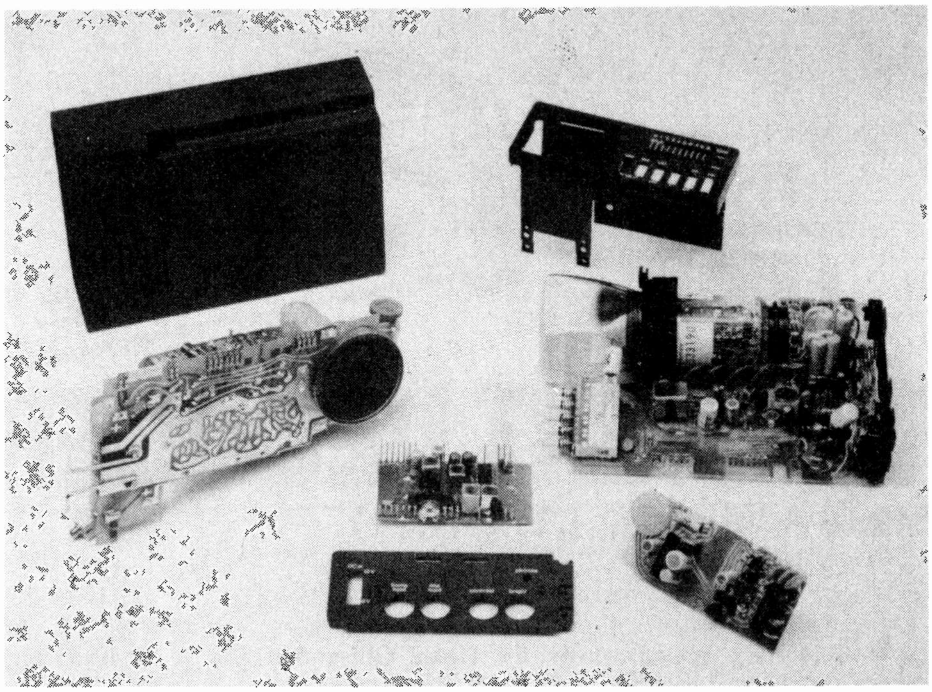
The correct viewing distance is roughly a foot to eighteen inches, when the picture is equivalent in size and brilliance to a normal portable viewed at about six feet or a 24in. table model viewed at 12ft. The audio output via the internal speaker is 50mW. There is also an earphone plug and when this is activated the speaker is muted.

The set operates at 5V d.c. which is obtained from four internal "AA" 1·2V rechargeable nickel cadmium batteries. These give roughly four hours viewing per charge. The recharging time is 14 hours. Connecting the a.c. line adaptor provides sufficient power to run the set and at the same time recharge the batteries – the battery recharging current is stabilised. An alternative external 6V battery pack using four heavy-duty "D" size cells (HP2 size in the UK) is also available: this provides up to 40 hours continuous viewing. The set can also be run and recharged from a car battery.

There are four principle printed circuit board modules which plug together. Final assembly consists of connecting the boards and the tube and housing them in the three-piece steel casing. To provide added strength there is a metal chassis. Sinclair intend to undertake all servicing themselves, and give a one year guarantee.

All praise to Sinclair on this notable technical achievement. It seems unlikely to us that there will be much of a home market, but Sinclair have decided to aim world-wide and deserve success in this endeavour. A single-standard version is under consideration however.

Photograph showing the modular construction of the Sinclair Microvision pocket TV set. The four printed circuit boards and case sections are as follows, from left to right. Top: main body case, and front with tuning dial and button selectors. Centre: tuner board, i.f. board, and power/deflection board with c.r.t. Bottom: rear panel and audio board. Final assembly consists of connecting the four boards, inserting and connecting the c.r.t., and housing the whole chassis in the three section black steel case.



NEW SPARES SOURCE

Rank Radio International have moved into general spares distribution to the trade and have now issued their first RSVP (Rapid Sound and Vision Parts!) catalogue. The aim is to offer a wide range of components in sensible quantities at low prices, backed by very quick service. The catalogue lists some 2,000 of the more frequently required replacement parts, clearly and concisely listed for ease of reference. The smaller items are supplied in resealable bags labelled for easy stock control and identification. Same day despatch is promised on all orders received by 3·30. Enquiries should be made to Rank Radio International at Watton Road, Ware, Hertfordshire SG12 0DY – telephone 0920 3966.

RECOMMENDED REPLACEMENT THYRISTORS

CES have issued further recommendations for replacement thyristors in stabilised power supplies in Pye group colour chassis. The TV106/2 is now recommended for use as a replacement for the BT106 in the 713/715/717 chassis, while the 2N444, which is supplied complete with heatsink, is recommended as a replacement for the BT116 in the 731 chassis and its subsequent derivatives (the 110° chassis). Incidentally, insufficient width in this latter chassis can be caused by C586 (0·047μF) in the EW diode modulator circuit: the replacement must be a polyester film/foil type, not a metalised polycarbonate type.

UK ELECTRONICS INDUSTRY SURVEYED

An interesting looking publication arrived on our desk recently – an addition to the Central Office of Information's "British Industry Today" series, this one entitled *Electronics*, published by Her Majesty's Stationery Office. There's some handy tabular data on the UK electronics industry and its performance during the early-mid 1970s, but other than that one can't say that it contributes much information of any particular interest. There is neither a technical, industrial nor economic perspective to the book, so that the whole thing is incredibly flat – it's really a written up listing of who makes what. Statements of painful obviousness abound: thus on page 29, roughly half way through the book, we're told that "Solid-state devices . . . are essential processors without which modern electronic equipment could not be produced." So now you know! The initial historical survey is in places misleading and sometimes wrong – it apparently took 22 years from its design for the Electronic Delay Storage Automatic Calculator to become operational! Admittedly to produce a survey of such a large and diverse industry is no easy task: but the way it has been done here makes an incredibly varied and interesting story both dull and rather pointless. For those interested, it costs £1·40 (£1·51 by post) and can be obtained from booksellers or from the various government bookshops.

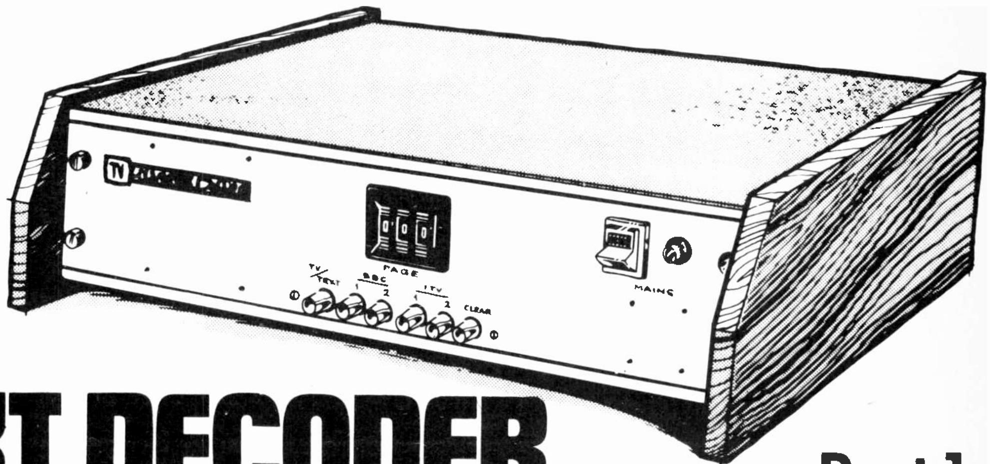
PAL vs. SECAM CONTINUED

The battle between the rival PAL and SECAM colour TV systems seems never ending, and goes on with the same behind the scenes enticements and pressures. The last country in Europe to take a decision was Italy. Now the battle has moved to Spain. France has agreed to provide considerable finance for the network and the studios if Spain adopts SECAM – the same ploy that was used in Italy, though the decision there went to PAL. Recently, the German chancellor is understood to have raised the subject during a visit to Spain, dangling the carrot of generous loans if the Spanish government adopts PAL. The battle is fierce since whatever Spain does may well be followed by Portugal and, more importantly, throughout the vast South American market.

AUTOMATIC TeD

The main disadvantage of the TeD videodisc system has been its limited playing time, and an autochange version to overcome this limitation has long been promised. An autochange version which is capable of providing over two hours viewing has now been shown – at the First International Videodisc Programming Conference in New York. The present ten-minute discs are retained, and the autochange is said to be too brief to be noticeable. This could well bring TeD back into the running, though nothing has been said yet about the economic competitiveness of this autochange version.

THE TV TELETEXT DECODER Part 1



Steve A. MONEY T. Eng. (CEI)

IT WAS recently announced by the Home Office that authorisation for the Ceefax and Oracle Teletext services, currently being broadcast by the BBC and ITV respectively, has been extended until the next review of broadcasting services in 1979. By then it seems certain that Teletext will have become an integral part of our broadcasting services in the same way that colour television did a few years ago.

Television receivers with built-in Teletext decoders are expected to be on sale later this year, but at first are likely to be relatively expensive. In this situation the amateur constructor will have an advantage over his neighbours since he can build his own decoder unit to enable him to view the Teletext information which is already being broadcast as a regular service. With this in mind the *Television* Teletext decoder project has been developed. The aim is to provide readers with a basic Teletext decoder unit which is reasonably easy to build and which does not involve the constructor in making modifications to his domestic TV receiver.

The Teletext System

For those readers who may not be familiar with the Teletext system it might be as well to start by reviewing what Teletext does and how it works.

Basically, Teletext is a process by means of which a series of data signals representing pages of written text can be transmitted in the same channel as the television picture and sound signals. After suitable processing in a decoder unit at the receiving end, the Teletext information can be displayed on the screen as a page of printed text which appears in place of the picture.

The data signals in effect ride piggyback on the normal picture signals by being inserted into some of the unused scanning lines that occur during the field blanking interval. At present only two of the lines in each field are used to carry Teletext signals, although in the future more lines could be used for this purpose. The lines used for teletext are numbers 17/18 in the even fields and 330/331 in the odd fields. Some of the other blank lines are already being used to carry engineering test signals.

On a normally adjusted receiver the Teletext signals are not visible because they occur off the top edge of the screen. If the picture height is reduced however the data signals can be seen as two rows of bright twinkling dots running across the screen just above the picture area.

A displayed page of Teletext information consists of 24 rows of text each containing 40 alphanumeric characters. Each of the lines of transmitted data will represent one complete row of characters in the display.

Fig. 1 shows the structure of a typical line of the transmitted Teletext data. The active part of the line scan is divided up into 45 equal portions each of which contains a pattern of eight pulses. The first five of these groups of pulses contain synchronising signals for the decoder and an identification code to show which row of text is being transmitted. These five data groups do not produce a display on the screen. The remaining forty code groups each control one of the symbols which make up the line of displayed text.

To provide a useful information service there may be several hundred different pages of text sent out in sequence on the same television channel. These can cover such topics as news, sport, entertainment, finance, weather and even crosswords in much the same way a newspaper or magazine does.

By using a selector switch attached to the decoder the viewer can select any one of 800 different page numbers for display, although some of these may not be in use in the series being broadcast on a particular channel.

To enable the decoder to detect which page is being sent, a page identification code is sent out during the top or header row of each page of text. Unlike the others, this row contains only 32 displayed characters, the first eight character code groups being used for page number and control codes. Apart from the page number the header row carries the same text for every page.

Each page of text takes approximately a quarter of a second to transmit, and usually the whole sequence of pages

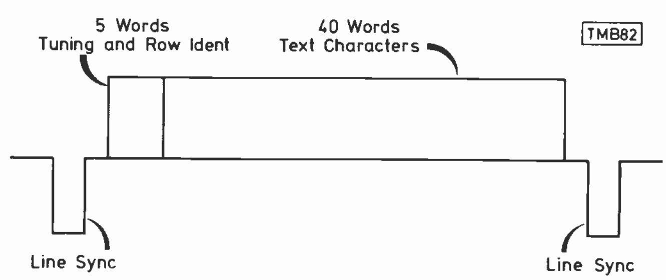


Fig. 1: Layout of transmitted data.

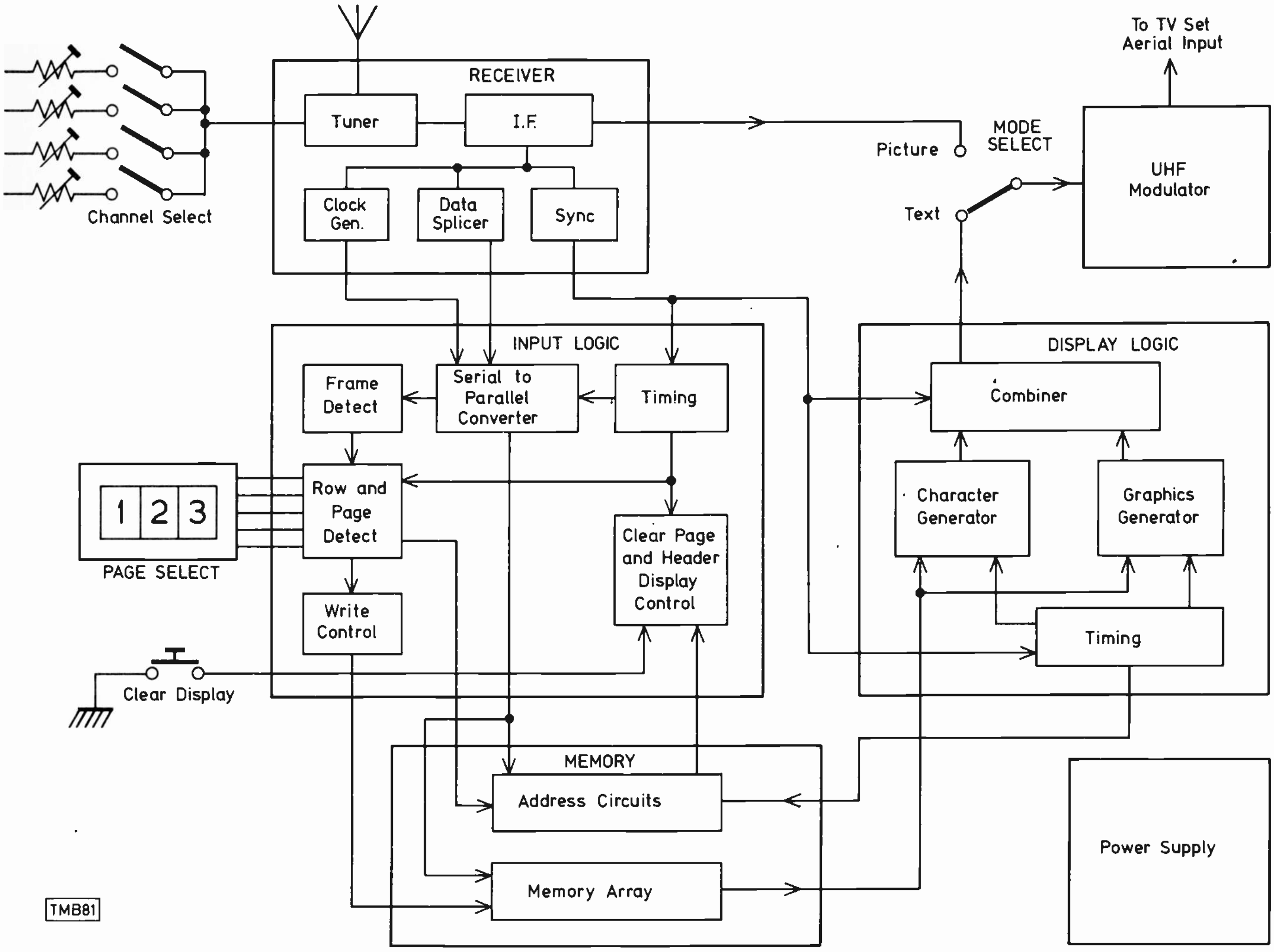


Fig. 2: Block diagram of the Television Teletext Decoder.

on a channel is repeated continuously about once a minute. When a new page is selected by the viewer the decoder checks each page number until the desired page is detected. At this point the data for the complete page is stored in a memory system and then displayed continuously until the selected page of text is updated or the viewer selects a new page.

Page numbers are grouped into sets of 100 which are known as magazines. The magazine number is the hundreds digit of the page number, so that page 567 will be located in magazine number 5. On the BBC channels all the pages on one channel usually have the same magazine number, whereas on ITV several pages in each magazine group are used.

Apart from alphanumeric text it is also possible to display simple graphics pictures such as weather maps or graphs. It's possible to display the symbols in seven colours, and recently extra control codes have been added to allow the background colour to be changed. Parts of the display can be made to flash on and off for extra emphasis, and it's also possible to present newsflashes and subtitles by inserting the text into blanked out boxes in the television picture display.

Aspects of Decoder Design

There are two basic approaches to the design of a Teletext decoder. In the first of these the decoder unit is built directly into the television receiver; this is the type most likely to be used by the commercial setmakers. Here the video signal is taken from the receiver i.f. strip and fed to the Teletext decoding circuits. A new video signal for the text display is generated in the decoder and then injected directly into the receiver video circuits in place of the picture video. It is possible to have the decoder itself mounted external to the receiver cabinet but still connected directly to the internal circuits of the receiver. This approach involves alterations to the receiver circuits, which vary from one model to another due to differences in receiver design.

It was decided that a directly connected decoder is not the best approach for the average home constructor. For one thing the results obtained would depend on the performance of the set's i.f. strip, while the many different approaches to video/RGB circuit design would call for a great deal of research into the feasibility of modifications to the many chassis in use. There is also the fact that this approach is not suitable for those with rental sets since rental companies do not approve of viewers meddling with their receivers.

The alternative approach to decoder design is to have a completely separate unit. In this case the decoder unit contains its own receiver system and is fed directly from the TV aerial. When the video signal for the text display has been generated it is used to modulate a u.h.f. carrier to produce a complete television signal on one of the unused channels. This output signal can then be fed to the aerial socket of any 625-line TV receiver which is next tuned to the appropriate channel. Thus the only connection to the television set is via its aerial socket and there is no need to modify any of its internal circuits. This type of decoder can of course be used with a rented set.

When Teletext is not required the picture and sound signals from the decoder's i.f. strip are switched directly to the modulator to produce a normal picture on the channel to which the television set is tuned. Changing channels is now carried out in the decoder tuner rather than on the television set. Since the decoder does not have to be near the TV set it gives the added facility that it can be used for remote channel changing from the viewing chair.

The Television *Approach*

Fig. 2 shows a block diagram of the *Television* Teletext decoder. Most of the circuits have been built on four plug-in printed circuit boards to make for easier assembly. These boards are inserted into sockets mounted on a printed circuit "mother" board which provides the interconnecting wiring.

Signals from the aerial input are passed through the receiver board which contains the tuner, i.f. strip and also the synchronising and data separation circuits. To simplify alignment of the i.f. strip a Surface Acoustic Wave (SAW) type filter is used to provide the correct frequency response.

Data signals from the receiver card are passed to the second card which contains the input decoding logic. This card decodes the data signals and selects the page of data to be passed on to the memory circuits.

On the new commercial receivers with Teletext built in, it is likely that page numbers will be selected by a keyboard similar to that used on pocket calculators. This makes for rather complex logic however. In this decoder a simple three digit thumbwheel type switch is used for page number selection.

Most commercial decoders also have a facility where the screen is automatically cleared each time a new page number is selected. To simplify the logic we have used a separate clear button for this purpose. Automatic circuits have been included however to clear the screen in response to a "Clear Page" command transmitted as part of the header row control signals.

After the page clear button is pressed the header row will be displayed and updated continuously so that the viewer can see the changing page numbers. This allows him to see if the page is actually included in the series being transmitted. A time display is included at the right hand end of the header row and this is updated continuously to give a real time clock display.

There is provision in the Teletext specification for pages which are identified by a time code as well as by a page number. The time code is transmitted as part of the control codes at the start of the header row. By using this facility a series of pages of text can be sent out with the same page number but different time codes and the decoder can be set to respond only to the page that occurs at some preset time. This facility, although available, is not being used at present except for test purposes. In the *Television* decoder the time codes are ignored and all pages with the selected page number will be accepted and displayed.

Error Protection

A fairly sophisticated system of error protection is built into the Teletext transmissions. By means of suitable logic in the decoder, errors due to noise or interference can be detected and in some cases corrected. Provided a good colour picture can be received, however, very few errors will occur and in view of this no error protection has been included in this design. Teletext signals are in fact surprisingly resistant to transmission problems, but if ghosting is present this can sometimes cause severe problems. For Teletext reception therefore, it is advisable that a good aerial should be used. If some errors do occur

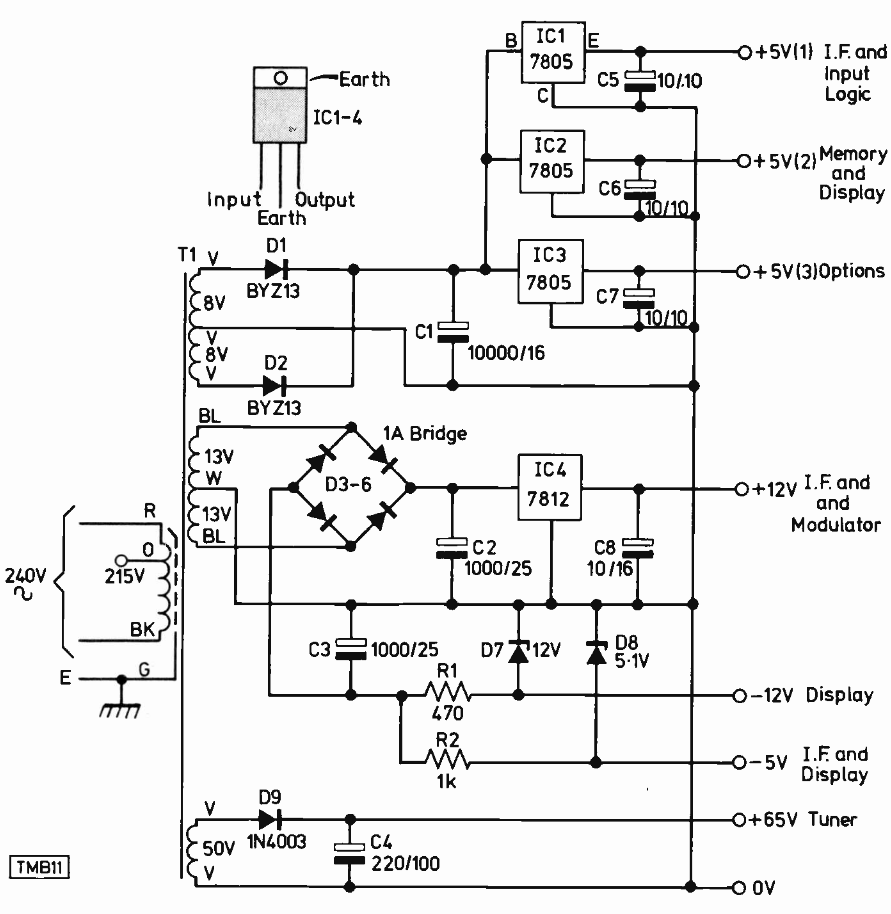


Fig. 3: Circuit diagram of the power supply unit. Component details will be found in the components list at the end of this article.

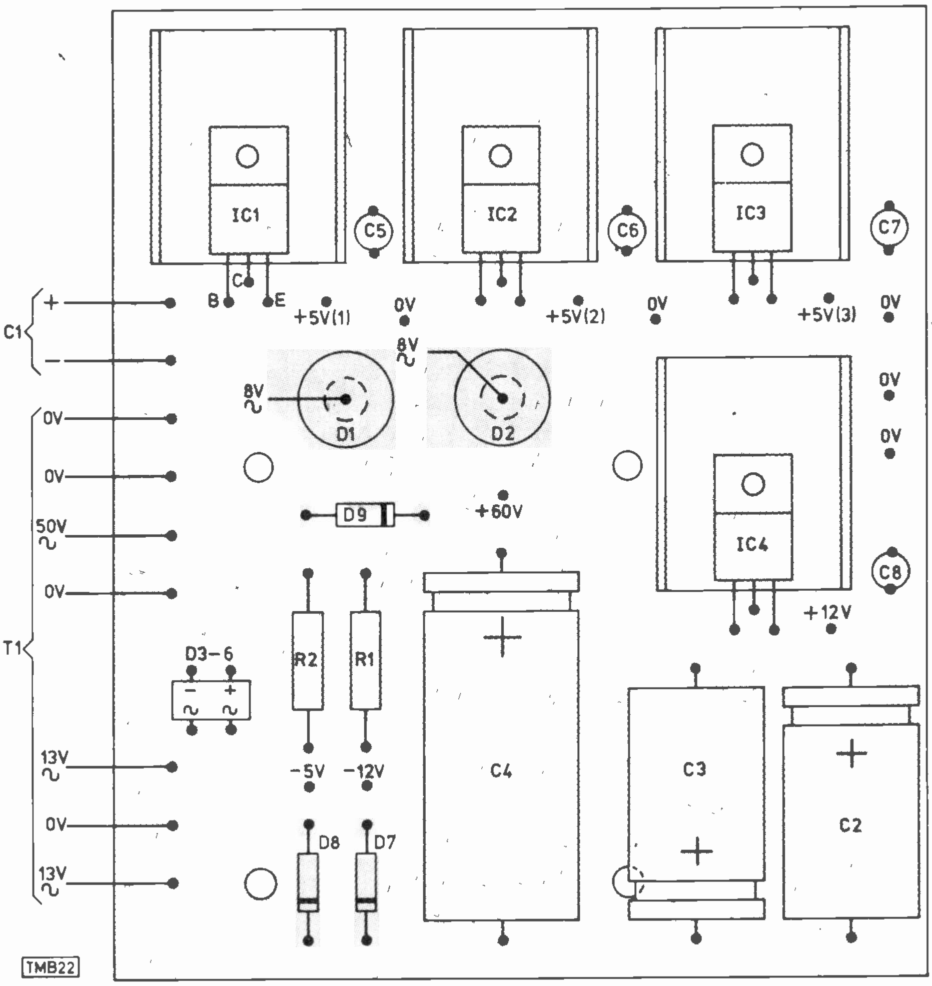


Fig. 4: Component layout diagram for the power supply.

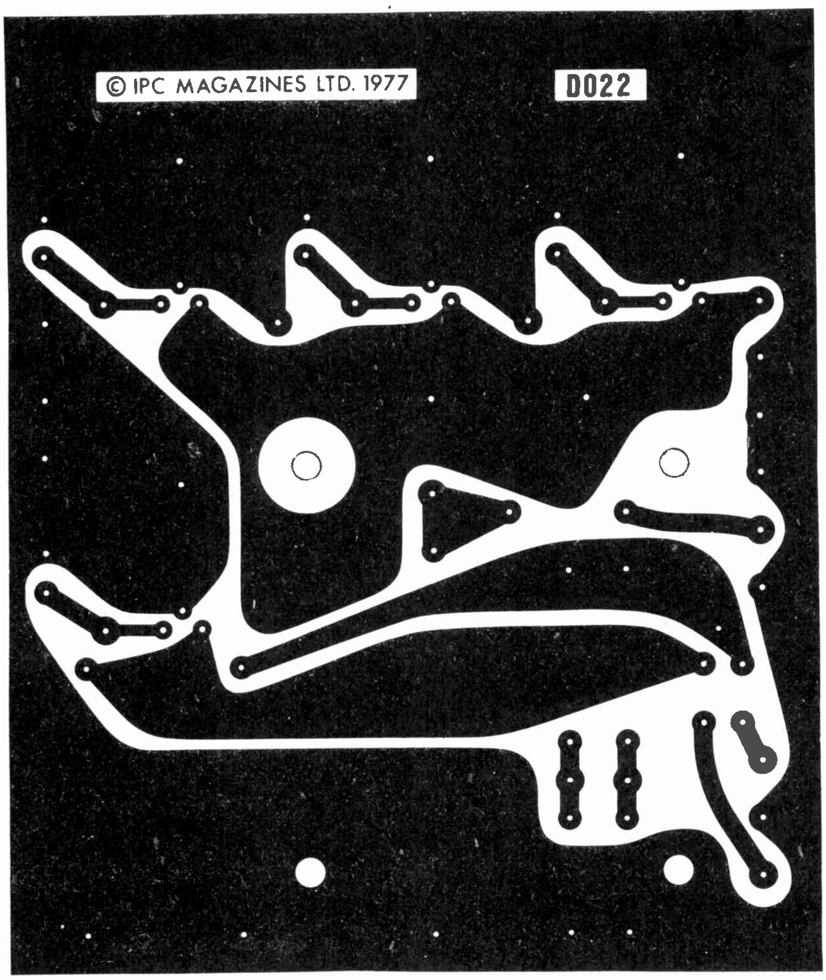


Fig. 5: The printed circuit board for the power supply shown full size.

they will usually show up as one or two incorrect characters in the displayed text and will be corrected next time the page is sent.

In order to display the page of text continuously on the screen some form of memory system is required. Data for all the text on the screen must be read out during each field scan in order to produce the video signal for the picture tube. This requires a memory capable of holding the codes for all 960 characters which make up a page.

The memory board itself is fairly straightforward and uses type 2102 memory devices to store the data. Included on this board is the addressing logic needed to select the individual store locations when data is read out or written into the memory.

Display

Video signals to produce the actual text display are generated on the fourth circuit board. The displayed symbols are produced by selectively lighting up a series of dots arranged in a 7 × 5 matrix in each character space on the screen. The patterns of dots are stored in a character generator circuit which is effectively a read-only-memory (ROM). When the code group for a particular symbol is applied to the character generator it produces at its output a pattern of dots which will produce the appropriate symbol on the display. Apart from character generation, the logic on this card also produces the special patterns for graphics-type displays and generates all the timing signals needed to drive the memory and produce the video output signal.

The dot video signals are combined with synchronising pulses from the receiver board to produce a complete video signal which can be used to drive the u.h.f. modulator.

In directly coupled decoder systems the dot video signals are gated with colour control signals and fed to the RGB amplifiers of the television receiver. This gives a fully saturated colour display of the text. When the r.f. output approach is used it is necessary to generate colour subcarrier signals and a reference burst to obtain a colour display. An added problem is that the dot video signals have a bandwidth which is too wide to go through the chrominance circuits of a normal colour receiver. One of the commercial decoders does however produce a colour display using the r.f. coupling approach and it is hoped that it might be possible to offer this facility as an add on option to the *Television* decoder. Provision has been made in the design for adding extra boards to provide new facilities at a later date.

Construction of the unit should be fairly easy, but some care will be needed when assembling the logic cards because they are quite complex and use double sided printed circuit boards. Most of the integrated circuits used are standard 74 series logic types, but there are some MOS type devices which can be damaged by static if not carefully handled. These devices are mounted in sockets to avoid any possible damage during assembly of the cards.

The Power Supply

We shall start off this month by building one of the simpler parts of the project, namely the power supply unit. The circuit diagram for this is shown in Fig. 3 whilst the printed circuit board layout is given in Figs. 4 and 5.

Three 7805 type stabilisers are used to produce the +5V supplies for the logic cards. Each card is fed from a separate stabiliser which can provide up to 1A. The receiver card needs a small amount of current at +5V and this is derived from the stabiliser feeding the input logic board. The total current drain at +5V is about 2A but the transformer and stabilisers can supply up to 3A so there is ample spare capacity to allow for adding extra circuits in the future. The 0V lines of the three logic cards are joined together to provide a common signal path between the boards.

A +12V supply for the receiver and modulator unit is produced by a 7812 type regulator and this too has some spare capacity to allow for adding extra circuits. There are two negative supplies at −5V and −12V which are used for biasing. Since they draw little current they are stabilised by simple zener diode circuits.

The varicap diodes in the tuner and modulator units need a stable tuning supply of about +30V. This is stabilised by a TAA550 i.c. on the receiver circuit board.

Next month we shall go on to look at the input logic board.

★ Power Supply Unit Components List

Resistors: (all 5%, ½W)
R1 470Ω
R2 1kΩ

Capacitors:
C1 10000μF 16V High-ripple electrolytic
C2, C3 1000μF 25V electrolytic
C4 220μF 100V electrolytic
C5, C6, C7 10μF 10V bead tantalum
C8 10μF 16V bead tantalum

Semiconductors:
IC1, IC2, IC3 7805 regulators
IC4 7812 regulator
D1, D2 BYZ13
D3-D6 Silicon bridge rectifier DIL
D7 BZY88 C12V
D8 BZY88 C5V1
D9 1N4003

Miscellaneous:
T1 Primary: 0-215-240V 50Hz
Secondaries:
1. 8-0-8V 3A
2. 13-0-13V 150mA
3. 50V 20mA
Four 19°C/W heatsinks for ICI-IC4
21 p.c.b. pins 0.040″

Printed circuit board, reference DO22, will be available from Readers' PCB Services Ltd., (TV), P.O. Box 11, Worksop, Notts.

The Problem of Mains Transients

H. K. Hills

BOTH in the UK and abroad considerable research has and is being carried out into the incidence, frequency ranges, energy levels and voltage peaks of the transients present on mains supplies. Such transients can have peak values in the region of 600V to 1kV, and especially when they coincide with the crests of the a.c. waveform can affect the operation of electronic control equipment and cause the breakdown of components unless suitable precautions are taken.

Motor Control Circuits

Multi-thyristor motor control circuits are particularly vulnerable in this respect since the peak value of the spikes can well exceed the forward breakover voltage of the thyristors, resulting in false triggering. In addition the voltage rise of the transient, which can be about 1kV/μs, can be greater than the maximum dV/dt (voltage rate of change) rating of the device, again causing false triggering. All but the very smallest thyristor power control circuits incorporate transient suppression or filter arrangements therefore to prevent random triggering and loss of control.

The filters consist of a series RC network connected across the thyristor's anode-cathode terminals. Suppression is achieved by shunting high-wattage zener diodes or voltage dependent resistors across the input or the thyristor rectifier bridge. Filter capacitors give protection by slowing down the transient's rate of change, the series resistor limiting the capacitor's charge/discharge currents.

Suppressor diodes operate by conducting when a transient which exceeds the device's voltage rating appears. The transient is thus dissipated by the loading effect of the diode. The diodes used are special types and are connected back-to-back across the a.c. inputs, each diode having a stand-off potential that exceeds the expected peak supply value.

Suppression v.d.r.s operate by rapidly falling in value when a high-voltage spike appears, thus reducing the amplitude of the spike to an acceptable value. Unlike the v.d.r.s used in TV circuits, those used for transient suppression are made of zinc oxide and are specially designed for intermittent power dissipation. They are thus ideal for absorbing the high-voltage transients produced by inductive loads at switch-off, and are much better than spark gaps and other discharge devices for absorbing the effects of secondary lightning strikes.

In the latter connection it's interesting to see the effect of such a v.d.r. on the waveform produced by a lightning simulator test circuit – see Fig. 1(a). The 10 μF electrolytic is charged to 2kV and then discharged via a spark gap followed by an RC network. Without protection the full voltage surge shown at (b) will be applied to any equipment linked to the circuit. As shown at (c), the use of a suitable v.d.r. (data courtesy of Mullard Ltd.) limits the surge to less than 600V.

Causes of Transients

Apart from direct or indirect lightning strikes, other causes of externally produced transients in the power supply are highly inductive loads being switched off, highly capacitive loads being switched on, and high-amperage fuses rupturing. Transients can be produced within electrical equipment by arcing across switch contacts, by switched rectifier circuits and by sudden changes in current loading. Fault conditions which result in a momentary break in current flow will also cause transients, especially where iron-cored transformers or chokes are involved.

Characteristics

It has been found that externally produced transients vary in duration from a few microseconds to some tens of milliseconds, the higher voltage spikes usually being of much shorter duration and energy level than those of lower voltage.

Tests suggest that in industrial premises spikes with an amplitude of 100-200V occur on average about a thousand times a day, 200-300V spikes occur about two hundred times and 300-400V spikes about five times a day. Really high-voltage spikes were noted rather less than once a day.

On the domestic side, a blown 20A mains fuse could cause a 1,030V, 30μs transient.

Mains Filter Capacitor

Research into mains-borne transients has been largely concerned with the protection of thyristor controlled power and motor control circuits. There seems to be little information on their effects on domestic equipment. All types of TV receiver however incorporate a mains filter capacitor across the mains input, and this largely absorbs

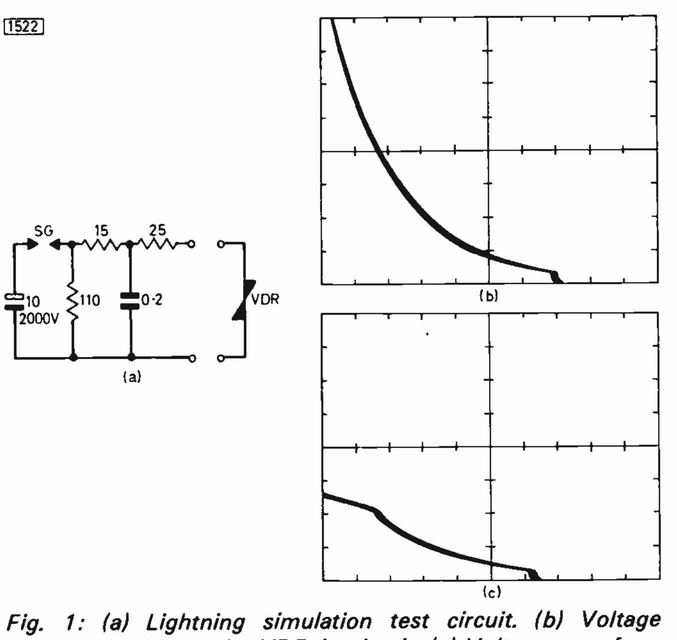


Fig. 1: (a) Lightning simulation test circuit. (b) Voltage waveform without the VDR in circuit. (c) Voltage waveform with VDR included. Vertical scale 200V/division, horizontal scale 500μs/division. Courtesy Mullard Ltd.

short-term voltage spikes. It seems though that they don't always stand up to the job, causing violent disruption of the mains fuse should they go short-circuit.

It's been my experience that the incidence of mains filter capacitor failure has increased in recent years, and in particular they seem to fail quite often in colour receivers. This raises the question as to whether the mains supply is getting dirtier as more, diverse equipment is brought into operation, or whether the causes lie within the set.

Since the cabinet temperature inside modern solid-state receivers is less than that in older valve and hybrid sets with mains droppers and so on, the effect of temperature can't be blamed for the failure of mains filter capacitors. Assuming that the capacitors are up to standard in the first place, the causes of failure are probably due to a combination of several factors – the effects of e.h.t. flashovers, "resonant" voltages across the input impedance, the pulsey nature of the a.c. feed to the mains rectifier, especially if it's a thyristor – this can itself instigate transients – and to some extent the greater possibility of arcing across the mains switch contacts due to the greatly increased current demand.

Mains Fuse Failure

A shattered mains input fuse with no apparent cause does not necessarily mean that something is amiss with the mains filter capacitor. It must be borne in mind that a shattered fuse is not necessarily due to a really tremendous overload current. If the fuse wire breaks for example, as often occurs due to frailty or ageing, a momentary miniature arc which maintains the current flow may be maintained, the resultant heat giving the fuse the look of having blown as a result of a massive overload.

From personal experience I have found that mains fuse blowing for no immediately obvious reason in sets with conventional power supply and line output circuits have been due to the following causes: a defective, incorrect or fatigued fuse; the effect of e.h.t. flashovers on the power supply and line output circuits; sparkovers inside boost diodes and line output pentodes; flashovers in triplers; and lazy sinewave oscillator stages which take much longer than usual to come into operation and provide drive for a valve line output stage.

ITT have reported that at one stage they found instances of unexplained fuse blowing in the CVC5 chassis to be due to "faulty manufacture of the fuse". It was found that the type of fuse concerned could be made to go open-circuit by simply being rolled down the bench! Explanations considered were that the wire was of a very close tolerance or possibly brittle, so that the slightest vibration caused a break. Needless to say the type of fuse was soon changed.

RRI have commented that failure of the 5A fuse in their A823 chassis might be due to the initial high current taken as the h.t. reservoir capacitor charges, especially if the set has not been switched on for several days. They also point out that replacement fuses may not have been of the correct anti-surge type. The correct fuse now specified by RRI for use in this position is a 3·15A anti-surge type.

On the subject of lazy sinewave line oscillators, while the PCF802 valve itself can be the culprit so too can polystyrene capacitors used in these circuits. If this is suspected, fit a different type.

The incidence of unexplained mains fuse failure is certainly on the increase. The mains filter capacitor is often held to be responsible due to intermittent shorting. Somehow, this seems doubtful. Perhaps others would like to comment on this subject. ■

Test Report:

Automatic Semiconductor

E. Trundle

THE Datest 1 is a new type of semiconductor tester capable of checking diodes and operational amplifier i.c.s as well as field effect and bipolar transistors. Transistors can be checked in circuit by means of a set of probes which come with the instrument. The read-out is presented in digital form – in fact by a matrix of l.e.d.s which give a characteristic pattern, different for each type of device. A go/no go indication is given simply by the display ceasing to flash. The pattern of the stationary display then indicates the polarity and type of the device under test. Finally, a three-position switch selects checks on gain and leakage. Diodes may be checked on a go/no go basis, or for leakage. It's not necessary to know the type, polarity or pin connections of a device prior to testing: all this information is supplied by the instrument. Connections for an external meter allow h_{FE}, I_{CBO} and other parameters to be ascertained with more accuracy.

Description

The instrument operates by reversing the polarity of the supply to the device under test until a stable state is established at the preset collector current. It then monitors the polarity of the collector voltage, emitter voltage, and base voltage and current. These are read-out by the display l.e.d.s. Four i.c.s are used in the instrument, plus six transistors. There are two fibreglass printed boards. The tester is housed in a plastic case and powered by a PP3 battery. Three transistor sockets are provided, together with sockets to accept three types of operational amplifier i.c.s. A spring-loaded push-button saves battery life when testing out of circuit; insertion of the probe switches the device on for in-circuit tests.

On the Bench . . .

The brightness of the display l.e.d.s was adequate, even at high ambient light levels. We found it easy to differentiate between silicon and germanium devices, and the tester never failed to reject a faulty device. We had difficulty in raising the 5μA meter required for the leakage and gain tests – such things are not very common! – and a little internal amplification would have been appreciated on the odd occasion when this facility was used. The transistor sockets cater for most types of signal devices, and are able to accommodate lockfit types. There are however many encapsulations, such as the TO3, TO66 and "plastic-power" styles, that require connection by flying leads. The pointed probes intended for in-circuit testing are not really

Datest 1

Tester

suitable for this: we made up flexible leads with mini-croc-clips to overcome the problem.

Diode Tests

No snags were encountered on the diode go/no go test, and we soon found that the diode leakage test is a stringent one which all germanium and some silicon devices could not pass. This is all to the good, but some confusion arose over interpreting the readout on diode leakage, inasmuch as internal reflections from five winking l.e.d.s tended to light up the one extinguished l.e.d. which indicates a good diode. The severity of this effect depended to some extent on the ambient light.

In-circuit Tests

We next turned to the in-circuit testing facility, and were successful with all types of signal transistor and f.e.t. As with the Avo in-circuit tester reviewed some time ago, in direct-coupled circuits where semiconductor junctions are in parallel in-circuit testing cannot be carried out. But this is fair enough – one can hardly expect an instrument to test two or more (possibly opposite polarity) junctions simultaneously! The instruction booklet quotes values of shunting resistance (in each case a few hundred ohms) below which in-circuit testing is not practical. These corresponded closely with our own findings. The Datest 1 fared better than the Avo TT169 with low-gain, high-voltage line output transistors, giving a positive indication of goodness once the base had been isolated from the low-resistance driver circuit.

Parallel Capacitance

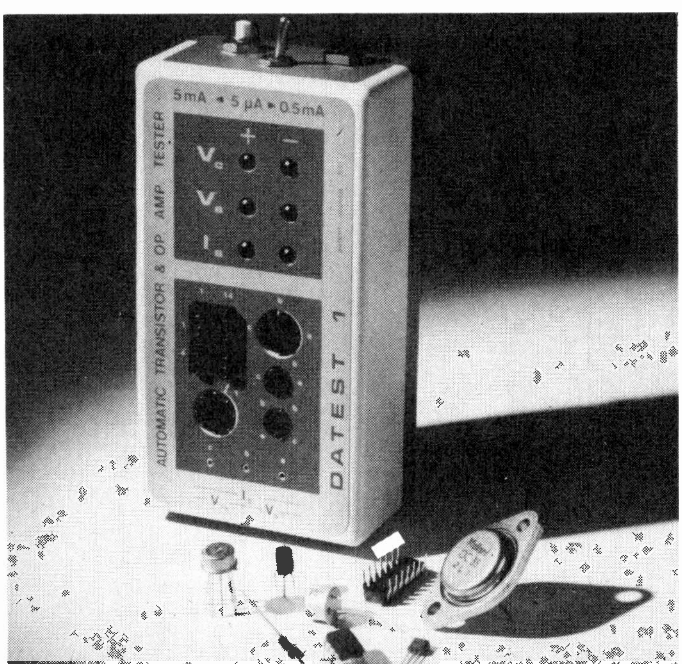
The one point on which the Datest 1 fell short of the opposition was the effect of parallel capacitance across the junction under test. About 100μF was the maximum the instrument would tolerate, as opposed to 2,500μF for the Avo tester. Such large capacitances are very rarely encountered across a junction however, so this is a fairly minor point.

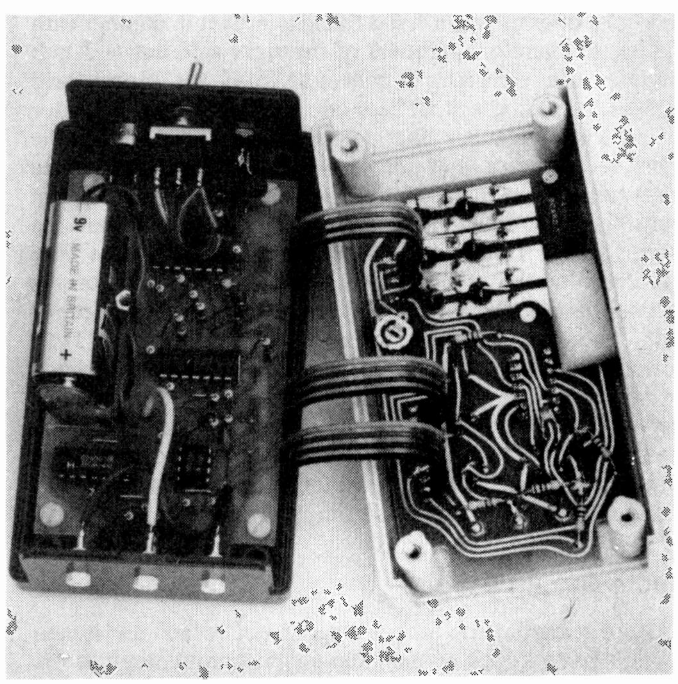
Conclusions

Apart from f_T and breakdown voltage, all the important parameters of a semiconductor device can be established with the Datest 1, and we found no need for our usual analogue transistor tester while this instrument was in our possession. When faced with an odd make of TV or radio receiver for which we had no data or voltage tables, a session with the Datest would very often solve the problem without more ado! A comprehensive manual is supplied, containing a battery-life table and precise technical data as well as operating instructions.

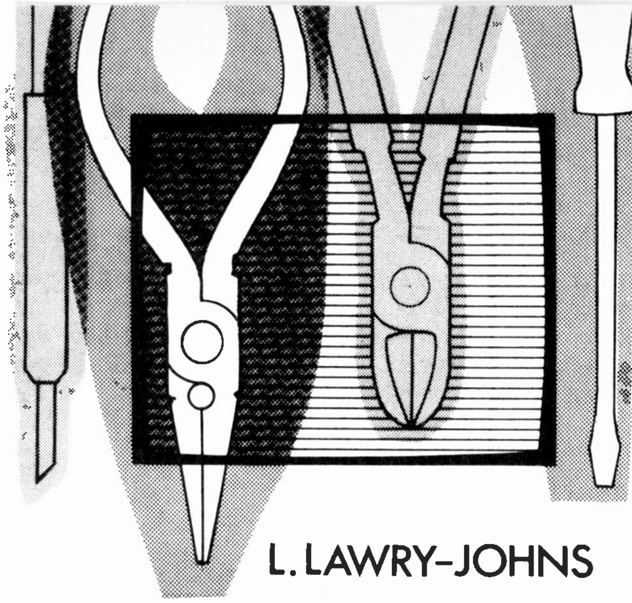
As the reader will by now have gathered, this is no ordinary transistor tester. In view of the facilities offered, the price is by no means excessive. Having parted with over fifty pounds however the purchaser will want to be sure that his investment is going to last the course! To our eyes the only wear-prone parts are the panel-mounted sockets. These are easily replaceable with a minimum of dismantling and are available from the manufacturers. Apart from physical damage it seems very unlikely that the instrument will fail. Should it be required, service is available from the makers. Regarding its usefulness, may we put it this way – the punctuation mark at the end of this sentence means we shall have to send it back, and we shall be sorry to see it go! ■

The Datest 1 is available from Datong Electronics Ltd., 11, Moor Park Avenue, Leeds LS6 4BT. Tel: 0532 755579.





The Datest 1 semiconductor tester. General view left, internal view right.



SERVICING TELEVISION RECEIVERS

PROBLEMS WITH PORTABLES – PART 2

L. LAWRY-JOHNS

Thorn 1590/1/3 Series

The 1590-91 series which followed was of course fully transistorised and suitable for mains or battery supplies. These were and are a very different kettle of fish, and require a somewhat different line of attack in servicing – as do all solid-state (never did like that term) receivers.

There are two main versions, the smaller 3816, 4816, etc. 12in. models and the larger 2818, 6818 14in. models. The latter have a push-button on-off switch at the bottom of the front panel and separate volume and brightness edge type controls at the top: the chassis main panel also has a swing out facility. For full details see the August-September 1974 issues.

Line Output Stage Faults

The main trouble with these sets has proved to be shorts across the supply line blowing the l.t. fuse which hides behind the lower left panel supporting strut. There is often doubt as to why the fuse is blowing, and a handy tip is to appreciate the fact that although the line output transistor (AU113 on most versions but not all) is secured by two nuts and bolts only the right-hand fixing is in fact in contact with the print. Therefore removal of the right side nut and bolt divorces the transistor's collector from the circuit and enables a quick check to be made from emitter to collector to ascertain whether the device is short-circuit. If the transistor is not at fault note that the disconnection kills the feeds taken from the secondary windings on the line output transformer so that one can also tell whether they are the cause of the fuse failure – by seeing whether the fuse continues to blow. We prefer to make a quick check on the rectifier diodes (W13 and W14) and their associated electrolytic reservoir capacitors C110 (10μF) and C111 (1μF) however – either of these can short, due to a defective diode or on their own account thus putting paid to the diode anyway – take your pick! In any case the trouble spots in the line output stage can be picked out quite quickly in most cases. Remember that the boost diode W11 is a special fast-acting type and any old diode simply will not do. See Fig. 3.

Audio Output Stage

Quite often the line output stage is not at fault and it then pays to have a look around the sound output stage at the front centre. The stage has been much modified during production runs, but the basic cause of a short is the output transistors themselves, with consequent damage to the associated emitter resistors etc. We usually fit a matched pair of AC187/01 and AC188/01 and rarely have further trouble. The more up to date circuit using silicon transistors seems a little more reliable but not much and can be exasperating: we have at times (under pressure) fitted the above transistors with a 20Ω bias resistor between the bases of the output pair, as the bias transistor or the associated preset bias adjuster used in this circuit cannot always be relied upon not to go open-circuit and damage the new output pair. This may be frowned upon by some and indeed is not our usual practice, but time does not always allow too much finesse when out in the field and the kids are bawling for their "own set". See Fig.4.

Field Collapse

The field frequently collapses, leaving a line across the centre of the screen, and although this is often transistor trouble (not necessarily one of the output pair) we have occasionally found the 1000μF output coupling electrolytic C78 open-circuit and on two occasions lately have found the diode (W5) between the collectors of the output transistors open-circuit.

Vertical White Line

Talking about white lines, we often receive these sets

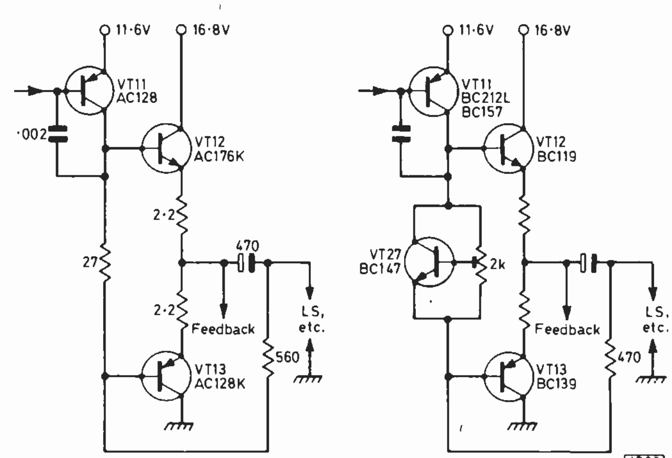
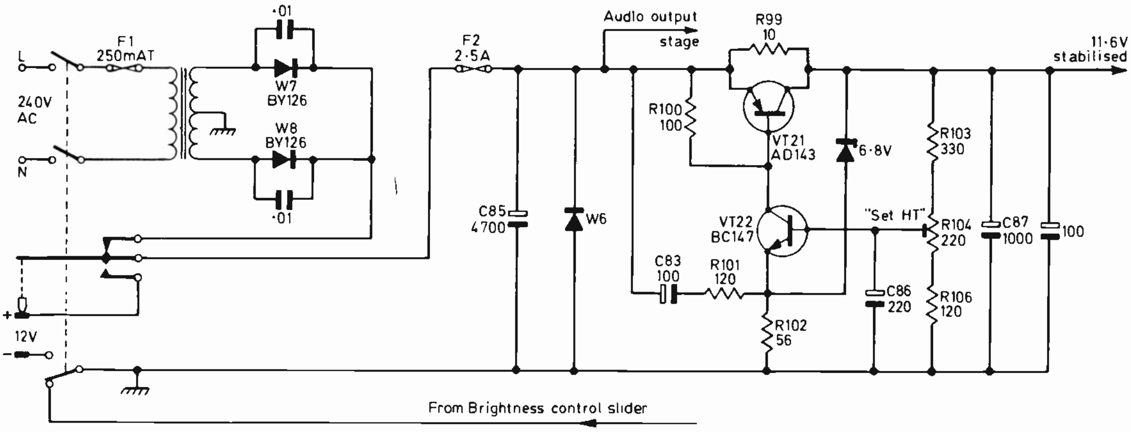


Fig. 4: Audio driver and output circuits used in the Thorn 1590/1/3 series chassis. (a) Original circuit using germanium transistors. (b) Later circuit using silicon transistors.



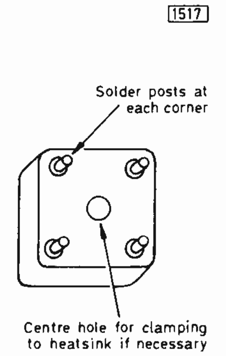


Fig. 5 (left): The power supply circuit used in the Thorn 1590/1/3 chassis. A suitable Mullard replacement for the series regulator transistor VT21 is the AD149.

Fig. 6 (right): Connections to the RS 4A, 100V p.i.v. epoxy-potted silicon bridge rectifier type 261-457.

with the complaint of a white line down the centre. This obviously cannot be due to line timebase failure since e.h.t. is present. Each time it has been due to a dry-joint on the print at point 15 or at the scan coil coupling capacitor C108 which we have not found faulty so far.

There are many other items which we do regularly find faulty however.

Poor Smoothing

We are often confronted with these sets exhibiting the classic symptoms of poor smoothing, i.e. loud hum and a shockingly distorted picture. These symptoms may be intermittent and may suddenly vanish leaving the set working as well as ever. In many cases simply rocking the main smoothing electrolytic C85 may bring on the symptoms, and although the trouble may be nothing more than improper contact between the stud and lead-out tags it is better to replace the thing than to try to patch it up.

Pale Picture

Another regular one is almost complete loss of contrast, and although this could be due to quite a number of things it is always a good plan to check out the video output transistor VT9. Whilst a dry-joint may be present, the transistor is very often at fault. Several types are suitable and we usually fit either a BF336 or a BF337.

A Nasty Occurrence . . .

We could natter on for hours about this chassis, but that would defeat the object of this article which is to have a general look at portables of various makes. Before leaving the 1590 series however we must record a rather nasty happening that occurs quite frequently.

The trouble is that the fault may not be detected before the tube has been ruined – due to its heater being fed from the regulated l.t. supply. The voltage regulator should keep the supply line constant at a trifle over 11V. It is very often the case however that a fault develops in the regulator, causing the picture to become larger and the voltage applied to the c.r.t. heater to be excessive. The best thing that can happen is for a component to fail or the line output transistor to short, thus drawing attention to the situation. Unfortunately this does not always happen, and the tube continues to be overrun until something does happen and the set is sent for repair – only to find that the correct voltage will no longer enable any sort of picture to be resolved.

Several things can cause this rise in l.t. voltage. For example, the AD149 series regulator transistor (VT21) can leak between its emitter and collector, or R103 (see Fig. 5) can change value – to name only two. But this is not the point. When the trouble has been sorted out it is often too late to save the tube.

We adopt a very simple approach to the problem. When we sell one of these sets we always instruct the customer to observe the following drill. Whenever the set is switched on, always look down through the back cover and observe the heater glow. As a result they become used to the normal dull glow of the tube heater, and if the glow gets brighter they detect this immediately, switch the set off and bring it in for inspection before damage can be done. We also advise customers who call to collect sets which have been left for repair for some other reason to carry out this drill. This has paid off on many occasions. Here endeth the lesson. Let's move on

Later Thorn portables do not seem to have established any fault patterns as yet so we'll keep quiet about these for now.

Philips Portables

The Philips T4 chassis is used in the Philips X12T740, Pye TV99 and other sets. We've had a fair crop of faults on these nice little sets but perhaps the most frequent is the most simple to clear. The symptoms are a sudden loss of gain with a very grainy picture. You would think that this could be due to a faulty aerial socket or a duff transistor in the tuner. This is very true, and it sometimes is due to one of these things – or to something else. It is the something else which we have repeatedly found. The tuner unit, which incidentally has a v.h.f. section, being of foreign origin, is secured by screws to the cabinet front and can be removed separately. The i.f. output coaxial cable is taken to the top of the tuner and is bent back on itself and secured in this uncomfortable position. After a time the insulation is punctured and the signals are either lost completely or seriously attenuated. Redress and all is well.

We also have trouble with the rectifiers (four to form a bridge) which seem to short on occasions thus opening one or both of the thermal fuse links. If you are good at jigsaw puzzles, try working out which winding is which on this type mains transformer, which houses the links. If you don't know what we are talking about, you have a rare pleasure in store . . . .

We could write reams on the original Philips T-Vette but there don't seem to be many around now. Readers wanting information should look up the February-March 1973 issues. We haven't much to add to what was said then – line output stage troubles, burn out in the sound output stage, dry-joints on the field output etc. All good fun.

Faulty Bridge Rectifiers

Now what about other British makers or marketers (ah!, the subtlety of it all). Well, let's lump together ITT, GEC and Decca. Not by any means the same sets we hasten to add, but all have a common failing. This is the bridge rectifier. In the ITT and GEC receivers (no need to name models) a block type is used, in the Decca there are usually four separate diodes. Various things can happen. The most obvious is that a diode shorts (look upon the block as four diodes in that order to keep things simple) and blows a fuse. One can go open-circuit to produce hum which distorts the picture, or it may leak to impair the smoothing and give a similar effect. Having repeatedly had this problem we have now settled on a common replacement. For convenience we also use it in other applications, so the unit has a rating well over that required in portable TVs. It is the RS Components 100V 4A bridge rectifier stock No. 261-457. Dearer than most, but oh! so handy. It may be wired free but in most cases can be bolted to the metal work for heatsink purposes, thus further increasing the reliability. See Fig. 6.

Imports

Where does one start with the imports? Far away places and strange sounding names. Singapore, Korea, Taiwan, Hong Kong, Japan, etc., etc. The number of faults is as various as the places of origin, so we don't want to dig too deeply. Usually transistor trouble, often in the final i.f. stage where the signal voltages are higher. We find the BF173 a handy transistor to have around for use in these stages, with the BC109 very handy in the post-detector stages. Carefully identify the base, emitter and collector pins and you shouldn't have much trouble.

Sound Realignment

We are often asked to realign the sound i.f.s when a set has been purchased abroad and the sound i.f. is say 5·5MHz instead of our 6MHz. The job here is to identify the right coil cans (which are often smack under the tube just to make things awkward). This isn't too difficult if you follow the wiring back from the volume control, and once you have access it is just a matter of tuning in the fine gratings on a test card and then bringing the cores in to produce the required sound signal. No need to interfere with the vision i.f. coils at all.

Indesit T12LGB

One of the most frequently met portables comes not from the far east but from Italy. This is the Indesit Model T12LGB and was the subject of a recent article. We haven't much to add except to say that our choice of field output transistors is different. We haven't a lot of faith in the smaller types of "AC" and "BC" medium-power transistors: they just don't seem up to the job. So we prefer to fit a BD131 and a BD132, with their legs crossed and sleeved so that the outer base comes over to the centre position and with a few large washers bolted to the body to form a heatsink – ensure that these cannot touch anything else since they contact the collectors. Crude you may say. Maybe so, but it has put an end to the frequent field collapse lark. One other point. There's no mains transformer, but a large dropper resistor (R908). This has been known to go open-circuit, giving no sound or picture on mains operation.

EHT Rectifiers

Most portables use a single stick e.h.t. rectifier, but there are still some around which use a valve for e.h.t. rectification. As time goes by some deterioration may take place in the insulation, with consequent discharge. This can of course also apply to the end caps of the single stick type.

The point about this is that a good hefty crack of e.h.t. discharge can damage transistors elsewhere in the set. For example we had a Teleton portable in for field collapse. This turned out to be due to defective field oscillator transistors. A new pair restored normal working, but a couple of weeks later back it came with the same transistors defective. The customer mentioned that before the field collapsed he had heard "that crack or click again". To cut a long story short, the e.h.t. rectifier was a valve inside the screened line output compartment. The base was secured to the bottom metalwork by two screws, and the discharge (albeit once per month) was taking place via the screws. We removed the screws and inserted a piece of insulation. The leads were so thick that no additional fixing was necessary . . . and we haven't heard a word since.

So there you are. It's getting late and it's time for bed. Sorry about all we haven't said. Perhaps another time.

Service Notebook

G.R.WILDING

No Red – and Intermittent Green Faces

We were called to see a Finlux colour receiver with the complaint of absence of red in the picture. On removing the back, the RGB output panel was spotted in the top left-hand corner and the heatsink and load resistor of the red output stage were found to be quite cold. The RGB circuits are of the same basic design as used in the RRI A823 chassis and the Decca 10 series. Failure of one of the RGB output transistors to conduct can be due to several causes – an open-circuit emitter resistor, no forward bias from the d.c. coupled driver transistor, or failure of the driver stage for one reason or another. In most cases however, it's the output transistor that's at fault – in this particular case due to a short-circuit base-emitter junction. On fitting a replacement a very good picture was obtained – then, suddenly, the faces on the screen turned from flesh colour to green. This of course is the classic symptom of a PAL switch operating in the wrong phase. Just as suddenly, the picture reverted to normal. The owner then said that the set has been intermittently displaying this fault for some time before the complete absence of red had occurred.

As the small panel with the burst, ident, colour-killer and bistable circuits is mounted directly behind the RGB output panel and is virtually inaccessible for voltage checks we decided to check the tuning of the ident coil. On looking at the circuit however, we discovered that there isn't such a thing! Instead, the burst ripple is used to synchronise a two-stage *RC* oscillator which produces a 13V peak-to-peak 7·8kHz sinewave output. The amplitude of the output is set by a variable resistor in the emitter circuit of the second transistor. It seemed logical to try adjusting this, but the occasional brief appearance of green faces persisted. Before getting involved in component checks in this area we decided to check the tuning of the burst output coil which drives the burst detector. This coil is situated on a small panel to the right of the RGB output panel, with access to the core through a $\frac{1}{8}$in. diameter hole in the RGB panel. Readjustment completely cured the trouble, but on reducing the picture width to the correct size a thin strip of incorrect colour was found to be present at the extreme left-hand edge of the raster. The bistable was clearly switching over slightly too late. Further slight readjustment of the burst output coil removed this trouble too.

Cut-out Operating

The owner of a set fitted with the Thorn 3000 chassis reported that following a series of bright flashes on the screen the picture and all screen illumination went off, the sound continuing for a few seconds before it too petered out. On inspection the cut-out was found to be open-circuit, though all the fuses were intact. The tripler had been changed recently, and in any case there was no suggestion of the odour associated with a faulty selenium type tripler. The only thing to do then was to reset the cut-out, switch on and note developments.

The cut-out tripped immediately, though once more all the fuses remained intact. Next we removed the lead from the e.h.t. transformer to the tripler and tried again. This time the cut-out didn't trip, normal sound developed and a normal arc could be obtained at the transformer's pulse feed connector. Classic symptoms of a defective tripler! On fitting a replacement however the cut-out once again operated, though this time we were able to see a blue flash inside the tube neck. The tube itself was faulty of course, placing a really excessive load on the tripler.

Loss of Picture

The owner of a Pye hybrid colour receiver fitted with the 697 chassis reported that the picture had suddenly gone off, leaving the sound normal, and that a slight burning smell had developed before he hastily switched the set off. On inspection we could find no short or undue leakage across the main reservoir/smoothing electrolytics, and no shorts or heater-cathode leakage in the PY500 and PL509 line output stage valves. This is one of the Pye hybrid sets with the printed circuit line timebase panel, but it was difficult to see with certainty whether any of the components mounted on it were damaged. Accordingly, we switched the set on again and kept a careful watch on the components in this area. After a few minutes, when the PY500 and PL509 had warmed up and come into operation, a thin wisp of smoke arose from a carbon resistor about half way down the panel.

On switching off we found that this was R227 (100kΩ) which, together with C224 (0·1μF), filters the boost voltage feed to the c.r.t. first anode controls (see Fig. 1). We then found that this resistor had fallen in value to only a few hundred ohms, though C224 was perfect and there was no circuit short or loading across the resistor. On fitting a replacement normal results were obtained.

The sequence of events must have been as follows – it's quite common with some types of carbon resistor. First there is a slight fall in value. This results in increased current flow and thus increased operating temperature. The effect is cumulative, with a continuous fall in value. Such resistors can quickly change from quite high to low values. In this circuit of course the high boost potential is applied to the resistor which is thus subject to considerable strain. It might seem that even so such a substantial reduction in

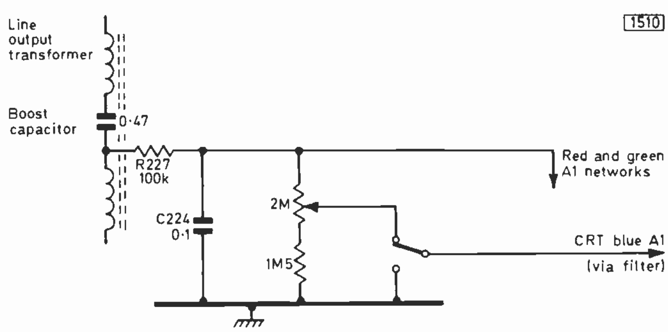


Fig. 1: The c.r.t. first anode supply on the Pye hybrid colour chassis. The filter components R227/C224 between the boost line and the first anode preset potentiometers are a regular source of trouble on these chassis.

value should not cause loss of picture, since the resistor feeds the 2MΩ presets which are each returned to chassis via 1·5MΩ limiting resistors. The very low value to which R227 fell however would have had the effect of placing C224 across the boost tapping on the line output transformer and chassis. C224 would have damped the inductance of the transformer therefore, preventing the line output valve operating normally and causing both this and the boost diode to pass excessive current.

Corona

The owner of an 18in. Pye colour set complained that there were occasional spots on the screen, rather like car interference, and that there was a faint hissing noise from inside the cabinet. On inspection we noticed slight corona around the leadout wires from the tripler, undoubtedly due to the damp air stream from a nearby small open window. Wiping the surface of the tripler, the e.h.t. lead to the tube and the final anode connector with a clean, dry cloth removed most of the moisture, but to really dry it out we placed a hair dryer near the tripler and left it running for several minutes. On retesting, there was no further corona. When a tripler breaks down there is no remedy except for replacement, but always make sure that surface leakage can't be cured by drying out.

Field Sync Diode

The ITT CVC5 and subsequent similar hybrid chassis use a conventional PCL805 oscillator/output pentode field timebase circuit, with the negative-going field sync pulses applied to the cathode of the triode section of the valve. The cathode is returned to chassis via an OA91 clipper diode connected with its anode to the triode cathode and its cathode to chassis, the diode being forward biased from the h.t. rail via a 5·6MΩ resistor. The negative-going field sync pulse initiates the flyback by switching the triode on. The clipper diode has a tendency to break down however, going either short- or open-circuit. In the former case the sync pulses can no longer control the oscillator, so that the picture simply rolls one way or the other. In the latter case there is field collapse since the triode can no longer conduct. The diode is conveniently mounted on the field timebase panel between the hold and height controls, and is worth checking first thing when either of these faults develops.

Rank A823 Series

The owner of one of these sets told us that the colour used to occasionally drop out while viewing but could be restored by changing channels. Now it had gone completely however. Loss of colour can be due to many causes on this chassis of course, but our first suspect is always the BC 148 transistor 2VT7 on the i.f. panel. This again proved to be the case, a replacement restoring full colour. The transistor is inside the controlled chroma i.f. can and is used to provide the a.c.c. action.

A fairly common fault on these models is low h.t. due to partially dried up reservoir/smoothing electrolytics. After replacing these capacitors always check the h.t. voltage since the "set e.h.t." control 8RV1 may well have been advanced previously in order to compensate for the reduced h.t. voltage. Excessive h.t. voltage, and thus e.h.t., is one of the most common causes of tripler and transformer breakdowns, quite apart from degrading the convergence.

A Two-Aerial Installation

Malcolm Burrell

As the number of television transmitters increases, while modern receivers have comparatively high gain, many people are finding that receiving an alternative station gives them a greater choice of programme material.

Using Two Aerials

The usual approach is to use two separate aerials, of the appropriate channel groupings, one directed to each transmitter. This entails fitting a switch on or near the receiver in order to change over from one aerial to the other. Alternatively there are those, to whom one seems to have to make frequent service calls to repair worn aerial sockets, who prefer manual swapping to the use of a switch. Then there are the enlightened few who are able to employ a diplexer to combine the outputs from the two aerials and can do this without any ill effects. This has the advantage that the extra channels can be selected by simply pressing the appropriate tuner button. It's the approach I adopted.

When I erected my aerials and linked the two outputs I found that reception of the local transmitter (Sudbury) was marred by ghosting due to nearby buildings and trees, while reception from the alternative transmitter (Crystal Palace) was so weak that a high-gain aerial and two mast-head preamplifiers connected in cascade had to be used in order to get reasonable results.

Distribution Amplifier

I use a distribution amplifier since more than one set at a

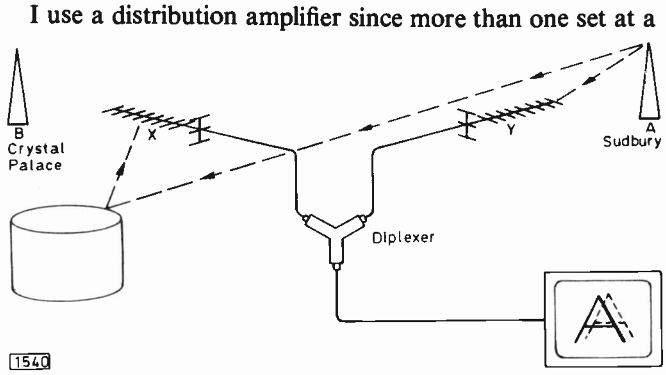


Fig. 1: The use of a diplexer simplified the installation but lead to unwanted signal pickup by aerial X during reception from station A (Sudbury), with the result that the picture was spoilt by ghosting.

time is often in use in the house – the high costs of aerials and the necessary roof-top hardware makes the use of separate aerials for each set impractical. With this system it would have been possible to use a switch to select between the two aerials for the two transmitters regularly received. But this would have meant that all sets had to receive the same station, and that could have had unfortunate domestic results!

Ghosting Problem

I experimented with an RS Components diplexer which turned out to be excellent in causing little attenuation or mismatching. Unfortunately however local reception from Sudbury was badly spoilt by ghosting due to reflected signal pick up by the aerial directed at the Crystal Palace transmitter. The situation is shown in Fig. 1. The Sudbury aerial had been painstakingly positioned so as to minimise ghosting, but the Crystal Palace aerial, pointing in roughly the opposite direction, responded to the reflected signals. Despite the fact that two group A preamplifiers were used with the Crystal Palace aerial the gain was sufficient to provide unwanted group B channel signals when the sets were tuned to these. It was decided therefore to investigate ways of "tuning" the output from this aerial so that the only signals it provided were those from Crystal Palace.

Stub Traps

The first method to be tried was suggested by a colleague and was only partially successful. This was to insert open-ended stubs at the Crystal Palace aerial side of the diplexer, each stub laboriously cut to minimise an unwanted signal. To do this the set was tuned to channel 41 and, beginning with about three feet of standard coaxial cable, a quarter of an inch at a time was snipped off until the point of minimum gain was reached. This is a tricky procedure because if too much cable is cut off the process has to be started again with a new length. Having cut a stub for this channel, it was then necessary to carry out the same procedure for channels 44 and 51, making three stubs in all. The result of all this was that with both aerials connected via the diplexer there was only a comparatively faint ghost on the picture. The cable termination was decidedly untidy however and since only the ITV station from Crystal Palace was wanted I decided to investigate other possible solutions to the problem.

Tuner Solves Problem

From a pile of goodies in the shed I dug a transistorised Thorn u.h.f. tuner – one from the 1500 chassis. This was temporarily connected to a 9V battery and the Crystal Palace aerial was plugged into its aerial socket – miraculously still intact. I then took a length of coaxial cable to the aerial socket of one of the sets, and with the other end probed inside the opened tuner. While swinging the tuning gang capacitors to and fro a point was found where, with the coaxial output cable connected directly to the mixer transistor (see Fig. 2), maximum signal could be obtained on channel 23. Reception with the cable connected thus and the gang left in position was checked on other channels, and found to be very low: the tuner was acting as a narrow-band amplifier.

The connections were tidied up and the cover refitted on the tuner to prevent stray signal pick up. By taking the output direct from the collector of the mixer transister the oscillator is damped, preventing any spurious patterning:

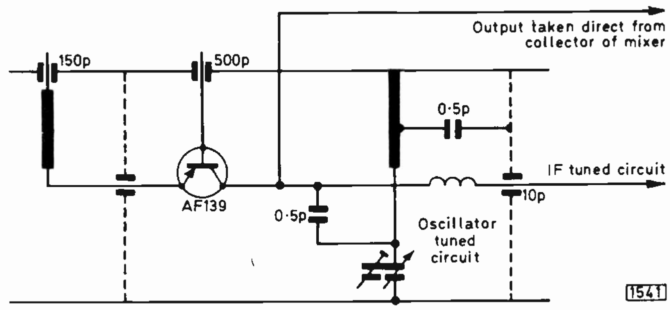


Fig. 2: Pressing an old tuner unit into service as a narrow-band amplifier. Take the output directly from the collector of the mixer transistor, not from the i.f. output point. The tuner unit used was one from a Thorn 1500 chassis.

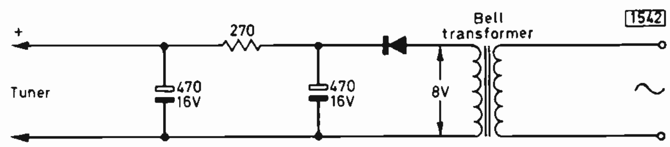


Fig. 3: Suitable power supply for the tuner – the component values shown are a guide only.

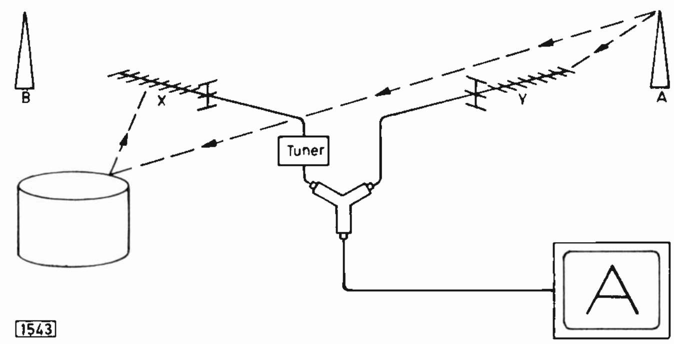


Fig. 4: The final installation. The tuner attenuates the signal picked up by aerial X when receiving station A.

this at the same time provides a convenient though rather approximate impedance match. A power supply (see Fig. 3) using a bell transformer was constructed for the tuner and the whole unit was mounted near the aerial distribution amplifier. The power supply can be quite simple and is not critical – though the smoothing must be adequate to avoid a hum bar mysteriously appearing on one or more channels.

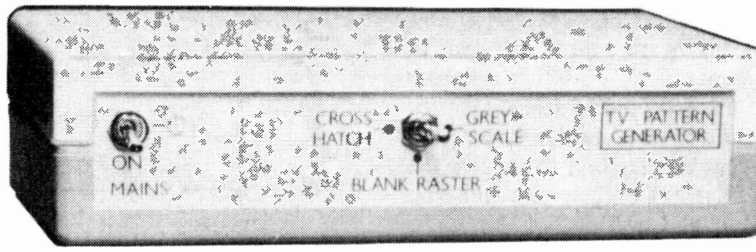
Final Installation

There is no reason why such a system – outlined in Fig. 4 – should not be used to enable the outputs from two or more aerials to be combined. One obvious use would be where satisfactory reception of all three programmes from a transmitter cannot be obtained without employing two aerials mounted in different positions.

The gain of a tuner used in this way is probably not as good as could be obtained from a suitable narrow-band amplifier. By tweeking the gang capacitor vanes for maximum signal on one channel however the gain is better than unity. It's also prudent to ensure that in doing this the bandwidth has not been so reduced that the chrominance information is being attenuated. A Mullard rotary u.h.f. tuner has also been tried successfully.

The unit has been in use for some months without problems and has enabled four programmes (three local, one distant) to be instantly selected, a thing that would not have been possible otherwise. ■

TV PATTERN GENERATOR



P.J.STONARD

PART 3

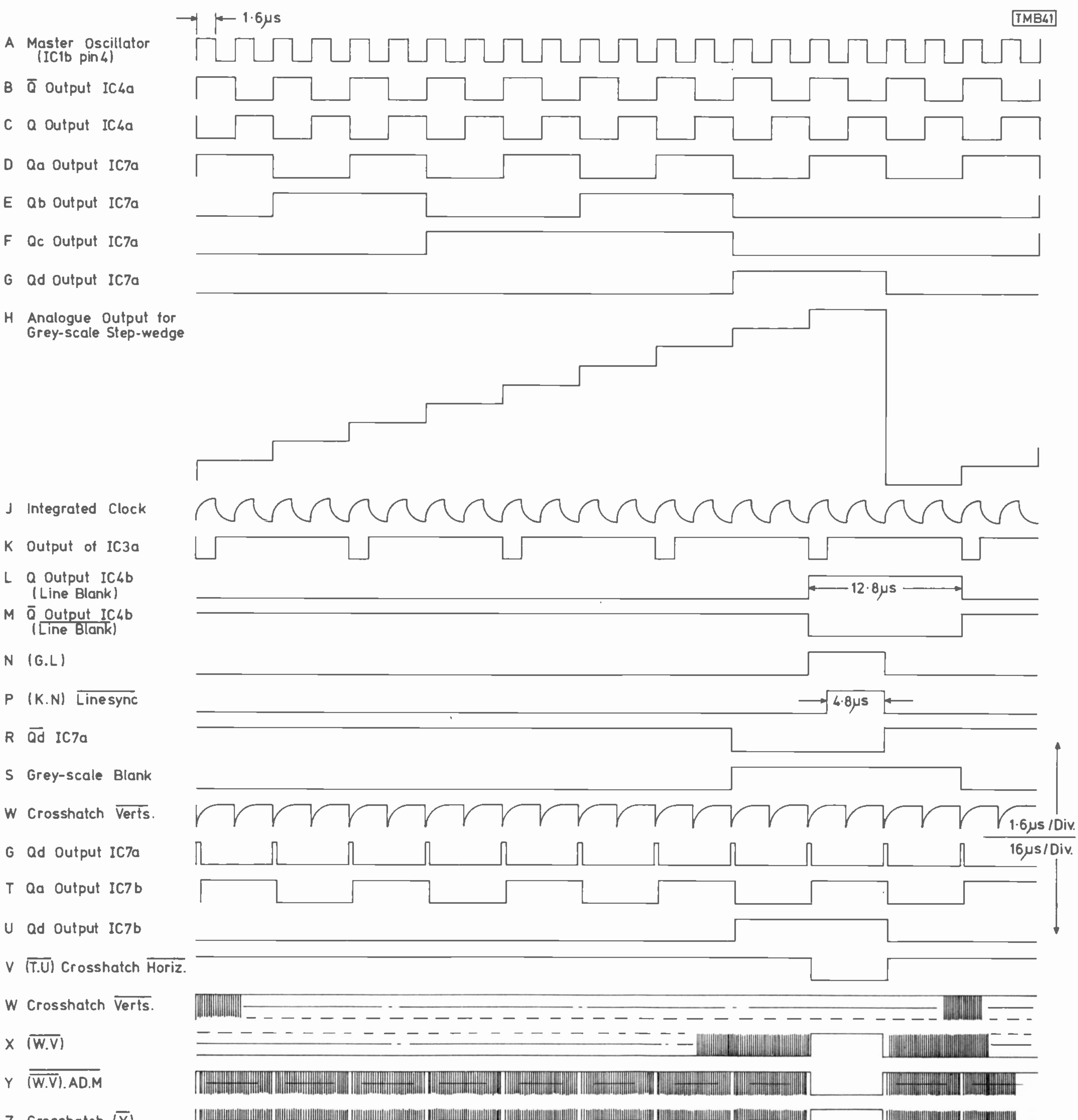


Fig. 4: Timing diagram. The waveforms above are related to line rate. Note that all waveforms except H are binary. S and Z have field components which are not shown. Shading on waveforms W, X, Y and Z represent fast pulses.

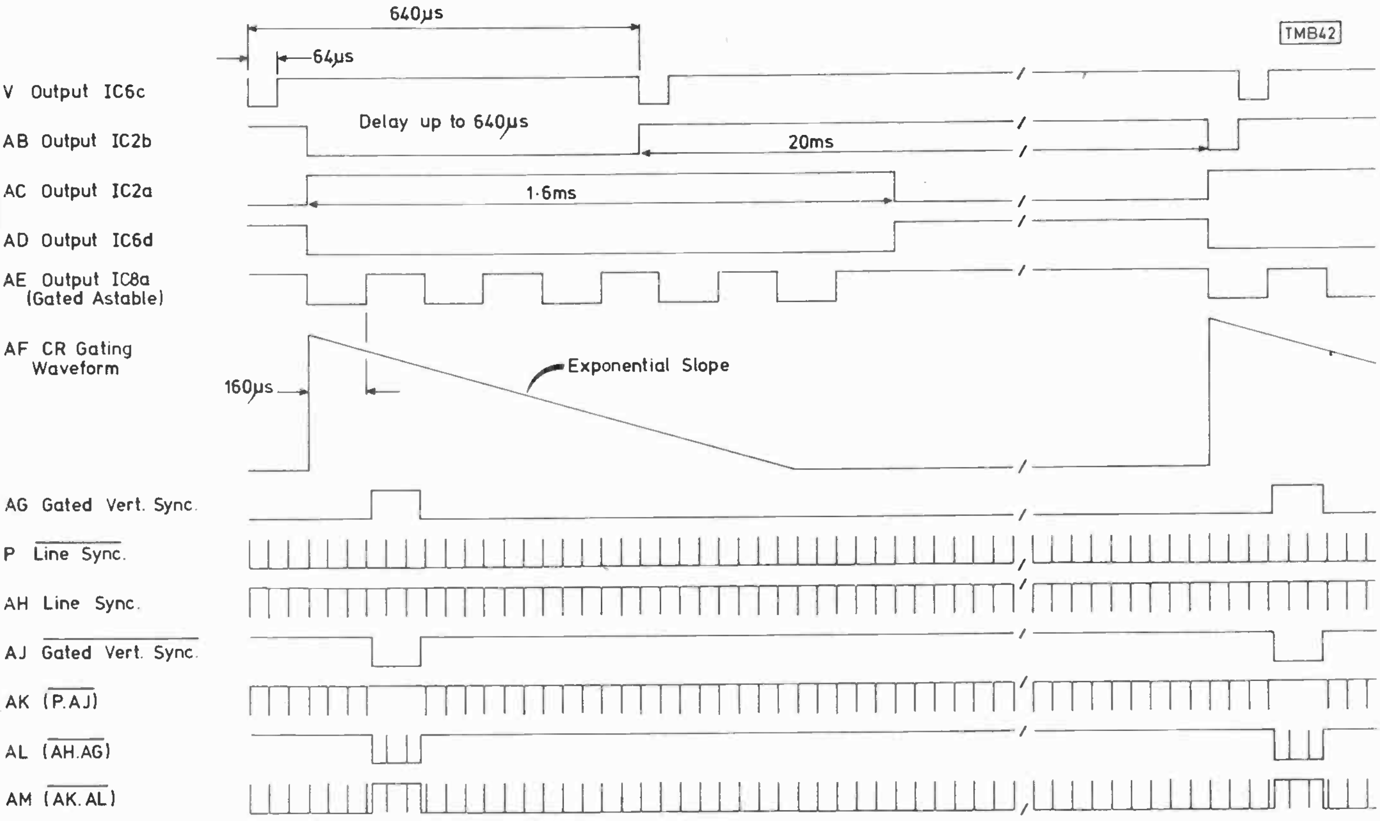


Fig. 5: Timing diagram with waveforms related to field rate. As with Fig. 4, these waveforms are ideal and some differences will be apparent when viewed on a scope.

Servicing the Beovision 2600/3000/3200 Chassis

Part 1

Keith Cummins

THE Beovision 3000 was the first B and O TV receiver to be imported into the UK. Quality audio products from this Danish manufacturer had been available for some years, and the arrival of their colour TV proved to be worth waiting for. At that time, in 1967, the single-standard receiver was of minority interest only, BBC-2 being the sole source of colour pictures.

The Beovision 3000 is a 625-line v.h.f./u.h.f. receiver fitted with a 25in. picture tube. It was followed by the 2600 and 3200, the former being a 22in. and the latter a 26in. version. The two later models employ circuit designs almost identical to the 3000 – except for some up-dating modifications.

Performance

My first experience of the 3000 receiver occurred at a local radio exhibition. We were promised that a 3000 would be provided, and the receiver arrived on the day. It was a little while before it was taken to the show, and by that time the other exhibitors all had their colour TVs running. The 3000 was duly put on display, and its outstanding performance drew a large crowd. After a couple of hours or so we became aware that the majority of the other exhibitors had turned their receivers off, leaving the B and O reigning supreme. I quote this instance to indicate just what a superb design this set represents: the B and O claim of placing quality and design before cost is amply justified in this case.

Basically, the receiver employs a "no-compromise" design. Because of this it is somewhat complicated. It certainly presents a daunting prospect to the inexperienced, and in fact if handled incorrectly can be very dangerous in the area of the e.h.t. supply.

Chassis Layout

The set is built on two chassis. A vertically mounted receiver chassis carries the tuner, the i.f. stages, the a.g.c. circuit, and early chrominance, luminance and a.f. stages (apart from the output valves). User controls provided are six tuning buttons, which are linked by an excellent B and O mechanism to a three-band Philips tuner, an on/off and volume control and, in "pop out" drawers, contrast, brightness, hue (tint), saturation, bass and treble controls.

The main chassis carries the output stages, colour decoder, power supplies and timebases. The convergence panel is situated behind a removable cabinet section to the left of the tube on the large screen versions; on the 2600 it flaps out from the bottom of the receiver – a fact which can make life very difficult at times if the receiver is not mounted on a stand.

CRT Drive

The receivers use colour-difference c.r.t. drive, with immaculate bi-directional clamping at each tube grid. The clamp diodes are all thermionic types – to avoid breakdowns caused by the odd tube flashover – and employ four type EAA91 valves (replaceable by type EB91). The colour-difference output valves are type ECL84, with two of the triodes in these valves being used in the field blanking circuit. The luminance output valve is a 12HG7, an American type with no European equivalent. It was chosen for its particular capability of providing a large linear voltage swing with adequate bandwidth.

Timebases

Now some general remarks on the timebases. The field timebase employs valves ECC81 and PL508, and is capable of providing a virtually perfect vertical scan. The line timebase consists of a PCF802 sinewave oscillator and reactance stage driving a PL504 line output valve with PY88 efficiency diode. The line timebase is not called upon to provide e.h.t.: this is provided by a separate e.h.t. generator circuit which uses a PL509 output valve with PY500A damper, a GY501 e.h.t. rectifier and a PCC85 which acts as driver and regulator. The use of separate line scanning and e.h.t. generator stages provides an extremely stable picture, bearing in mind the black-level clamps mentioned earlier.

The e.h.t. supply is capable of supplying a peak current of 7mA at 25kV, and is highly lethal since it employs virtually instantaneous regulation totally devoid of hunting or "breathing" effects.

This brief discourse, prior to getting down to the circuitry in detail, will give a good idea of how this B and O receiver achieves such outstanding performance. The total lack of raster movement and excellent linearity, grey scale, convergence and colour combine to produce a stability and accuracy of presentation which can hardly be bettered. Watching a programme is a delight for the technician, since there are no imperfections to detract from his enjoyment.

Tuner Unit

The Philips tuner is of the mechanical type and yields an excellent signal-to-noise ratio. Although varicap tuners were available when the receiver was designed, the early versions had an inferior signal-to-noise ratio and B and O decided to stick to the mechanical type. The frequency stability, even on v.h.f., is particularly good and no a.f.c. system is provided. The output from the tuner is taken via the input selective filter network to the first i.f. transistor Tr1. This stage has a.g.c. applied to its base and is fed from a stabilised 12V supply rail – delayed a.g.c. is applied to the tuner.

IF Stages

The following two i.f. stages, Tr2 and Tr3, are fed from a 27V rail to enable good signal handling without cross-modulation to be achieved. Tr3 drives the luminance detector circuit. Besides driving Tr3, the output from Tr2 is also fed to Tr15, a separate i.f. stage catering for the

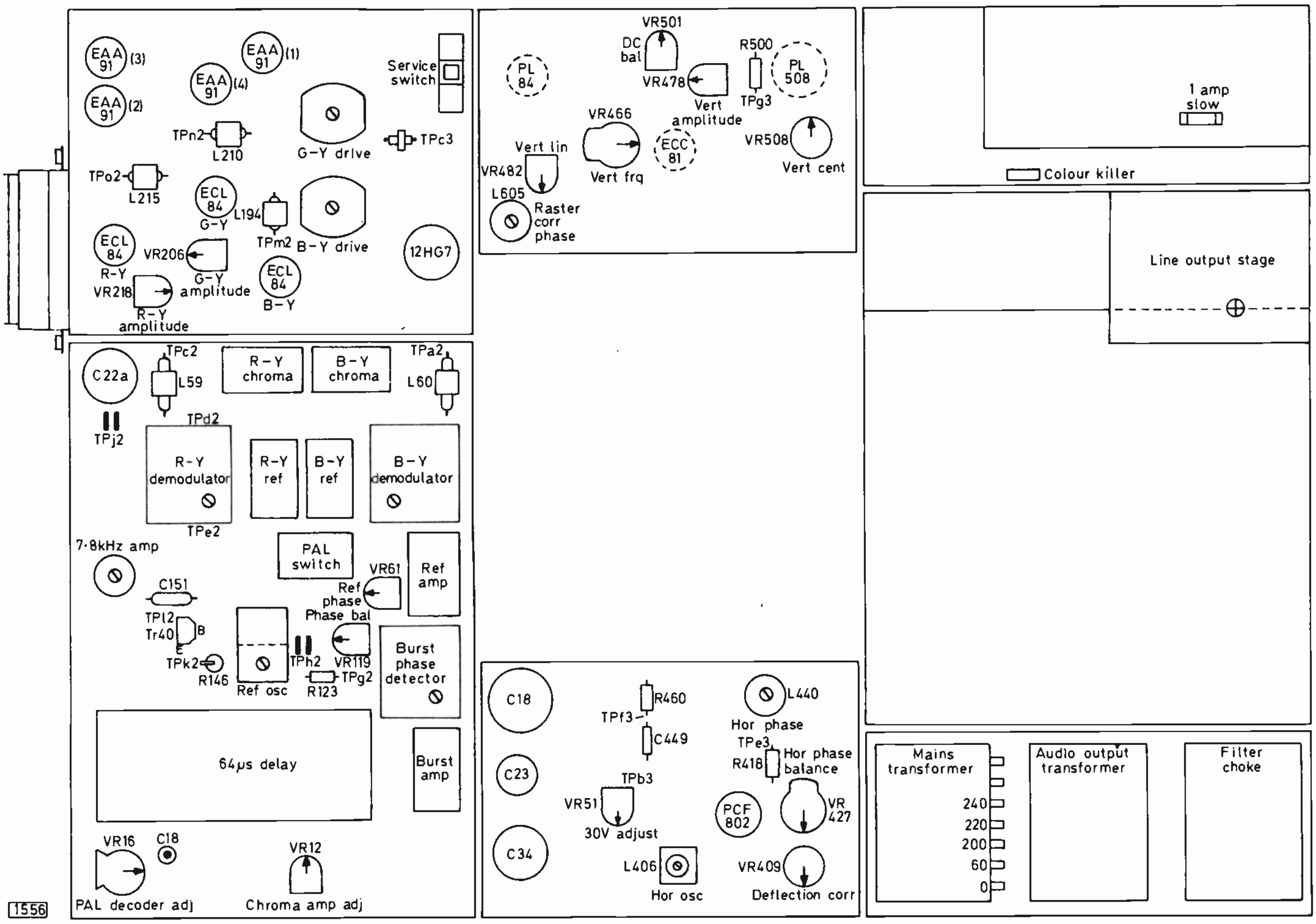


Fig. 1: Rear chassis view.

chrominance and intercarrier sound signals only: we shall return to this part later.

Luminance Channel

The luminance detector D1 is d.c. coupled, via i.f. filtering, to the base of Tr4, an emitter-follower stage driving the luminance phase splitter Tr5. The emitter output of Tr5 is taken to the sync and a.g.c. circuits, while negative-going luminance from the collector feeds the contrast control. The contrast control itself forms the "diagonal" link in a bridge circuit consisting of resistor R145, Tr5 and resistors R154, R157 and R160. The circuit is d.c. coupled and it is important that adjustment of the contrast should not affect the d.c. level – hence the use of the bridge circuit. A 4·43MHz trap coupled to the collector of Tr5 is diode-switched by the colour-killer bias so that it operates on colour transmissions only, reducing the subcarrier interference.

The slider of the contrast control is connected to the base of amplifier Tr6. A tuned circuit at 6MHz provides emitter feedback to eliminate sound patterning. The collector of Tr6 feeds the luminance delay line, which is accurately terminated by components R165, L166, R170 and L171. The delay line output is buffered by emitter-follower Tr7 before being taken to the luminance output stage.

Sync Circuit

We must now return to the sync and a.g.c. arrangements. Tr11 and Tr10 form a two-stage sync separator which produces a negative-going sync output at the collector of Tr10. The d.c. path from Tr10's emitter to chassis is completed by Tr9 which is normally conducting – as a result of the permanent base current through resistor R207. Fed from the luminance detector stage however is the noise detector diode D3, coupled to Tr8. Tr8 is normally non-conductive, but if a large noise or interference pulse is rectified by D3, Tr8 turns on. The resultant rapid collapse of Tr8's collector voltage is conveyed by capacitor C208 to the base of Tr9. This latter transistor turns off for the duration of the noise pulse, and hence any spurious output from the sync separator, in response to noise, is eliminated.

This sophisticated approach is more essential for v.h.f. reception of negatively-modulated video signals, where interference is much worse than on u.h.f. It should be remembered that 625-line transmissions take place on all Bands over most of the Continent and in Denmark where the sets come from.

AGC Circuit

Tr14 is a gated signal-measuring stage for the automatic gain control system. A negative pulse from a winding on the line output transformer is applied via diode D4 to the collector of Tr14. This gating action takes place during the line sync period, which always represents 100% modulation. So a measure of signal strength is achieved by monitoring the current flowing through Tr14 during the gating period. Remember that Tr14 is turned on by a negative shift of its base voltage, d.c. coupled from the detector diode D1, which produces a negative output with positive-going luminance.

The "cold" end of the line output transformer's gating winding is connected to capacitor C199 which acquires a positive charge to a level determined by the conduction of

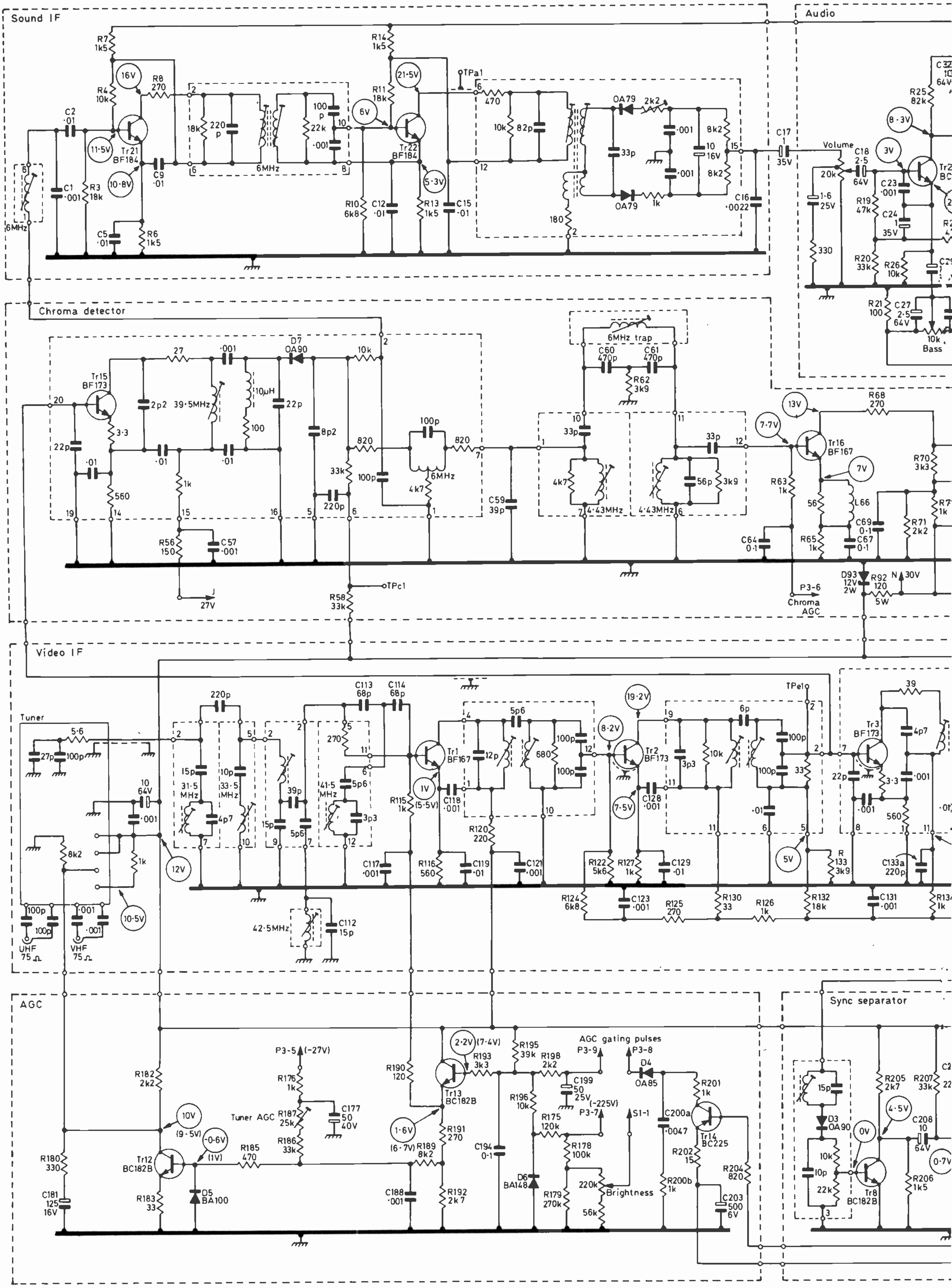
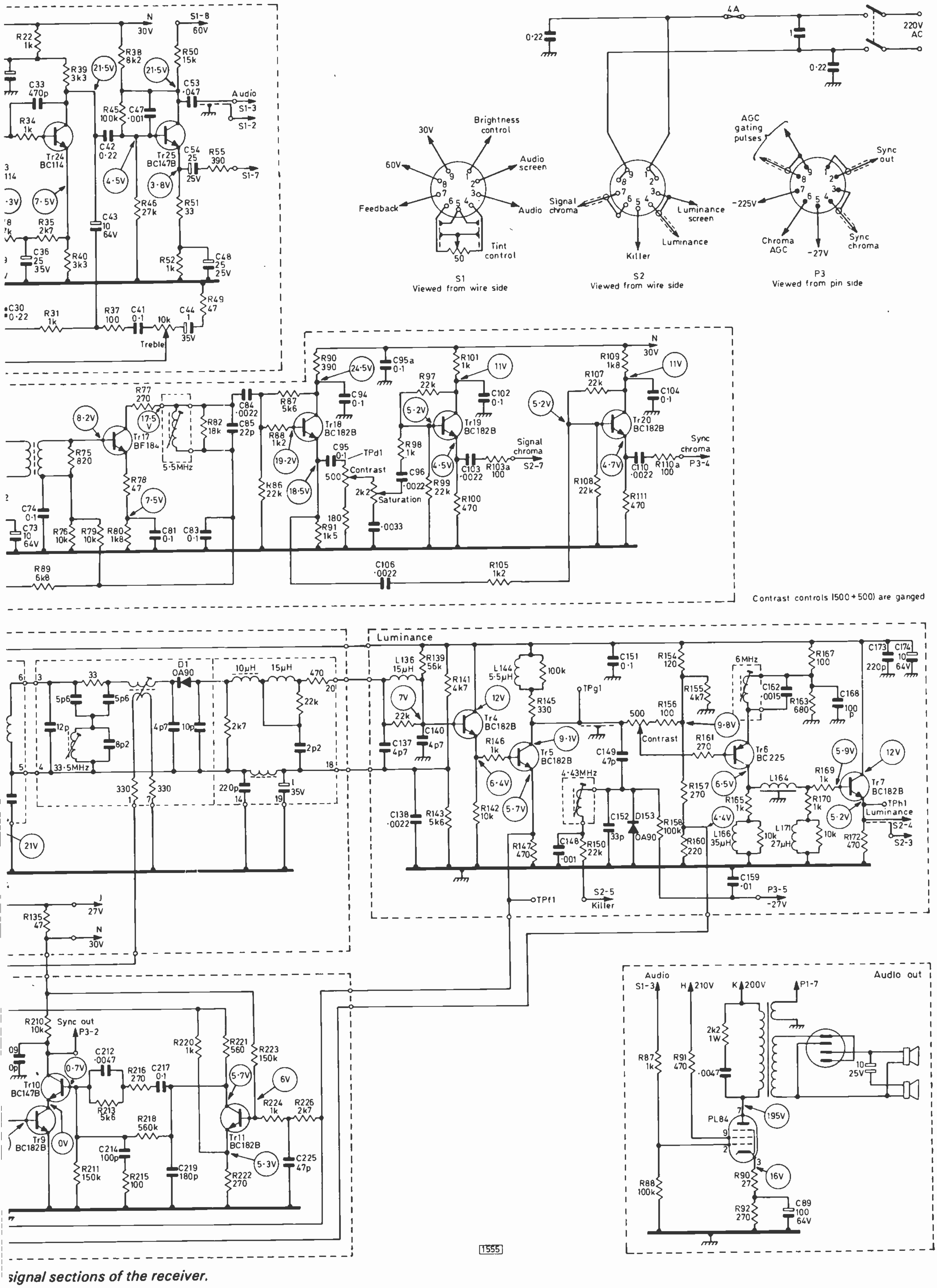


Fig. 2: Circuit diagram of the s



signal sections of the receiver.

Tr14. The positive voltage developed across capacitor C199 is a measure of the signal strength therefore, and can be used to control the gain of the receiver.

Tr13 is a d.c. emitter-follower which provides forward a.g.c. to the base of Tr1. Tr12 controls the tuner a.g.c. rail, the "take-over" point being controlled by a negative bias via potentiometer R187. This negative bias is normally clamped by diode D5 under low-signal conditions. Under high-signal conditions the bias is overcome by the positive feed from Tr13 emitter, so enabling Tr12 to be turned on to reduce the gain of the tuner.

Because this B and O chassis is a hybrid one – employing both valves and transistors – no a.g.c. gating is available until the line output stage has warmed up. Precautions have been taken therefore to prevent the receiver side from operating "flat out", i.e. with no a.g.c., during the warm-up period. The −225V supply applied to resistor R175 normally forward biases diode D6. During warm-up however this −225V supply, derived from the line timebase, is not present. D6 is open-circuit therefore, the junction of R195 and R196 moving positively. This turns Tr13 on and "kills" the i.f. stage Tr1 and the tuner until the line output stage is operative.

Sound Channel

To complete our examination of the receiver chassis we must turn to the chrominance and sound section, starting with Tr15. This transistor drives diode D7 which acts as demodulator for the chrominance signal and intercarrier mixer for the sound. Thus the output from D7 consists of a 6MHz sound signal and a chrominance signal centred on 4·43MHz.

The sound signal is blocked from entering the chroma channel by a 6MHz bridged-T filter. Instead it's diverted to the 6MHz tuned circuit at the base of Tr21, the first intercarrier sound i.f. stage. A double-tuned transformer couples the output of Tr21 to the input of Tr22. Finally the output at the collector of Tr22 feeds a ratio detector circuit which demodulates the sound from the 6MHz f.m. carrier.

The output from the ratio detector is taken to an unusually elaborate sound section consisting of a two-stage transistor amplifier (Tr23 and Tr24) which, with selective feedback, provides comprehensive control of treble and bass, and an output driver stage Tr25. A loudness-compensated volume control is fitted directly after the ratio detector. Negative feedback from the audio output transformer is taken to the emitter of Tr25.

Chroma Signal Path

The chrominance signal is taken via a bandpass filter (which includes a second 6MHz sound trap) to the first chroma amplifier Tr16. This stage is gain controlled by the a.c.c. circuit – which is in the decoder section. Tr16 is transformer coupled to Tr17, and finally feeds the emitter-follower Tr18 via a 5·5MHz "top lift" tuned circuit. Two further emitter-followers are fed from this stage. Tr20 provides the output for the a.c.c. circuit and burst amplifier, while Tr19 provides an output, variable by the colour intensity control, to the chroma delay line and synchronous detectors. Note that while the adjustment of colour intensity can be varied individually there is also a second potentiometer which is ganged to the main contrast control: this ensures that the colour level tracks the luminance level when the contrast is adjusted.

CONTINUED NEXT MONTH

LONG-DISTANCE TELEVISION

ROGER BUNNEY

THERE was a decline in long-distance TV reception during December in comparison to the previous month, and on looking back over my log it's clear that for most of the time the only reception was via MS (Meteor Shower/Scatter) propagation. The exception was the reception of YLE (Finland) ch. E2 via Sporadic E on the 28th. The Geminids meteor shower produced an uplift in MS reception, particularly over the period 13th-15th in Band I. Clive Athowe (Norwich) reports that a good Sporadic E opening occurred on the 9th, with SR-1 (Sweden) on chs. E2, 3 and 4; and NRK (Norway) on chs. E2 and 3. Clive comments that the signals during the morning period were "strong stuff"!

Month's Log

My log for the period follows. For new readers I should point out that I normally log the broadcasting organisation's initials as this often assists with station identification. The first entry for each organisation is always followed by the country. Exceptions are West Germany and Switzerland which have various networks with different initials. In these cases the countries themselves are listed. All loggings are MS unless otherwise indicated.

1/12/76 CST (Czechoslovakia) ch. R1.
2/12/76 CST R1; DR (Denmark) E4; ORF (Austria) E2a; WG (West Germany) E2.
3/12/76 TVP (Poland) R1.
4/12/76 SR (Sweden) E3.
5/12/76 SR E3, 4; WG E4.
6/12/76 TVP R1; WG E2.
9/12/76 SR E4; WG E2, 4.
10/12/76 SR E2, 4; ORF E2a.
11/12/76 SR E2, 4; NRK (Norway) E2; TVP R1.
12/12/76 DFF (East Germany) E3, 4.
13/12/76 SR E2, 3, 4; NRK E2, 3, 4; DR E3; TVP R1; CST R1.
14/12/76 SR E2, 3, 4.
16/12/76 DFF E4; SR E2.
17/12/76 MTV (Hungary) R1.
20/12/76 WG E2.
21/12/76 TSS (USSR) R1; JRT (Yugoslavia) E4.
22/12/76 NRK E4; DFF E4.
23/12/76 DFF E4; WG E2; SR E2; NRK E2; CST R1.
27/12/76 DR E4; SR E2.
28/12/76 WG E2; SR E2; NRK E2; YLE (Finland) E2 via SpE late morning.
29/12/76 DFF E4; SR E4; WG E2.

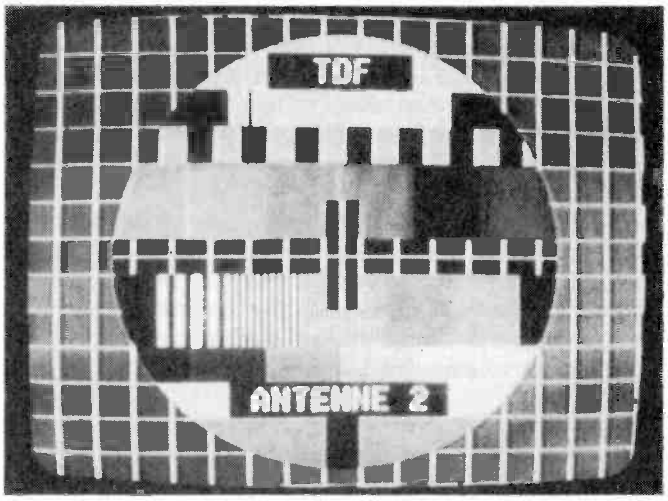
December wasn't an eventful month then and I've been taking the opportunity to overhaul my receivers here – mainly the Bush TV125 series. Apart from the usual valve changes and realignments I've been looking into the line sync circuit to investigate slight drift. Garry Smith (Derby) has suggested a rebuilt line sync stage as used in the later TV141 series – he has done this successfully – but initially I've opted for lesser modifications. The discriminator diodes have been replaced with BA148 diodes and series 47kΩ resistors (a lower value than 47kΩ tends to produce fluctuating line frequency with interference pulses) and the preset trimmer (line hold preset) has been replaced with a fixed 400pF capacitor. These initial modifications have resulted in much reduced drift. One further problem which has been eliminated is that of instability associated with the use of the v.h.f. tuner as an i.f. preamplifier (along with the external varicap tuners). I'd noticed that certain lengths of coupling lead would cause instability. The problem was solved by (a) bypassing the internal i.f. rejector circuits; (b) fitting an additional 1000pF capacitor between the input coupling screen and the tuner chassis (inside the tuner and adjacent to the input socket); and (c) improving the contact of the metal screen over the tuner chassis. Work continues on a major overhaul – hopefully to achieve greatly improved reception!

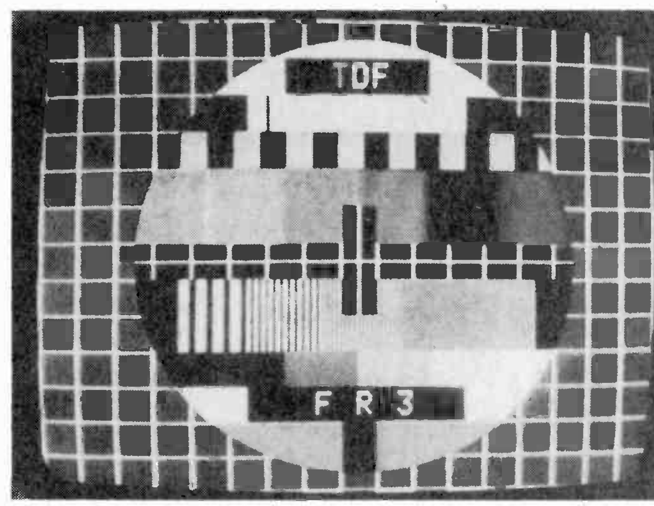
Interference Problems

Regular readers will be aware of the interference problems I've had recently since a computer system was installed at the nearby brewery. I have now met and discussed the problem with the operators, Whitbread Wessex Ltd., who seem most concerned and sympathetic. Several letters to the manufacturers of the equipment have so far failed to produce a reply however, so it has been necessary to instruct a solicitor who has now written to the respective parties. The problem has continued daily except for the three days before Christmas and today when the main plant seemed to be inoperative. Parts of the equipment are left on full time, giving a form of radiated line pulse. The interference levels when all the computer's monitors are operating is quite incredible – it's peaked at 42μV maximum!

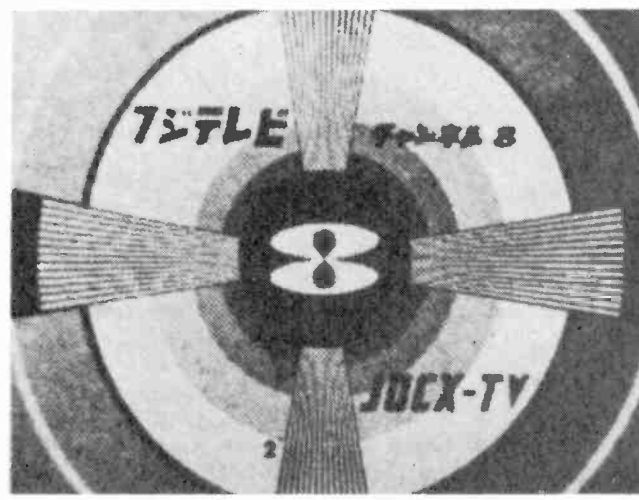
News Items

Satellites: Radio Moscow has announced (11/12/76) that the latest "Ekran" satellite is providing TV programmes to parts of the USSR. It contains "powerful" TV transmitters which enable the ground receivers to be simpler. The up link is at approximately 6GHz and the down link at 702-726MHz. To give a sharp beam, two aerials are phase coupled, the total aerial having an area of 130 sq. ft. Power is derived from large solar panels which give a maximum 2kW input. Its position is Equatorial 99°E, at 36,000km.





Two shots of the PM5544 test pattern as used by France. Left, the second chain; right, the third chain. These photographs by D. F. Brown (near Brighton, Sussex) were taken in colour from the screen of his SECAM receiver.



Left, the TSS (USSR) news programme caption. Courtesy Keith Hamer. Right the JOCX-TV test card, Japan. Again courtesy Keith Hamer.

Reg Roper (another successful ATS-6 DXer, at Torpoint) has been in contact with G. Perry at Kettering Boys School (the school that has a very active satellite tracking section). Apparently the satellite (Statsionar T) was launched during the Summer and positioned over the Equator on about November 11th, at 35,600km height, some 99°E. A second Statsionar satellite is to be positioned at 35°E (same as the ATS-6) but will have a down link at 3.42-3.87GHz. Yet a third satellite will be positioned at 85°E, exclusively for the USSR and using the same frequency down link. Our thanks to Reg and to Mr. Perry for this valuable information.

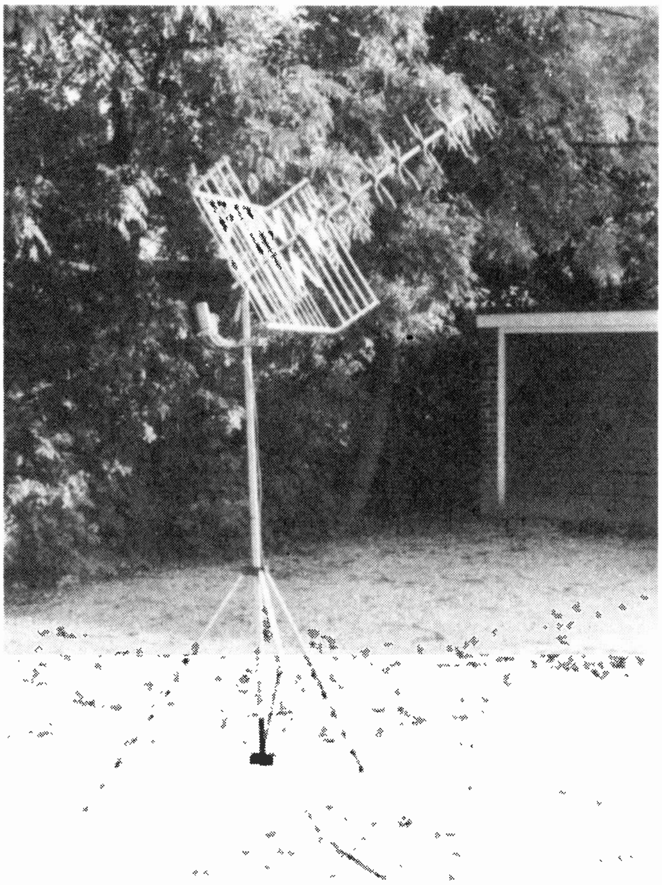
France: The 819-line v.h.f. transmissions are to cease on June 1st, 1981, except for those areas without an effective TF1 u.h.f. coverage. Discontinuation in these latter areas will occur when u.h.f. is available. The 819-line bandwidth meant a lower start to Band III (ch. F5). The spectrum 162-174MHz is to be given to the mobile services: the remaining part of the v.h.f. band will remain available for television services, though no specific plans have been announced. No compensation will be given to viewers using single-standard 819-line receivers at the time of closure in 1981.

Belgium: The transmission standards are to change shortly, with the v.h.f. service using system B instead of system C. Peter Vaarkamp reports that the changeover will take place during the second half of April. Egem ch. E46 and Genk ch. E47 will then be ready. Oostvleteren will change over on September 3rd. The 1st/2nd BRT/RTB networks will be as shown in the chart below. BRT are Dutch language transmissions, RTB French language transmissions.

Network	*Station*	*Channel*	*System*	*Power (kW)*	*Polarisation*
BRT-1	Waver	10	B	100	H
	Egem	43	H	1000	H
	Genk	44	H	200	H
	Oostvleteren	49	H	20	V
BRT-2	Waver	25	H	1000	H
	Egem	46	H	1000	H
	Genk	47	H	200	H
	Schoten	62	H	200	H
	Oostvleteren	55	H	20	V
RTB-1	Wavre	8	B	100	H
	Ougree/Liege	3	B	100	H
	Anlier	11	B	10	H
	Riviere	52	H	200	H
	Froidmont	57	H	20	V
RTB-2	Wavre	28	H	1000	H
	Ougree/Liege	42	H	1000	H
	Anlier	60	H	200	H
	Anderlues	61	H	200	H

News in Brief

Summertime will be adopted this year by Holland, France, Spain, Italy and possibly Belgium, and in 1978 by West Germany.... Graham Fitch reports that MTV



The experimental aerial mast – previously a rotary washing line.

(Hungary) has installed new USSR constructed transmitters at Page, Serga and Cosa.... Cuba is using the "letterbox" type test pattern used by the USSR TSS 2nd chain.... The Greek network "EIPT" is now "EPT", the letter I being dropped for Greek grammatical reasons! They are using the EBU bar pattern at times.... RTVE (Spain) is still experimenting with both PAL and SECAM colour, but during a recent "get together" between the Spanish and French authorities the latter offered to finance the installation of equipment if the SECAM system was adopted.... The Oman Television Service, based at Salalah, is using the PM5544 test card!

Experimental Aerial Mast

A couple of months ago I mentioned the use of an inverted rotary washing line as a temporary aerial mast. This has enabled me to test and experiment with aerials at heights up to about 12-15ft. The accompanying photograph shows the mast with an aerial I'd been using in the hope of picking up the ATS-6 experimental transmissions made during its repositioning over S. America. It seems that no one succeeded in picking up these transmissions. The aerial shown consists of a wideband u.h.f. backfire aerial modified by adding a group C/D Multibeam multi-director assembly chain cut down to 860MHz. A Wolsey Supa Nova masthead amplifier is mounted on a small arm behind.

The mast itself consists of a steel tube just over 6ft long. It's mounted the opposite way round to its conventional way when used as a rotary washing line. All the lines are removed, and the legs can be splayed out farther to give additional stability if a larger than usual aerial is mounted on the mast. I have quite safely used large Band I arrays at 12ft and feel that 15ft should be possible by clamping on an extension tube.

The lower end of the mast fits into a plastic socket, giving complete rotation. The socket should be well greased and at least one metal disc inserted to avoid wear. The upper feed-through plastic socket can be greased although it's best left until positioned.

Such a system is ideal for temporary arrays during the SpE season, or for the trip to the local mountain with portable equipment. I have also used mine for testing arrays since it allows easy rotation. In the interests of minimising signal absorbtion from nearby objects I usually operate from the top of a nearby flat-roofed garage.

Stacked Aerials

I've recently been giving thought to the possibilities of using stacked v.h.f. aerials – in order to overcome the interference problem mentioned earlier. The interference is arriving from below the aerials in use – so by reducing the vertical beamwidth of the system it should be possible to reduce or eliminate the interference. The use of stacked aerials does, among other things, reduce the beamwidth. In fact, the resultant beamwidth – and gain – depends on the spacing of the aerials. Various books were consulted and provided much information, though in the outcome it was difficult to get guidance on the best spacing to adopt. First however let's consider the basic principles involved.

Consider a conventional Band III Yagi array horizontally mounted. When accurately directed towards a transmitter the approaching wavefront will induce in the directors weak signal voltages. The spacing between the directors is such that the signal voltages are in phase, giving signal addition along the chain and maximum signal across the dipole itself. A signal arriving from below will not be helped by the director chain, but there is every likelihood that it will produce a response at the dipole and thus be conveyed to the feeder.

Effects of Stacking

If we stack two similar arrays one above the other however and orient them towards the wanted transmitter several things happen. Assuming that the arrays are spaced by some distance between 0·75-2 wavelengths, there will first be an increase in the signal voltage available. The front-back ratio will also be improved. Of equal importance

Augsburg (West Germany) transmitter identification slide. Photo courtesy Ryn Muntjewerff.

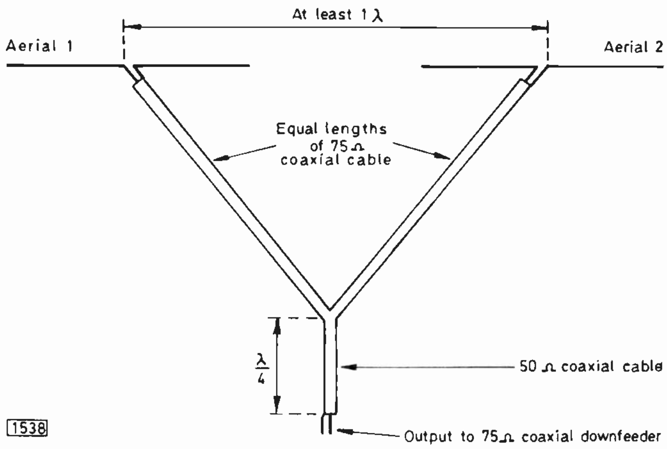


Fig. 1: Method of interconnecting two stacked aerials. To calculate a quarter wave, use the formula (246/f) x cable velocity factor. Answer in feet; frequency f in MHz.

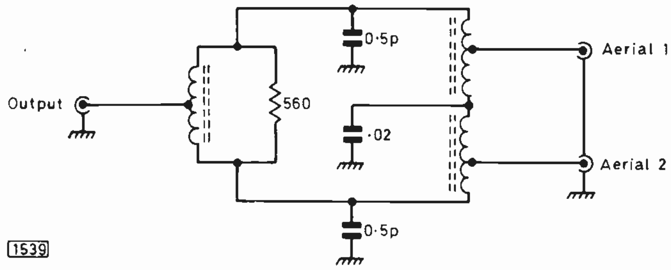


Fig. 2: US broadband hybrid coupler.

however will be the changed polar response: the horizontal beamwidth will remain virtually unaltered, but the vertical beamwidth will be reduced, thus restricting interference arriving from below or above. The reason for this is the phase relationship of an interfering signal within the aerial system. For example, in the case of an interfering signal arriving from below, this will reach the lower aerial a fraction before it reaches the upper aerial. The result of this is that the signals thus induced in the dipoles are not in phase and thus tend to cancel, the degree of cancellation depending on the aerial spacing. The wanted, incident signal from the transmitter arrives head on however, and is thus in phase within the system.

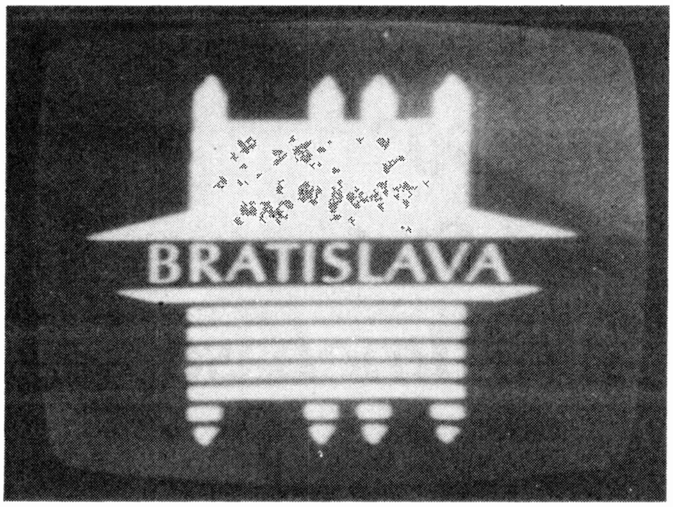
The same principle holds for aerials stacked side by side. In this case however the vertical beamwidth remains unaltered while the horizontal beamwidth is reduced.

In both cases there is an increase in the wanted signal. This depends on the spacing but in practice reaches to some 3dB.

For economy we could stack two different types of aerial, say a ten-element Yagi above and a three-element Yagi below, in order to reduce the vertical beamwidth. The larger array will be more efficient, with a power gain of say 12dB over a single half-wave dipole, while the smaller array will give an improvement of around 6dB. Obviously if we stack two such aerials we must take care that the aerial apertures don't overlap, otherwise the maximum gain won't be achieved.

Aerial Spacing

There seems to be some confusion over the maximum allowable spacing in the books I studied, ranging between 0·95 and 2 wavelengths for optimum gain, and down to an agreed minimum spacing of half a wavelength. An average figure would seem to be 0·75. For maximum side lobe reduction rather than maximum gain however the lower order spacings seem to be recommended. One graph shows that for a 50° beamwidth between the half power (−3dB) points there is a 10dB side lobe reduction with 1¼ wavelength spacing, a 20dB side lobe reduction with just under one wavelength spacing, and virtual elimination of side lobes with half wavelength spacing.



Bratislava (Czechoslovakia) station identification card. Photo courtesy Hetesi Laszlo.

Connections

Another problem that arises is with the electrical connection. If we are interested in a single-channel narrowband system the connections are simple. The two aerials are connected to a common point via equal lengths of 75Ω coaxial cable, a further quarter wavelength of good quality 50Ω coaxial cable being added at this point to bring the output impedance of the system back to 75Ω (see Fig. 1). Most readers however will be interested in wideband systems. Jaybeam provide a matching harness for their wideband Band III arrays, as indeed they and other manufacturers do for grouped u.h.f. aerials. It would undoubtedly be possible to stack and combine two wideband Band I arrays with a harness cut to a midband frequency of say 55MHz and retain a fair compromise over the 20MHz or so bandwidth – particularly if the feeder end of the 50Ω section is connected to a masthead amplifier, thus swamping any mismatch. Indeed most wideband aerials tend to be a compromise, sacrificing gain for bandwidth and with a wider VSWR margin.

While reading the WTFDA's monthly bulletin recently however I came across a matching device marketed in the USA by a major aerial manufacturer. It's called a broadband hybrid coupler (see Fig. 2). The unit has a very wide bandwidth, from low v.h.f. (50MHz) through to high u.h.f. (880MHz), and would seem to be the complete answer to the problem of stacking wideband v.h.f. and u.h.f. aerials. It's available in versions for use with both 300Ω ribbon and 75Ω coaxial feeders. I am hoping to be able to test these units shortly and will report. There are even four input versions available!

Finally, to calculate a free space half wavelength in feet use the following formula: $492/f$, f being the frequency in MHz.

For further study I suggest *The ARRL Antenna Book* published by the American Radio Relay League. It's available in the UK from the Radio Society of Great Britain.

Servicing the Rank 90° Solid-State Field Timebase

John Law

THE single-standard Rank 90° solid-state colour chassis has been in production since 1969. Inevitably, with such a long production run there have been several different versions of the chassis. This article is concerned with the field timebase, which is on the scan drive panel. There have been two scan drive panels, the earlier A803 and the later Z504. The differences mainly concern the sync separator and the line oscillator and driver stages however – the field timebase has remained largely unaltered. Unfortunately the component reference numbers used on the later panel are entirely different to those used on the original panel. Since there are more sets around fitted with the later Z504 panel, the circuit and the component reference numbers given here relate to this later panel.

The field timebase consists of a silicon controlled switch field oscillator, a discharge transistor, a driver transistor and a two-transistor output stage. The circuit, as used in the Z504 panel, is shown in Fig.1.

The SCS Field Oscillator

The BRY39 silicon controlled switch has been in use as field oscillator since the earliest versions of the chassis. These devices can be used in various ways and a detailed account of their mode of operation was given in the July 1976 issue. The silicon controlled switch (s.c.s.) is a four-layer device and in addition to the anode and cathode connections there are connections to the anode gate and the cathode gate. Briefly, the operating conditions are as follows. The application to the anode of a voltage which is positive with respect to the cathode will result in a small leakage current flowing, though the s.c.s. will be in a high-impedance state. Assuming that the anode gate voltage is fixed, increasing the anode voltage will, above a certain critical point, result in the s.c.s. switching to a low-impedance state in which it is capable of passing a considerable current. This condition will continue until the current flow falls below another fixed level. The s.c.s. then switches off, reverting to its high-impedance state. Alternatively the anode voltage can remain fixed, the device being turned on by lowering its anode gate voltage.

The basic mode of operation in this circuit is to use the field hold control 5RV1 to set the s.c.s.'s anode gate voltage and to use an *RC* timing circuit (5C22 and 5R26) to vary the anode voltage. At the start of the scan, the s.c.s. is off, 5D5 is forward biased and 5C22 charges via 5R26. When the voltage at 5THY1's anode has risen sufficiently above its anode gate voltage it switches on, discharging 5C22 via 5R27, the s.c.s., and 5R23. This initiates the flyback action. To synchronise the circuit, negative-going field sync pulses are fed to the s.c.s.'s anode gate. Once 5C22 has discharged, the current through 5THY1 falls below the hold-on value and 5THY1 switches off.

Charging and Driver Circuits

While 5THY1 is conducting during the flyback, the voltage developed across 5R27 switches on 5VT5 which in turn discharges the field charging capacitors 5C24 and 5C25. During the forward scan these charge via the height control 5RV2, 5R32 and 5R31 from the stabilised 200V h.t. rail. The positive-going sawtooth thus produced progressively turns off the pnp driver transistor 5VT7 which, connected as an emitter-follower, produces a positive-going sawtooth to drive the base of 5VT10.

Output Stage

As 5VT10 is turned on progressively during the scan, 5VT9 is in turn driven towards cut off since 5VT10 drives its base via 5R41. The scan coils are driven from the mid-point of the output stage. A.C. coupling is used, the coupling capacitor 7C5 feeding the scan current to the series connected vertical convergence circuit. D.C. is applied to the coils from 6RV3 to provide vertical shift.

Linearity Correction

Linearity correction is achieved by feeding the waveform developed across 5R49 via 5R44 and the single field linearity control 5RV3 to the junction of the two field charging capacitors. 5TH1 provides compensation against variations in height due to temperature changes in the output stage.

Field Timebase Supply

The 40V supply for the field timebase is obtained from rectifiers 5D12/5D13 which are fed from a winding on the line output transformer. They are protected by 6L25 which is not present in earlier versions. In the latest production a single BY207 rectifier is used.

Field Collapse

Complete collapse of the field scan to a thin, bright horizontal line is perhaps the most common fault. There are several causes. Before suspecting the transistors or components in the field timebase, check that the 40V supply is present and check the interconnecting plugs and sockets – 5Z1, 6Z2 and 6Z3. Even after several years' use it is sometimes found that there is an unsoldered wire inside a plug.

Intermittent field collapse has on several occasions been traced to a dry-joint at the base of the pincushion correction phase coil 6L20 on the scan control panel. An unsoldered joint on the pincushion correction amplitude control 6RV4, which is below 6L20, was found to be the cause of this trouble on another occasion.

Breakdown of one or both field output transistors can occur for no apparent reason. VT10 should be the first suspect however as it works much harder than 5VT9. Early chassis used BD131 output transistors but these have been replaced by the more generously rated RCA 16040/16041 pair – note that the base and emitter connections of these are reversed compared to the BD131. The TIP41 is a

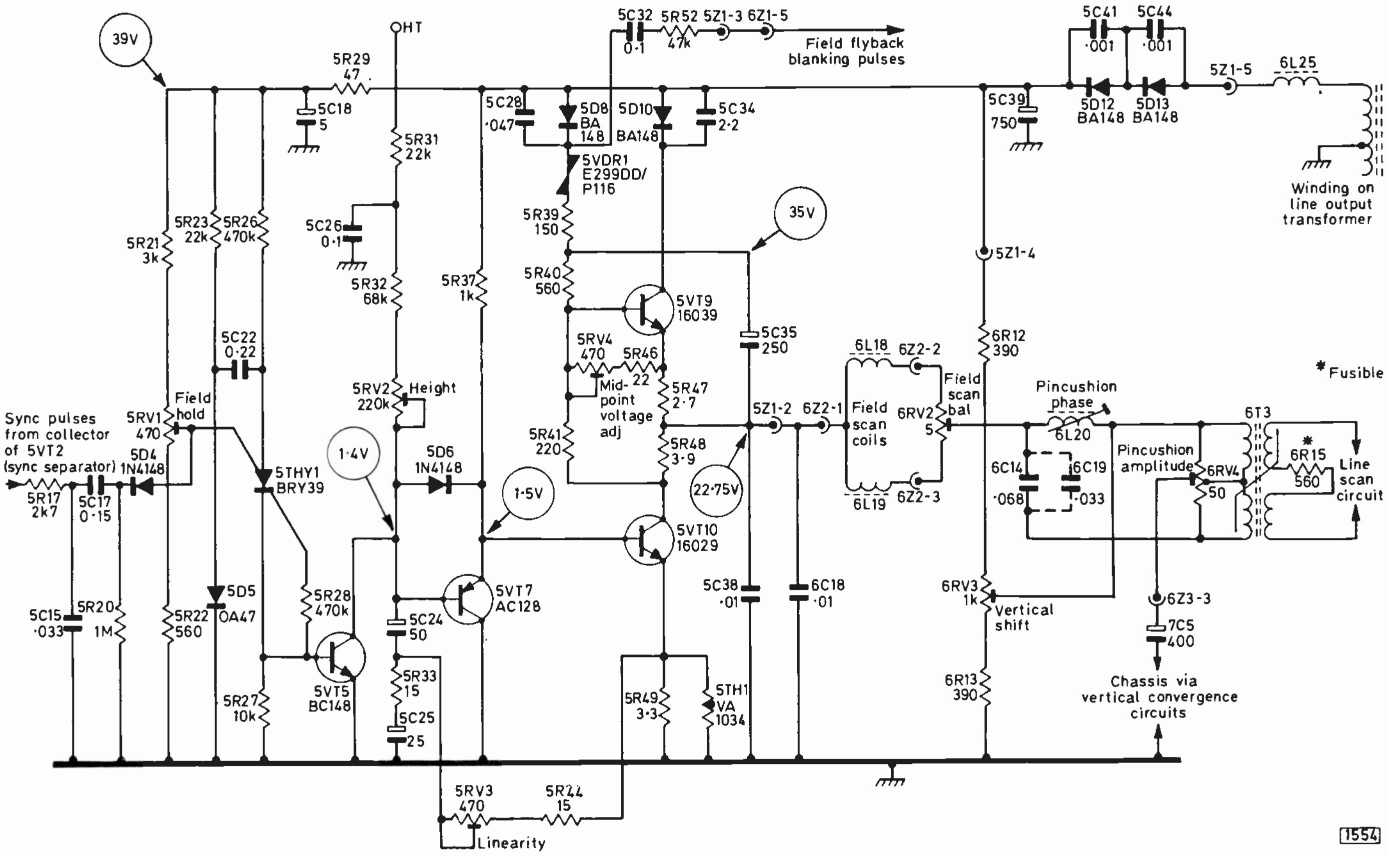


Fig. 1: Field timebase circuit used in the Rank A823A/AV/B chassis.

reliable replacement which is probably more readily available. Its base connections are the same as the BD131.

Output Stage Faults

5VT9 and 5VT10 are not a matched pair. So when the height has been shrinking over a period of time, try changing them over. The 5VT10 transistor may then overscan in the less demanding position of 5VT9.

Apart from field collapse and lack of height the output transistors can also be responsible for foldover and cramping at the bottom of the raster.

Setting Up

When the output transistors have been replaced or interchanged it is important to reset their relative voltages. This is done with the mid-point voltage potentiometer 5RV4. Connect the meter's negative lead to chassis and its positive lead to pin 4 of plug 5Z1 – make the connection via a thin needle pushed down through the hole in the top of the plug, and clip the meter lead to the needle. The reading should be around 40V. Halve this figure and add 2V to obtain the correct mid-point voltage. Transfer the needle and meter lead to pin 2 of plug 5Z1, and adjust 5RV4 for the voltage found in this way.

Voltages

Talking of voltages, since there is d.c. continuity from the s.c.s. through to the scan coils a breakdown in any one of the transistors will affect the voltages throughout the circuit. 5VT5 and 5VT7 both occasionally fail.

Don't attempt to measure the voltages on the s.c.s. with an Avo or other moving-coil meter – this will stop oscillation and result in the immediate destruction of the output transistors. A high-impedance oscilloscope or electronic voltmeter can be used, but neither are likely to be available outside a service workshop – and not always inside. The quick and simple answer to a suspect BRY39 is to replace it – it costs less than a pound.

Jitter, Bounce, Etc.

Faults traced to the s.c.s. include field bounce, jitter, and partial or complete field collapse.

Jitter can be due to faults in the power supply however. The cause in early chassis was often the BR100 diac used to trigger the BT106 regulator/rectifier thyristor. This was subsequently replaced by a 4EX581 or XK3100, with the value of its series resistor 8R12 increased from 10Ω to 47Ω. Also make sure that the associated resistor 8R13 (connected to chassis) is 1kΩ and not 22kΩ. The BT106 can also be responsible for jitter/flutter. Make sure that the connections to the power supply plugs and sockets 8Z2 and 8Z4 are above suspicion.

Field Hold Faults

Another source of field trouble external to the scan panel occurs in earlier sets which are fitted with the A809 i.f. panel. Here 2C37 (125μF) which decouples the collector of the a.g.c. amplifier transistor 2VT6 (BC158) can lose capacitance, causing weak field sync. Another cause of weak field sync in sets fitted with the earlier A803 scan drive panel is when 5C5 (400μF) dries up. This smooths the supply to the sync separator.

After integration, the field sync pulses are differentiated by 5C17 and 5R20. These were not incorporated at one stage in production but were subsequently reinstated following complaints of field bounce. It is worth checking that these components are present on a chassis with this symptom.

Miniature Presets

There are four miniature preset potentiometers in the field timebase circuit – the hold, height, linearity and mid-point voltage controls. After a few years' use the tracks get gritty, the point of contact deteriorates and they can become a constant source of jitter, bounce, etc. All four can be replaced at a cost of about £2 and this course is recommended.

A misadjusted mid-point voltage control 5RV4 may show up in the form of centre cramping. Difficulty with Teletext lines at the top of the raster should also lead to 5RV4 being investigated.

Electrolytic Troubles

Next to preset potentiometers, electrolytic capacitors can cause such troubles as jitter and bounce. 5C18 which smooths the supply to the field oscillator circuit, and the bootstrap capacitor 5C35, are known culprits. As with potentiometers the best advice is – when in doubt, whip it out. Replacements are cheap.

Diode Failures

Miniature diodes can fail for no apparent reason. They can generally be tested by disconnecting one end and making resistance checks. With the red lead connected to the cathode and the black lead to the anode a reading of around 900Ω will be obtained if the diode is in good condition. If the reading is over 3kΩ or under 800Ω replace the diode. Reversing the leads of an Avo Model 8 should give no reading – i.e. greater than 200kΩ on the scale.

If the 40V field timebase supply rectifiers 5D12 and 5D13 fail they should be replaced with more generously rated BY207s. This also applies to 5D8 and 5D10 in the field output stage.

Miscellaneous Faults

Excessive height accompanied by field foldover is caused by lack of capacitance in one of the field charging capacitors 5C24/5C25 – remember that they cut off the driver transistor as they charge.

Low scan amplitude has been traced to faulty scan coils.

For flyback lines on the picture check 5C35 and 5C32.

Panel Defects

Apart from faults caused by defective transistors or other components, there are breakdowns due to cracks or breaks in the printed panel. These can be the result of careless or rough handling or a fall should a set topple off its stand. The panel itself may crack, breaking the print. This trouble is usually visible, and the cure is to bridge the two sides of the print with wire and solder, having first cleaned off any paint in order to ensure a clean soldered joint.

More tricky is a fine hairline crack which may require the use of a magnifying glass to locate it. The cure is the same.■

Service Commentary

K. C. Alford

FAULTY COIL CONNECTION

We were called to see a Thorn colour receiver fitted with the 8500 chassis. The complaint was no results, with the cutout operating. We reset the cutout button and it wasn't long before it popped out again. This was found to be due to a dead shorted line output transistor. We replaced this along with the flyback tuning capacitor (C406) and obtained a perfect picture. The customer was highly delighted and we left feeling triumphant. A week later however another call was requested and this time no fault could be found. The customer reported that the picture came in an inch on either side and that the line hold was lost. Back on the bench this turned out to be so, and after a lot of tapping it was discovered that one end of coil L408 in series with the base of the line output transistor (see Fig. 1)

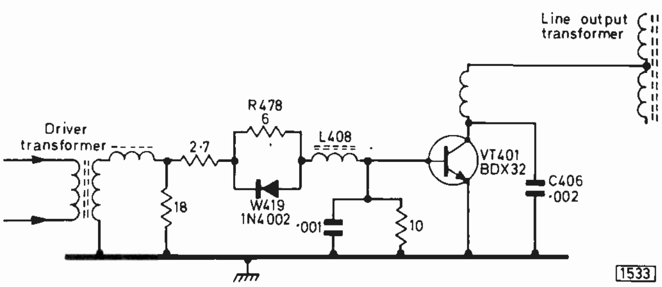


Fig. 1: Line output transistor circuit used in the Thorn 8500 chassis. A dry-joint on L408 upset the drive conditions, leading to demise of the line output transistor and, subsequently, lack of width and loss of line sync when a replacement transistor was fitted.

was dry-jointed where the enamel wire hadn't been tinned properly. Obviously this dry-joint had caused the failure of the original line output transistor, since the line drive would have been insufficient to drive the transistor into saturation, a condition which is essential to the cool running of the line output stage. This could have been the answer to the problem raised in *Your Problems Solved* on page 544 of the September 1975 issue (Ferguson Model 3713).

FLARING WHITES

Another of these receivers came in with the complaint of whites flaring to the right after the set had been on for some time. On test, the set operated for two and a half hours before the flaring started and gradually became worse until the picture was nearly all white. By reducing the contrast a normal picture could be obtained, though lacking in contrast of course. The c.r.t. voltages were all found to be correct, and it didn't half look like a duff tube. It was then noticed that the heaters were not very bright. The heater voltage was checked and found to be 4V instead of 6·3V. Pulling the heater wires revealed a dry-joint between the print and the heater wire terminal on the c.r.t. base. Resoldering this restored a perfect picture.

CRITICAL FIELD HOLD

The complaint with a Bush Model TV161 was critical field hold but normal line hold. A new PFL200 video/sync valve and PCL805 field timebase valve failed to improve matters so next we changed the five-leg sync diode block, again with no improvement. The voltages around the video and sync sections of the PFL200 were found to be correct, and changing all the electrolytics in this area made no difference. Since the main smoothing block was leaking we changed this, bringing a definite improvement to the slight buzz on sound. We seemed to be getting nowhere however so we poured a cup of tea and sat down to view the occasionally steady picture. While doing this we noticed that the l.f. response was poor, proving that the fault must lie somewhere in the video circuitry. A check with the circuit revealed that there is a phase-splitter stage between the detector and the video output pentode. The voltages around this transistor (2VT4, BF184) were measured and found to be wildly astray, with only 0·5V at the base (TP F) instead of 5V. Replacing the transistor restored perfect field hold and increased the contrast.

NO SOUND OR PICTURE

A house call was made to service a set fitted with the Thorn 1400 chassis, the complaint being no sound or picture, the latter due to absence of e.h.t. The tripler and the line output stage valves (PL504 and PY801) were changed but there was no improvement. We then noticed that the c.r.t. heater was not alight, but thought we would get some e.h.t. first. The line whistle was unusually loud and low, so the line oscillator and the d.c. amplifier in the flywheel sync circuit were next investigated. While removing dust we found that the 30PL1 audio valve was not alight, nor was the 30FL14 flywheel sync d.c. amplifier/vision i.f. amplifier valve. A quick look at the circuit revealed that the earthy end of the series connected heater chain consisted of the 30PL1 followed by the 30FL14 and then the c.r.t. and so to chassis. A heater-cathode short in the audio valve was the obvious suspect and on replacing it perfect picture and sound were obtained.

SYNC FAULT CAUSES COLOUR TROUBLES

We had a hybrid GEC colour set (Model 2040) in with the complaint that the colour faded out after an hour and that the faces would sometimes turn green. The latter fault was the classic symptom of an out-of-phase bistable in the PAL switch circuit, so we tried adjustment of the 7·8kHz ident amplifier coil. This turned out to be set correctly however. We then noticed that the verticals were bent, and discovered that the colour could be restored by carefully adjusting the line hold control. So the fault could be somewhere in the sync separator or line oscillator circuits. A new PCF802 line oscillator valve was tried, and the voltages and electrolytics in the stage were checked.

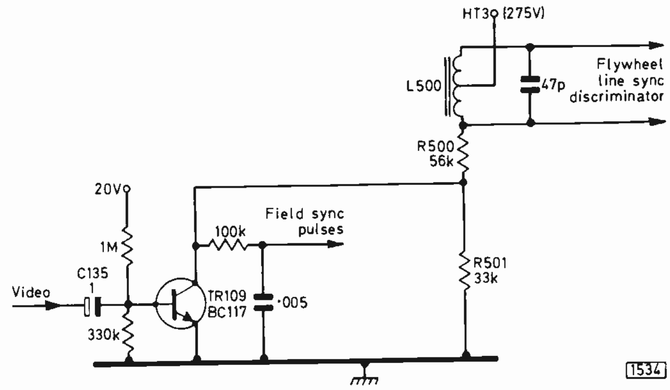


Fig. 2: The sync separator circuit used in the GEC hybrid colour chassis. The collector load resistor R500 tends to go high-resistance. In the case in question the result was various colour faults plus bent verticals.

Everything turned out to be in order here so we moved back to the sync separator transistor TR109. On checking at its collector we found only 45V instead of 80V. This left three main possibilities, either R500 had gone high, the transistor was leaky, or its base input coupling electrolytic C135 was leaky (see Fig. 2). In fact R500 had gone up to 120kΩ from 56kΩ – not surprisingly since it's a poor little $\frac{1}{2}$W resistor fed from the HT3 rail. After replacing it with a 1W type the colour was restored, the verticals straightened up, and the bistable phased correctly.

RANK DEGAUSSING CIRCUIT

Some letters followed the original mention in *Service Notebook* (June 1976) of 8R5 (Rank A823 chassis) smoking when plug 8Z3 is removed. When 8Z3 (see Fig. 3) is disconnected 8TH1 and 8R5 are placed straight across the mains. With 8TH1 in its low-resistance, i.e. cold, state (40Ω) 0·333A passes through 8R5, requiring it to dissipate

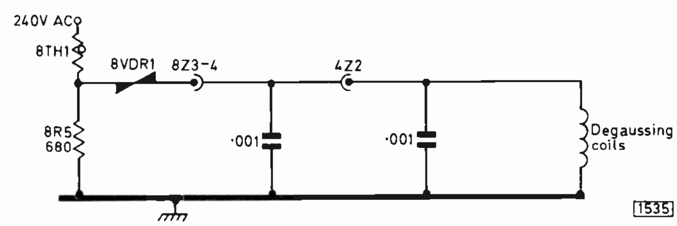


Fig. 3: The degaussing circuit used in the Rank 90° solid-state colour chassis. When the set is cold and 8TH1 in its low-resistance state, removal of 8Z3 will place 8R5 across the mains, leading to smoke when the power is applied.

75·55W – so it will smoke! When 8TH1 has heated to about 90°C it is in its high-resistance state (6kΩ) and the current through 8R5 falls to 0·0359A, requiring it to dissipate a mere 0·8763W. I suggest that the fact that 8R5 was found to be low in value was probably due to the chroma panel having been replaced at some time: this requires the removal of 8Z3 and it's all too easy to forget to reconnect it. The result is a great cloud of smoke from the receiver, to the great alarm of its owner. There is also an earth return from the tube base to the chassis below the tube base. This is the degaussing coil earth return path, and failure to reconnect it again results in a charred 8R5. I wouldn't like to guess how many service engineers have found out what happens when 8Z3 is disconnected, or how many charred 8R5s there are around. Certainly if the value of 8R5 falls low enough, i.e. to under 25Ω, it will blow the mains fuse, but only when 8TH1 is cold.

The Art of Alignment

Part 4: Decoders and Synchronous Demodulators

Harold Peters

NO two decoder circuits are alike, and in consequence no two sets of decoder alignment instructions are the same. As always, practice on discrete component boards is the fastest way to gather experience – i.c.s do a number of things in a rather roundabout way in order to suit their internal circuitry. Follow the manual and its running order where possible to avoid repetition. Unfortunately, the manual seldom explains why you are doing what you are doing.

Basic Decoder

The nearest we can get to setting out a universal decoder alignment method is to run through the features of the basic decoder shown in Fig. 1, since in doing so we shall touch upon the effect and action of each variable in turn. There are three signal paths through a decoder panel: the luminance and chroma signal paths and the burst path. The two latter ones constitute the decoder proper. In addition there are several interconnecting circuits.

Alignment Methods

There are three common methods of aligning a working decoder, the most conventional being by oscilloscope and colour-bar generator. The "X—Y" method is a speedier alternative, while fastest of all is the use of cancelling signals – as provided by many colour-bar generators and by the PM5544 pattern in its unmodified form. With these items as our agenda then we will work through the decoder shown in Fig. 1, assuming that it is being fed with a colour-bar signal (composite video).

Luminance Path

The luminance circuits are often incorporated on the decoder or chroma board. There is but one adjustment, the subcarrier trap. This is tuned for the minimum amount of colour subcarrier on the luminance signal – simply by connecting a 'scope to the output and adjusting for the least 4·43MHz content (see Fig. 2). It can be managed on a picture by adjusting for the minimum annoyance of the crawling dot pattern. A few traps are connected to the colour killer circuit so that they are inhibited on monochrome. This is done to extend the luminance channel bandwidth, since the trap degrades the response from 3·5MHz upwards. An inadequate trap will remove the dots from the middle of the bars but still leave large amounts of crawling dot on the transients between one colour and the next. Subcarrier traps should be of medium Q. If they are too narrow and steep they trap out only the basic subcarrier, and this was removed from the picture at the transmitter anyway. To be effective they must also trap out the colour sidebands.

The 6MHz trap could count as a luminance adjustment, since it's in the common lead and is set to the point where it reduces the 6MHz dots to a minimum. This should coincide with minimum sound-chroma beat pattern in the colour circuits. If your input signal is fed in via the aerial socket, detune the receiver to enhance the effect.

Chrominance Path

It's conventional practice to disable the colour killer during all preliminary adjustments to the chroma circuit. Otherwise you will suffer from loss of signal when you least expect it. Make all adjustments with the contrast and saturation controls at normal viewing level, nominally 6dB down from maximum. There are usually phase changes at different control settings, and by doing this they should be confined to the ends of the travel of the controls, where a little Hanoverian blind interference will not hurt.

Chroma Bandwidth

The ideal bandwidth of the chroma channel is + or —1MHz around 4·43MHz at the —3dB points. In practice three things are against you getting this right.

(1) The roll-off below 35·07MHz in the i.f. strip has already attenuated the upper chroma sideband, so the 5·43MHz point will be well below 3dB down when the chroma signal arrives from the vision detector.

(2) The ratio of frequency to bandwidth is low (4·43:1), which precludes the use of efficient bandpass circuits in the chroma channel. In practice tightly coupled transformer circuits are used, with heavy damping to give the best compromise. This limits their tuning range and by inference their ability to recover the loss of upper colour sideband (5·43MHz) due to the vision i.f. roll-off.

(3) The thing that has the most profound effect on the bandwidth of the chroma channel is the characteristics of the glass delay line and its terminating coils. The passband is 3·4MHz to 5·3MHz and the input coil, which has the most effect on the shape of the chroma alignment curve, is set to correct phase errors in the delay line regardless of what sort of tilt this puts on the total response curve.

Excessive bandwidth in the input stages should be avoided, despite the temptation to resolve everything that is transmitted. If the bandwidth exceeds $\pm$ 1MHz, the signal which takes the bypass path around the delay line has a faster rise time than the signal going through the line. So when these signals are added and subtracted in the chroma matrix, distortion will be produced on colour transients – in the form of a red-green twinkle to the right of abrupt changes of colour. Twinkle is also the visible manifestation of cross-modulation between the chrominance and luminance signals. It can also be due to asymmetric alignment of the chroma channel, a mistuned rejector in the i.f. strip, or a poorly made delay line. Before changing the

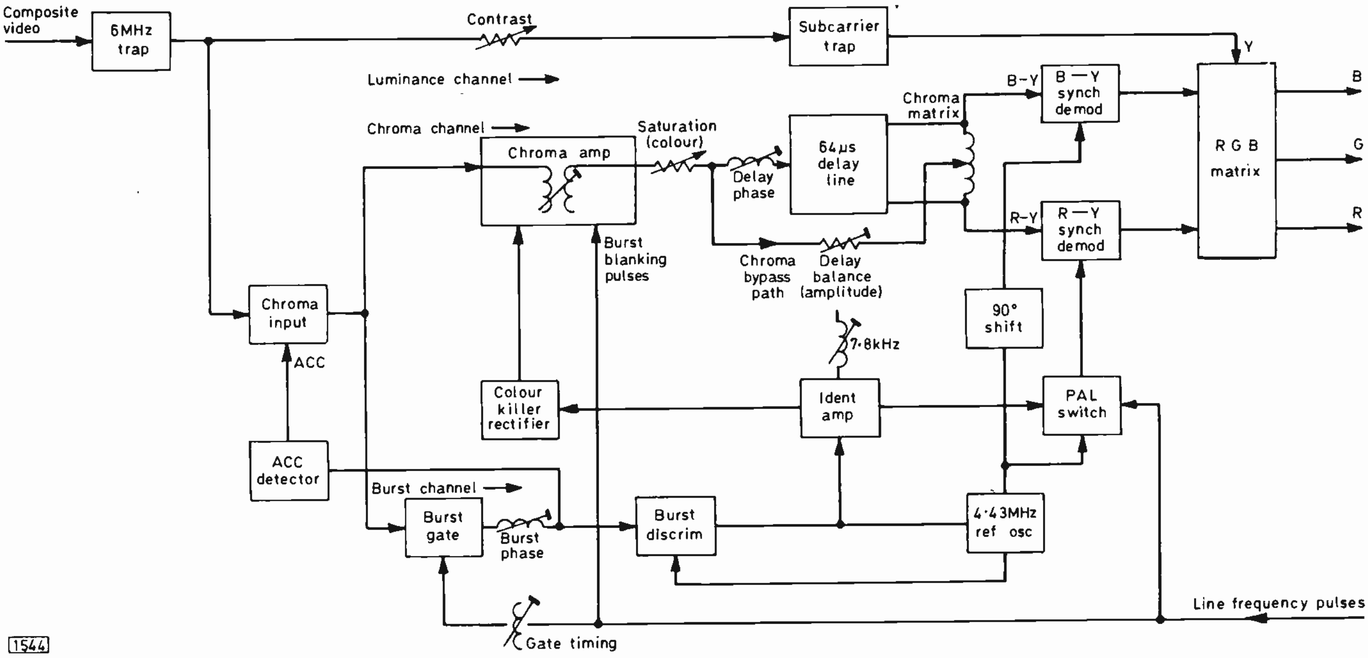


Fig. 1: Basic decoder block diagram. The contrast and saturation controls are sometimes linked so that they track together

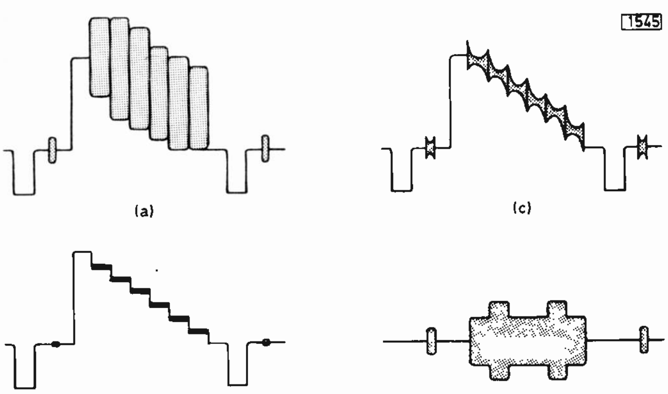


Fig. 2: Alignment of the 4·43MHz subcarrier trap in the luminance channel. (a) Composite video signal entering the decoder. (b) The same signal after passing via the subcarrier trap – note the low chroma content and the otherwise sharp rise times. (c) The effect of insufficient trapping: note the large amount of chroma on the transients. (d) Normal chrominance waveform with the luminance signal removed – the "cotton reel".

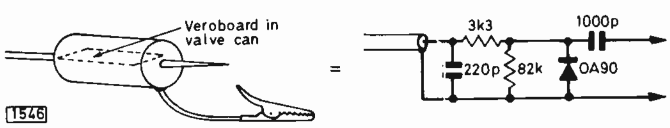


Fig. 3: A diode probe for the display.

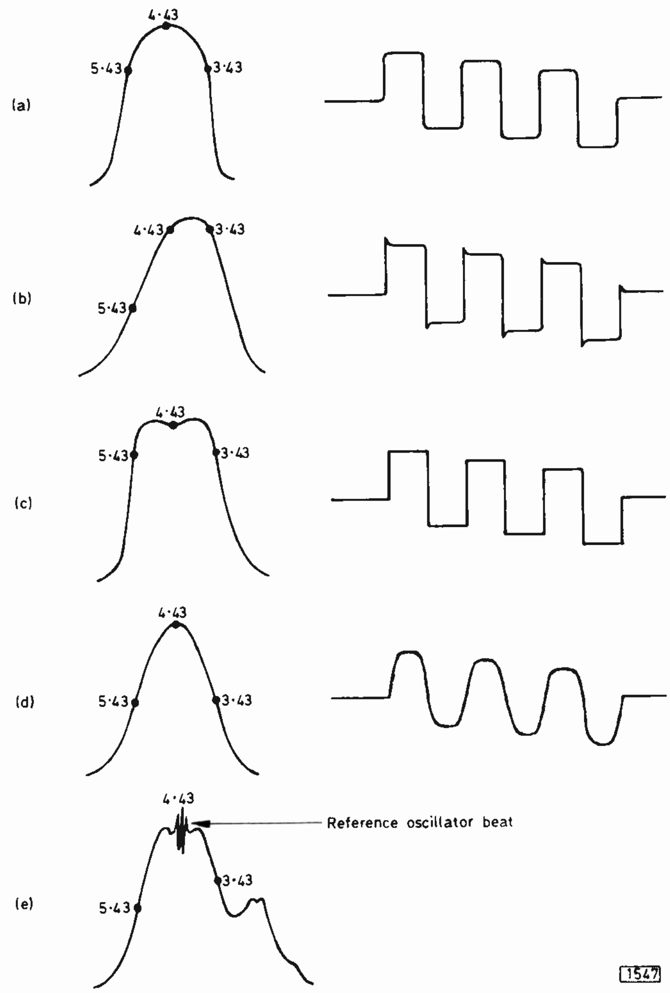


Fig. 4: Chroma channel alignment – sweeps on the left and the corresponding appearance of the B–Y signal on the right. (a) Theoretical optimum. (b) Peaked to the lower sideband – note the spikes on the B–Y signal. (c) Correction compensating for the i.f. roll-off by tuning the chroma circuits to 5·2MHz. (d) Narrowband tuning rounds the B–Y waveform and also affects the colour fit. (e) The sort of waveform you usually see if you sweep a chroma strip – note the disturbance at the top of the trace due to the reference oscillator.

lot make sure the twinkle is not on the transmission! We will deal with adjustments to the delay line circuit at the end of the section on the burst path.

Chroma Strip Sweep

Sweeping the chroma strip with a video sweep can be frustrating, because the colour reference oscillator, the burst blanking pulses and spurious beats can distort the trace. A diode probe (see Fig. 3) is needed to detect the sweep, and the most accurate results are obtained by running at a very slow sweep rate and using a long-persistence tube. Fig. 4 shows the sort of response curves you can expect during alignment, with beside them the corresponding appearance of the detected colour bars seen at the B–Y output. Several

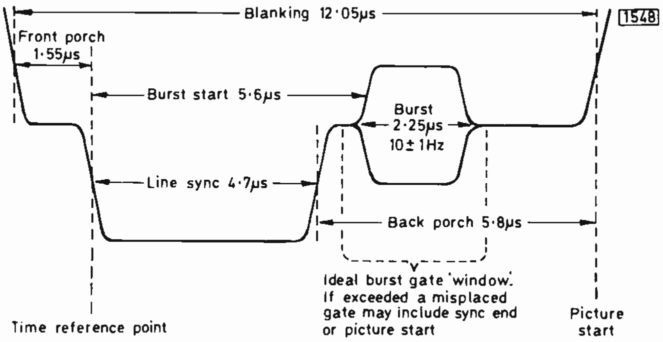


Fig. 5: Line flyback blanking period parameters.

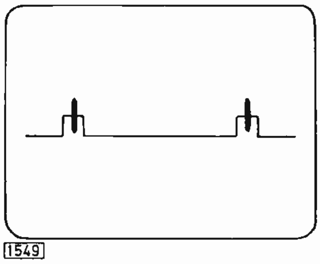


Fig. 6 (left): Typical oscillogram showing a correctly adjusted burst gate.

years' experience of aligning chroma channels by the squareness of the detected colour bars leads the writer to commend this as just as accurate a method as sweeping the strip.

Burst Path

The burst is conventionally separated from the chroma signal after initial amplification, the separation taking place in a gate which is triggered by a delayed line flyback or sync pulse. The burst starts 5·6µs after the leading edge of the sync pulse – this latter point is known to broadcasters as the Time Reference Point, or TRP – and continues for 2·25µs or 10Hz give or take a Hz (see Fig. 5). The gate should be about 4·25µs wide. If it is any narrower, the start or finish of some bursts will be cut off; if it's wider it may let through the trailing edge of the line sync pulse or, at the other side, the start of the picture information. Because of the close tolerances the gate pulse timing is normally adjustable by means of a coil or potentiometer. Check the phase of the line timebase before making any adjustments if the gating pulses are derived from here instead of from the sync separator. An oscilloscope connected to the burst gate output will permit accurate adjustment (see Fig. 6), but a good approximation can be had by metering the a.c.c. line. Optimum burst gating gives maximum a.c.c. and naturally minimum colour. Given a choice of bursts, select the non-networked BBC-2 one as the most consistent.

After being gated the burst is fed to some form of discriminator where it is compared with the output from the 4·43MHz crystal reference oscillator in a phase-locked loop in order to keep the oscillator in step with the transmitted burst. This section of the decoder has three basic adjustments: (1) oscillator frequency; (2) discriminator balance; (3) burst phase. They are usually carried out in that order.

Remembering that we are still watching a colour bar, these adjustments in detail are as follows.

Oscillator frequency: The killer must be over-ridden and the discriminator outputs or loads shorted out to suppress the burst. The colours on the screen will then rapidly "run through", and a 'scope on the B–Y output will show a rotating trace similar to a car's crankshaft. Adjust the reference oscillator's frequency until the colours are almost stationary and slip from side to side. The 'scope crankshaft will then be almost stationary. If there is an oscillator amplitude control, set this for maximum output and recheck the oscillator frequency. Measure the d.c. voltage at the point where the control voltage from the discriminator would have been applied to the varicap diode which controls the oscillator's frequency.

Discriminator balance: Note the voltage as above, i.e. with the oscillator correctly set, and remove the short from the discriminator output. Adjust the discriminator balance control for the same voltage. Some manuals help by telling you in advance what it ought to be (usually 4-5V). You have now locked the oscillator on tune, with the discriminator balanced to pull in equally from either side. To check this involves offsetting the subcarrier – a factory type facility – and most makers tolerate a pull-in range of 400Hz either way, with a holding range of 600Hz.

Burst phase: This adjustment is to the coil at the output of the burst gate. Above resonance this is capacitive and below resonance it is inductive. You can use it to swing the phase of the burst with respect to the chroma path by up to 90° either side of midpoint therefore. The signal from the reference oscillator is used to "open up" the chroma synchronous demodulators on the output side of the delay line at the correct times to inspect the B–Y and R–Y signals. Because the oscillator is locked to the burst, adjustment of the burst phase coil will determine the point at which both demodulators open. The demodulator output to look at with the 'scope is the one which is *not* phase shifted further by a 90° shift network to keep the two demodulators always opening up a quarter of a cycle apart, i.e. check the R–Y demodulator output. Set the 'scope to display two alternate lines superimposed (details later) and turn the set into a simple PAL receiver by shorting out the input to the delay line. Adjust the burst phase coil so that the two superimposed traces coincide. Now transfer the 'scope to the other detector (B–Y) and adjust the variable arm of the 90° phase shift network, again for superimposed traces.

You have now adjusted the decoder for correct working in the simple PAL mode. Remove the delay line short.

Ident Coil

The ident coil was a crucial component in most decoders before the two, three or four i.c. decoder packages came along. The purpose of the coil was to convert the 7·8kHz ripple in the burst discriminator's output into a 7·8kHz sinewave. This was used to synchronise the PAL switch which provides the alternate line R–Y signal inversion. In this way the PAL switching at the transmitter and receiver are kept in step. Decoders using i.c.s go about this synchronisation differently and don't have an ident coil.

The ident amplifier normally drives the colour killer as well (see Fig. 1), so a check on the colour-killer rectifier's output will provide an accurate indication of ident coil tuning.

Ident Tuning

Starting with the core out, screw inwards for a maximum and then a turn beyond. At maximum, a colour reversal may be observed if the set is working. Once again this is because the coil is being tuned through resonance from a capacitive mode to an inductive mode. Although resonance provides the best performance, and most immunity from spurious triggering of the killer by noise, thermal drift can easily flip the coil back into a capacitive state, reversing the colours, so a little way down on the inductive side is the best setting.

Chroma Delay Line Circuit

Although in the signal path, the chroma delay line circuit cannot be adjusted until the "simple PAL" alignment of the burst path has been completed. The centre-tapped output coil (labelled chroma matrix in Fig. 1) is preset to suit the impedance of the delay line. The delay phase and balance adjustments are provided so that the delayed and bypass signals fed to the chroma matrix are in phase and of the same amplitude (the line introduces attenuation).

The oscilloscope is connected to the B–Y output and adjusted to show superimposed two consecutive lines (see Fig. 7). Any phase error between the delayed and bypass signals will show as a double trace, and is cancelled out by adjusting the input (delay phase) coil for coincident waveforms.

To balance the amplitude of the two signals involves displacing the burst phase sufficiently to upset the sync demodulator action. This results in a double trace due to the amplitude difference between the two signals. With little effort the routine of shorting the delay line to set the burst phase, and then displacing the burst phase to set the delay balance, could turn into a vicious circle. This is easily avoided by taking a capacitor of approximately 180pF from the "hot" end of the burst phase coil to chassis whilst the adjustment of the delay balance potentiometer is made to produce coincident traces once more.

The above adjustments are essential on most decoders. Additional ones may be present to set the bias and black levels.

Test Gear Required

It goes without saying that a multimeter must be available for the setting of various levels at decoder test points. An imperative piece of gear is an oscilloscope with a bandwidth better than 3dB down at 6 to 10MHz and sufficiently sensitive to permit the use of high-impedance x 10 probes. A double-beam 'scope is desirable but not essential.

In the text we frequently refer to superimposing two consecutive lines of the waveform (Fig. 7). This is best done with one beam only, or if two are used by selecting the "chop" facility. If the 'scope is connected to the B–Y demodulator's output, and the delay phase coil is detuned to display strong Hanoverian blinds, the fine frequency control on the 'scope can be adjusted to display two superimposed traces as opposed to a single trace that jumps up and down. External trigger from the line pulse is advised.

Finally a colour-bar generator is becoming a must now that trade test transmissions are getting rarer. If initial investment permits, a generator which includes cancellation signals, such as the Philips PM5508 or PM5509, is best since it enables all the burst and delay adjustments to be made simply by looking at the screen of the set under test.

Alignment Procedures

There are three alignment methods, as follows.

(1) Colour bar and oscilloscope: This basic method, although the most long-winded, is essential for fault-finding purposes. Since it is the method outlined during our previous description of the three paths through the decoder no further comments are necessary.

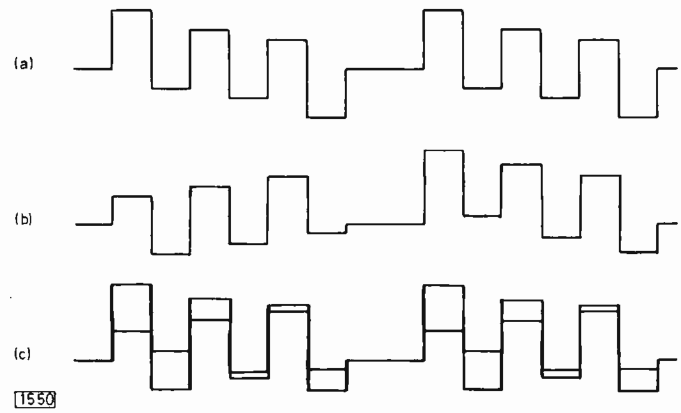


Fig. 7: The use of coincident traces in chroma alignment. (a) Correct B–Y waveform. (b) Phase displaced: alternate lines as seen on an oscilloscope scanning consecutive lines. (c) Phase displaced, this time alternate lines as seen on an oscilloscope superimposing alternate lines as required to give correct alignment.

(2) Cancellation signals: By using these it is possible to set the burst phase, quadrature (90° shift), delay phase, delay balance and oscillator tuning by reference to the picture. Several modern colour-bar generators have this facility built in, as do most electronic test cards such as the PM5544 detailed in our test signals supplement (see April 1976). In the latter case however the broadcasters are usually unsporting enough to delete them, rather than have them give error indications in "worst path" signal distribution conditions. Different generators perform differently in use, but their underlying principles are the same.

In the PAL system the R–Y signal is inverted on alternate lines (i.e. swung). The B–Y signal is not inverted. If we were to reverse this, swinging B–Y but not R–Y, a correctly aligned decoder would cancel them both so that there would be no colour on those parts of the screen where the signals are present. If the decoder is not correctly aligned full cancellation will not occur and tints will appear in the areas where the signals are.

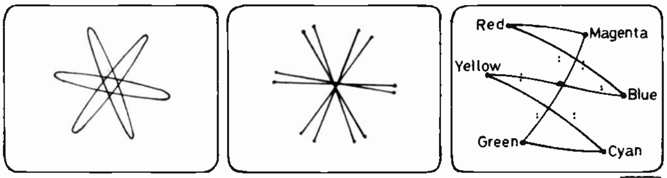
A pattern generator incorporating this facility will, for example, display one area of no colour for reference, one area of swung B–Y, one area of R–Y and one area with a fully saturated colour-difference signal correctly transmitted, – (B–Y) for preference. Sometimes the signals are in pairs on two or more buttons, and sometimes the pattern is split between the top and bottom. In the latter case the adjustment is to get the two halves looking alike for hue, saturation, or Hanoverian blind cancellation.

The alignment principles hold good for them all, namely:

Burst phase: Adjust to cancel out tints in the swung B–Y and unswung R–Y areas. Both will be affected. If they cancel at different points, use the quadrature adjustment to make both of them become colourless together.

Delay phase: Adjust to remove Hanoverian blinds from the fully saturated correct colour-difference signal area.

Delay balance: Adjust for minimum Hanoverian blinds in the two colourless areas which you have previously produced by setting the burst phase (some manuals call this burst matrixing, but this can be confused with the deriving of G–Y).



(a) (b) (c) 1551

Fig. 8: Aligning decoders by the X-Y method. The procedure is as follows : (1) Display a colour-bar pattern. (2) Connect the R−Y signal to the oscilloscope's Y input and the B−Y signal to its X input. A trace similar to (c) should be obtained. (3) Short out the burst discriminator, disable the killer and detune the reference oscillator until the colours run vertically on the tube face. If the set is misadjusted the trace will be as shown in (a). (4) Adjust the delay amplitude to close the loops shown in (a) so that the trace looks more like that shown at (b). (5) Adjust the delay phase to bring together the pairs of lines shown in (b). (6) Adjust the quadrature control (90° shift) to cancel out any remaining ellipses (usually diagonal). Then retune the oscillator to give stationary colours, remove the short across the burst discriminator's output and the trace will be as shown in (c). (7) Next adjust the burst phase control until the pairs of half-amplitude dots coincide. If this cannot be seen clearly, short the delay line input – the trace will then split as shown in (b). Adjust the burst phase to coincide the paired trace then remove the delay line short-circuit.

Connecting the colour-difference signals to the 'scope's X and Y inputs makes it into a vectorscope. By slipping the reference oscillator, the synchronous demodulators operate randomly so that any coincidence is due to the delay line circuit adjustments. To finally adjust the burst phase, the oscillator must be relocked and the cancellation effects of the delay line disregarded. This means either shorting out the delay line signal or else using the first and last lines of a field, which do not go through the delay line and bypass path respectively, producing a pair of half-amplitude dots which may be paired up to give an indication of correct adjustment.

(3) The X-Y method: If your oscilloscope permits, a more rapid way of adjustment with the colour bar is to feed the decoder's R—Y output to the 'scope's Y input and its B—Y output to the X input or X—Y facility. If the sensitivity of both 'scope channels is the same the display will consist of a bunch of six dots connected by faint lines, vaguely resembling the constellation Orion – see Fig. 8(c). You have in fact made a vectorscope out of your oscilloscope, the dots displaying the phase relationships between the various colours of the bars. Adjustments are carried out by pairing up the dots, closing ellipses, and adjusting the dots for maximum radial displacement from the centre. As with the cancellation method, this can usually be done without having to provide shorts or 180pF capacitors, thus saving time. Fig. 8 shows typical waveforms and the expected effects of the adjustments. These, like spiral staircases, are easier drawn than described.

Synchronous Demodulation

Synchronous demodulators have always been necessary for chroma signal detection. More recently, with the increasing use of i.c.s, they have come to be used for vision signal detection.

Our basic vision detector, which technology seems bent on eradicating, has been the simple diode – see Fig. 9(a). It poses no problems that matter or that cannot be put right later on. Indeed in areas with around 800μV signal, where noise just begins to be a problem, a viewer with a diode detector could be 6dB better off in signal-to-noise ratio than a neighbour with a synchronous demodulator. One disadvantage of diode detection (nowadays called "envelope detection") is the attenuation of the h.f. component of the modulation caused by the damping effect on the circuit of the diode's capacitance and its *CR* load. There is also distortion of the lower part of the signal due to the forward bias needed to turn the diode on. This is typically 0·4V for a germanium diode, and 0·7V for a silicon diode. It means that the bottom half a volt or so of the detected waveform is missing. On 625 lines this is "whiter than white" and represents the residual carrier necessary to maintain freedom from distortion. The practical effect is crushing of the yellow and cyan bars of the pattern.

Synchronous demodulation is now, with integrated circuits, a practical way of overcoming these difficulties. The chrominance detector in the decoder is the best example to begin with, representing as it does synchronous demodulation in its purest and simplest form. We have already seen how the stable part of the chroma signal, the burst, is used to lock a 4·43MHz crystal oscillator in frequency and phase to the transmitter subcarrier. As a result of this the diodes in the demodulators following the delay line are turned fully on, with correct timing, once during each subcarrier cycle. When this occurs, the delay line output passes through the demodulator unattenuated – see Fig. 9(b). A filter removes the subcarrier, and what remains is the chrominance information completely demodulated.

A second form of synchronous demodulator is found in the ubiquitous intercarrier sound i.c. – see Fig. 9(d). Here, the input signal is amplified, limited, and passed to the bases of a pair of transistors whose common emitter load is a third transistor. This transistor is switched on and off at 6MHz to provide the demodulator action. The 6MHz switching signal required is obtained by applying the 6MHz intercarrier sound signal to a high *Q* coil – called the quadrature coil since it imparts a 90° phase shift to the signal. This coil "rings" the input signal so that only the basic carrier frequency emerges. The switching transistor allows the upper two transistors to conduct only when it is "on", i.e. once a cycle for a finite time, phase shifted from maximum by 90°. This results in a balanced output appearing at the collectors of the upper transistors when no modulation is applied. As soon as sound f.m. begins to "wag" the upper pair, one will begin to conduct more and the other less, due to the phase shift of the lower transistor. So at the collectors, audio corresponding to the modulation frequency appears, the amplitude being determined by the deviation. All we now need is the conventional de-emphasis and we then have a usable signal.

Vision Synchronous Detection

The synchronous vision demodulator uses similar principles. This time however we are concerned with amplitude modulation, while a 6MHz bandwidth needs to be covered. This calls for greater tuning precision than with the sound signal. The signal fed to the switching transistor is amplified and limited, in other words the signal is clipped at residual carrier level so that only the plain carrier remains – see Fig. 9(e). The process of switching on the upper pair of transistors 39·5 million times a second by means of the switching transistor in their common emitter circuits is exactly the same as described for the intercarrier sound i.c.

With the popular TCA270 vision synchronous demodulator i.c. two external coils are required while within the i.c. there are two separate demodulators, the type we have already discussed and a second one which detects the error between the received i.f. carrier and 39·5MHz. This is the automatic frequency control (a.f.c.) detector. It supplies a d.c. voltage swing of plus or minus 5V around a mean value. This is applied to the varicap tuner to correct for any drift. It is imperative that the vision demodulator's "tank

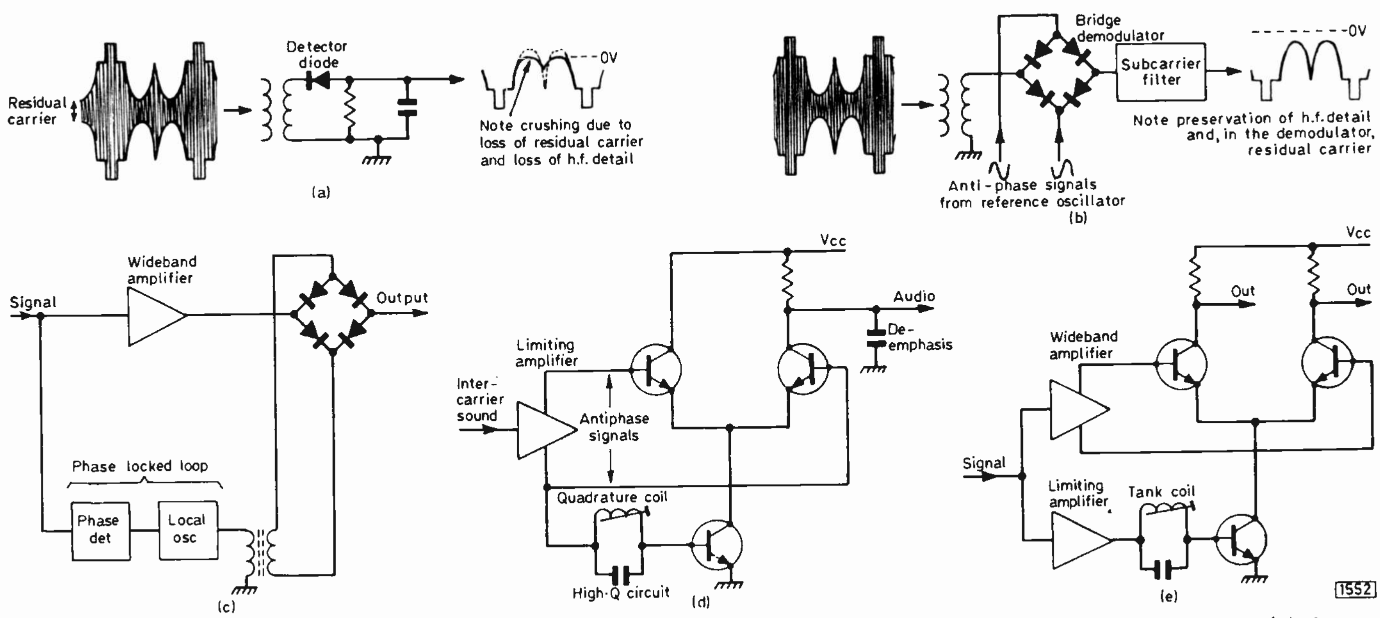


Fig. 9: Synchronous demodulation. (a) Basic diode envelope detector. (b) Diode bridge synchronous detector. (c) A true synchronous demodulator, with a local oscillator for switching, locked to the incoming signal. (d) The type of detector generally used in intercarrier sound i.c.s to provide demodulation. (e) Typical vision synchronous demodulator arrangement. Part of the incoming signal is amplified and limited, phase shifted in a high-Q tuned circuit (tank coil) and used to switch the lower transistor: this in turn switches on and off the upper pair of transistors to give coincidence detection. In practice balanced demodulators are generally employed in i.c.s – this means that the circuits shown in (d) and (e) are doubled up.

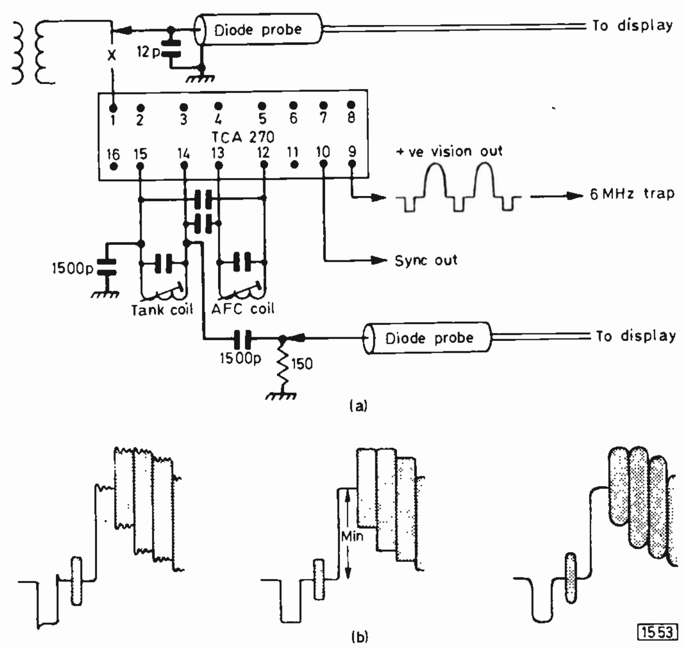


Fig. 10: Aligning the TCA270 vision synchronous demodulator i.c. (a) Connections for i.f. alignment: either break the input at X and load the diode probe with a 12pF capacitor, or decouple pin 15 and connect the diode probe to pin 14 as shown. (b) Aligning the tank coil. Look at the output from pin 9 after the 6MHz trap, and adjust for minimum height of the white bar consistent with the squarest response. Left, vision carrier too low; centre, on tune; right, vision carrier too high.

coil" and the a.f.c. coil are both set to the same frequency: otherwise the user will be unable to correct tuning errors. Even if he leaves the a.f.c. muted, as when tuning in, he will find that retuning is frequently required during a night's run.

Synchronous Demodulator Alignment

Most manuals take the easy option and tell you to leave the vision synchronous demodulator alone. Certainly you cannot "twiddle" it with any confidence of accuracy. A spoilt one can nevertheless be set up properly in situ if care is taken. You may first need to check the i.f. alignment, and the normal display take off at the vision diode is denied to you (the output of a sweep seen through a synchronous demodulator looks rather like the Loch Ness monster chasing a whale). A diode probe is necessary and can be connected at the input to the synchronous demodulator (see Fig. 10) in place of it. A small capacitor across the probe input will be needed to simulate the 12pF loading of the i.c. The i.f. output at this point is only 60mV, so more Y gain than usual will be needed. The alternative is to connect the diode probe at the tank coil connections, and in this case it's essential to bias the i.f. strip back to prevent limiting in the i.c. Both methods give results within 1dB of each other over the whole band.

You cannot use a sweep to set the tank and a.f.c. coils effectively. Adjustment should be done on a television signal with a square pulse, e.g. the white bar of the colour bar, injected into the i.f. amplifier at exactly 39·5MHz. An off-air signal of suitable type can be used, in which case the a.f.c. must be muted, and a signal generator set to 39·5 MHz loosely coupled in so as to produce a beat pattern. Look at the output on an oscilloscope connected after the 6MHz trap in the i.c.'s output circuit. Tune the set to zero beat with the signal generator which is then muted. Tune the tank coil for the best shape of the top corners of the bar – see Fig. 10(b). This should coincide with a dip in the black-to-white amplitude of the bar. Reconnect the a.f.c. and tune the a.f.c. coil to give the same result. Repeat if necessary until no further improvement results.

By getting the best shape at the top of the bar you have adjusted for best h.f. response, while by setting for minimum black-to-white dip you have produced maximum residual carrier (remember that the waveform on 625 lines is "sync up, white down" – sloth-like!). These of course were the two shortcomings of the simple diode detector.

Fixed Parameters

Finally let's look at two aspects of the set over which we have little control: the video response, and group delay.

Video Response

If your sweep generator permits this, it's possible to see what happens to the signal after detection – by applying a 0-6MHz video sweep to the vision detector output and looking at it via a detector probe at various points along its path. The results can be clouded by the presence of blanking pulses, and when you get to the output stage(s) will be frankly disappointing. A good response maintained right up to the base of the output transistor will take an abrupt dive at the h.f. end due to the capacitances between the output transistor's collector and the tube cathode. A slow sweep gives a more accurate presentation of the response, and a point by point graph of frequency against output is usually better still.

Compensation for h.f. attenuation in the output stage is normally provided for in the shape of peaking chokes and frequency-selective emitter decoupling. The latter can also compensate for poor demodulator response. Attempts to improve the overall response invariably introduce ringing and upset the colour registration.

To appraise the true total response of the set it is necessary to add together the i.f. response and the video response. This can be done by using a composite sweep fed to the i.f. input point. To produce a composite sweep, the output of the signal generator which normally gives the 39·5MHz marker is increased by about 26dB until it is of equal amplitude, i.e. output voltage, to the sweep itself. Bias can be removed, since the set's a.g.c. will now operate. The output at the vision detector and beyond should be looked at via a diode probe or alternatively using a full bandwidth 'scope. Adjust the sweep and signal generator input voltages so that clipping does not occur at the top of the trace. Because a static i.f. carrier is being mixed with the swept i.f. the detector produces their difference, which is a video sweep. This carries on through the video stages, where a diode probe will reduce it to a readable sweep.

Group Delay

Group delay is the name given to any time lag imparted to some of a band of frequencies passing through a circuit. As far as this series of articles is concerned, the bands are 0-6MHz and 33·5-39·5MHz. Only a few professional bodies can afford to have measuring equipment, so any problems must for most of us go unseen. In view of the confusion their intangibility causes we will end by giving a simple analogy which we hope will clarify matters.

Suppose we are watching a test card on which there are 1·0, 2·0, 3·0, and 4·0MHz bars. At the transmitter they are locked to line start. So they are all in step, like four dynamos all rotating together. By the time the 1MHz dynamo has gone round once the others will have gone round exactly two, three and four times respectively. If we were able to look at the same four dynamos as seen through our set, stopping the action at the moment when the 1MHz dynamo is at top dead centre, we might see the 2MHz dynamo lagging by a quarter turn, the 3MHz one upright, and the 4MHz one leading by a quarter turn. Expressed as a group delay, 2MHz minus a quarter turn is $500\text{ns} \div \frac{1}{4} = -250\text{ns}$, 3MHz has no delay, while 4MHz has a delay of $250\text{ns} \div \frac{1}{4} = +125\text{ns}$. After getting this far it seems fatuous to advise readers with video response or group delay troubles to try and resolve them by using "pulse and bar" K rating methods. ■

Book Reviews

Practical Repair and Renovation of Colour TVs, by Chas. E. Miller, published by Babani Press, The Grampians, Shepherds Bush Road, London W6 7NF. 79 pages, 95p.

This very interesting little book sets out to tell you how to obtain a working colour TV set for the minimum expenditure – by acquiring and renovating an old set that has been written off by a dealer or rental concern as being "beyond economic repair". There is no doubt that what is economic to the trader and to the enthusiast are two different things, and no doubt either that many of our readers will find it worthwhile undertaking this sort of work. For them, the book is packed with useful tips and sound guidance – as you would expect from someone with Chas. E. Miller's long experience as a TV service engineer. Some selection as to what to cover had to be made, and the book restricts itself to the earlier "first" generation of colour receivers – those in fact most likely to have been written off and thus readily available at bargain prices.

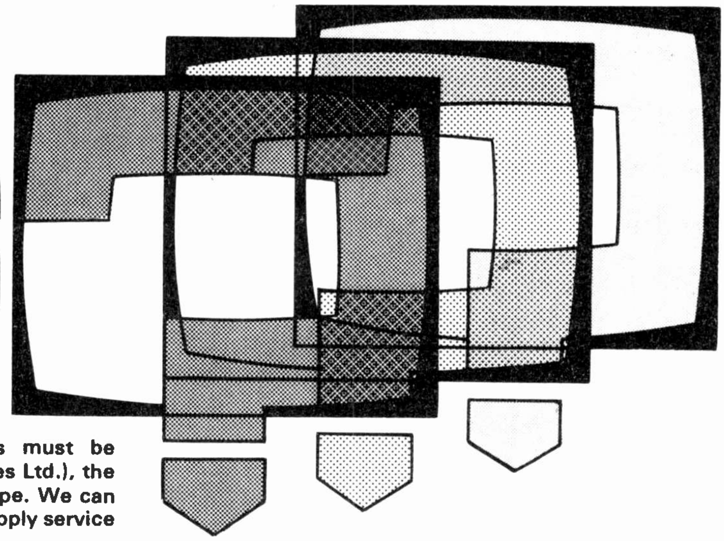
The coverage extends beyond the purely technical aspects of the matter in giving guidance on prices and sources and commenting on spares and alternative parts. There's an interesting section on converting sets using valve e.h.t. systems to the use of a tripler. There are also practical designs for a tube tester/reactivator and a crosshatch generator – and an appendix on receiving continental transmissions.

Our one criticism is that there are inaccuracies on one or two of the diagrams. The decoder block diagram has a rather mysterious extra phase detector – between the reference oscillator and the bistable. Not too serious that. What could be serious however is that the information given on semiconductor testing – the diagrams on page 21 – is wrong. The transistor test results would be correct if, as the text says, they were npn types – but pnp types are shown. And the diode tests do not follow the same meter battery polarity system as is assumed for the transistor tests. But here again anyone knowledgeable enough to tackle colour receiver renovation is not likely to be fooled.

Long Distance Television, by Roger W. Bunney, published by Weston Publishing, 33 Cherville Street, Romsey, Hants. SO5 8FB. Third edition, 58 pages, £1.11 including postage.

The hobby of DX-TV is really about probing the extremes of what's possible in receiving television signals. If the thought of this intrigues you, then this is the book to buy. As regular readers will know, Roger has been at this game for many years now and knows all the tricks. This latest and much expanded edition of his book on the subject tells pretty well all there is to be said, covering TV systems, modes of propagation, receiver requirements and modifications, aerial systems and various types of preamplifiers – even colour reception, off-screen photography and receiving satellite transmissions. The numerous photographs illustrate aerials, common test cards and patterns and, most important of all, examples of long distance TV signals as they appear on the screen. The emphasis throughout is on practical details, and the book is warmly recommended to all those who feel they'd like to have a go at "over the horizon" TV reception.

Your PROBLEMS solved



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FERGUSON 3722

The problem with this set, fitted with the PIL colour tube, is excessive width. Any ideas before I plunge into the Syclops line output/regulated power supply circuitry?

As with all sets which use a diode modulator for EW pincushion correction, this trouble occurs when one of the diodes goes short-circuit. The one to check is W712 – the one with its anode connected to chassis. (Thorn 9000 chassis.)

DEGAUSSING COIL

The c.r.t. of my colour set has become excessively magnetised so that it's impossible to obtain good purity. Details of a suitable degaussing coil would be welcome so that I can carry out demagnetisation.

An efficient degaussing coil can be made by winding 800 to 1,000 turns of 31 s.w.g. enamelled wire into a 15in. diameter loop. Wrap round with insulating tape and connect through a 250V push switch to the mains. Don't switch on for more than a minute at a time as the coil will heat up.

MARCONIPHONE 4714

Although the set is now almost four years old the picture is still good. For some months however when the set is first switched on the picture has ragged verticals, though it settles down after a few minutes with a good picture for the rest of the evening. Also, when the set was originally first switched on the picture used to appear in seconds. It's now taking roughly five minutes to come on and a few minutes longer to reach the required brightness – the contrast and brightness controls are almost at maximum. The picture in fact is not nearly as bright as it used to be.

For the distorted verticals, replace C619 on top of the power supply module. This was a 140μF electrolytic but Thorn now fit a 220μF electrolytic in this position and we recommend you do the same. The voltage rating should be at least 75V. The brightness troubles are likely to stem from a single cause. Set up the c.r.t. grid bias control R450, the first anode controls, the porch bias control R221 and the clamp pulse amplitude control R230 as set out in the manual. If the problem persists, suspect the offset pulse generator/adder transistors VT204/VT205 and the associated diodes W202/W303, and check C221 (1μF) which decouples the slider of R230. (Thorn 3500 chassis.)

BUSH TV166

The set has developed a field hold fault. The picture either jumps up and down by $\frac{3}{4}$in. at a fairly rapid frequency when the field "holds", or alternatively the picture rolls up or down at varying speeds. The heater circuit diode dropper and the field timebase and video/sync valves have been changed. This seemed to help, but only temporarily. The setting of the field hold control is very critical and has to be in one precise position to avoid fast rolling.

Make sure that 2C48 (8μF) which decouples the screen grid of the sync separator section of the PFL200 is up to standard. Then check the back-to-front resistance of the field interlace diode 3MR3 – or fit a separate diode in this position. Check the setting of the interlace control, and the cross-coupling capacitor 3C28 in series with it. Other components to check are the field sync pulse coupling capacitor 3C29 and 3R41 – again in the cross-coupling network – which is a cause of this trouble as it falls in value from its rated 33kΩ. We have known the output pentode's grid leak resistor 3R41 (1MΩ) to increase in value to cause jittering – but only once. (Bush TV161 series.)

RGD T121

The raster is present but there is neither vision nor sound and when the roof aerial is plugged in very clear sound is received from Radio Stockholm! This signal cannot be tuned out. There is also a ripple sound at about 25Hz coming from the loudspeaker.

This problem is usually due to failure of the TDA1330 vision demodulator i.c. Equivalent devices are the MC1330 and BRC1330. (ITT VC300 chassis.)

DECCA CS2030

After the set has been on for two to three hours the picture develops a twitch, increasing then decreasing in size for a split second. This increase and decrease is in the height only but continues until the set is switched off.

We have often traced this to a dud spot on the height control (VR404). If this is not the cause the PCF80 field oscillator or one of its associated components is responsible. Assuming that the twitch is a height variation and not a linearity variation, the fault is unlikely to be far from the height control network. Check the filtering components in the feed to the control – R405 and C401 – and R402 which is in series with it. (Decca 30 series.)

MARCONIPHONE 4714

The brightness on this set faded away and on checking the voltage across the beam limiter's emitter resistor R901 this was found to be high at 2·5V instead of 1·3V. Adjusting the beam limiter preset control R903 brings the picture back but does not vary the voltage across R907.

It seems that the line output stage is being loaded excessively. In order of likelihood the following are suspect: (1) shorting turns on the shift circuit a.c. blocking choke L504; (2) leakage in the c.r.t. first anode supply rectifier W505 or its reservoir capacitor C523; (3) the e.h.t. tripler; (4) shorting turns in either the line output (T504) or the e.h.t. (T503) transformer. (Thorn 3500 chassis.)

PYE CT152

This set is about 4½ years old. Twice during this time a black band has appeared at the bottom of the screen. On both occasions it could be removed by adjusting the height control. Now however there is a black band which varies from ¼in. on a light screen to about an inch on a dark screen, also from night to night, while the height control has no effect.

Suspect the two field output transistors VT26 and VT27. They are both type BD124 but VT27 works harder than VT26. So try interchanging them. Make sure that the +20V and −20V supplies to the field timebase panel are not low. (Pye 691 chassis.)

FERGUSON 3807

The picture on this set can be focused only at the centre of the screen, while as the brightness is turned up the focusing in the corners gets worse – there is almost a double image. I suspect the tube as the set is otherwise normal, with no non-linearity or ballooning. The focus voltage seems normal and all the resistors in the focus network are o.k. Since the raster is not distorted I've not tried changing the scanning coils yet.

These sets commonly do suffer from a degree of deflection defocusing due to the design of the scan coils. If the symptom is severe however and has developed in use then the c.r.t. is likely to be faulty. We assume that the e.h.t. is correct – confirm that the picture is of normal size and that there is no expansion as the brilliance is increased. (Thorn 1500 chassis.)

ITT 651/1

A buzzing noise which drowned the normal sound would start after the set had been on for about three-quarters of an hour. This happened on all channels. The fault was assumed to be drift and was cured by altering the tuning. About two weeks later however the fault started to appear as soon as the set was switched on. It is continuous, on all three channels, varies in pitch slightly with picture content and cannot be eliminated by retuning.

Our first suspect is the smoothing electrolytic C272 in the power supply: if this is open-circuit there will be a 20V ripple on the h.t. supply to the sound output stage. If this is o.k., check the PCL86 audio valve and carefully examine the wiring around the volume control on the control panel, ensuring that the braid of the audio lead is not earthed to the metal frame of the control panel sub-board. Check for dry-joints around the audio stage. Finally suspect the intercarrier sound can and replace complete if necessary. (ITT CVC8 chassis.)

ULTRA 6715

It takes anything from half to three-quarters of an hour before the picture – or sound – come on. The trouble is due to the chopper transistor not conducting during this time, though there is d.c. at its collector and the drive waveform is present at plug pin 3/2 on the line timebase panel. The power supply consists of two printed panels mounted back-to-back with soldered interconnections. It seems impossible to separate the two to make tests with the set switched on.

Access to this module is undeniably difficult. Undo the panel retaining screws and hold the panel clear by wedging in a matchbox! With regard to the fault, first ensure that the 30V supply is at full voltage – check at F602. If not, replace C607 (1,000μF) which is mounted at the back of the module chassis. If this is in order the trouble is likely to be one of the transistors in the chopper drive circuit – check VT602, VT603, VT605 and VT606. (Thorn 3500 chassis.)

EKCO TC435

The trouble is foldover approximately three to four inches from the left-hand side of the picture. The sound and picture are otherwise perfect.

Trouble such as this on the left-hand side is usually due to the efficiency diode circuit. We suggest you try a new PY800 and check the capacitors associated with the boost rail. (Pye 11U series.)

FERGUSON 3711

The colour content of the picture intermittently breaks up into wide horizontal bars of desaturated magenta and cyan. The bars remain locked and correspond to the red and blue castellations of the test card. The picture can be restored to normal by depressing the tuning button, or by detuning and retuning. The fault is not temperature related as it sometimes occurs when the set is first switched on.

The trouble is almost certainly due to a late or misshaped burst gating pulse. See waveform 23 in the manual. Check the components around the pulse polarity splitter transistor VT308 on the decoder panel, especially the two OA91 clipper diodes W315/W323 and the 400V pulse feed components R351 (220kΩ) and C334 (82pF). Finally, adjust the pulse width control R354 as given in the manual. (Thorn 3500 chassis.)

PYE CT200

The problem with this set is intermittent loss of colour which can be restored by switching the set off and on several times.

Unfortunately the trouble could be due to faulty i.f. alignment or to any of a number of faults on the decoder board. To check the reference oscillator, which is in the TBA540Q i.c., lift one end of R349 (150Ω) to disable the colour killer, short together pins 14 and 15 of the TBA540Q, and adjust C372 on a colour picture until the oscillator is running through lock. Remove the short, reconnect R349 and retest. (Pye 713 chassis.)

MARCONIPHONE 4609

The set worked quite satisfactorily until one evening when on switching it on there was only a horizontal white line across the screen accompanied by a single low-amplitude sinewave. These waveforms are stationary.

The symptoms suggest that the field scan coils are open-circuit. Check their continuity. (Thorn 850 chassis.)

PHILIPS G20T322

The problem is that dark scenes are too dark while bright scenes are too bright. There is also a tearing noise on some captions/scenes.

The symptoms suggest too strong a signal. With the contrast control at minimum, the picture should be grey. Make sure that the tuning range, set HT1 and preset brightness controls are correctly adjusted. If the picture is then still too black and white, try a 6dB attenuator in the aerial lead. If there is still caption buzz, the intercarrier sound i.c. IC2301 (TBA750Q) may be defective. (Philips 320 chassis.)

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 colour set fitted with the ITT CVC9 chassis had the following symptoms. With normal sound, screen illumination in the form of a somewhat defocused picture could be obtained on any channel though only when the front-end was slightly detuned. The picture in this condition was badly defined, weak and patterny. Tuning for the best picture resulted in total loss of screen illumination however, regardless of the setting of the brightness and contrast controls.

As it appeared to be an a.g.c. fault this section of the circuit was tested first, but apart from abnormally high-amplitude gating pulses all was found to be in order. The pulses provided at various tags on the line output transformer all seemed to be on the high side, as also was the voltage across the line output valve's cathode resistor – this voltage is sampled by the beam current limiter circuit.

In view of all this, attention was directed to the line output stage, the first items to be tested being the line oscillator valve V4f (PCF802), the line output valve V6h (PL509) and the boost diode V5h (PY500A). Replacements produced no change in the conditions. The line frequency was then monitored and found to be correct and the line lock good. Attention was next directed to the various high-voltage capacitors in the line output stage, but all to no avail. In desperation the technician changed the line output transformer, but after this and all the foregoing tests he found himself back at square one!

A reappraisal of the situation revealed the additional facts that the picture was less affected after adjustment of the beam current limiter preset control, while the symptom could be removed by disconnecting the aerial – i.e. after tuning correctly and losing the screen illumination, the illumination (raster) could be restored by extracting the aerial plug.

What was the most likely cause of these effects? See next month's Television *for the solution and for a further item in the Test Case series.*

SOLUTION TO TEST CASE 170
Page 219 last month

Although the 10MΩ focus preset control provided a point of focus it somehow did this with the resistive element open-circuit. A much better range of adjustment was obtained after replacing the control, but even after this the slow defocusing cycles could still just be discerned.

There are three connections to the tripler used in this chassis, the input, the e.h.t. output, and a third one which feeds the focus network and also goes via a 10kV 0·0025μF capacitor and a 470Ω resistor to one of three tappings on the line output transformer. The purpose of this is to provide width/e.h.t. adjustment. The resistor was checked with a multimeter and found to be in order, but the only action that could be taken with the capacitor was to try fitting a substitute. Fortunately one of near value and with the required high-voltage rating was available in the mobile kit of spares, and on fitting this the trouble was completely cleared.

Back in the workshop the capacitor was checked on a Marconi bridge. Its value was found to be within 10% but its loss was high – of the order of 40%, which is unacceptable for a component in this position. For comparison the loss of a stock replacement capacitor was measured – and was found to be zero! Capacitors seem to be responsible for some curious troubles of late.

Later similar triplers have four leads, with the capacitor concerned encapsulated within the unit.

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TELEVISION MAR. 1977

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AC152	0.34
AC153	0.42
AC153K	0.43
AC154	0.31
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AC179	0.48
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AC187K	0.45
AC188	0.42
AC188K	0.42
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AF125	0.38
AF126	0.36
AF127	0.45
AF139	0.48
AF147	0.52

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AU107	1.90
AU110	1.90
AU113	2.40
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BC108*	0.15
BC109*	0.17
BC113	†0.16
BC114	†0.20
BC115	†0.21
BC116*	†0.21
BC117	†0.20
BC118	†0.17
BC119	0.32
BC125*	†0.22
BC126	†0.24
BC132	†0.17
BC134	†0.20
BC135	†0.19
BC136	†0.20
BC137	†0.20
BC138	†0.30
BC140	0.90
BC141	0.95
BC142	0.29
BC143	0.33
BC147*	†0.12
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BC149*	†0.13
BC152	†0.25
BC153	†0.20
BC154	†0.20
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BC178*	0.22
BC179*	0.28
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BC183*	†0.14
BC183L*	†0.14
BC184*	†0.14
BC184L*	†0.14
BC186	0.25
BC187	0.27
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BC208	†0.12
BC212*	†0.17
BC212L*	†0.17
BC213*	†0.16
BC213L*	†0.16
BC214*	†0.17
BC214L*	†0.17
BC237*	†0.16
BC238*	†0.15
BC239C	†0.23
BC251A & B	†0.27
BC252A*	†0.25
BC253B	†0.38
BC261A	0.28
BC262A*	0.26
BC263B	0.27
BC267	0.16
BC268C	0.14
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BC303	0.60
BC307A & B	†0.17
BC308 & A	†0.17
BC309*	†0.17
BC317*	†0.22
BC318C	†0.23
BC319C	†0.26
BC320	†0.28
BC322	†0.24
BC323	0.68
BC327	†0.23
BC328	†0.23
BC337	†0.24
BC338	†0.19
BC347A*	†0.17
BC348A & B	†0.17
BC349A & B	†0.17
BC350A*	†0.20
BC351A*	†0.18
BC352A*	†0.18
BC360	0.24
BC377	0.22
BC441	0.59
BC461	0.78
BC477	0.20
BC478	0.19
BC479	0.19
BC547*	†0.13
BC548*	†0.12
BC549*	†0.15
BC550	†0.15
BC556	†0.18
BC557*	†0.14
BC558*	†0.13
BC559*	†0.15
BD115	0.93
BD123	0.98
BD124	0.88
BD130Y	1.56
BD131	0.49
BD132	0.54
BD133	0.51
BD135	0.42

Type	Price (£)
BD136	0.46
BD137	0.48
BD138	0.52
BD139	0.55
BD140	0.59
BD144	2.24
BD145	0.75
BD157	0.51
BD160	1.65
BD163	0.67
BD177	0.58
BD178	0.59
BD181	1.04
BD182	0.90
BD183	1.18
BD184	1.43
BD187	0.61
BD188	0.65
BD189	0.71
BD201	1.15
BD202	1.50
BD222	0.78
BD225	0.91
BD232	2.20
BD233	0.52
BD234	0.75
BD235	0.69
BD236	0.62
BD237	0.69
BD238	0.70
BD253	2.58
BD410	1.65
BD437	0.98
BD438	1.17
BD517	0.41
BD518	0.43
BD519	0.88
BD520	0.88
BD599	0.87
BD600	0.92
BDX14	1.02
BDX18	1.55
BDX32	2.75
BDX64A	1.89
BDX65A	1.69
BDY16A	0.43
BDY18	1.55

Type	Price (£)
BDY20	1.07
BF115	0.30
BF117	0.45
BF120	0.55
BF121	0.85
BF123	0.58
BF125	0.55
BF127	0.68
BF137F	0.78
BF152	†0.19
BF157	0.32
BF158	†0.25
BF159	†0.27
BF160	†0.22
BF161	0.45
BF162	†0.65
BF163	†0.65
BF164	†0.95
BF166	0.38
BF167	0.52
BF173	0.30
BF177	0.36
BF178	0.38
BF179	0.42
BF180	0.36
BF181	0.35
BF182	0.44
BF183	0.52
BF184	0.31
BF185	0.28
BF194*	†0.12
BF195*	†0.11
BF196	†0.14
BF197	†0.15
BF198	†0.29
BF199	†0.29
BF200	0.65
BF218	0.42
BF224J	†0.20
BF240	†0.32
BF241	†0.31
BF244	†0.37
BF245B	†0.68
BF255	†0.58
BF256L*	†0.49
BF257	0.49
BF258	0.53

Type	Price (£)
BF259	0.61
BF262	0.64
BF263	0.62
BF270	0.47
BF271	0.52
BF273	†0.33
BF274	†0.34
BF333	0.67
BF336	0.43
BF337	0.46
BF338	0.58
BF355	0.52
BF362	†0.62
BF363	†0.62
BF457	0.68
BF458	0.84
BF459	0.91
BF594	†0.16
BF596	†0.17
BF597	†0.17
BFR39	0.33
BFR40	0.29
BFR41	0.26
BFR60	0.35
BFR61	0.29
BFR62	0.28
BFR79	0.36
BFR80	0.32
BFR81	0.28
BFT41	0.48
BFT43	0.55
BFW11	0.66
BFW30	2.17
BFW59	†0.19
BFW60	†0.20
BFW90	0.28
BFX29	0.33
BFX84	0.30
BFY18	0.53
BFY50	0.33
BFY51	0.31
BFY52	0.30
BFY90	1.37
BLY15A	1.09
BR101	0.47
BRC4443	0.76
BRY39	0.48

Type	Price (£)
BRY55	†0.46
BRY56	†0.44
BT106	1.50
BT109	1.99
BT116	1.45
BT119	5.18
BU102	2.85
BU105	1.95
BU105/02	1.95
BU108	3.15
BU126	2.18
BU133	1.77
BU204	2.02
BU205	2.24
BU206	2.97
BU208	3.15
BUY77	2.50
BUY78	2.65
BUY79	2.85
D40N1	0.64
E1222	0.47
E5024	†0.19
GET872	0.46
MC140	†0.36
MJE340	0.68
MJE341	0.72
MJE370	0.74
MJE371	0.79
MJE520	0.85
MJE521	0.95
MJE2955	1.20
MJE3000	1.95
MJE3055	0.78
MPF102	†0.40
MPS6566	†0.31
MPSA05	†0.47
MPSA06	†0.48
MPSA55	†0.50
MPSA56	†0.53
MPSU05	0.66
MPSU06	0.78
MPSU55	1.26
MPSU56	1.32
OC26	0.90
OC28	1.19
OC35	0.93
OC36	0.88

Type	Price (£)
OC42	0.55
OC44	0.34
OC45	0.32
OC71	0.73
OC72	0.73
OC81	0.53
OC81D	0.57
OC139	0.76
OC140	0.80
OC170	0.34
OC171	0.34
ON236A	0.72
R2008B	2.25
R2010B	2.65
TIC44	†0.29
TIC46	†0.44
TIP29A	0.49
TIP30A	0.58
TIP31A	0.62
TIP32A	0.67
TIP33A	0.99
TIP34A	1.73
TIP41A	0.80
TIP42A	0.91
TIP2955	1.78
TIP3055	0.67
TIS43	†0.38
TIS73	†1.36
TIS90	†0.23
TIS91	†0.25
ZTX108	†0.13
ZTX109	†0.14
ZTX213	†0.21
ZTX300	†0.16
ZTX304	†0.24
ZTX500	†0.17
ZTX502	†0.19
ZTX504	†0.30
2N696	0.30
2N697	0.36
2N706	0.16
2N708	0.35
2N914	0.21
2N916	0.24
2N1164	3.60
2N1304	0.55
2N1711	0.45

Type	Price (£)
2N1893	0.40
2N2102	0.51
2N2221A	0.50
2N2222A	0.52
2N2369A*	0.44
2N2484	0.55
2N2646	0.75
2N2696	1.30
2N2904*	0.42
2N2905*	0.33
2N2926G	†0.15
2N2926O	†0.14
2N2926Y	†0.14
2N2955	1.12
2N3053	0.25
2N3054	0.62
2N3055	0.70
2N3702	†0.19
2N3703	†0.18
2N3704	†0.18
2N3771	1.85
2N3772	1.92
2N3773	2.90
2N3819	†0.35
2N3866	1.72
2N3904	†0.24
2N3905	†0.26
2N4032	0.57
2N4036	0.60
2N4058	†0.18
2N4291	†0.27
2N4392	2.84
2N4902	2.40
2N4921	0.61
2N5060	†0.32
2N5294	0.46
2N5296	0.62
2N5496	1.05
2N6178	0.71
2N6180	0.92
2SC643A	1.36
2SC1172Y	2.80
2SD234	0.89
40361	0.48
40362	0.50
40595	0.89

*Alternative gain versions available on items marked **

LINEAR IC's

Type	Price (£)
BRC1330	†0.93
CA3005	1.80
CA3012	1.32
CA3014	1.80
CA3018	1.06
CA3020	1.86
CA3028A	1.06
CA3028B	1.26
CA3045	1.35
CA3046	1.02
LM309K	1.98
MC1307P	†1.32
MC1310P	†2.94
MC1312P	2.20
MC1314P	3.85
MC1315P	4.15
MC1327P	†1.86
MC1327PQ	†1.86
MC1330P	†0.93
MC1350P	†0.85
MC1351P	†0.90
MC1352P	†0.90
MC1353P	0.92
MC1355P	1.15
MC1357P	1.42
MC1358P	†1.80
MC1358PQ	†1.85
MC1458G	0.98
MC1496L	0.88
MC3051P	0.58
MFC40008	0.85
MFC4060A	0.98
MFC6040	1.11
MIC1P	†2.58
ML231	†4.60
ML232	†4.60
NE555	0.72
SAS560A	†2.01
SAS570	†2.01

Type	Price (£)
SC9503P	0.95
SC9504P	0.97
SL414A	1.91
SL432A	2.52
SL450	5.10
SL901B	†4.10
SL917B	†5.50
SN72440N	†0.96
SN76001N	†1.45
SN76003N	2.24
SN76013N	1.50
SN76013ND	1.25
SN76023N	1.50
SN76023ND	1.25
SN76033N	2.24
SN76110N	†2.30
SN76226N	†3.15
SN76227N	†1.85
SN76502N	†0.92
SN76530P	†1.85
SN76533N	†1.20
SN76544N	†1.85
SN76660N	†0.60
SN76666N	†0.90
TA7073P	†3.51
TAA300	†1.84
TAA320	0.94
TAA350A	†1.96
TAA435	†0.85
TAA450	†3.39
TAA550	†0.60
TAA570	†2.30
TAA611A	1.70
TAA611B	1.85
TAA621AX1	2.43
TAA630Q	3.91
TAA630S	4.18
TAA661B	1.75
TAA700	†3.90
TAA840	†2.38
TAA861A	0.95

Type	Price (£)
TAA960	†1.35
TAD100	†2.66
TBA120A	†0.90
TBA120S	†0.99
TBA240A	†3.98
TBA281	†2.07
TBA395	†2.58
TBA396	†2.40
TBA480Q	†1.84
TBA500	†1.99
TBA500Q	†2.00
TBA510	†1.99
TBA520Q	†2.98
TBA530	†1.98
TBA530Q	†2.50
TBA540	†3.21
TBA540Q	†3.20
TBA550Q	†4.10
TBA560C	†3.13
TBA560CQ	†3.22
TBA570	†1.29
TBA641AX12	2.55
TBA673	†2.19
TBA700	†2.50
TBA720AQ	†2.38
TBA720Q	†2.39
TBA750A	†2.07
TBA750Q	†2.07
TBA800	2.40
TBA810AS	1.95
TBA920Q	†3.68
TBA940	†1.95
TBA950	†1.95
TBA990	†2.90
TBA990Q	†3.35
TCA270A	†3.55
TCA270CQ	†3.55
TCA270Q	†3.55
TCA800	5.55
TDA440	†3.70
ZN414	†1.45

DIODES

Type	Price (£)
AA113	0.17
AA119	0.13
AAZ13	0.30
AY102	1.85
BA100	0.24
BA102	0.25
BA104	0.19
BA110	0.80
BA111	0.70
BA112	0.85
BA115	0.15
BA121	0.85
BA129	0.39
BA145	0.19
BA148	0.19
BA154	0.19
BA155	0.19
BA156	0.15
BA157	0.25
BA158	0.28
BA201	0.13
BAX13	0.08
BAX16	0.10
BAY72	0.18
BB104B	0.52
BB105B	0.52
BB105G	0.45
BB110B	0.45
BR100	0.40
BY100	0.35
BY103	0.35
BY118	1.10
BY126	0.16
BY127	0.18
BY133	0.35
BY140	1.40
BY164	0.55
BY176	1.68
BY179	0.60
BY182	1.14
BY199	0.29

Type	Price (£)
BY206	0.31
BY238	0.25
BYX10	0.31
FSY11A	0.58
FSY41A	0.51
ITT44	0.08
ITT210	0.63
ITT827	0.80
ITT921	0.12
ITT922	0.12
ITT923	0.18
ITT1075	0.15
ITT2001	0.12
ITT2002	0.13
ITT2003	0.25
OA10	0.37
OA47	0.15
OA81	0.17
OA90	0.10
OA91	0.12
OA200	0.10
OA202	0.13
S2M1	0.38
S6M1	0.49
TV20	2.25
IN914	0.07
IN916	0.09
IN1184	1.10
IN1185	1.30
IN4001	0.05
IN4002	0.06
IN4003	0.07
IN4004	0.08
IN4005	0.09
IN4007	0.14
IN4148	0.06
IN4448	0.10
IN5400	0.15
IN5401	0.17
IS44	0.07
IS920	0.09
IS921	0.12

ZENER DIODES

400mW plastic 3.0-33V	12p each
1/1.3W plastic 3.3-180V	20p each
1.5W flange 4.7-75V	85p each
2.5W plastic 7.5-75V	48p each
20W stud 7.5-75V	74p each
75W stud 7.5-75V	£5.60 each

VDR'S ETC.

Type	Price (£)
E295ZZ /01	†0.21
/02	†0.21
E298CD /A258	†0.20
E298ED /A258	†0.18
/A260	†0.18
/A262	†0.18
/A265	†0.18
/P268	†0.18
E298ZZ /05	†0.20
/06	†0.18
E299DD/P116 – P354	all †0.17
E299DH /P230	†0.72
2322 554 02221	†0.59
VA1015	†0.78
VA1026	†0.64
VA1033/34/38/ 39/40/53	all †0.17
VA1055s/56s/ 66s/67s/	all †0.21
VA1074	†0.17
VA1077	†0.27
VA1086	†0.17
VA1096/97/98	all †0.19
VA1104	†0.44
VA8650	†1.20

VALVES

Type	Price (£)
DY86/87	†0.54
DY802	†0.54
ECC82	†0.54
EF80	†0.54
EF183	†0.70
EF184	†0.70
EH90	†0.94
EL34	†1.08
PCC84	†0.65
PCC85	†0.79
PCC89	†0.74
PCC189	†0.94
PCF80	†0.65
PCF86	†0.74
PCF200	†1.16
PCF801	†0.74
PCF802	†0.79
PCL82	†0.65
PCL83	†0.74
PCL84	†0.65
PCL86	†0.74
PCL805/85	†0.74
PD500	†2.16
PFL200	†0.94
PL36	†1.08
PL81	†0.94
PL84	†0.79
PL504	†1.05
PL508	†1.33
PL509	†1.80
PL802	†1.80
PY81/800	†0.58
PY500A	†1.16

RESISTORS

Carbon Film (5%)†	ea
¼W 5.6 Ω-330K Ω (E12)	1.5p
½W 10 Ω-10M Ω (E24)	3p
1W 10 Ω-10M Ω (E12)	3p
2W 10 Ω-10M Ω (E6)	5p
Wirewound (5%)	
2½W 0.22 Ω-270 Ω	17p
4W 1.0 Ω-10k Ω	18p
7W 1.0 Ω-22k Ω	19p
11W 1.0 Ω-22k Ω	20p
17W 1.0 Ω-22k Ω	24p

SPECIAL OFFER each
DL1 chrome delay lines **75p**
DL1E chrome delay lines **80p**
RCA scan coils (90° colour) complete **£10** per set
(Please add 30p postage to delay lines and £1.20 postage to scan coils.) PAL subcarrier crystals (wire-ended) **ONLY 55p** each

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Labgear CM6037/DB:VHF/UHF gives standard B band colour bars + grey-scale step wedge + red raster + centre cross + centre dot + cross-hatch + dot pattern + blank raster. Sync output also provided. **£131.41**

VHF TO UHF CONVERTERS†

Labgear "Televerta" for DX-ing, or uhf receiver use on relay systems, Eire, etc. Type CM6022/RA. **£19.24**

P. & P.: UK: £0.12 per order. **Overseas:** At cost.
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UHF/625 LINE

Can produce remarkable improvements in colour and picture quality in fringe or difficult areas with significant reduction in noise (snow).

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WHITE PLASTIC CASE 3¼ × 3¼ × 1¾ FELT BASE

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Please	**Group B, Yellow code**	39-51
Specify	**Group C-D, Green code**	52-68

EQUALLY SUITABLE FOR BLACK AND WHITE

Also the M4 DUAL BAND VHF UNIT

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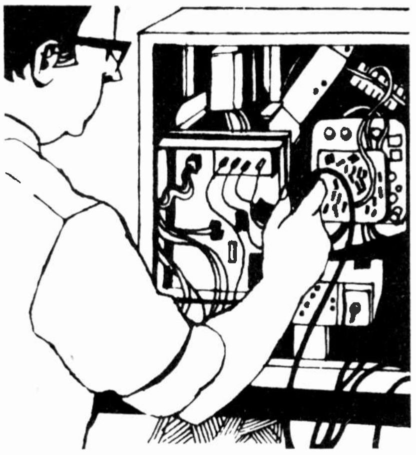

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Five valves or over postage paid
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DY86/87	15p	PC900	8p	PCL85/805	20p
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ECC82	10p	PCC85	20p	PL504	25p
ECL80	8p	PCC89	8p	PY32/33	15p
EF80	8p	PCC189	8p	PY81/800	15p
EF85	8p	PCC805	15p	PY801	20p
EF183	10p	PCF80	8p	U191	15p
EF184	10p	PCF86	15p	6F23	15p
EH90	13p	PCF805	20p	6/30L2	15p
EY86/87	13p	PCL82	15p	30F5	10p
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PC88	15p	PCL84	15p	30PL14	15p

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EF184	15p	PCL82	12p	PL36	15p
PC86	15p	PCL84	15p	U26	20p

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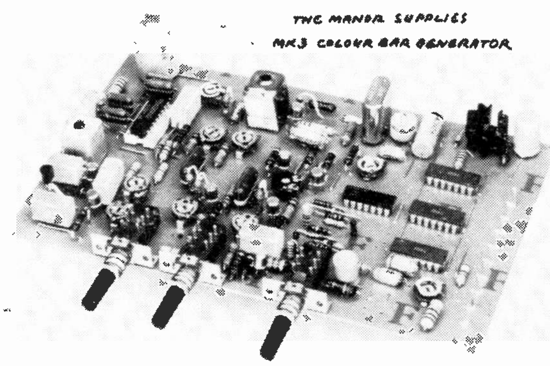

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AC17601	50p	BC114	19p	BC209	15p	BF152	30p	BFX89	30p
AC187	23p	BC115	19p	BC212L	11p	BF154	30p	BFY50	22p
AC187K	24p	BC116	19p	BC213L	11p	BF157	30p	BFY51	22p
AC188	24p	BC117	19p	BC214L	11p	BF158	24p	BFY52	22p
AC188K	40p	BC118	28p	BC225	15p	BF163	24p	BU105/01	1.90
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AF115	23p	BC148	11p	BC547	12p	BF185	25p	MJE2955	1.10
AF116	23p	BC149	13p	BD115	64p	BF194	14p	MJE3055	73p
AF117	19p	BC153	19p	BD116	60p	BF195	14p	MPSU05	65p
AF118	48p	BC154	19p	BD124	79p	BF196	14p	MPSU55	1.25
AF121	30p	BC157	14p	BD131	44p	BF197	14p	R2008B	2.00
AF124	23p	BC158	12p	BD132	49p	BF198	19p	R2009	2.00
AF125	23p	BC159	14p	BD133	49p	BF199	24p	R2010B	2.00
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AF127	23p	BC172	13p	BD135	39p	BF240	19p	TIP32A	60p
AF139	34p	BC178	21p	BD136	45p	BF241	21p		
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