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JUNE 1974

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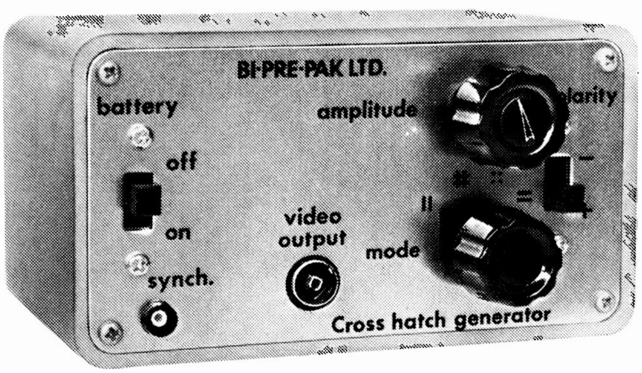

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TELEVISION

VOL 24 No 8
ISSUE 284

SERVICING·CONSTRUCTION·COLOUR·DEVELOPMENTS

JUNE 1974

VIDEO DISCS IN THE UK

Amid the speculation about the future of the television servicing industry, and the slowing down of colour set sales resulting from the present economic situation, it is refreshing to hear prominent businessmen speak with forthright determination about continued growth. Such has been the case recently from top executives of Mullard and Philips. The British and Dutch ends of this huge organisation have every right to be confident in view of their strong position in the consumer electronics market.

It can be argued that they exert considerable influence on world electronics' trading patterns: two examples of their initiative that have developed into international and inter-company agreements are their compact cassette tape recorder and VCR videotape system, both now widely accepted as international standards. In this issue we are paying particular attention to the Philips VLP (video long play) video disc system.

We have published a number of reports on the progress of various video recording systems for industrial, educational and domestic applications over the past two or three years. During this period there has been a great deal of sceptical talk about the viability of video discs, particularly for domestic use. There is still much controversy over their likely acceptance by the public, partly because of the cost. But did we not hear similar doubts over the likely success of colour television, also because of cost?

There are ways round the problems of gaining general acceptance of such a system, not the least being widespread marketing of the video player required through television rental firms. The discs themselves are likely to cost very little more to purchase than a standard long-play gramophone record, since similar mass pressing techniques can be employed.

The video disc is due to be launched on the British public before long and it would be churlish to dismiss it. We saw the UK industry caught unprepared for the colour television upsurge. Whilst not pretending that the video disc will create such a large market, we nevertheless take heed of Philips' comments: they forecast a not unreasonable ten per cent colour set user interest and this already amounts to several thousands of likely buyers or renters—quite apart from potential users still viewing monochrome sets.

Here then is another development to keep installation and service engineers busy. Training courses will be required to support the sales side and Philips have already indicated that they will be selective in appointing well organised service retailers and rental firms. Other manufacturers are likely to be interested in producing under licence equipment to the same basic specifications, and in a few years there could well be another boom such we have seen with colour receivers. Will the UK radio/TV industry be prepared this time?

M. A. COLWELL—*Editor*

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Cover: The cover photograph of a VLP disc and player plus receiver was kindly provided by Philips, Eindhoven.

TELETOPICS

COLOUR CRTs: THE NEW BREED

When the UK's largest c.r.t. manufacturer demonstrates prototype versions of a new tube for colour receivers it is time to sit up and take notice. The new tube, to be known as the 20AX, has been developed by Mullard in conjunction with the parent Philips organisation and will be produced by several Philips subsidiary companies on the Continent as well as by Mullard in the UK. Mullard envisage quantity production of the tube by 1976, mainly for export at first, with large-scale production for UK setmakers starting in 1977.

The tube has been developed as "probably the final phase in the design of the 110° shadowmask tube". Its main features are the use of three guns mounted horizontally in line, the use of a shadowmask with slots instead of circular holes, and a screen with the phosphors deposited in vertical stripes instead of as a pattern of dot triads.

It seems therefore that the days of the present delta gun shadowmask tube are now numbered, though considerable production will have to continue for many years to provide replacement tubes for the millions of colour sets already in use. So far as the viewer is concerned however it is important to appreciate the time scale involved (see above) and the reasons for the development of the new tube. There is nothing wrong with the type of shadowmask tube we have known since the beginning of colour TV: it is able to provide superb pictures. But in its 110° form it does require rather a lot of scan/convergence correction circuitry. If this can be reduced by means of an alternative approach—as with the 20AX tube—considerable benefits in set production and servicing will be obtained. This has been the aim behind the development of the new tube, and the demonstration tube we have seen operating with its associated deflection yoke and circuitry gave a picture every bit as good as we have come to expect from the present "conventional" approach to colour tube design.

There are now four colour tubes with in-line guns, the Sony Trinitron (the first to come along), the RCA/Mazda PI tube which was described in this magazine in some detail in June 1973, the Toshiba RIS tube and now the Mullard 20AX. It is interesting to compare them.

The Trinitron is a 90° narrow neck (29mm) tube. It differs from the others in using an aperture grill (slits from top to bottom) instead of a mask behind the screen to shadow the beams and a tube face which is substantially flat in the vertical plane. On the domestic market it is used exclusively in Sony sets and certainly represented a break through in simplifying the convergence circuitry and setting up adjustments required.

The Toshiba RIS (rectangular flare, in-line guns, slotted shadowmask) tube has now turned up in the UK in the recently introduced 18in. Sharp Model C1831H. Its most distinctive feature is the rectangular instead of conical tube flare and the rectangular semi-toroidal scanning yoke which is used with this. It is a 110° thick neck (36mm) tube. The convergence arrangements are fairly simple.

The most interesting comparisons however are between the PI tube and the 20AX. The first is a 90° tube of the narrow neck variety and features a toroidal yoke which is cemented to the tube—thus if either is faulty the entire tube/yoke assembly must be replaced. The great advantage is that no dynamic convergence adjustments or circuitry are required. It is at present limited to sizes up to 20in. and the designers say that it is not intended as a successor to the standard shadowmask tube above this size. Its depth compares with 110° tubes because of the simplified gun structure used.

The Mullard 20AX tube differs from it in several respects. First it is basically a 110° tube which can be produced in a whole range of sizes—production of 18, 22 and 26in. versions is proposed—so that setmakers can use it with a single chassis for models of various sizes. Secondly it uses saddlewound deflection coils which are separate from though accurately aligned with the tube. And thirdly it is a thick neck tube.

Unlike the PI tube in which all the gun electrodes except the cathodes are common to all guns the electrodes of each gun in the 20AX are separately available at the base. This means that in addition to RGB drive to the cathodes the grids are available for blanking and beam limiting and the first anodes for background control setting in the normal manner. In fact Mullard emphasised that the new tube is entirely compatible with existing colour set techniques—though the whole convergence system is greatly simplified.

The basic idea behind these in-line gun, slotted mask tubes is that by mounting the guns horizontally in line the convergence errors are confined to the horizontal plane and by applying an astigmatic deflection field these errors are cancelled. This means that a fair amount of cunning in the design of the deflection yoke is required.

A saddlewound yoke is more efficient than a toroidal yoke since the deflection fields are totally enclosed. In comparison to current 110° Mullard tubes the 20AX requires much the same horizontal deflection power but about twice the vertical deflection power (which can be obtained without trouble from modern semiconductor devices).

The use of a separate yoke with a tube of this type means that some dynamic convergence controls are still necessary, in order to match the assemblies. Mullard refer to these as "tolerance adjustments" rather than "dynamic convergence controls". About seven are required at present though further work is being done on this and by the time sets with the new tube appear we can expect some reduction. A single pincushion transductor is required instead of the two needed with 110° shadowmask tubes of the present variety. In comparison the PI tube requires no dynamic convergence adjustments, only some simple tube neck magnets for static setting up. It is a little less efficient however because of the type of yoke employed.

Whatever else happens there is no doubt that the vast majority of colour tubes fitted to our sets come 1977 will be of the in-line gun, slotted mask, vertical phosphor stripe variety.

Two further points made by Mullard at their demonstration: first, this type of tube requires less degaussing so that there are worthwhile savings in the amount of copper required for the degaussing coils; secondly their new tube, and in fact all Mullard monochrome tubes and shortly their colour tubes as well, will incorporate "instant on" guns which come into operation about five seconds after the set is switched on instead of the 30 seconds or more taken by present tubes. This instant-on feature is based on a new heater/cathode assembly in which the use of mica insulators has been avoided.

Meanwhile we understand that in addition to RCA and, in the UK, Mazda, ITT and Videocolour SA are to produce PI tubes.

Whilst congratulations all round are appropriate on the successful development of these new tubes it does seem a pity that we are about to enter for the first time an era of non-compatible colour c.r.t.s.

US AND JAPANESE COLOUR RECORDS

1973 was a record year in the USA too for colour set sales. In all over ten million colour receivers were sold representing a growth of 14% over 1972. Over eight and a half million of these sets were US manufactured. Monochrome set sales declined by 10·9% to just under 7·3 million.

1974 is turning out to be a miserable year in the US as well, with a noticeable decline in sales during the first two months. Stocks, especially of manufacturers undelivered sets, are rising.

Against this background comes the surprise news that Motorola, one of the largest US setmakers, has decided to withdraw from the TV market—in order to concentrate instead on communications, semiconductors, government electronics and automotive products. Despite record earnings last year Motorola's consumer products division made a loss, with sales below expectations. Motorola's US and Canadian TV plants have been sold to the Japanese electronics company Matsushita (National Panasonic) who will thus acquire a share of the US market representing about 9%—third behind Zenith and RCA.

Matsushita is the third Japanese company to have manufacturing plant in the US—Sony and Hitachi are already established there. Japanese interest in having manufacturing facilities in the USA follows difficulties experienced as a result of the devaluation of the dollar—the US is the main export market for Japanese TV setmakers.

Japanese colour set production in 1973 increased by 5% to a record 8·75 million sets: exports rose by 13·5% to a record 2·1 million.

TWO MORE RELAY STATIONS OPEN

The following relay stations are now in operation:
Bristol, Kings Weston Hill ITV channel 42 carrying HTV West programmes. Receiving aerial group B.
Eyemouth, Berwickshire ITV channel 23 carrying Border Television programmes. Receiving aerial group A.

The transmissions from both stations are vertically polarised.

COLOUR SET DISTRIBUTION IN UK

The market research firm AGB has published in its journal *Audit* its findings on how colour sets are acquired in the UK. Rental accounts for 75% of colour sets going into people's homes, cash sales 19% and HP purchases 5%. The small residue is accounted for by gifts etc. AGB found that this pattern varied only marginally over the years 1972-73. The rental organisations certainly seem to have been able to get themselves well organised while it is now clear that HP cannot be blamed for the soaring colour set demand that put the UK's consumer electronics trade balance so severely in the red last year.

ACTION ON THE SERVICING FRONT

The Radio and Television Retailers' Association is to start a "strenuous campaign" to boost servicing by recruiting and training more engineers. A meeting has already been held with the Distributive Industry Training Board and discussions are planned with careers officers, education authorities and manufacturers in a bid to sponsor more courses, up-date existing ones and accelerate training. RTRA president Roy Axon has commented that "recruits must find the work attractive—so the association is looking into job evaluation and the possible grading of engineers. The consumer should be aware that the man who comes to repair his equipment is a skilled technician—and should be prepared to pay the correct rate. For too long our labour has been too cheap".

Meanwhile RCA are continuing to expand their chain of service depots in the UK. These can handle any make of equipment and will take over dealers' entire servicing needs.

NEW TELETON SERVICE DIVISION

Teleton have formed a new service division known as the Technical Services Organisation. This is based at Teleton House, Waterhouse Lane, Chelmsford, Essex (phone number 0245 66739) and has a staff of 23 including nine service engineers. Teleton were taken over two years ago by Mitsubishi.

THE VLP VIDEO LONG PLAY SYSTEM

THE Philips VLP (video long play) video disc system was first unveiled in the autumn of 1972. Development work on the system has continued since then and it is expected to be introduced on the European and US markets before long. VLP has been registered by Philips as a trade mark.

The great advantage of disc systems is the cheapness of the discs. Philips regard the VLP system as complementary to their VCR (videocassette recorder) system in the same way that gramophone LPs are complementary to sound tape recorders. The VCR offers the advantage of both record and playback facilities, but it is more expensive to produce recorded tapes than to press VLP records.

System Fundamentals

The information is impressed on the VLP disc in the form of a spiral track of microscopic pits of equal width and depth. The modulation varies the frequency and length of these pits. The player unit uses a laser optoelectronic system to scan this recorded signal track: the laser light is modulated by the pits as it scans along the track and the modulated light reflected from the disc is then converted into an electrical signal by a photodiode. A full colour signal—to the PAL or NTSC specification—with sound can be recorded on the disc and played back using this technique, providing a signal suitable for feeding into a normal domestic TV receiver.

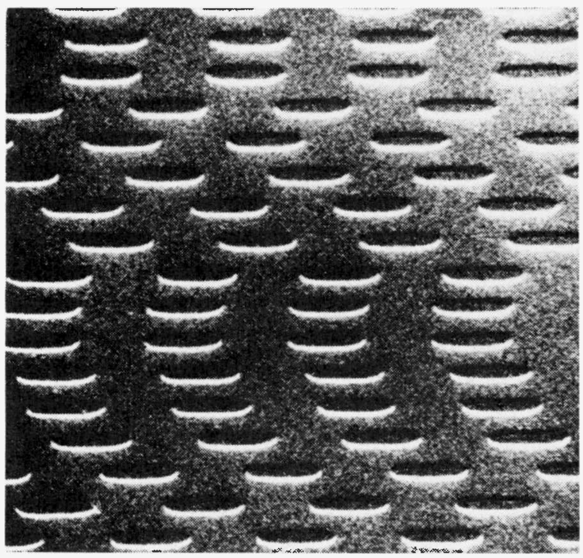
The VLP Disc

The VLP disc can contain up to half an hour of material and is similar in size and substance to the present LP gramophone record—the diameter is 30cm. The recorded track occupies the part of the disc between the 10 and 30cm diameters. The disc rotates at a speed equal to the picture frequency (i.e. two interlaced fields) of the television system in use—one twenty-fifth of a second for the European system and one thirtieth of a second for the US system. This makes it possible to freeze a picture or to speed up or play back in slow motion or in reverse.

For a half-hour playing time the above figures mean a pitch of 2μm for the track. The coherent (i.e. laser) scanning light spot is of $1{\cdot}2\mu$m diameter and is projected on to the track by a lens of aperture value equivalent to 0·4. The pits forming the track are of $0{\cdot}8\mu$m width and $0{\cdot}16\mu$m deep. Since the surface roughness of a normal gramophone record does not amount to more than $0{\cdot}01\mu$m there is no problem about pressing a pattern of such pits on the disc. The surface of the VLP disc is coated with a thin layer of evaporated metal to improve the reflectivity and a protective transparent layer is added on top of this. Contamination or damage affects only this outer surface of the disc and since the diameter of the scanning beam at this protective outer surface is much larger than the spot that actually scans the pits imperfections on the outer surface have very little effect on the detected signal.

Scanning the Disc

When the scanning light spot falls on the disc surface between pits most of the light will be reflected back into the projecting lens. When it falls on one of the pits however the light will be



The signal is recorded on the surface of the disc as a track of pits: this photograph shows the pits in a minute section of the surface of the disc.

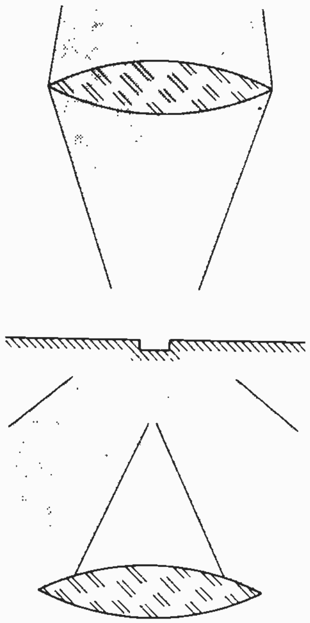


Fig. 1 (*left*): *How the pits in the surface of the VLP disc modulate the scanning beam.*

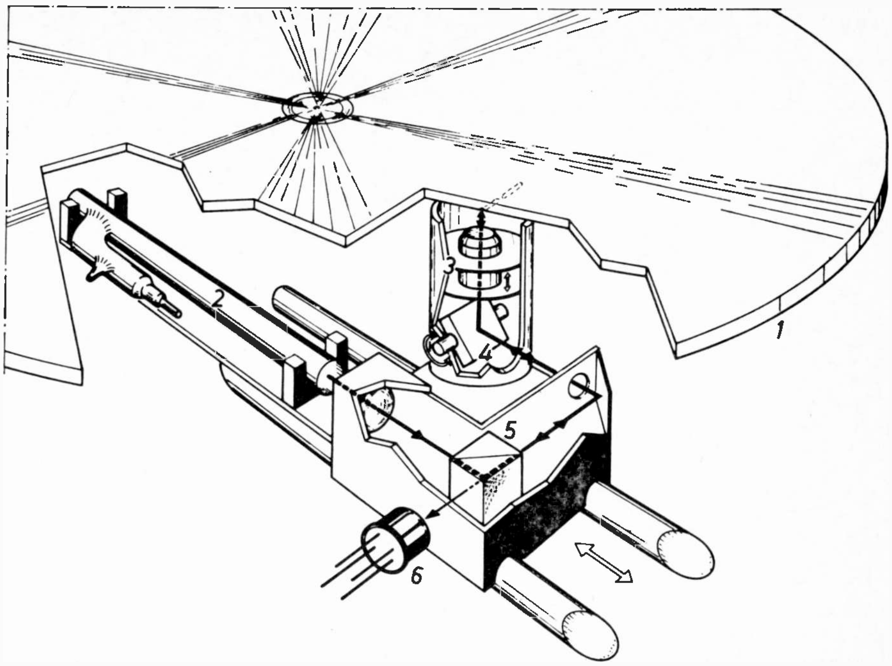


Fig. 2 (right): Simplified schematic diagram of the VLP playback system. The disc (1) is scanned from below by light from the helium-neon laser (2). Focus lens (3) is suspended in the same way as the cone of a loudspeaker, an automatic control system providing drive so that the focus remains correct. Pivoting mirror (4) is automatically controlled to keep the beam centred on the track. Prism (5) separates the incident and reflected light which is detected by the photodiode (6).

deflected by diffraction at the pit so that most of it is not reflected. This method of modulating the scanning light beam is demonstrated in Fig. 1. For clarity the system is presented as if the disc is transparent, with the beam incident from above and a second lens to receive the modulated beam placed beneath the disc. The pit is also shown many times enlarged with respect to the rest of the diagram.

If the disc surface is flat all the incident light will arrive at the lower lens. If there is a pit at the surface however diffraction will occur and some of the light will be deflected. With a correctly dimensioned pit much of the incident light is deflected away from the lower lens. In practice the record surface is reflective and a single lens is used to focus the light on to the record and receive the modulated reflected beam.

Use of Frequency Modulation

This technique means that the recorded signal has just two levels. The signal is recorded as variation of the frequency and duration of these levels, i.e. the system uses frequency modulation.

The Laser

For good signal-to-noise ratio the reflected beam should be of as high intensity as possible. To provide this requirement a helium-neon laser which can be manufactured in quantity has been developed for the system. This 1mW laser is built into the player in such a way that it can be of no danger to the user. In addition to its high brightness the helium-neon laser has low noise at MHz frequencies.

Master Record

A glass disc with a specially prepared surface is used as the master record in the recording process. The recorded pattern is cut on this by a laser. Subsequent processing and pressing follow conventional gramophone record techniques.

VLP Player Requirements

To give satisfactory operation the VLP player must be capable of fulfilling the following four requirements. First the speed must be constant to an accuracy of 1 in 10^3. Secondly the lens must keep the scanning beam correctly focused on the surface of the record: because of its large aperture the lens has only a very small depth of focus, and although record surface irregularities are locally very small deviations over a wider area can be as much as 0·5mm. Thirdly the light beam must remain centred on the track even though the track may be not truly circular (out-of-round) or eccentric. Deformation of the disc during pressing can cause out-of-roundness whilst eccentricity of the spindle hole in the record and play between it and the playback unit shaft can result in eccentric track rotation. The player must be able to operate correctly even when the total track deviation from the ideal position is as much as 0·1mm. Fourthly the complete optical system must move radially across the disc at the rate at which the track advances (tracking) without

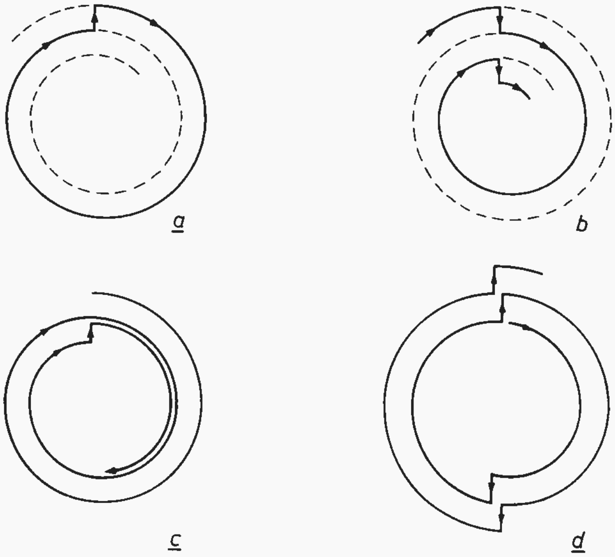


Fig. 3: Different ways of using the picture recorded on the VLP disc—twice per revolution during the field flyback period an opportunity occurs to change from one track to another. (a) A reverse jump after each revolution gives a stationary picture; (b) a forward jump after each revolution gives motion at twice the true speed; (c) reverse jump after every second revolution reduces the speed by half; (d) a reverse jump every half revolution gives reverse motion at the correct speed.

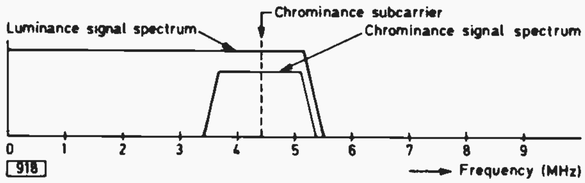


Fig. 4: Frequency spectrum of the basic PAL signal.

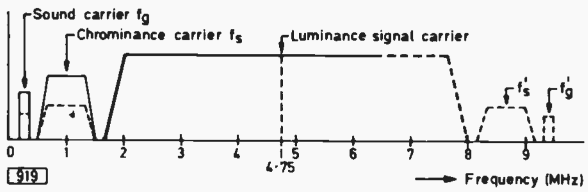


Fig. 5: Frequency spectrum of the signal recorded on a VLP disc. Solid lines represent the spectrum after summing the luminance, chrominance and sound signals. Broken lines represent the spectrum after symmetrical limiting. The relative amplitude ratios of the various signal components are not shown to scale. In the VLP system the chrominance subcarrier fs is shifted to 1MHz: fs' is the corresponding frequency which arises in the upper sideband after symmetrical limiting. The sound carrier fg also has a counterpart fg' in the upper sideband.

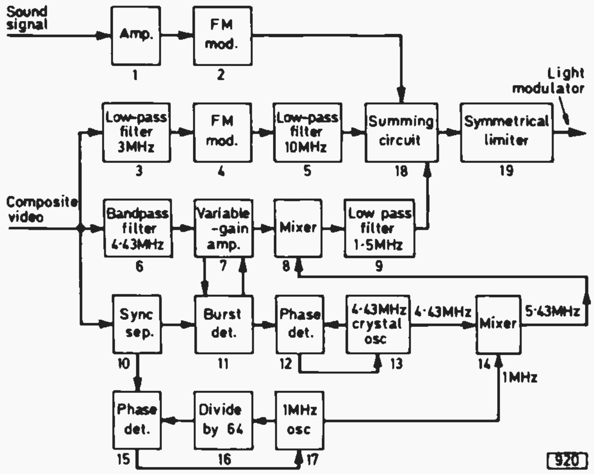


Fig. 6: Block diagram of the circuits used in recording a VLP record.

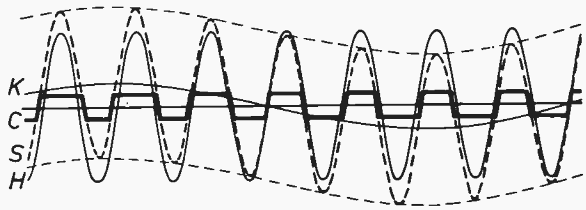


Fig. 7: Schematic diagram of the waveforms in the VLP system. H is the frequency-modulated luminance signal, K the frequency-modulated chrominance and sound signals—there are three separate frequency-modulated carriers. S shows the three signals superimposed and C the rectangular pulse signal produced by symmetrical limiting. The luminance information is still present as frequency modulation while as a result of the finite rise time of the luminance carrier the chrominance and sound signals are present as duty-cycle modulation of the rectangular pulse signal.

the aid of a groove or other mechanical guide. A number of control systems are incorporated in the player unit in order to meet these very exacting requirements.

The speed control system has an accuracy of 25Hz ± 0·1% and consists of a tachogenerator and d.c. motor plus a precision network to convert the tachogenerator output into a control signal. The focusing system has a reduction ratio of over 500 at 25Hz and obtains its error signal from a capacitive sensor. The correction drive applied to the lens operates on the same principles as a moving-coil loudspeaker—the lens is suspended in fact in the same way as the cone of a moving-coil loudspeaker. The beam centring system also has a reduction ratio of over 500 at 25Hz: its error signal is obtained by optical means. Correction is applied by using a small pivoting mirror driven by a rotating-coil system to displace the scanning spot. For continuous tracking purposes a carriage moves the entire optical system radially. The control system employed here ensures that the average deflection of the beam centring mirror remains small.

VLP Player Mechanism

The optical arrangements used in the VLP player are shown in simplified form in Fig. 2. The carriage can move backwards and forwards on rails beneath the disc (1). The light from the laser (2) is focused on to the disc by the lens (3). Control systems as outlined above act on the lens and the mirror (4) to keep the beam focused and centred on the track. The prism (5) is used to ensure that the light reflected from the disc falls on the detector (6).

Extra Features

As we have seen there are two fields per rotation of the disc. Thus the field sync pulses are always at positions diametrically opposite each other and wherever the spiral track crosses the two sectors the same information is available. This means that inside each sector the beam can be allowed to change from one turn of the track to an adjacent one without spoiling the picture. To do this a control pulse can be applied at the correct moment to the control system. By continually repeating the same turn and thus the same picture a stationary picture is obtained and by omitting every other frame the action of the scene appears at twice the normal speed. A reverse motion picture is obtained by jumping back a turn at each half revolution. Fig. 3 shows the various possibilities.

As the scanning light beam is accurately centred on the track cross-talk between adjacent turns is very small ($<$ —30dB). This means that completely different pictures can be recorded on successive turns giving a "picture book" per disc of about 45,000 different pictures. Address coding allows any particular picture to be rapidly found.

These features enlarge the scope of the VLP system beyond the field of simple home entertainment.

Recording Technique

To record the signals—luminance, chrominance and sound—as a pattern of pits on a disc means that they must undergo considerable processing. The basic PAL video spectrum is shown in Fig. 4. The luminance signal occupies the band from 0—5·5MHz with the chrominance information on its 4·43MHz subcarrier interleaved in the upper part of this spectrum. In the VLP system the luminance signal is cut off above 3MHz and is then used to frequency modulate a 4·75MHz carrier. The VLP frequency spectrum is shown in Fig. 5. The bandwidth below 1.75MHz is available for the chrominance and sound signals. The chrominance subcarrier is shifted from 4·43MHz to 1MHz (PAL system) with a total bandwidth of $\pm$0·5MHz. The sound information frequency modulates a 250kHz carrier with a frequency sweep of 75 kHz. If desired a second sound channel can be included at the low-frequency end of the spectrum to provide stereo sound or a spoken text in another language.

Fig. 6 shows in block diagram form the signal processing carried out during recording. The video input is a composite (luminance, chrominance and syncs) signal from tape or a camera. After individual processing the luminance, chrominance and sound signals are combined (18) in the amplitude ratio 10:2:1 and are then clipped by a symmetrical limiter (19) to give the two-level signal which determines the length and spacing of the pits on the disc being recorded.

Returning to Fig. 5, we can consider the chrominance and sound signals as artificial lower sidebands in a single-sideband modulation with the luminance signal as the carrier. Symmetrical amplitude limiting of such a single-sideband modulated signal results in the synthesis of the missing upper sidebands at the expense of the power in the lower sidebands. The amplitude ratio of the signals becomes 20:2:1 after limiting therefore. Looked at another way the symmetrical limiting gives a signal of rectangular pulses in which the luminance signal is contained as frequency modulation while the chrominance and sound signals give symmetrical modulation of the width of the pulses.

Fig. 7 shows the waveforms involved. H is the luminance carrier which is frequency modulated. K represents the f.m. chrominance and sound signals. Superimposing these signals gives the combined carrier S which after symmetrical clipping becomes the rectangular pulse waveform shown as C—the waveform recorded in the form of pits on the VLP record. As can be seen the luminance signal is present in this recorded squarewave signal as f.m.; the sound and chrominance signals are present as duty-cycle modulation.

Reference Signal

For correct playback a 4·43MHz reference signal which must remain stable despite variations in the speed at which the disc rotates is required. This is the reason for choosing 1MHz as the chrominance subcarrier frequency since this is exactly 64 times the line frequency (15·625kHz $\times$ 64 = 1MHz). By locking the line frequency and the chrominance subcarrier frequency together a stable 4·43MHz carrier can be recreated at playback.

Encoding the VLP Signal

We will next run through the signal encoding processes shown in Fig. 6. The sound signal path is easy enough: amplification (1) followed by f.m. modulation (2) and then combination with the other two signals in the summing circuit (18). The luminance signal is bandwidth limited by the low-pass filter (3) and then passed to the f.m. modulator (4). This consists of a multivibrator which is driven by the modulation: thus a frequency-modulated rectangular pulse output is obtained. If the chrominance and sound signal duty-cycle modulation of the combined signal is to work properly however, the rise time of the modulated luminance signal must not be too short. For this reason the output from the luminance modulator is passed to the summing circuit via a low-pass filter (5) with a cut-off at 10MHz. This makes the frequency-modulated luminance signal almost sinusoidal.

The 4·43MHz bandpass filter (6) extracts the chrominance information from the composite video signal and passes it to the variable-gain amplifier (7). The gain of this is determined by the amplitude of the burst signal. This is measured by the burst detector (11) on receipt of a gating pulse from the sync separator (10). If the video signal is a monochrome one there will be no burst signal of course. The gain of the amplifier is then reduced to zero (colour-killer action) so that noise in the colour circuits does not produce interference on the picture.

The burst signal is also used to synchronise the 4·43MHz crystal oscillator (13). This action is carried out by the phase detector (12) which compares the phase of the bursts with the oscillator output

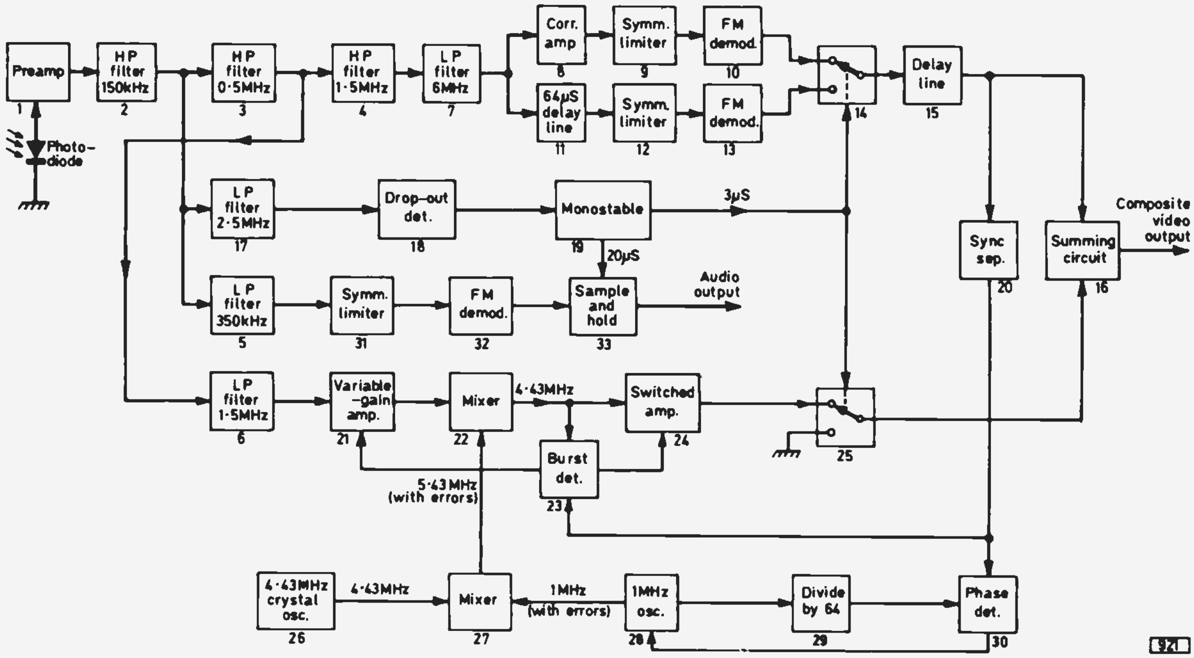


Fig. 8: Block diagram of the circuits used in a VLP player.

and produces an output to control the oscillator. A second oscillator (17) produces the 64th harmonic (1MHz) of the line frequency. This oscillator is locked to the line frequency by dividing its output in the divider circuit (16) by 64 and comparing the result in the phase detector circuit (15) with the line pulses obtained from the sync separator (10).

The mixer (14) gives the sum frequency (5·43MHz) of the two oscillators. This sum frequency is then mixed with the chrominance signal on its 4·43MHz subcarrier in the mixer stage (8). The difference-frequency component of the mixer output, the chrominance signal on a 1MHz carrier, is then filtered out by the low-pass filter (9).

As we have seen the three signals are then combined in the correct ratio—in the summing circuit (18)—and the output amplitude clipped by the symmetrical limiter (19). The output is applied to the light modulator used for recording the VLP disc.

Decoding the Playback Signal

Fig. 8 shows in block diagram form the way in which the signal obtained from the photodetector in the VLP player is processed so that a signal suitable for playing back via a monitor (i.e. input at video frequency) or standard television set (input at u.h.f. or v.h.f.) is obtained. Apart from demodulating the luminance and sound signals the most important operations are restoring the chrominance subcarrier to 4·43MHz and the correction of drop-outs (places where the signal is missing because of damage to the record).

The luminance, chrominance and sound signals are separated by means of filters (2-7). The luminance signal passes via high-pass (cut-off below 1·5 MHz) and low-pass (cut-off above 6MHz) filters (4, 7) to the correction amplifier (8) which gives a falling linear characteristic and also to the 64μS (one line period) delay line (11). The symmetrical limiter (9) following the correction amplifier produces a purely f.m. output with emphasis on the h.f. end of the spectrum at the expense of the l.f. end which was boosted in the correction amplifier. Following f.m. demodulation (10) the luminance signal passes to the electronic switch (14) which also receives the luminance signal via the delay line (11) and the subsidiary processing/demodulator channel (12-13). This latter channel provides a signal delayed with respect to the signal in the main channel by exactly the time of one line scan. The transmission characteristic of the delay line gives a falling linear response as given by the correction amplifier in the main channel. If a drop-out occurs the electronic switch (14) can thus use the signal from the identical point along the previous line as a replacement signal.

Drop-out Detection

Filter (17) filters out the part of the signal below 2·5MHz. This is used to detect drop-outs. If the photodiode misses a pit a signal exactly half that of the f.m. luminance signal occurs. The drop-out detector (18) reacts to this and as a result switch (14) is operated for a period of 3μS so that the luminance signal from the preceding line is selected instead. This 3μS is sufficiently long since in practice very few drop-outs of longer duration occur. The transit time of the signal through the luminance channel is longer than the time taken for the drop-out detector to operate so that switch (14) is already changed over before the signal drop-out arrives at this point.

Chrominance Signal Processing

The chrominance signal (0·5-1·5 MHz bandwidth) is filtered out by filters (3) and (6) and passed to the variable-gain amplifier (21). The gain of this is controlled by the burst signal amplitude in the same way as in the recording circuit. Colour-killing however is effected by obtaining from the burst detector a second output which controls the switched amplifier (24).

The 1MHz oscillator (28) is locked to the sync pulses in the recorded signal by means of phase detector (30), the 1MHz output thus obtained including any frequency deviations that may arise during playback. The free-running crystal oscillator (26) produces a 4·43MHz signal which functions as the new chrominance subcarrier. Mixer stage (27) produces a 5·43MHz signal containing any frequency errors present, and the difference between this frequency and the 1MHz chrominance signal reproduced from the record is produced by mixer stage (22). Since the frequency deviations of the two signals cancel out the stable 4·43MHz subcarrier required is produced. If there is a drop-out, switch (25) short-circuits the colour signal. Because of the delay line signal averaging process which is carried out in PAL-D receivers the result is that the missing colour fragments are filled in at half saturation.

Sound Channel

Filters (2) and (5) filter out the sound signal which after limiting (31) is demodulated (32). Circuit (33) counteracts spikes in the signal level caused by drop-outs.

Video Output

The luminance and chrominance signals are combined in the summing circuit (16) to provide a composite video output. A delay line (15) is necessary in the luminance signal path to the summing circuit to compensate for the different signal transit times resulting from the difference between the chrominance and luminance channel bandwidths. To produce a signal for feeding to the aerial socket of an ordinary domestic TV receiver the video and sound signals must then modulate a v.h.f. or u.h.f. carrier.

Optical Scanning System

The optical scanning system is shown in greater detail in Fig. 9. This also indicates how the optical arrangement provides a reference signal for the control system which keeps the scanning beam centred on the track. Two auxiliary light beams are used for this purpose. Each is imaged on to its own detector by the optical system after reflection from the surface of the disc. These auxiliary beams strike the track at equal distances in front of and behind the main beam. Both auxiliary beams are slightly displaced in opposite directions from the centre line of the track so that as shown in Fig. 10 each is partly on and partly alongside the track. The average current through the auxiliary beam detectors depends on the deviation of the beams from the centre of the track. The difference between the two detector output signals is applied to a low-pass filter (cut-off frequency 20kHz) whose output forms a suitable error signal for the beam centring control system. The auxiliary beams are obtained by splitting the laser light into three beams of approximately equal intensity by means of a diffraction grating (G in Fig. 9).

The intermediate lens (L) ensures that the laser beam is imaged on the entrance pupil of the main focusing lens (Obj): it also produces a beam path such that the beam reflected from the disc is imaged on to the photodetector without other aids. This means that the detector can be easily adjusted and reduces the sensitivity of the arrangement to small displacements or vibrations. A transverse magnetic field in the laser ensures that the laser beam is linearly polarised parallel to this field. As a result a quarter-wave plate (W) and polarising mirror (P) can be used to separate the incident and reflected light beams. This enables the laser power to be used efficiently and prevents feedback of the modulated light to the laser.

For beam focus control the capacitance between the metallised disc coating and an electrode bonded to the focusing lens is measured and applied to a phase-sensitive detector circuit which produces an error signal for the focus lens position control system.

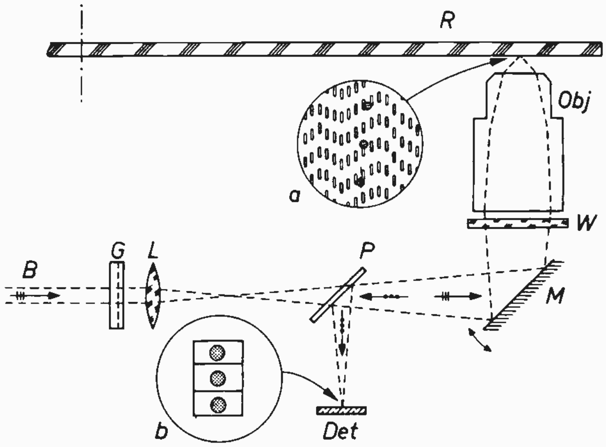


Fig. 9: A more detailed view of the optical scanning system. R is the disc, B the laser beam, G the grating which produces the two auxiliary beams, L the intermediate lens which adapts the laser beam to the entrance pupil of the focusing lens Obj and also makes it possible to focus the reflected light readily on to the detector Det, P the polarising mirror which in conjunction with the quarter-wave plate W separates the incident and reflected light, and M the pivoted mirror which ensures that the beam remains centred on the track. Insert a shows the positions of the three beams in relation to a section of the track while insert b gives an impression of the three detectors with the three reflected beams focused on them.

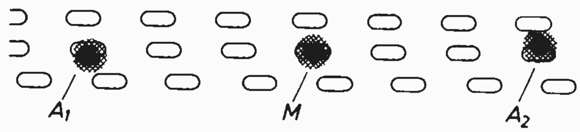


Fig. 10: Position of the main beam M and the auxiliary beams A1 and A2 in relation to the section of the track being scanned.

Acknowledgement

We wish to acknowledge the help of N. V. Philips' Gloeilampenfabrieken in providing the information for this article which is based on details given in the *Philips Technical Review.* ■

PYE S-S COLOUR CHASSIS common faults

PAUL E. SOANES

THIS article is mainly concerned with faults experienced in Pye group (Pye, Ekco, Invicta) single-standard colour chassis though some sections of these, for example the decoder, colour-difference amplifier and field timebase circuits, are basically the same as those used in the earlier dual-standard models. Apart from the system switching and circuit duplication necessary in the dual-standard sets the main difference with these was the use of valve e.h.t. rectifier/regulator circuits: a note on these is given at the end. There have been several versions of the basic single-standard chassis, the original 691, the 693 and 697 which incorporate (different) varicap tuners and the 722 chassis. The later 713 (18in.) and 731 (110°) chassis use entirely different circuitry throughout.

Mains Fuse Failure

The following faults have been experienced in the power supply/line timebase unit. Several will cause the mains fuse to blow. The h.t. rectifier going short-circuit will obviously cause fuse failure but it does not seem to be as troublesome on this chassis as on some. This is probably due to the VA1104 thermistor connected in series with the surge limiter resistor R306 (see Fig. 1). The thermistor has been known to fail however. The mains fuse will blow if C224 (see Fig. 2) which decouples the boost feed to the c.r.t. first anode preset potentiometers goes short-circuit—or sometimes leaky. In this event it will usually be necessary to replace the associated filter resistor R227 as well. Other capacitors which can go short-circuit and blow the mains fuse are the line output transformer tuning capacitor C219 and the boost reservoir capacitor C218. Failure of the line output transformer itself will also cause fuse failure in most cases.

EHT Tripler Failure

In the event of the e.h.t. tripler failing it is worth checking C226 since if this is faulty the replacement tripler may well be damaged.

Sound, No Picture

No picture but normal sound lead us to check the line output stage where we found absence of line drive and the line output valve beginning to glow cherry red. A fault in the line oscillator was suspected but a new PCF802 produced the same results. Voltage readings were then taken around this valve and no reading could be obtained at either anode. As the 285V h.t. rail voltage was present this suggested that either the feed resistor R208 in this stage was open-circuit or that the associated decoupler C215 was short-circuit. On checking, R208 was found to be open-circuit. It is important to be careful not to damage the line output valve when carrying out tests with no line drive at its control grid. Line drift is sometimes caused by C215 being leaky.

A common cause of sound but no picture is failure of the PL509 line output valve screen grid feed resistor R231.

Width Troubles

The high-value resistors (R223 and R224) in its control grid circuit can change value, causing lack of or even varying width.

Line Shake

Intermittant line shake can be cured by replacing C211 and C212 in the line oscillator circuit with better types.

Striations on Left-hand Side

Striations on the left-hand side of the screen are caused by the line linearity coil damping resistor R228 going high-resistance or open-circuit.

Lack of Height

Low field amplitude at first suggested that the height control needed adjusting but after setting it to maximum the field scan was still insufficient. This lead us to take voltage readings around the field output stage and it was discovered that the 20V supply which should have been present at PL10A on the board was missing. The continuity between PL10A and B7 (the lead connecting this power supply to the field timebase) was checked therefore but was in order. From this it appeared that the fault was in the power circuitry: either R310 was open-circuit, zener diode D52 or C312 short-circuit or the print open-circuit—as there was no voltage at the junction D52/R310 however this last possibility was eliminated. A meter check across D52 and C312 gave a short-circuit reading which cleared on disconnecting D52. A replacement zener restored the correct 20V supply. The power supply feeds to the field timebase are +20V, +20V stabilised (D52) and −20V (see circuit given on page 259 of the April issue): the height control is fed via PL10A from the stabilised +20V supply with the field generator charging capacitors returned to the −20V line. The low-amplitude field waveform was being generated between earth potential and the −20V line therefore. This particular power supply

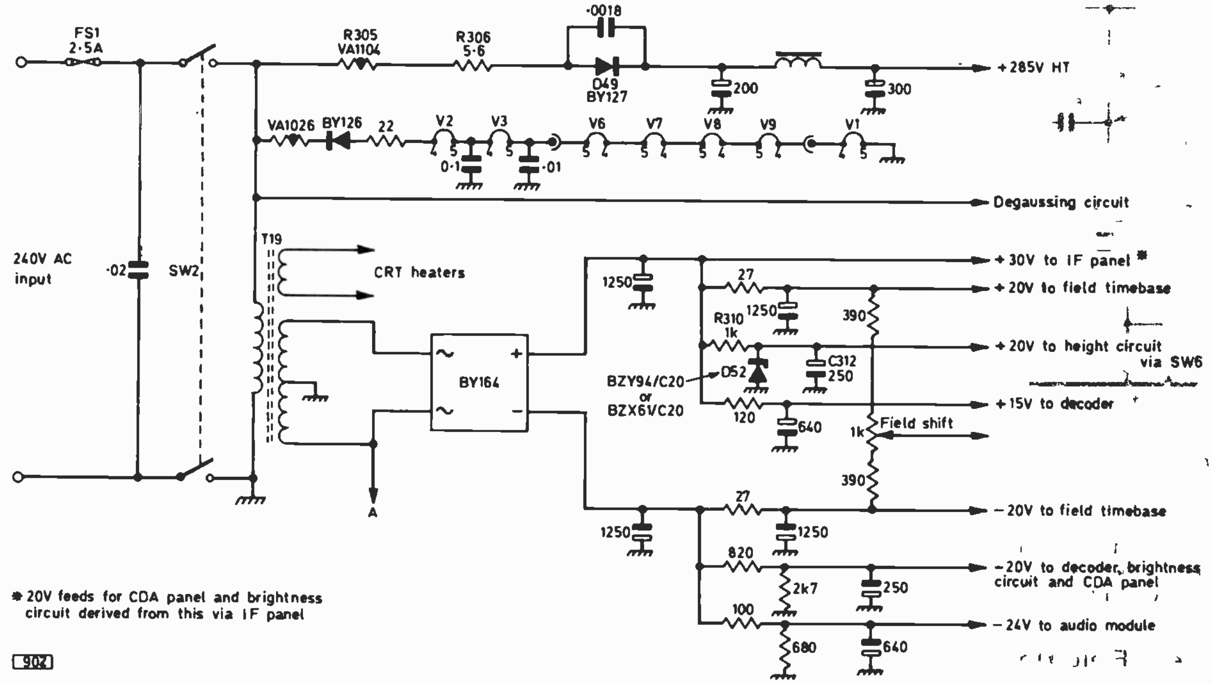


Fig. 1: The power supply circuit. Some models use an i.c. in place of the audio module: the —26.5V supply required for this is obtained from an additional 1N4002 rectifier connected to point A above.

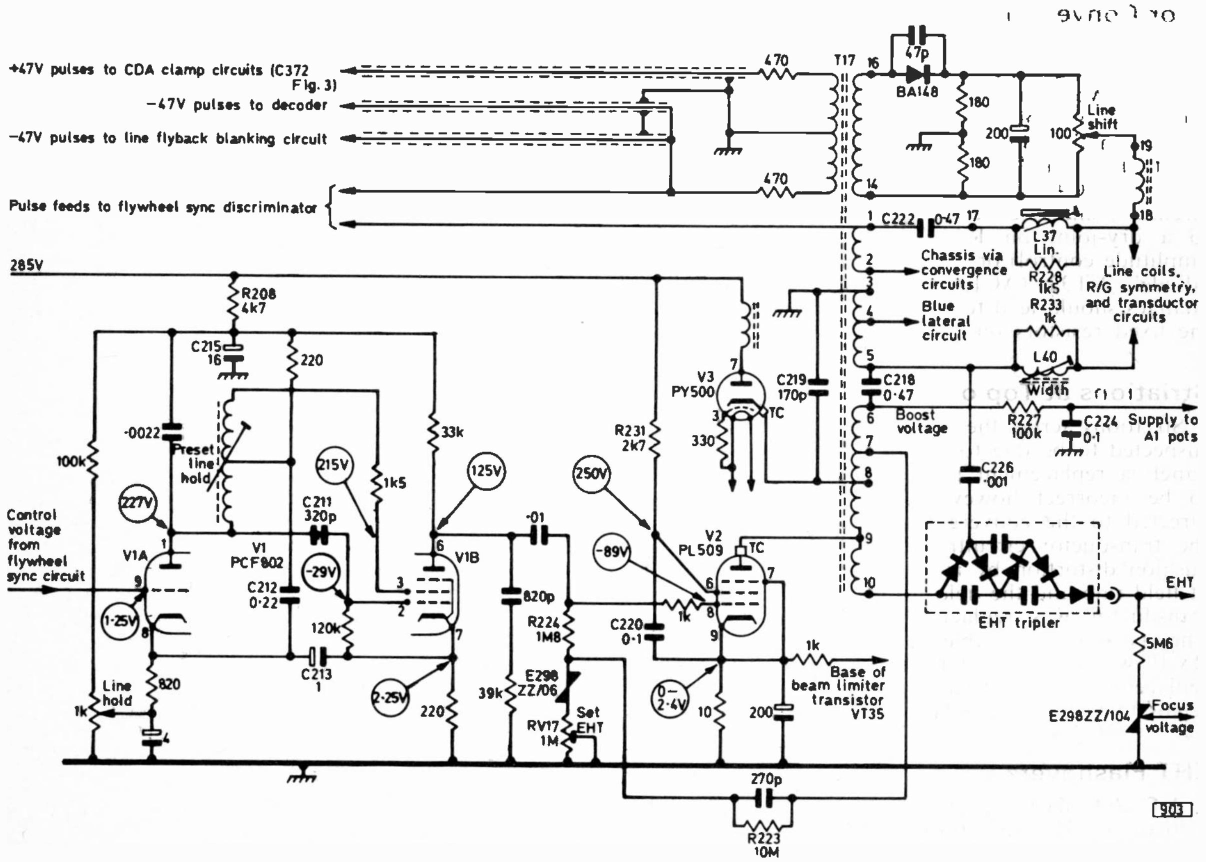


Fig. 2: Circuit of the line oscillator and output stages.

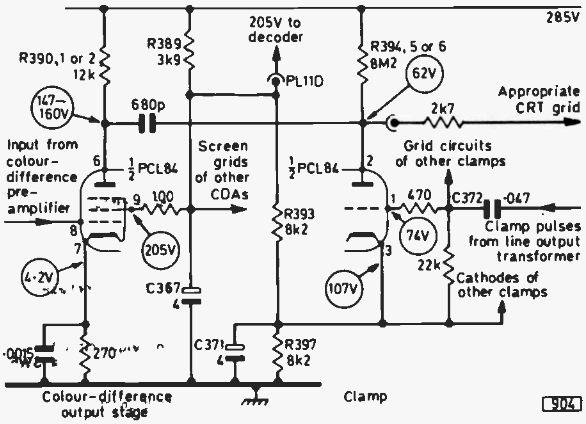


Fig. 3: Colour-difference output stage/clamp circuitry.

arrangement is not used in other setmakers' chassis which employ similar field timebase circuitry and in these absence of supply to the height control circuit would simply collapse the raster.

Weak Field Hold

Field hold troubles can be caused by the electrolytic capacitor C255 which decouples the supply on the field timebase board going open-circuit.

Poor Convergence

The symptom of poor blue convergence led us to suspect drift, which is likely to occur over a period of time. We found however that adjustment of the blue parabola control (L51) and the blue tilt control (RV28) in the blue line convergence circuit had no effect. The usual cause of this is that the $0{\cdot}47\mu F$ capacitor (C452) between these controls is open-circuit. A similar condition can however be attributed to a dry-joint on R452 (in series with the blue amplitude control) or failure of the associated clamp "diode" VT32 (AC128). Intermittent convergence changes should lead to a check for dry-joints around the fixed resistors on the convergence board.

Striations at Top of Screen

Striations across the top of the screen were at first suspected to be due to a fault on the field timebase panel: a replacement panel proved this assumption to be incorrect however. Our attention was next directed to the convergence unit, especially around the transductor circuitry. This device corrects pincushion distortion by modulating the line deflection at field rate and the field deflection at line rate. The transductor was replaced but the fault remained. The associated variable amplitude control resistor RV41 was then found to be open-circuit and after replacement the fault had cleared. This preset control seems to burn out regularly in fact.

EHT Flashovers

An e.h.t. flashover will occasionally damage the field or sound output transistors. When this happens they usually go short-circuit. If this trouble is experienced make sure that the e.h.t. voltage setting is correct. To adjust connect an e.h.t. meter to the c.r.t. anode cap, reduce the brightness control setting to minimum and adjust the set e.h.t. control RV17 for 25kV. Then adjust the line linearity (L37) and width (L40) controls as necessary. It is advisable to recheck the e.h.t voltage after doing this.

Brightness Faults

Low brightness is a condition encountered from time to time, often due to a fault in the colour-difference output clamping circuit. The triode sections of three PCL84 valves act as the clamps, with their cathodes strapped together (see Fig. 3) and fed from a potential divider across the h.t. supply. If the upper resistor R393 of this potential divider goes open-circuit the voltage at the cathodes drops from around 110V to almost zero volts while the anode voltages drop to about 10V. The result is low brightness. When the lower resistor R397 of the potential divider goes open-circuit the triode cathodes rise to nearly h.t., say around 240V, while the anode voltages increase by 20V or so. The result this time is high brightness.

The luminance output stage can also be responsible for a change in the brightness level. This occurs when the PL802 luminance output pentode screen grid decoupling capacitor C353 ($4\mu F$) goes leaky resulting in the associated feed resistor R357 ($2{\cdot}7k\Omega$) changing value, or when either the blanking transistor in its cathode lead or the transistor's OA91 base-emitter junction protection diode is faulty.

Beam Limiter Setting

Incorrect setting of the beam limiter control RV16 will result in the brightness level falling. This variable resistor is connected between the emitter of the beam limiter transistor VT35 (BC108) and chassis. To adjust, insert a meter in series with the c.r.t. anode to read the beam current and turn both the contrast and brightness controls to maximum. Then adjust RV16 for the appropriate reading as follows: 0·8mA or 1·1mA 19in. tubes; 1mA or 1·5mA 22in. tubes; 1·2mA or 1·5mA 25in. tubes. These readings depend on the value of R212 which is connected between the collector of the beam limiter transistor and the brightness control: when this resistor is $47k\Omega$ the first figure given applies, when it is $39k\Omega$ the second figure applies.

Colour Casts

The resistors (R464-6) connected in series with the c.r.t. first anode preset controls (on the earthy side) can go open-circuit. When this happens the associated preset potentiometer has no effect and an overcast of the appropriate colour will be present (since the relevant first anode voltage is increased).

A fault which at first sight could be confused with a purity error occurs when one of the colour-difference output pentode anode load resistors R390, R391 or R392 goes open-circuit. Inspection of the raster concerned will probably show shading from one side to the other. An impure raster can sometimes be caused by C367 which decouples the screen grids of all three output pentodes or C371 which decouples the cathodes of the clamp triodes being faulty. A similar condition can occur when the colour-difference amplifier panel has poor earth connections.

Colour drift can be due to one of the clamp triode

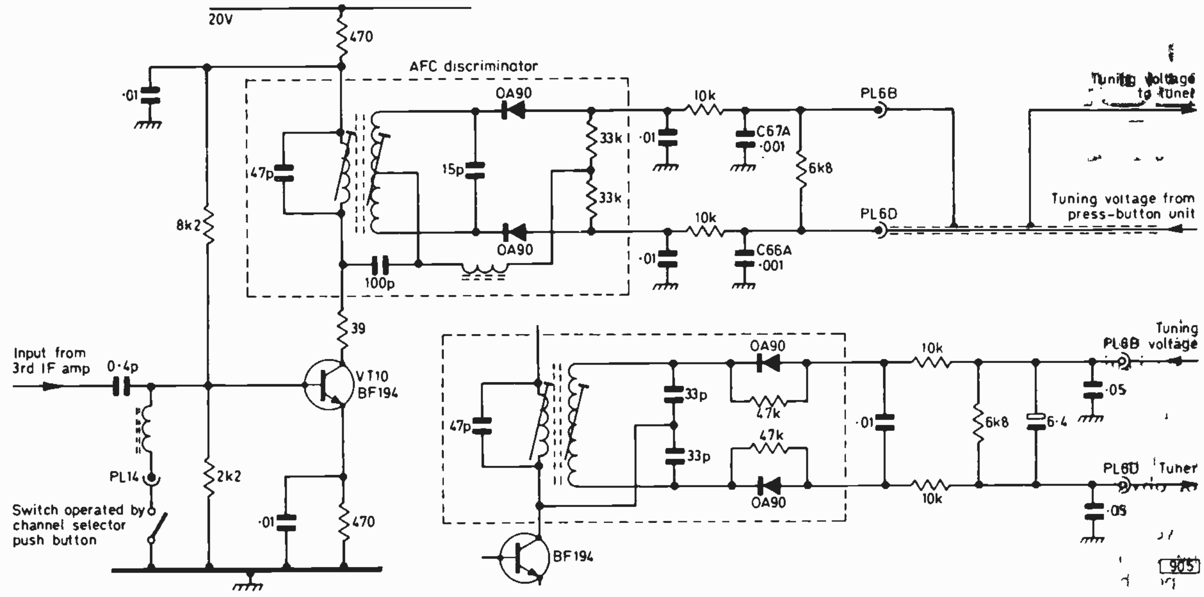


Fig. 4: Single-stage a.f.c. circuit used in chassis fitted with varicap tuners. Complete circuit, 693 chassis; below right, modifications in the 697 chassis.

anode load resistors R394, R395 or R396 being faulty.

The IF Panel

A few minor changes have been made to the i.f. panel during the production of these chassis. The original TAA350 intercarrier sound i.c. was replaced with a TBA480Q, some changes in the surrounding circuitry being necessary. This i.c. gives a higher and better quality output than its predecessor. The 1·5kpF tuning capacitor C76 across its quadrature coil L19 goes open-circuit on occasions however, causing low output.

AFC Circuit

The a.f.c. circuit has been reduced from two to a single stage (see Fig. 4). Drift can sometimes be caused by either C66A or C67A being leaky. In our experience however the most common fault in this circuit consists of dry-joints in and around the a.f.c. discriminator transformer can.

Instability

Instability can be caused by poor earth connections around the outside of the i.f. panel.

Tuning Troubles

The tuner can sometimes be the culprit in cases of drift. Far more often however the TAA550 stabiliser i.c. is at fault.

Difficulty with tuning is sometimes caused by the a.f.c. discriminator transformer secondary being incorrectly aligned. This can be proved simply by disconnecting the a.f.c. and tuning the set in.

The Decoder

The decoder is generally reliable but the occasional fault is experienced. For example failure of the reference oscillator to lock (colour patches all over the screen) with the a.p.c. bias control having no effect was found to be due to one of the burst phase detector diodes (D17) being short-circuit. In another case noisy, intermittent colour as a result of the reference oscillator floating in and out of lock was traced to a leak in C99 (150pF) which couples the first and second burst amplifier stages. This was affecting the gating pulse applied to the base of the second burst amplifier.

DUAL-STANDARD CHASSIS

The line timebase used in the dual-standard chassis is very similar to the single-standard version except for the use of a GY501 e.h.t. rectifier and PD500 shunt stabiliser triode. By using a tripler instead in the single-standard chassis the need for X-ray radiation shielding is avoided.

Common Faults

The focus control (RV17, 500kΩ) in the dual-standard chassis gives trouble. Sometimes the cause of this is the capacitor (C230, 270pF) from its slider to the focus rectifier (MR1, TV6·5/3) going short-circuit. This damages the rectifier as well so that replacement of this is also necessary. During the course of production the positions of these two components, also the PL509 anode d.c. injection choke L40 and R231 (1MΩ) which is in series with the feed to the c.r.t. focus electrode, were moved to a lower part of the transformer.

Most of the faults mentioned in connection with the single-standard chassis may be encountered on dual-standard versions.

Sound-on-vision can usually be traced to C316 (640μF) in the power supply section. This electrolytic smooths the −24V line to the LP1162 audio module.

Some unusual effects can occur due to poor earth connections and checking these is worthwhile.

LONG-DISTANCE TELEVISION

ROGER BUNNEY

AT times the active DX enthusiast despairs for signals. When all too few signals are being received one can have vague thoughts that there may be a fault in the aerial system or feeders. I must confess to having had such thoughts during the past month. There is usually a slackening in conditions in winter/early spring, with the only activity being MS (meteor shower/scatter). It seems that even MS has been lacking this year and only the presence of Lopik ch. E4 via tropospherics each day has prevented me scaling the lattice mast to look for obvious cable/aerial faults! Letters from our regular correspondents also comment on the lack of signals however so we all seem to have suffered. The events of the month can be summarised as an improvement in tropospherics over the 19th-24th due to prevailing high pressure systems, and unusually low MS reception. My log illustrates the prevailing gloom . . .

1/3/74 NOS ch. E4 (Holland); BRT E2 (Belgium)—trops.
2/3/74 CST R1 (Czechoslovakia); DFF E4 (East Germany)—MS.
4/3/74 WG E2 (West Germany); Swiss E2—both MS; JRT E4 (Yugoslavia)—SpE (Sporadic E).
5/3/74 TVP R1 (Poland); WG E2—MS.
6/3/74 CST R1—MS.
7/3/74 TSS R1 (USSR); TVP R1; CST R1—MS.
8/3/74 TVP R1; WG E2—MS.
9/3/74 SR E2 (Sweden)—MS.
12/3/74 TVP R1—MS.
14/3/74 DFF E4; TVP R1—both MS; at 2253 GMT (2353 CET) a 12 vertical bars type pattern was noted on ch. R1—suspected CST.
15/3/74 TVP R1; CST R1; SR E2—MS.
16/3/74 TSS R1—MS.
17/3/74 NRK E2 (Norway); WG E2—MS.
18/3/74 SR E2; ORF E2a (Austria); NRK E4—MS.
19/3/74 CST R1; DFF E4; SR E4—all MS; also improved trops into ORTF (France).
20/3/74 DFF E4; TVP R1; TVE E2 (Spain)—MS.
21/3/74 DFF E4—MS.
22/3/74 TVP R1—MS.
23/3/74 DFF E4—MS.
27/3/74 DR E4 (Denmark)—MS.
28/3/74 DFF E4; CST R1 and 2; NRK E4; TVE E2—all MS; also SpE two minutes of TVE E2.

Improved tropospherics were noted over the 19-24th, mainly into Belgium and France at this location. The majority of the above MS loggings were during the early morning period.

We can now say definitely that the mystery Fubk test card so often seen via MS in Band I (chs. E2, 3, 4) originates from the Bayerischer Rundfunk in West Germany.

News from our friends in the USA via the WTFDA. A new TV network has commenced operations in Canada adjacent to the US border on the shores of the Great Lakes—Ontario, Erie and Huron. Six transmitters are involved including one on ch. A2. Of particular note is the ch. A22 outlet. This operates with 5MW and is claimed to be the World's most powerful TV transmitter. It uses dual Marconi 55kW B7318 transmitters and an RCA TFU-36JDAS pyon aerial. The Global Television Network covers all Ontario, with studios in Toronto. All the transmitters are remotely controlled and maintained by a roving crew of technicians. Roger Brown also reports that severe ice storms swept the Central Plains and into the mid west in December. One victim was the 2000ft. mast of KCRG-9 TV, which toppled.

Even more depressing news from the Europese Testbeeldjagers (Holland). Due to interference in Band I during the summer months (!) moves are afoot for transmitter changes in this spectrum. Rumour has it that BRT (Belgium) wishes to replace the ch. E2 Ruislede transmitter with a u.h.f. outlet. NDR-1 (West Germany) is rumoured to be thinking about replacing the ch. E2 Steinkimmen outlet with several lower powered u.h.f. transmitters, possibly as soon as 1975. We already know that Tampere, Finland ch. E2 is off the air during part of the summer; also that TVE Santiago ch. E2 is to go u.h.f. The latter was supposed to go u.h.f. some eighteen months ago but is believed to be still on the air—it was in Band I at the end of last year's SpE season.

I hear that a few TV broadcasters are issuing some form of QSL card. This hobby hasn't yet reached the stage of a race to receive the farthest, most in number, etc. of TV transmitters and I feel that any form of competition of this sort must be discouraged. We have just mentioned that certain broadcasters are considering changes in Band I. Requests for QSL cards and reports of excellent signal reception of distant Band I transmitters which are intended to serve a relatively small area would unfortunately endorse their views about removing themselves from Band I. Thus we could be left with fewer stations! Because of this I suggest that enhusiasts do not write to stations unless a particularly great distance is received or sufficient doubt exists as to the origin of an "exotic" signal. It is better simply to photograph one's reception—this leaves one with a permanent record of reception and is of direct interest when comparing results with other enthusiasts.

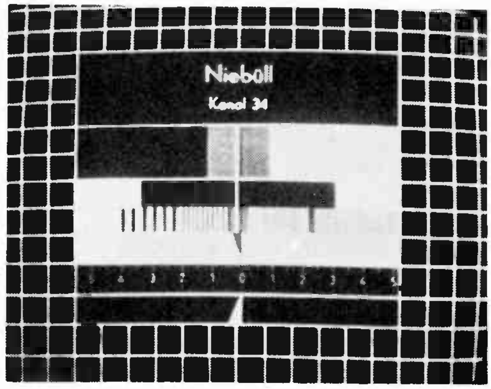
News Items

USSR: The TV mast at Tbilisi (180 metres high) has now been replaced with a new structure of some 277.5m. Of prefabricated sections (1500 tons) manufactured at Chelyabinsk (Urals), the mast was erected on Mt. Mtatisminda and continues to transmit ch. R4 programmes. It has capabilities for four channels and at the end of 1975 will take the Moscow programme in addition to the local Georgian one. The old mast has been taken to Gori.

Nigeria: Pye TVT is to build a new TV chain in Kano State including a new studio complex and microwave links to the transmitters—a main one and two ancillary ones. The country is very flat and coverage will be provided from masts up to 500ft. in height.

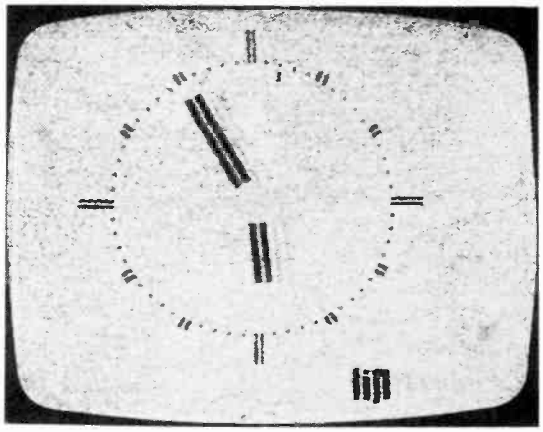
Singapore: Marconi is to supply colour equipment, with a projected 1974 opening. The transmitters (B7103) are

Aramco TV station (HZ22, ch. A2) identification crest (Saudi Arabia). Photograph courtesy G. Smith.



ZDF test card—see text.

Pakistan Television Corporation Ltd., Rawlpindi test card Photograph courtesy K. Hamer.



Tele-Luxembourg (CLT) clock. Photograph courtesy of Ryn Muntjewerff.

15kW v.h.f. types.

Ivory Coast: Radiodiffusion Television Ivoirienne is to "go colour" in the very near future—in time for the thirteenth anniversary of independence. Already the Akakro ground station has relayed colour programmes from overseas broadcasters but the celebrations will be the first local colour transmissions for domestic use. Communal colour receivers will be placed in rural areas and in public buildings in Abidjan.

Arabian Gulf: Dubai is to be converted to colour by EMI, using the PAL system. The projected date is mid 1974. Transmissions will be in Band III (the Band III transmitting aerial consisting of two tiers of Mesny panels). Along the coast at Qatar the EBU reports an early introduction of colour: the ch. E9 200kW transmitter has a service area of 300km, due to the "peculiar atmospheric phenomenon known as ducting" in the region. All Arabian Gulf countries have decided to use the PAL system when re-equipping their existing facilities. An earth station (satellite communication) is under construction.

Carrier Offset

In an effort to reduce co-channel interference a system in which the carrier frequency of one transmitter is shifted slightly with reference to another has come into use. This shift is not great—indeed often no more than 10kHz, though shifts of up to 26kHz may be experienced. If two transmitters capable of producing co-channel interference operate on exactly the same frequency line pairing can be seen on vision: the frequency offset obviates this. For the DX enthusiast this frequency shift can result in improved chances of transmitter identification.

The EBU list gives considerable information on West European transmitters, with one column showing the offset frequency (if any) of the sound and vision channels. The sound offset is given as a frequency in kHz relative to the nominal channel—if there is no shift the suffix "0" is given. Any vision offset is given as a function of line frequency, expressed in twelfths of the line repetition frequency. Thus with a line repetition frequency of 15,625Hz one unit will be approximately 1.3kHz. Both the sound and vision offsets are suffixed by either "P" or "M", indicating a positive or negative shift respectively.

If we are receiving a signal on say ch. E2 and another signal is also received on this channel but is being transmitted with an offset the result will be that the carriers will beat together and in addition to the two signals a beat pattern will be seen on the screen. If the second signal has an offset of 8P (10.4kHz) approximately 7-12 horizontal bars will be seen. If the offset is 15P (19.5 kHz) between 18-50 fine bars will be seen. A 0 offset will produce very large bars—2-5 only. The same rule applies with M offsets.

The practical significance of this for DX reception can be illustrated as follows. Say we are fortunate

Lisbon v.h.f./u.h.f. (chs. E7, E25) transmitting mast—RadioTelevisao Portuguesao SARL. Photograph courtesy of P.F. Vaarkamp.

enough to be receiving two West German ch. E2 transmitters on programme. Reference to the EBU list shows four WG ch. E2 transmitters (we are assuming a SpE opening in Band I): Biedenkopf 2M, Goettelhorner Hoehe 8M, Gruenten 8P and Steinkimmen 0. This covers a maximum offset range of 16 x 1.3kHz = 22.8kHz (8M to 8P = 16). If the 8M and 8P carriers beat we will see a very fine bar pattern. If the 2M and 0 carriers beat the result will be prominent bars—5 or so. If the 0 carrier beats with either the 8M or 8P carrier (8 x 1.3 = 10.4kHz) we will see more bars and so on. Thus we are able to identify transmitters with a certain amount of accuracy without any form of test card/localised identification. With the mass of u.h.f. stations operating in WG this method of identification could be extremely useful during a good tropospheric opening with plenty of co-channel reception.

The EBU station list is a must for such identification. West Germany has been used to illustrate how this offset method works because it is first in the list with any offset information. The same principles apply to other countries but with 405- or 819-line standards recalculation must be carried out to find the fundamental one twelfth of the line repetition frequency.

New EBU Listings

France: Saarebourg-Donon ch. E50 250kW (West of Strasbourg); Hyeres ch. E62 50kW (South-West of Cannes); Epinal ch. E63 100kW (South of Nancy). All with horizontal polarisation and carrying ORTF-3 programmes.

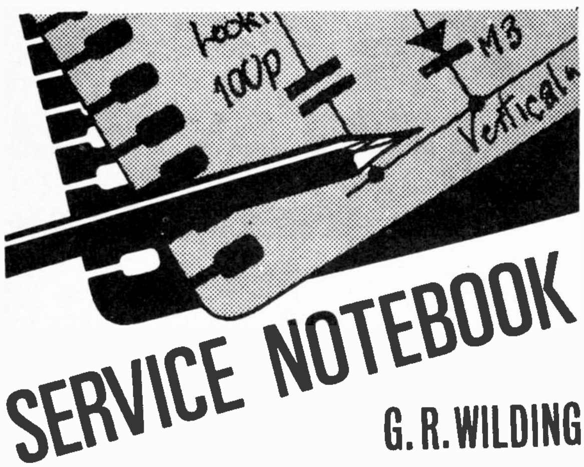
From Our Correspondents . . .

Hugh Cocks has sent us a colour post card from Rio de Janeiro, Brazil—he was fortunate enough to accompany his father on a business trip, flying via New York. Numerous photographs have been taken (we hope to feature more about this expedition later). Hugh comments that the aerials in Rio are mainly four-element Band I, seven-element Band III and various log-periodic types. Philips are well to the fore with receiving equipment—what with that and colour (PAL-M) the PM5544 may soon be seen there! In New York classified advertisements can be inserted on cable TV systems via electronic generation at $2 per line.

Clive Athowe (Norwich) who also received suspected TVP (Poland) via trops on ch. R25 using the RETMA card reports that a letter from TVP says that the RETMA card is not used on Tuesdays (it was a Tuesday—January 22nd—that the signal was received). The sound-vision spacing was 6.5MHz which certainly confirms an OIRT origin. I feel that this may be a transmitter error and that the RETMA card was in fact radiated that day. Other comments in his letter: BRT was noted with an identification at the *top* of its PM5544 card for one day only; the DFF ch. E31 was noted on test pattern but with the identification "DDR F 1"; on February 6th ORF (Austria) was noted at 1252 on ch. E2a with the normal "ORF FS1" identification on its PM5544 card but with an additional black band which had small white writing on it. I feel that this could be an indication of the music accompanying the test card—NRK used this method until recently and in the old days TVE similarly superimposed music information. Finally Clive has noted ZDF using a modified Fubk card with transmitter identification and a series of numbers on it. See accompanying photograph.

Correction

We must apologise for a production error in the March column—the TNT ch. 9 test card was printed upside down.



Excessive PL509 Current

Sound but no raster was the complaint with a GEC Model 2040 single-standard colour receiver. On investigation this was found to be due to absence of e.h.t., the red overload cut-out button at the rear of the chassis having jumped out. This cut-out operates when the line output valve (PL509) draws excessive current, removing the h.t. supply to the line output stage under these conditions. On being reset the button stayed in for just a little longer than it took for the PY500A boost diode to warm up.

In case the cause of the excessive current in the PL509 was lack of drive from the PCF802 line oscillator a new PCF802 was tried. The fault remained however and on checking the voltage at the grid of the PL509 the normal negative voltage was found. The cause of the heavy PL509 current was thus due to heavy loading in its anode circuit. This directed our suspicions to the e.h.t. tripler which is a simple matter to test since it is fed from a soldered tapping right on top of the transformer winding. On unsoldering this lead and checking again the cut-out stayed in and a normal a.c. output was developed at the PL509 anode. A replacement tripler cleared the fault and after making minor adjustments to the convergence a first class picture was obtained. Where an e.h.t. tripler is fitted therefore and the line output valve passes excessive current with normal grid drive first check the tripler unit.

Line Collapse

The picture in a set fitted with the BRC 1400 chassis had suddenly collapsed horizontally and on seeing smoke curl up from the back the owner had immediately switched off. We could see no signs of burning or heat damage on removing the back cover and swinging the hinged chassis open so we switched on again, obtaining normal sound and picture. After a few minutes we tapped the valves in case one had an intermittent interelectrode short but the only one to give any sign of this was the 30PL1 audio valve which produced some quite large blue sparks. After replacing this and running the set for a further ten minutes or so the raster suddenly and erratically reduced in width and a large plume of smoke rose from the area of the line output transformer. Once more inspection failed to reveal anything burnt so we switched on again. Within about three minutes the fault reappeared but on switching from u.h.f. to v.h.f. normal results were restored. The fault was clearly due to a component in circuit on 625 lines only so we decided to check the 625-line scan-correction capacitor C107 which is in series with the line scan coils on this system. On touching its case we found it to be quite hot and a meter check showed that it was short-circuit. A replacement restored normal u.h.f. operation. The switched capacitors in the line output circuit on 405 lines are frequent offenders in this chassis: it seems that we can now expect trouble from the 625-line one.

Convergence Fault

The presence or absence of most signal and pulse waveforms can generally be ascertained by using an a.c./d.c. testmeter: in many cases this is all that is necessary for fault diagnosis. A small positive or negative—depending on diode polarity—voltage will for example always be detectable across the vision detector diode's load resistor on signal reception, thereby proving at least that the tuner unit and i.f. strip are operational. In dual-standard receivers when switched to 405 lines the detector output is usually d.c. coupled to the video output valve and the small positive voltage can be found conveniently on the valve's control grid pin, varying in amplitude as the station is tuned through. In multistage transistor video or timebase circuits the waveforms can be detected by feeding the meter, switched to a suitable a.c. range, via a d.c. blocking capacitor.

After replacing the e.h.t. tripler in a GEC Model 2040 recently we discovered that the red and green horizontal convergence were well out and that the R/G tilt preset potentiometer P609 (see Fig. 1) and R/G amplitude inductor L601 had absolutely no effect. A look at the circuit diagram suggested that there was either a break in the print on the convergence panel or that there was no pulse feed to this circuit from the line output transformer. This pulse feed is of 480V peak amplitude so its presence could clearly be proved with the meter on an a.c. range. With the test prod applied to each end of L601 the presence of a high-amplitude pulse feed was shown and although it was still present at the junction C605/C604 there was zero reading at the earthy side of C604 even with P609 adjusted for maximum resistance. The reactance of C604 at line frequency should have been low enough to have given a considerable needle deflection. Then suddenly on checking again a reading was obtained and the convergence jumped back to near normal. It was apparent that test prod pressure or the minute "contact spark" had healed a dry-joint in the printed circuitry or within C604. The capacitor was changed and no further misconvergence was experienced.

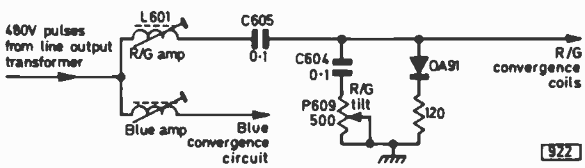
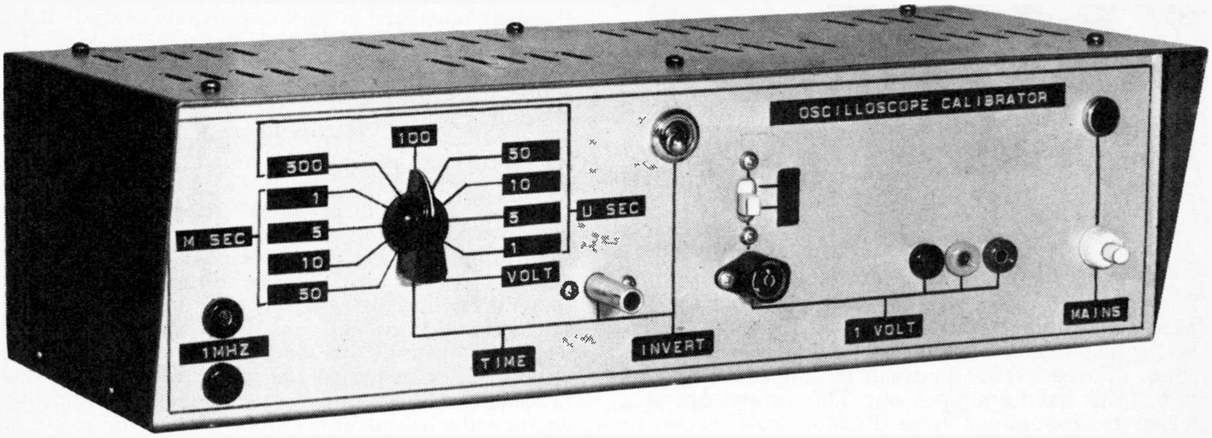


Fig. 1: Part of the horizontal R/G convergence circuit in the GEC 2040 series. Red/green horizontal convergence was well out due to lack of pulse at the junction C604/P609.

OSCILLOSCOPE CALIBRATOR PART 2

ALAN C. AINSLIE



The calibrator can be constructed in perhaps thirty or forty hours by someone fairly competent, with all materials to hand. The project is not recommended to absolute beginners but should not prove too difficult for those who have need of it. Individual readers will doubtless have their own ideas as to the best method of construction but the divider section at least must be built on a printed circuit board. The rest of the electronics (oscillator and power supply) could if necessary be assembled on tag strips etc.

Method of Construction

Veroboard is not recommended for the divider section. We are dealing with a series of fast pulse edges which could be capacitively coupled to other gates, causing spurious switching. It must be admitted however that Veroboard has not been tried: it is possible that a satisfactory layout could be achieved given plenty of forethought and preparation.

Two prototypes have been built, both on normal printed circuit boards. Fibreglass is best because of the high stability of its characteristics. The board layout shown in Fig. 7 is for a single panel containing the dividers, power supply, output unit and voltage calibrator. The oscillator board is shown in Fig. 8. Although the oscillator in the prototype was constructed on a separate board there is no real reason why it should not be included on the main board. Testing and setting up are easier however if a separate board is used.

Making the Printed Boards

The design can be drawn on the copper—after thorough cleaning—using a P.C. marker pen or a fine paint brush with plastic enamel. Great care must be taken to ensure that no shorts occur between adjacent pins of the i.c.s. A bit of practice on an old piece of board is advisable if you are new to the art.

The copper can be marked lightly in pencil and the paint or resist pen used to draw in the connections. It is helpful to put a small indentation in the copper pad with a compass point to indicate the precise location of the holes to be drilled.

It is essential to keep the earth conductors as wide as possible to prevent interaction between the gates and to prevent instability.

When accurately painted with resist the boards can be etched in ferric chloride solution. To ensure even etching of the large board it should be floated copper side down on top of the liquid. In this manner the precipitate falls from the surface and the speed and uniformity of etching are improved.

The etched board is then cleaned and drilled. Generally a 1/32in. or No. 55 bit will suffice and does a very neat job in an electric pedestal drill or a hand drill. Larger sizes will be needed for the presets and possibly some capacitors with thick leads. All drilling should be done from the copper side of the board. When drilled the board is ready to accept the components—as neatly as possible!

Wiring

Before any further wiring is done it is best to prepare the case and the front panel. The panel layout will depend very much on personal preferences and the available switches, sockets etc. but some idea of a suitable arrangement is given by the photographs.

The "volts cal" coaxial socket must be isolated from the chassis, which is connected to the 0V line by the p.c. supporting pillars. The p.c. boards are best mounted on threaded pillars so that there is plenty of clearance beneath them.

The front panel wiring can be completed before the boards are mounted. This allows plenty of space to work in. The boards can then be mounted and connected up, together with the mains wiring. It is several hours to check the long term stability. A faulty i.c. in the author's unit caused excessive jitter on all pulses below 1mS after several hours running and this was missed in the early stages of checking.

"Volts Cal" Set Up

When the time side of the calibrator has been carefully adjusted and checked the voltage calibrator can be set up. The "Volts Cal" output is an attenuated version of the main time output. With the range switch S2 set to "volts" the 1mS output from the time multipliers is available at SK5. Set the output to exactly 1V peak-peak by means of VR10. If an accurately calibrated 'scope is available it can be used as the standard, otherwise the level can be set against the laboratory voltmeter. This latter is a good idea as the absolute error of the 'scope and the meter will then be the same, ensuring consistent results between the two instruments.

To set the output against the laboratory voltmeter the oscillator input must be disconnected at R7. This places all the monostables in their high and low states alternately.

When the range switch S2 is switched between the 1mS and 5mS positions the output swing of the gates will be given if operating normally. The laboratory voltmeter is used in conjunction with VR10 to set the higher output exactly one volt higher than the low output with respect to chassis. The meter is then disconnected and a fixed resistor put in its place to maintain the same conditions. The value of this resistor should be equal to the meter's ohms/volt sensitivity times the f.s.d. volts range used and can be wired at the back of the socket.

The Cal "1" and Cal "0" reference levels can be set with the meter to be the same as the upper and lower levels as previously measured—once again the meter being replaced with the appropriate value of resistance. The lower level is set up by VR11 and the upper level by VR12.

Final Test

When this setting up procedure has been completed the instrument should be run for several hours and the varous points perodically checked. The unit is now ready to be used for its job—oscilloscope calibration.

Using the Calibrator

The calibrator can be used with both calibrated and uncalibrated 'scopes. For the calibrated 'scope it represents a standard of time and voltage to be matched to, say every six months. With an uncalibrated 'scope the calibrator is used as a reference—a method of comparison for both time and voltage.

When calibrating any 'scope it is essential that all preliminary adjustments have been made—setting of supply rails, balanced amplifiers etc. It must also be remembered that a change in the e.h.t. will invalidate any previous calibration.

Setting Timebase Ranges

The time output is used to set the timebase ranges. Ranges from 0·1μS/cm to 50mS/cm can be easily calibrated and the range can be extended if one has a sharp eye. The low scan rates are very difficult to set however, being almost hypnotic.

The invert switch S3 is provided to produce an inverted output. More important is the fact that the output of G21 has a superior wave shape at high speeds and the output of G22 a better shape at low speeds. The rise time of the output from G21 on the author's model was a little less than 12nS but this could be improved by using more direct wiring.

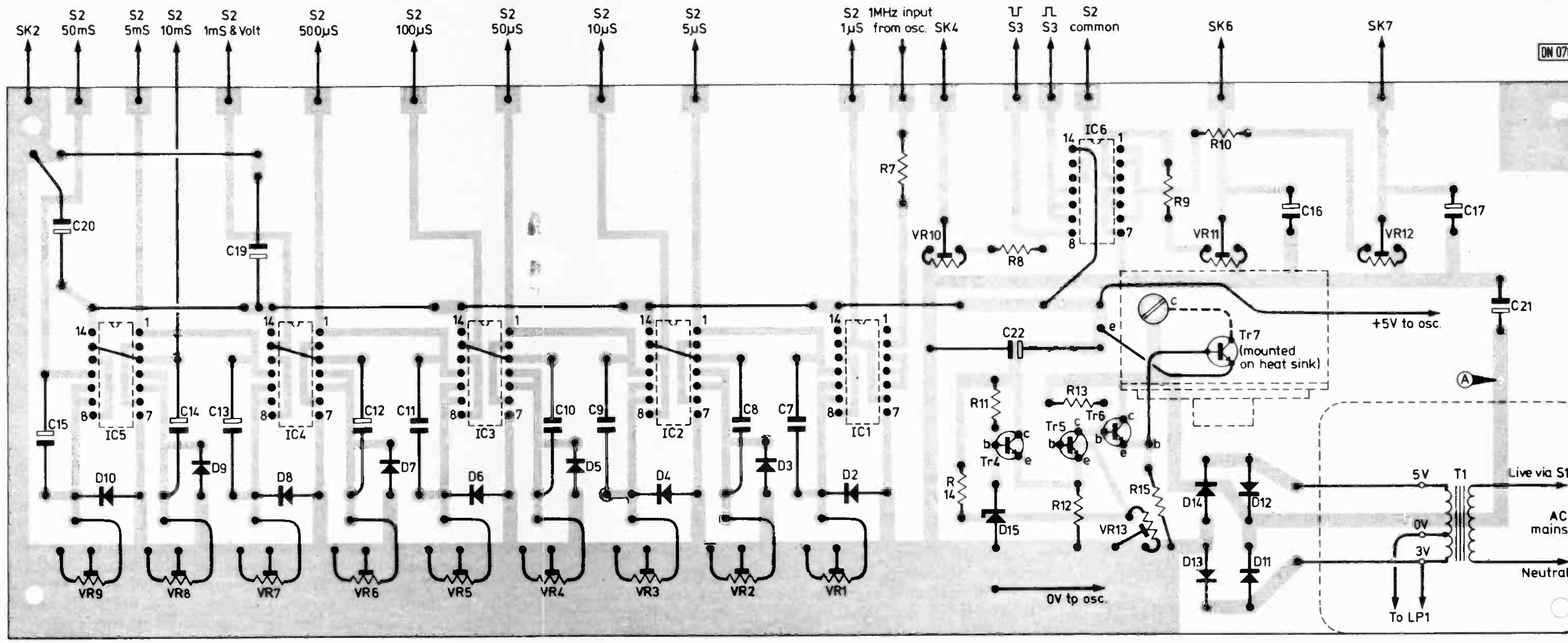


Fig. 7: Layout of the main panel used in the prototype, viewed from the copper side. Note that incorrect pin numbers were given for IC6 in the main circuit (Fig. 3) last month: the pin numbers shown there for G21 and G24 and also for G22 and G23 should be interchanged to conform with the layout above.

Rise Time

This pulse can be used to find the rise time of oscilloscopes with rise times greater than about 15nS. The pulse rise time is unimportant if the rise time of the 'scope being evaluated is more than about 30nS. If a high-speed 'scope (rise time less than 10nS) is available this can be used to measure the pulse rise time accurately and the rise time of the 'scope under evaluation then found from:

$$\text{Rise Time}_{\text{scope}} = \sqrt{RT^2_{\text{Displayed}} - RT_{\text{Pulse}}}$$

As the pulse has a clean edge and very little distortion it can also be used when setting up delay lines and inductive response "tweakers".

Voltage Calibration

The "Volts Cal" output, when taken with respect to the Cal "0" reference, is a positive-going squarewave. With respect to the Cal "1" reference it is a negative-going squarewave. The polarity is selected by S4 and the signal is available at the insulated coaxial socket SK4. The level is 1V peak-peak and the frequency 1kHz. It can be used to calibrate with respect to a graticule, calibrated shift, or both.

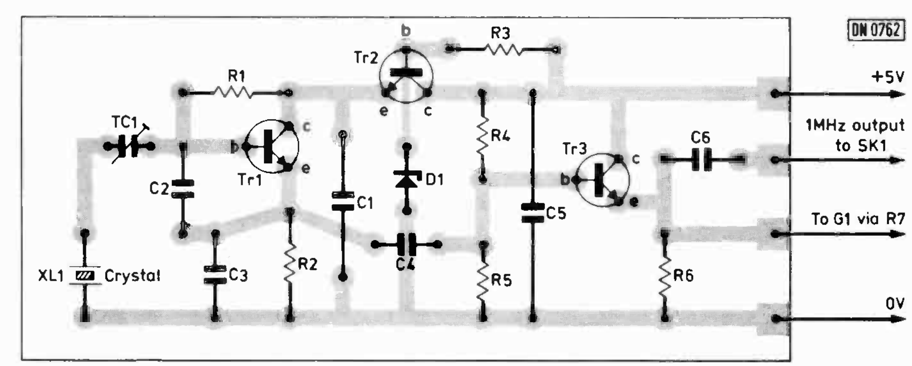


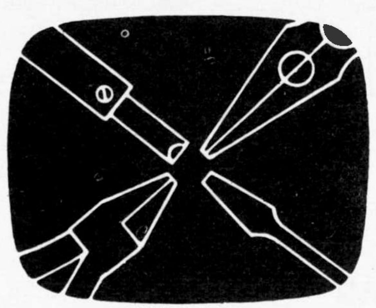
Fig. 8: Layout of the oscillator board, viewed from the copper side. (C5 is an electrolytic.)

Uncalibrated 'Scopes

When used with 'scopes without calibration, the calibrator can be used to place nominal calibrations on the time and voltage controls. These cannot be expected to hold for long however. The most useful method if a double-beam 'scope is being time calibrated is to display the time output on the second beam. For voltage and time calibration of single-beam 'scopes the signal is replaced by the calibrator output.

Brightness Modulation

Alternatively the calibrator output can be used to brightness modulate the beam, providing a "spotted" display: the spacing of the spots corresponds to the time set on the calibrator. Exact details of connection depend to a great extent on the 'scope but generally some kind of buffer amplifier will be required. Several recent 'scopes have TTL-compatible brightness modulation inputs however. ■



SERVICING television receivers

L. LAWRY-JOHNS

PHILIPS 300 CHASSIS

THESE single-standard models, fitted with 20in. or 24in. tubes, were developed from the 210 dual-standard chassis and retain many of the same features. Model numbers include G20T300, G20T301, G24T300 and G24T301, also the later "306", "307" and "308" versions. The front controls consist of volume/on-off (pull out to switch on), brilliance and four tuner push-buttons.

The main chassis is fairly easy to service, the components which are difficult to get at being those that do not normally give trouble. The chassis is secured by a large captive screw at the top right above the mains dropper and a small PK screw on the left side into the woodwork.

With these screws released the chassis can be lifted off the retaining lugs and moved to the extent of the leads, providing access to the DY87 and its base etc. Further dismantling necessitates disconnection of the e.h.t. connector, tube base socket, tube earthing lead and scan coils plug.

The volume and brightness controls are on a separate small panel which is secured by a couple of 4BA nuts whilst the tuner is held in position by a single large screw.

Nine times out of ten the faults which occur in these models concern the power supplies or the valved stages.

Power Supply Faults

Taking the power supplies first, the live mains is taken via the 1·5A fuse FS1571 to the 30Ω section (R1541) of the dropper resistor assembly. It is essential to identify the separate sections of this assembly and to have a clear picture in one's mind of the function of each.

R1541 is the left side section and is the only one operating with a.c. If this section is open there will be no sound or vision and the heaters will be out. The only indication of life will be the presence of mains voltage at the extreme left side tag. Whilst we have found R1541 faulty on several occasions, in the vast majority of cases it is one of the other sections that becomes open-circuit.

R1545 is the heater circuit element and is the one which appears to fail most often. It is the centre section of the left hand assembly and its value is 125Ω. The writer has come across many instances where this element has failed and has been shunted by a resistor of far lower value by someone who hasn't bothered to check its value and has fitted the first (perhaps the only) one to hand irrespective of value. The result of this is gross over-running of the valve and tube heaters. By the time the correct value has been fitted it is all too often too late to save the valves and tube.

The third section from the left is R1544. This is the 2·8kΩ (actually 2·85kΩ) section that drops the h.t. down to the 18V required by the transistors. This value must obviously not be decreased either by accident or design and is one of the reasons why the purpose of each section of the dropper resistor assembly should be understood before any action is taken.

The separate dropper unit to the right has two h.t. sections: R1542 is 118Ω and R1543 148Ω. The spring on the extreme right is the thermal cut out FS1551 which is designed to spring open when R1542 becomes hot enough to melt the solder securing it.

Provided these few points are borne in mind there should be no difficulty in correctly rectifying one of the most common faults in these receivers, failure of one or other section of the dropper assembly.

Sound Output Stage

Looking through our records we find that the next most common fault concerns the sound output stage. The PCL82 valve tends to run into grid current thus damaging its 470Ω cathode resistor R2100 (to the right of the valve) and sometimes the associated decoupling electrolytic C2023.

Another little fact worth remembering is that the supply line/screen grid resistor R1547 can also suffer damage but can escape attention because of its position and the fact that it tends to lose value thus keeping the circuit operating but causing a new PCL82 to draw just that little extra current—enough to shorten its life. When the PCL82 fails therefore, check the cathode resistor, the cathode electrolytic and R1547–which is mounted on the main smoothing block—as well. The value specified for R1547 is 1kΩ but can be increased to 2·2kΩ or more to extend the life of the replacement PCL82.

Line Output Stage

We have had several of these sets in with quite a spectacular firework display occurring around the line output transformer. On most occasions this has been due to the single-turn DY87 heater winding losing its insulation as a result of the plastic cracking. It is a comparatively easy job to remove the

important to get the connections to S2 in the correct sequence.

Components

The components used are all readily available and are not too critical, except the preset potentiometers which should be of high quality to maintain the setting up conditions. Diodes D2–D10 can be any small general purpose diodes of high switching speed and low forward resistance. If one of the diodes in the low-speed gates—G11 onwards—fails there is a possibilty of the gates being damaged by reverse input voltage.

The choice of transistors is not critical but the specified types are easy to obtain. Tr4 and Tr5 should be of the same type to maintain symmetry in the comparator and thus reduce the possibility of thermal drift.

A 2N3054 is specified for Tr7 but virtually any npn silicon transistor with a power rating of greater than 0·5W should be suitable. The transistor is mounted on a small bracket consisting of a piece of 1in. aluminium angle. This forms a heatsink and is riveted or bolted to the p.c.b.

The mains transformer can be an 8V bell type. These are cheap and can be obtained in a physically small package, enabling the transformer to be mounted directly on the main printed board. Alternatively an 8V or 9V centre-tapped transformer as used in small radio power supplies could be used: there is need for only two rectifier diodes in this case.

Power Supply Circuit Testing

At this stage no connections should be made to the 5V output of the power supply as a supply in excess of 5·5V will damage the i.c.s. Switch on with a voltmeter connected to Tr7 emitter and adjust VR13 to bring the voltage reading to 5V. After one hour check the reading again: if it has decreased by a significant amount (say 50mV) suspect D15. The temperature coefficient of a 3·9V diode is slightly negative and the output may fall due to diode self-heating. With a 50Ω load applied to the 5V output the voltage should not drop noticeably. Leave the power supply operating into this load for a couple of hours, making periodic checks on the output.

An oscilloscope connected to the 5V line should show no more than 10mV ripple. If necessary this can be reduced by connecting a 33kΩ resistor between the positive end of C22 and the base of Tr5: this modification has not been found necessary except when Tr4 and Tr5 are very low gain devices, giving poor regulation anyway. When the power supply has been tested and set to give a 5V output the positive supply leads to the oscillator, output unit and time divider can be connected.

At this stage of testing the prototype it became apparent that additional decoupling was needed to overcome the effects of wiring impedances. A 1μF capacitor (C5) was added between Tr3 collector and earth and C19 and C20 were added between pin 14 of IC5 and IC6 respectively and earth.

Testing the Oscillator

The oscillator is the next section to be tested. An oscilloscope connected to Tr3 emitter should show a fairly good 1MHz sinewave of about 2–3V peak to peak. If the waveform is not present and the wiring is correct it is possible that the oscillator transistor Tr1 is incorrectly biased (it is rather critical at this low voltage) or that the supply to the oscillator is too low so that the crystal is not oscillating. If necessary replace R1 with a 250kΩ potentiometer and vary this over its range: if this action fails to produce oscillation the supply to the oscillator panel must be obtained from point A on the power supply and the zener voltage of D1 increased to perhaps 6 or 8V.

The oscillator output is fed to the front panel socket SK1 via C6. This output can be fed to a digital frequency meter and trimmer TC1 adjusted to bring the frequency to spot on 1MHz. Over a period of a couple of hours the frequency should change only very slightly—by less than 1 part in 10^4 if a good crystal is used.

Time Standard

The majority of oscilloscopes have an X deflection of 10cm and the resolution of measurement can be perhaps 0·5mm, more often 1mm. This represents a reading capability of 1% which, allied with X amplifier non-linearity and parallax errors, makes graticule measurement accurate to about 5%. Oscilloscopes that have calibrated shifts can manage a 2% or 3% error of reading, but this is still fairly high. This serves to show that if our calibrator is to within 1% —1 part in 10^2—then we have a perfectly acceptable standard of time. In practice a much higher accuracy is possible with this calibrator: at worst it should be a 0·1% error.

Multiplier Chain Adjustments

When the oscillator has been set to 1MHz and checked—together with the 5V rail—for long term drift, the calibrator can be adjusted to give the required time multiplication factors.

Switch S2 to the 1μS range (G2 output) and connect an oscilloscope to the time output socket SK3. A 1μS squarewave of about 4V peak to peak should be obtained. Set the oscilloscope so that about 5 or 6 cycles are displayed on the screen and note the length of a single 1μS period.

Next move the range switch S2 to the 5μS range and view the output. Adjust VR1 to give an output period five times that of the previous output. Only outputs whose period is an integer multiple of 1μS can be obtained so once the correct "step" has been chosen there is no error.

The oscilloscope is then switched down a range so that two or three cycles of the 5μS signal are on the screen and S2 set to give a 10μS output. Adjust VR2 to give an output twice the period of the previous 5μS signal—once again the variation occurs in integer multiples of 5μS.

Carry the process right down the chain to the last monostable (controlled by VR9). It is as well to re-check the timing of the whole chain at each stage of the process so that timing errors do not occur.

As the timing of each monostable is controlled by the previous gate right back to the 1MHz crystal no small errors can occur—only gross errors due to wrong timing of a monostable.

It is advisable to leave the calibrator running for

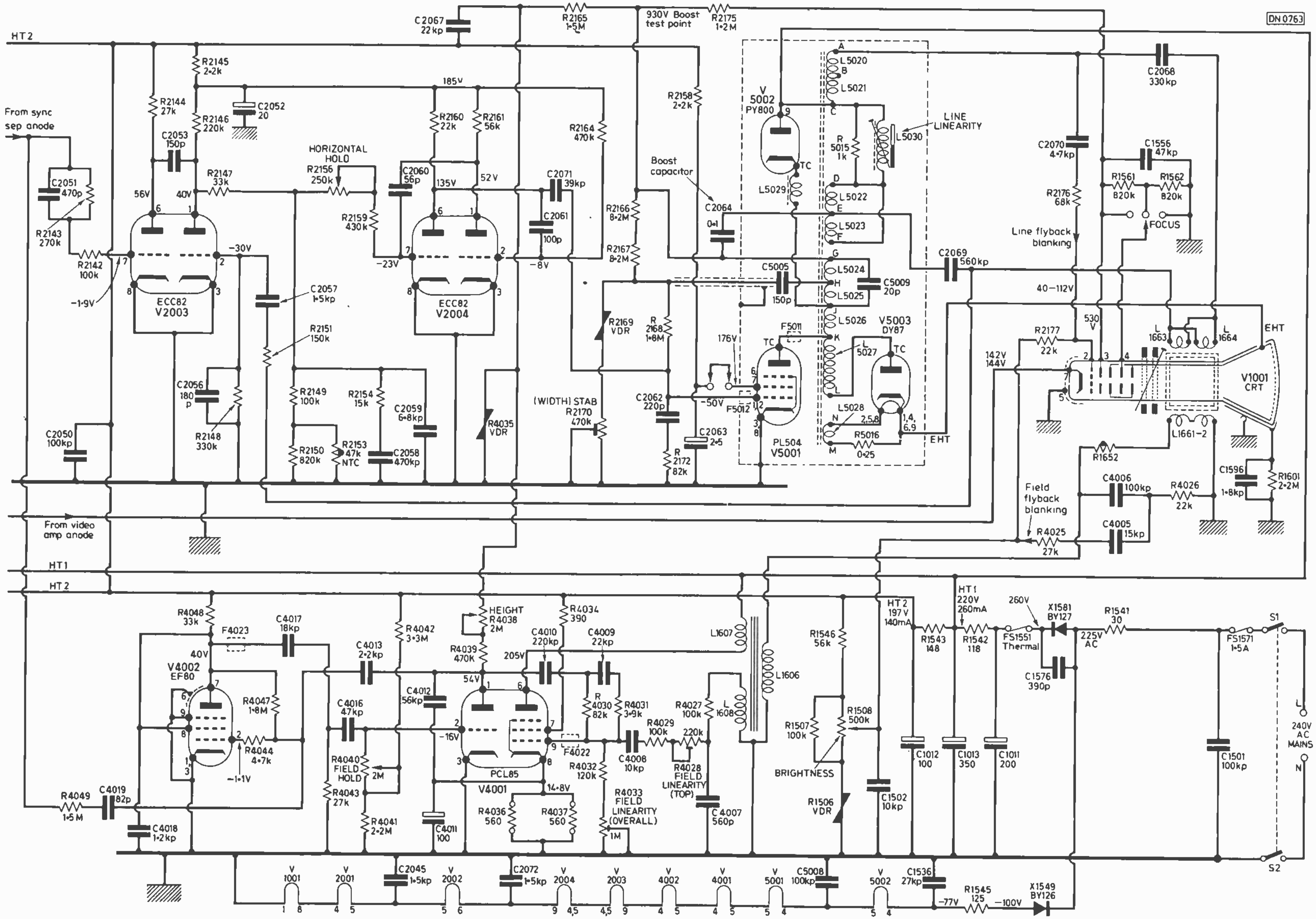


Fig. 1: Timebase and power supply circuits of the Philips 300 chassis. Voltages measured using a 100k Ω/V meter, with no signal input. V4001 triode anode voltage varies with the height-control setting.

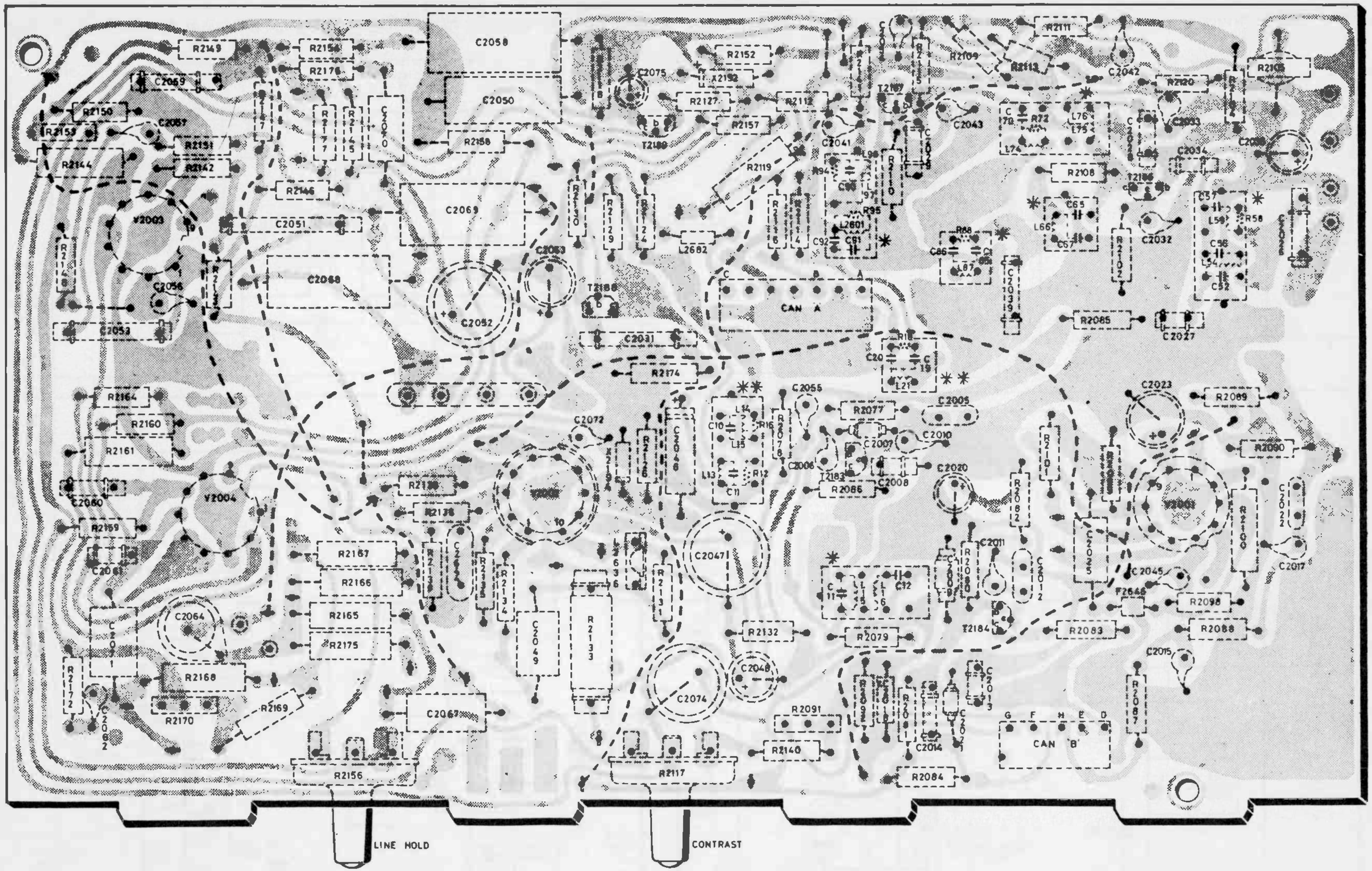


Fig. 2: Layout of the i.f. and line timebase panel. Some sets have a 6.8k Ω resistor soldered to the print in parallel with R2558. In some sets a 100 Ω resistor (R2103) is wired in series with C2039 on its earthy side. The field timebase panel is identical to that used in the 210 chassis—see Fig. 3, page 317 last month—except for the addition of R4034 to pin 7 of the PCL85.

DY87 base from its holder, clip off the defective wire and connect in its place a piece of suitable cable of good insulation. The writer uses RS e.h.t. cable for this purpose and has not had a failure yet —from the 170A series up to the present.

It is not only the heater winding which fails however. The e.h.t. lead to the tube anode can also break down, mainly across to the DY87 top cap, sometimes cracking this valve as well as damaging the insulation of the top cap. No attempt at patching up should be made. Remove the base as before and fit a new length of cable to the tube connector.

Recently we carried out a repair of this type to one of these sets only to find on switching on that the raster was narrow with a vertical line down the left side. We did not have to locate the cause as smoke issuing from R5015 (1kΩ slung on the side of the transformer) proclaimed it. As this resistor is wired across the linearity coil (to provide damping) it appeared that the coil was open-circuit. On inspection however we found that one of the leads from the coil had never been properly soldered to the tag on the transformer but instead had happily made mechanical contact until other work had disturbed it. A clean off, a touch of solder and a new 1kΩ resistor completed the job and resulted in a nice picture. Incidentally, it is essential to ensure adequate clearance between R5015 and the transformer winding as this can be another source of arcing.

Other sources of trouble experienced in the line output stage include a breakdown between windings in the transformer, giving the impression that the boost capacitor has shorted (as it can do, and this should of course be the first check); arcing in the PY800 boost diode; and the tendency of the two 8·2MΩ resistors R2166 and R2167 to rise in value causing lack of width. The width control itself can develop a dud spot and if this does happen the control should be changed rather than risk transformer breakdown due to overdriving.

Line Generator

An ECC82 line oscillator drives the output stage and apart from one or two minor points the oscillator circuit is fairly trouble free. The valve itself is the main cause of incorrect line speed but we have known cracks in the print to or from the hold control to cause sudden and irritating variation after protracted periods of trouble free working. Running solder along all suspect tracks is sometimes the only way of solving the problem without running unsightly leads all over the place.

Overheating in the line output stage due to lack of drive is nearly always rectified by replacing the line oscillator ECC82.

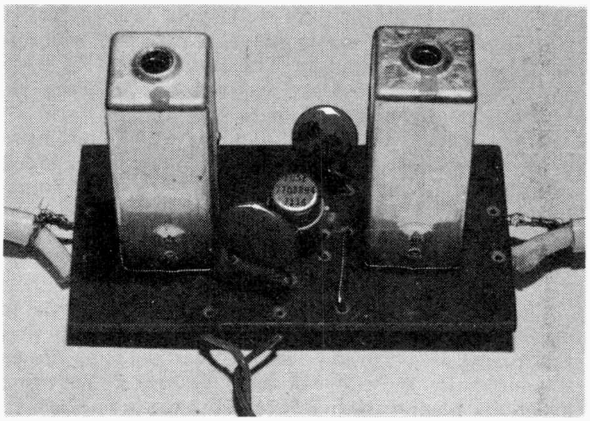
The second ECC82 (farther back and less accessible) is the line sync pulse amplifier and flywheel sync discriminator. Apart from the valve itself causing weak or no sync resistor R2144 (27kΩ) is the component which is likely to give trouble after a period of use, the symptoms being inability to reliably lock the picture horizontally.

R2164 and, less often, R2146 can also change value causing poor line sync. In difficult cases thermistor R2153 is another suspect.

CONTINUED NEXT MONTH

IC IF PREAMPLIFIER

STEVE MONEY



One of the problems encountered by the television enthusiast from time to time is insufficient gain in the i.f. strip. This can occur when a different tuner unit is fitted or when a receiver system is assembled using surplus units from different makers—the problem then usually arises because the units were not originally designed to work with one another. To overcome lack of gain in the i.f. strip the simplest solution is to add a preamplifier between the tuner unit and the i.f. strip input. In this article a simple preamplifier using a single integrated circuit is described. This preamplifier was designed for use in a colour receiver but can naturally be used just as effectively in a black and white set.

When transistors are used as r.f. amplifiers it must be remembered that they are basically triode devices: there is a feedback path therefore from the output to the input via the base to collector capacitance. At high frequencies this feedback can become positive so that the amplifier tends to oscillate. This is of course unacceptable in a television i.f. amplifier.

One method of overcoming this instability problem is known as neutralisation, in which a second feedback path is provided. The signal fed back through this second path is adjusted to be of equal amplitude but opposite phase to the feedback via the transistor. Thus the two feedback components cancel each other. This arrangement is quite effective but can be rather tricky to set up in a wideband amplifier.

An alternative approach is to use a more complex type of amplifier stage. One possibility is the two transistor cascode amplifier shown in Fig. 1. Alternatively the two transistors can be connected in the emitter-coupled pair configuration shown in Fig. 2.

In both of these circuits the second transistor Tr2 acts as a grounded-base amplifier which provides good isolation between the input and output circuits. Transistor Tr1 in both circuits provides an impedance match between the input circuit and the very low emitter input impedance of the grounded-base stage.

Transistor Tr3 in the emitter-coupled circuit acts as a constant-current source feeding the emitters of Tr1 and Tr2. This maintains the emitters at almost constant voltage, with current transfer between Tr1 and Tr2 as the signal varies, thus providing maximum signal transfer.

It is possible to build cascode or emitter-coupled amplifiers using discrete components but it is far more convenient if the transistors and their associated bias components are incorporated in an integrated circuit. This reduces the physical size and the stray capacitances, thus producing a more useful amplifier.

One of the more readily available integrated circuit r.f. amplifiers is the Fairchild type μA703C. Although it is one of the earliest designs of r.f. amplifier integrated circuit it is nevertheless a very effective device.

The 703C is basically an emitter-coupled type circuit arranged as shown in Fig. 3. The two transistors Tr1 and Tr2 act as the emitter-coupled stage with Tr3 as the constant-current source. Bias for the three transistors is provided by the two diodes D1 and D2 in conjunction with resistors R1 and R2. D1 and D2 are in fact transistors on the integrated circuit chip itself but since they are connected as diodes they have been shown as such in the diagram. Resistor R1 can also be used as a supply decoupling resistor.

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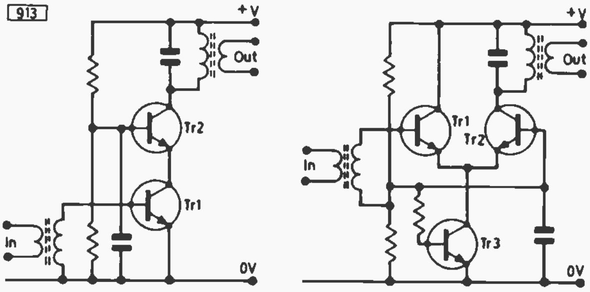

Fig. 1 (left): Cascode amplifier circuit.

Fig. 2 (right): Emitter-coupled amplifier.

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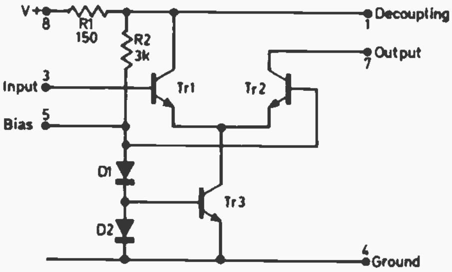


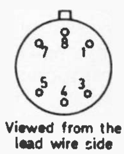


Fig. 3 (left): Circuit of the μA703 i.c.

Fig. 4 (right): Pin connections of the μA703 i.c.

★ Components list

IC1	μA703C (Fairchild) or equivalent, e.g. L103 (SGS-Ates) or LM703C (National)
C1	1,000pF ceramic disc
C2	10pF ceramic or polystyrene
C3	1,000pF ceramic disc

T1 and T2 wound on Neosid 722/1 formers and tuned with 6/500 cores

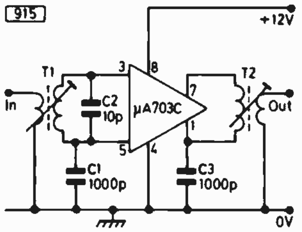


Fig. 5: Circuit of the i.f. preamplifier using the μA703 i.c.

The 703C comes in a TO5 type metal can but has six lead wires. Looking at the base of the package the lead connections are as shown in Fig. 4.

At 37MHz the forward transadmittance (y21) of the 703C is 28mmho and the reverse—or feedback—transadmittance (y12) about 0·005mmho. Now the maximum gain that can be achieved with unconditional stability is approximately the ratio of the forward to the reverse transadmittance of the device. At 37MHz the maximum stable gain of the 703C amplifier will be some 37dB.

For a 703C the input resistance is 1,250Ω in parallel with an input capacitance of about 6·5pF. At the output the resistance is 6kΩ in parallel with an output shunt capacitance of 3·5pF. These values are dependent upon the operating frequency, which in this case is taken as 37MHz.

Preamplifier Design

The i.f. preamplifier circuit using a 703C is shown in Fig. 5. This circuit is designed to operate at a centre frequency of 37MHz with a bandwidth of 6MHz to ensure good performance with colour signals.

Transformer coupling is used at both the input and the output to match the amplifier to the output impedance of the tuner and to the input impedance of the following i.f. amplifier. In this circuit it has been assumed that both these impedances are about 75Ω, which will usually be the case with transistor tuners and i.f. amplifiers. In some receivers however it may be necessary to alter the transformer ratios to match the particular tuner or i.f. amplifier being used.

To achieve wide bandwidth with a single tuned circuit it is necessary to keep the loaded Q of the circuit low. The value of Q required for a given bandwidth is found by dividing the resonant frequency of the circuit by the bandwidth. Thus for a 6MHz bandwidth at 37MHz the tuned circuit needs to have a working Q of about 6. To obtain a low operating Q without using damping resistors the L/C ratio of the tuned circuit must be kept high. Because

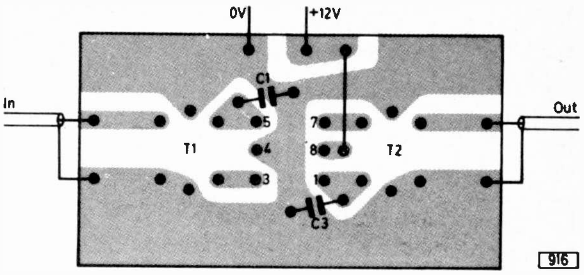


Fig. 6: Layout of the printed circuit.

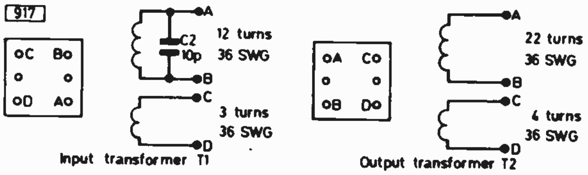


Fig. 7. I.F. transformer winding details.

of this the output circuit is tuned solely by stray circuit capacitance.

The output capacitance of the 703C is about 3·5pF and if we allow a further 5·5pF for stray capacitance the total tuning capacitance will be about 9pF. This has a reactance of 477Ω at 37MHz. The working Q of the tuned circuit is given approximately by the ratio of the shunt resistive load used across the circuit divided by the reactance. We can have a load of 2,900Ω for a Q of 6 therefore.

An inductance of 2μH is required to tune the circuit to 37MHz with a capacitance of 9pF. The tuned winding is 22 turns on a 6mm. diameter former. A four turn link winding at the earthy end of the tuned winding is used to match the circuit to the input of the following i.f. amplifier. If the i.f. amplifier input impedance is 75Ω the load presented to the 703C will be about 2,300Ω.

For the input circuit a similar transformer coupled arrangement is used. Here the input resistance of the 703C is 1,250Ω so the tuned circuit reactance needs to be 200Ω for a Q of 6. A tuning capacitance of 22pF is required: this consists of a 10pF capacitor in parallel with the input and stray capacitances of the 703C.

A tuning inductance of 0·9μH is needed and this is produced by 12 turns on a 6mm. former. A three turn coupling link at the earthy end of the coil matches the input to 75Ω. The 10pF capacitor is a ceramic or polystyrene type mounted inside the can.

Construction and Use

Figure 6 shows a suitable printed circuit board layout for the preamplifier unit. The supply and bias decoupling capacitors are 1,000pF ceramic types. Details of T1 and T2 are shown in Fig. 7.

Assuming that the main i.f. amplifier is already properly aligned, simply tune the preamplifier for maximum signal. Alternatively the i.f. strip and preamplifier can be aligned with a sweep generator and oscilloscope.

The gain of the preamplifier was found to be about 28 to 30dB, corresponding to a voltage gain of about 30, whilst the bandwidth was a little over 6MHz. ■

MILLER'S Miscellany

Chas. E. MILLER

In my area there are large numbers of Philips 210 receivers which have been bought by means of a slot meter. Now that these sets are no longer maintained by the supplying company they account for a fair percentage of my service calls. It has become my habit of late to check the mains droppers on these sets, regardless of any other faults that may be present. This is because I have repeatedly found that the vulnerable 125Ω section of the dropper has been replaced by what appears to have been the nearest resistor to hand! These have been 50, 33 and even 25Ω! The results of an incorrect value may not be immediately visible, particularly if the valves are viewed in daylight, but over-running the valves and c.r.t. will result in their early failure. I find it incredible that a large firm should not (a) supply its engineers with correct replacements and (b) ensure that they are used.

Five O'Clock Blues

It niggles me that people are prepared to wait weeks for the services of a chimney sweep, and will rise at the crack of dawn to prepare for his coming, when the TV engineer is so often brusquely told "you'll have to come after five o'clock—there's no one in till then"—and if you don't turn up that very evening they call in someone else!

A Trip in the Night

When I was young and foolish I used to advertise a special evening service for clients of the above mentioned type. To operate this I had a legion of part-time and largely unpaid assistants. One evening I set off with Alf, who shares my surname but is no relation, to do some calls in the old part of the town. There was driving rain and the narrow gas-lit streets had pockets of deep shadow. We guessed roughly where the house we were looking for stood and I then left Alf in the van while I went to check the numbers with a torch. To my relief we'd stopped almost opposite the correct one. I gave the door a hearty thump and beckoned Alf to join me. Shuffling footsteps approached the door from inside. Alf ran across the road, dodging the puddles. The door started to open and at that precise moment Alf tripped on the kerb, shot across the pavement and buried his head in my stomach.

The bellow of pain to which I gave vent was delivered straight into the ear of a small inoffensive customer who stood quivering on the doorstep. I was incapable of saying anything, but Alf managed to stutter something about "the telly" before succumbing to silent hysterics. This appeared sufficient to allay the little man's fears. He led us through some unlit rooms, wittering the while about how bad his picture was. By now I had recovered my breath, even if my self control left something to be desired. I prayed that my barely concealed snorts of mirth might be construed as sympathetic noises.

When we finally got to the set it was painfully obvious that the tube had a heater-cathode short. In those days the failure of a c.r.t. was so serious a matter that one was wont to deliver the fell news with all the solemnity of a BBC reporter describing a national catastrophe. In this instance however it went something like this:

"I'm afraid (snigger) that your tube (tee-hee!) has gone and you'll have to have a new one. (Ha-ha!)"

Alf was standing with shoulders bowed but shaking, endeavouring without much success to appear concerned. I dared not look him in the eye. The little man surveyed us doubtfully.

"I'll let you know" he said.

He never did: I honestly can't blame him!

Vintage Spot: Focus Systems

Nowadays the focus control on a monochrome set seldom if ever needs adjustment. Indeed there is often only a preset plug and socket affair which is set at the factory for virtually the life of the set. It's a far cry from the vintage years when almost all receivers had a prominent focus knob, often on the front of the set.

The principle of nearly all focusing systems then used was that of varying the current passing through an electromagnet placed around the neck of the c.r.t. The exact way of doing this differed considerably between manufacturers however. The simplest method, employed by firms such as Regentone and Vidor, was to include the focus coil in the h.t. smoothing circuit, with a variable shunt resistor. An electrolytic capacitor would be connected across the network to eliminate any residual hum (see Fig. 1). The snag with this system was the need for a high-wattage potentiometer which proved troublesome in service.

A different and characteristically more complicated method was tried by Philips. The focus coil was tapped, the centre going to h.t. and the ends going to the 300V boost rail and the sound output stage respectively. Sounds straightforward so far? Stick around! The current through the section fed from the boost rail was constant while that through the other section could be varied by altering the grid bias—and thus the anode current—of the sound output valve. For this purpose a source of negative voltage was required. It was obtained by placing the smoothing circuitry in the negative h.t. line. There

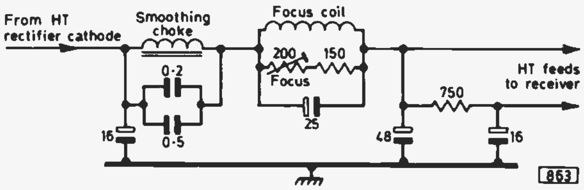
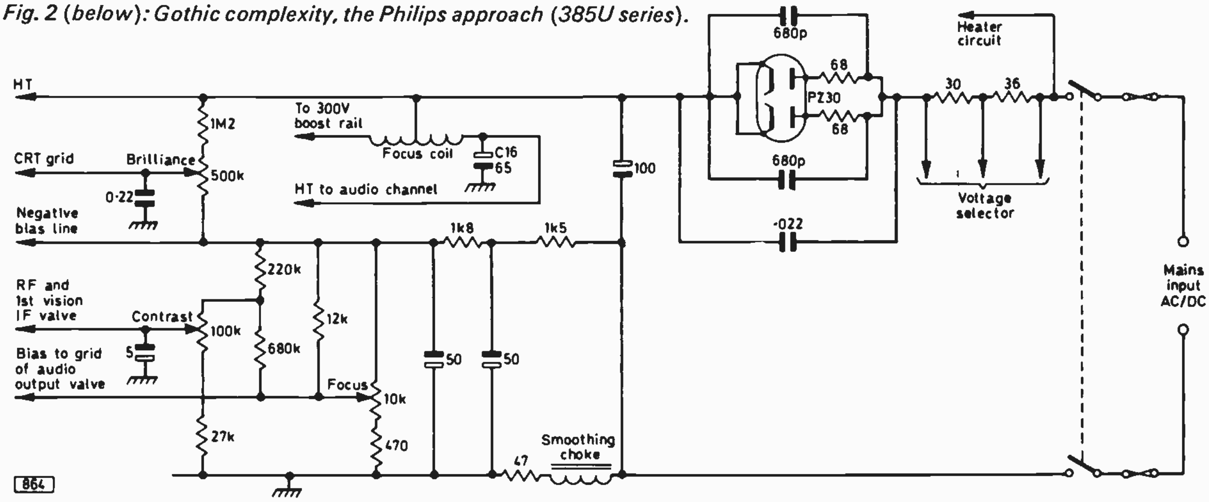


Fig. 1: Classical simplicity, the focus system used by Vidor and others.

Fig. 2 (below): Gothic complexity, the Philips approach (385U series).



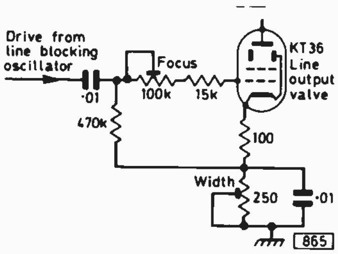


Fig. 3 (right): An EMI compromise. The focus control alters and flyback time and thus the e.h.t. voltage and the focus.

was a labyrinth of voltage dividers (see Fig. 2) supplying not only the focus potentiometer but also the contrast control and the negative side of the brightness control! By and large the system worked well enough, apart from the splendid sound-on-vision effects resulting from an open-circuit C16!

One of the defects inherent with electromagnetic focusing was the inevitable "drift" due to the change in resistance of the coil as it warmed up. EMI in their Marconiphone Model VT59DA and associated sets used a permanent magnet in conjunction with a low-resistance coil to minimise the "drift". This system was in a way a step backwards from the previous VT53DA series of models in which electromagnets had been thrown out altogether and yet a potentiometer focus control was retained. Focus adjustment in this series was achieved by placing the potentiometer in the grid circuit of the KT36 line output valve (see Fig. 3). By varying the flyback period this altered the e.h.t. and thus the focus.

Electromagnets faded from the scene when better permanent types (notably ceramic) became available. These in turn were supplanted in the late 1950s by the electrostatically focused tube which has remained unchallenged since then.

PHILIPS TO LAUNCH VCRs ON THE DOMESTIC MARKET

Videocassette recorders are shortly to be released on the domestic market: the Philips VCR machine is to be made available within the next couple of months through a limited number of appointed dealers who will have to be able to convince Philips that they can provide adequate servicing facilities. The machine will retail for about £450 including tax and Philips anticipate that some 5,000 VCRs should be sold by the end of the year. To date some 4,500 of these machines have been supplied to industrial and educational users in the UK.

The machine will provide an output at u.h.f. for feeding into the aerial socket of a standard domestic receiver. The only modification required to the receiver is one to make it possible to reduce the time-constant of the flywheel line sync circuit in order to increase the pull-in range. This is necessary so that the display is not disturbed by the inevitable sync pulse phase variations that occur as a result of wow and flutter in the tape transport system.

Sir John Stewart Clark, managing director of Philips Electrical, estimates that some 15 million colour sets may be in use in the UK by 1977 and that as many as ten per cent of homes with a colour set may want a videocassette recorder.

Philips have reached standardisation agreements with Thorn and Pye in the UK for the manufacture of VCRs. Thorn is already selling a VCR to the Philips standard at around £368 (including tax) to industrial and educational users. This machine is handled by Thorn TV Rentals and carries the Radio Rentals label.

Doubts have been expressed in some quarters as to whether this is the right time to launch VCRs on the domestic market. Price is one cause for this concern; another is whether an adequate amount of prerecorded material is available yet. It is notable that the attempt to get VCRs established as a mass consumer product in the US came to a lamentable end last year. The videocassettes themselves are likely to be on the expensive side—about £12 for an hour's playing time: thus unless some lending library system is introduced the cost of having a selection of tapes available for playing will be considerable. A lending library arrangement is likely to take some time to arrange.

E. C. Lough, managing director of Thorn TV Rentals, has commented that he sees VCRs "becoming more acceptable possibly in three or four years' time when there are special programme tapes available and increased production ensures more competitive prices".

transistor circuits
LINE TIMEBASE
Part 1: MONOCHROME

S.GEORGE

WHILE there are many features common to valve and transistor line output stages nevertheless because of the completely different characteristics of transistors there are important differences—which may not be apparent from a circuit diagram—in the design and operation of a transistor line output stage. The three important differences with transistors are as follows. First, while a valve conducts in one direction only this is not the case with transistors. When the collector potential of a line output transistor connected in the common-emitter mode reverses following the flyback period its collector-base junction is forward biased, permitting current to flow across this junction and then to chassis via the low-impedance base circuit. This characteristic enables the efficiency diode to be dispensed with if the output stage is operated from a sufficiently high supply. The second difference is that a line output transistor is bottomed (i.e. fully conducting) for most of the forward scan time. During this time its collector current is directly proportional to the supply line voltage, implying that this must be stabilised if the width and e.h.t. are to remain constant. The third difference is the low input impedance of a transistor. This, plus the fact that a low-value resistor may be shunted across the base-emitter junction, means that the drive to it must be supplied from a matching low-impedance source.

Because of this last requirement a transistor line timebase consists of three stages—an oscillator, an impedance matching driver, and the output stage.

Line Generator

As line generator it is common to find a blocking oscillator circuit since this provides much harder synchronisation than a multivibrator circuit which can be easily tripped by extraneous pulses. The blocking oscillator transformer may be auto, dual or treble wound, often with an adjustable core which acts as the line hold control. The base of the blocking oscillator transistor is fed with a bias potential obtained from a conventional flywheel line sync circuit. If the blocking oscillator transformer core is not adjustable, line hold setting is usually provided by means of a potentiometer connected between limiting resistors across the l.t. supply, the slider tapping off a potential which is added to that obtained from the flywheel sync discriminator circuit. As alternatives to the blocking oscillator, sinewave oscillators and i.c. arrangements are widely used.

The output waveform produced by the oscillator is often far from the ideal switching waveform required to control the line output transistor. Thus the driver stage may have to provide waveform shaping in addition to acting as an impedance matching device and a buffer stage to prevent pulses from the output stage affecting the oscillator. Waveform shaping to obtain the correct squarewave signal to drive the output transistor is obtained by repeatedly driving the driver transistor from cut-off to saturation—see waveform (e), Fig. 3.

Typical Circuit

A typical transistor line timebase circuit (Ekco 9in. Model T545) is shown in Fig.1. The blocking oscillator transistor Tr21 produces a 15V peak-to-peak signal across the autotransformer T701 in its emitter lead and an approximately 12V peak-to-peak pulse signal at its collector. T701 core provides hold control and the control voltage from the flywheel sync circuit is applied to Tr21 base to maintain the correct operating frequency.

The pnp driver transistor Tr22 is driven from the junction of the two resistors R709 and R710 which form the oscillator's collector load. C709 is a speed-up capacitor, providing a sharp edge to the waveform applied to the base of the driver transistor so that it switches rapidly from one state to the other.

The line output transistor Tr23 is also a pnp device, with its collector returned to chassis while its emitter is fed from the positive l.t. rail via the primary winding of the line output transformer. While this arrangement may at first sight seem surprising—one might expect to see the transistor connected in the common-emitter mode analagous to the way in which a line output pentode is connected—nevertheless the basic action remains the same. However it is connected, the output transistor operates as a switch in series with the line output transformer primary winding and the supply rail.

Tuning the Output Stage

The capacitors connected between the emitter of the line output transistor and chassis tune the circuit and thus determine the flyback time. In doing this they set the width: if one of them is removed the flyback time is decreased, the flyback voltage increased, the e.h.t. thus developed rises and the width is reduced. CR703 is the efficiency diode.

Auxiliary Supplies

Various supplies for other parts of the receiver are derived from the line output transformer; CR709 produces a −27V supply which is fed to the "bottom" of the brightness control, CR704 produces

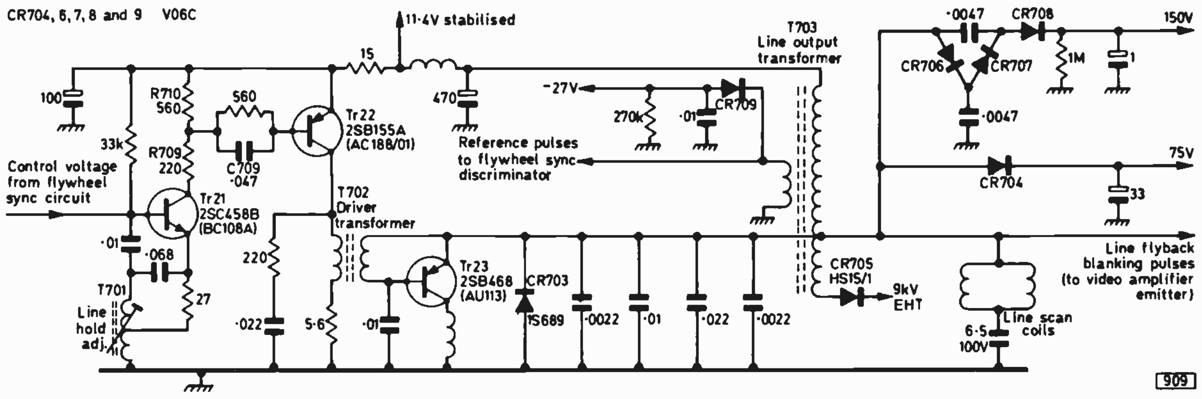


Fig. 1: Line timebase circuit used in the Ekco Model T545 9in. mains/battery portable. The pnp line output transistor Tr23 is operated in the emitter-follower mode.

a 75V supply for the video output stage and the "top" of the brightness control, and the voltage doubler CR706/7/8 produces 150V for the c.r.t. first anode. An overwinding feeds the e.h.t. rectifier (CR705) which produces 9kV for the c.r.t. final anode.

NPN Output Transistor

The circuit in Fig. 2 (Murphy Model V1400) shows the basic similarity when an npn output transistor is used, again with a positive supply rail. The secondary winding of the driver transformer is once more connected across the base and emitter of the output transistor whose emitter is in this case connected to chassis while its collector is fed from the positive l.t. rail via the output transformer primary winding, i.e. it is connected in the common-emitter mode. The efficiency diode D503 is connected the same way round, so that apart from reversing the output transistor emitter and collector connections and the phasing of the driver transformer secondary winding the two circuits are basically alike. A shunt efficiency diode—as used in these examples—is always connected the opposite way round to the base-emitter junction of the output transistor.

In both circuits the line deflection coils are returned to chassis via a capacitor which acts as a d.c. block and also provides scan correction.

Waveforms

These two transistor line timebase circuits are typical of those used in monochrome portables and while they look extremely straightforward nevertheless the transistor characteristics, including the charge storage effect, mean that precise component values are essential. Also the current and voltage waveforms actually present tend to vary far from the rectangular or sawtooth shapes one might expect to find.

This is brought out in Fig. 3 which shows typical base and collector waveforms for the high-power Mullard BU105 line output transistor operated from an h.t. supply and thus not requiring a separate efficiency diode—see also the circuit shown in Fig. 4.

The driver *V*ce waveform (e) may appear to be approximately a squarewave but in fact has a mark space ratio of 1 : 1.37 while the waveform (a) developed at the base-emitter junction of the output transistor is very different. Then the output transistor's base current curve (b) is quite different from its base-emitter voltage curve (a), due mainly to its non-linear input impedance and also to the effect of connecting in the recommended circuit (Fig. 4) a small inductor in series with the base feed. Nevertheless, as the *V*ce curve shows, the transistor remains firmly bottomed while it is conducting during the forward scan period. This is essential in order to avoid excessive power dissipation in the device and for this reason it is customary to apply more than the nominally required forward base bias during the transistor's forward conduction period.

Cutting Off the Output Transistor

A transistor cannot turn off instantaneously however and this high forward bias results in a large number of charge carriers being stored near the base-collecter junction—the charge storage effect. Unless these carriers are rapidly removed the collector current will slowly tail off after the switching pulse had ended, resulting in high dissipation during the flyback time. To overcome this effect with high-power transistors in the sort of circuit now being discussed a small inductor may be found connected in series with the base feed (L1 Fig. 4). This lessens the rate-of-fall of the switching pulse towards its

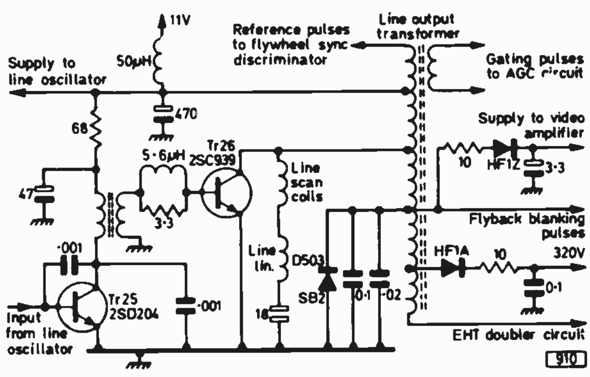


Fig. 2: Line driver and output stages of the Murphy Model V1400 14in. mains/battery portable. The npn line output transistor Tr26 is operated in the common-emitter mode.

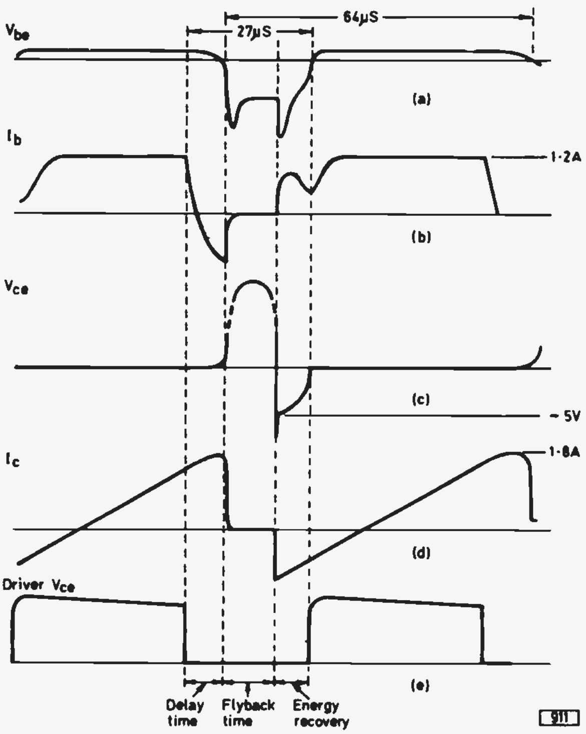


Fig. 3: Several large-screen monochrome receivers use the Mullard BU105 line output transistor. The correct waveforms in a stage using this transistor are shown above.

termination, producing a clean collector current cut-off. The inductor usually introduces a delay of between 7 and 10μsec in the collector current waveform. In some designs the leakage inductance between the windings of the driver transformer is such that a separate coil is not required.

Flyback Period

The sudden cessation of collector current results in a high voltage being developed across the line output transformer primary winding. As shown in waveform (c) the transistor's collector voltage swings to a high positive peak. The subsequent negative half-cycle of this oscillation forward biases the transistor's collector-base junction which together with the transistor's low-resistance base circuit provides a low-impedance current path to chassis. The transistor's collector is not completely shorted to chassis however since the negative collector-emitter voltage present is made up of the potential needed to forward bias the collector-base junction—about 1V for a BU105—and the potential developed across the base-emitter junction—about 4V. Consequently the collector-emitter voltage during this period is, as shown in waveform (c), about –5V (during the forward scan, when the transistor is bottomed, the collector-emitter voltage is the *difference* between the collector-base and base-emitter voltages—usually no more than a volt or so).

The appreciable negative collector-emitter voltage developed immediately after the flyback explains why a separate efficiency diode is generally necessary when a line output transistor is fed from an l.t. in-

Note: C2 should be connected directly across the BU105 whose emitter should be the common earthing point.

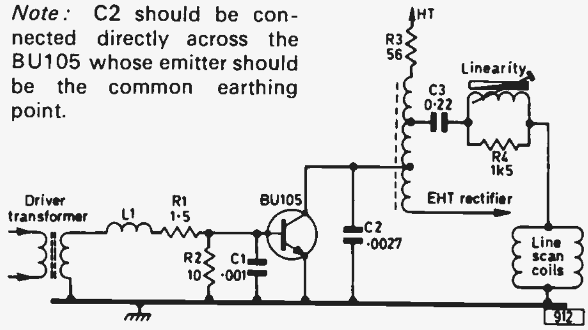


Fig. 4: The basic BU105 line output stage: the component values shown are typical of those found in practice.

stead of an h.t. rail—to avoid distortion on the left-hand side of the raster. With an h.t. supply in the region of 150-160V the –5V collector-emitter voltage introduces only about 3% raster distortion. When the power supply is only about 11V, as in a mains-battery portable, this collector-emitter voltage must be minimised, for example by incorporating a separate shunt efficiency diode—which requires only a small forward bias to maintain full conduction—connected as shown in Figs. 1 and 2.

Circuit Details

Returning to Fig. 4, the undecoupled resistor R3 in series with the h.t. supply to the output transistor limits the overloads which can result from e.h.t. arcing or flashovers in the c.r.t. The transistor's base-emitter junction is protected against transients fed back via the collector-base capacitance by C1. R1 limits and stabilises the transistor's base current. R2 damps the base circuit to prevent ringing which could turn the transistor on during the flyback period. C2 tunes the output circuit, C3 provides a d.c. block and scan correction and R4 damps the linearity coil.

Follow-up

So much then for a survey of the type of circuit generally found in monochrome transistor receivers and an outline of basic transistor line output stage operation. In a following article we shall be taking a look at the arrangements used in solid-state colour receivers.

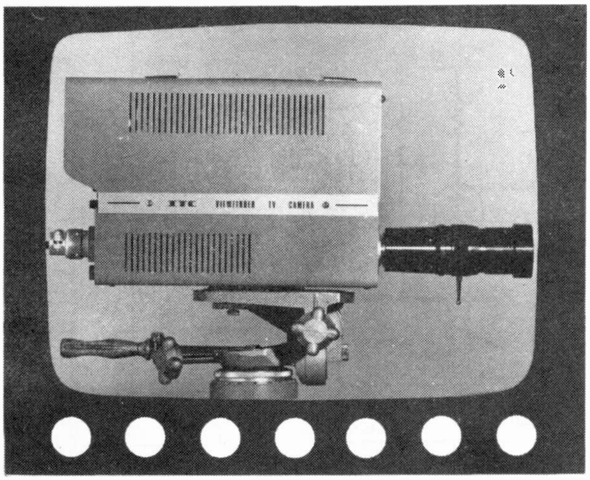
AERIAL NEWS

Antiference have introduced Mark III versions of their popular Trucolour range of aerials. The new versions have various improvements including increased forward gain and a particularly easy form of cable connection (just push in prepared cable and screw clamp down).

For use with caravans Aerialite have introduced the Traveller, a wideband log-periodic aerial in kit form. The VAT inclusive price of £13 includes a 12ft. telescopic mast and 25ft. of cable.

A new low-loss u.h.f. diplexer, the Fuba AKW045, is available from Audio Workshop.

CCTV



PART 3

Peter Graves

IN some camera designs the first stages of amplification (the "head amplifier") are physically separate from the rest of the video circuitry (the "main" or "processing amplifier"). The tube, the scan coil assembly (sometimes part of the scanning circuit) and head amplifier are mounted in their own enclosure —the "head"—see Fig. 1. Typically this is tubular, with the lens at one end and the connecting cable (the "camera cable") socket at the other. Metal bands clamp it to a base for mounting purposes. The head operating supplies (h.t., l.t., heaters, target, beam, etc.), pulses (scan voltages and camera blanking) are fed to the camera head along the cable from a remote control unit (the "camera control unit" or, more commonly, "CCU") which contains the main video amplifier, the scan circuits and the power supplies. The video output from the head amplifier is fed back down the cable to the CCU. There are two main advantages of this arrangement: (a) small camera size and (b) that all the set up and operating controls are on the CCU in a remote position—extremely convenient if for example the camera is mounted on the roof or is looking down a sewer!

Camera Cable

From the details given previously on the vidicon it will be appreciated that it is not feasible to feed the tube output directly down the cable—the signal level is far too low. The head amplifier is mounted as close to the target ring as possible so as to raise the signal level and preserve its integrity. The camera cable itself is a complex set of different types of leads: thin ones for low-current h.t. supplies, thick ones (for minimum voltage drop) for heaters, and coaxial lines for the pulses and the video output to the CCU. There may also be control wires feeding for example sunshutters and filter insertion mechanisms, and telephone wires for intercommunication during fault finding or alignment on the required scene. Typically over thirty different leads may be fitted into an approximately one inch diameter plastic sheath which may have an additional cover of steel armouring wires for additional protection for heavy duty work. The cable is very reliable unless it is mechanically damaged or bent into too tight a radius (20in. radius is typical, more if the cable is moved frequently—this is a minimum measurement). Plugs and sockets and the connections in them are a notorious source of trouble however.

A further advantage for the service engineer of this type of camera design is the ease with which the various parts of the system (CCU, head, cable) can be isolated. A substitute head (on a short cable) or CCU can be quickly plugged in for rapid fault finding. In addition the head can be removed from its remote position and can be tested and initially set up on a short cable (10 feet with a plug at one end and a socket at the other is a convenient length for a test cable). A word of warning is necessary here. The tube heater control will be set to compensate for the voltage drop along the long cable and will be set too high therefore for the short cable, overloading the tube heater. Set the heater current control (and the nuvistor heater control where appropriate—see later) to zero before connecting the camera to the short cable and don't forget to reset the controls when the camera head is reconnected to its long cable.

Types of Amplifier

Cameras which have the head and CCU combined are referred to only loosely as having a head amplifier, the term being used in this case for the first few stages of amplification (also referred to as the "front end").

Modern cameras use a completely transistorised video amplifier (indeed in many designs the only non-solid state component is the vidicon), often with a field effect transistor (f.e.t.) at the front end to achieve low noise and a high input impedance. At least one manufacturer supplies a conversion kit for the front end to replace the existing transistor with a f.e.t. and the associated components required.

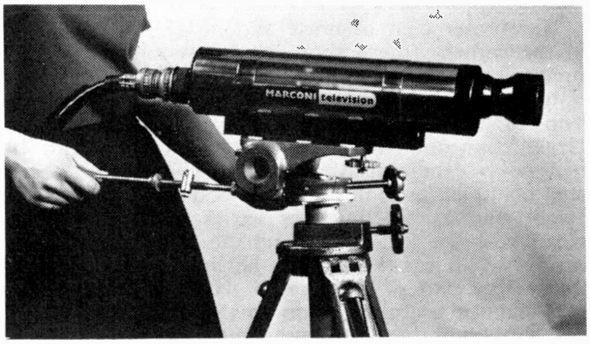


Fig. 1: A typical separate-head camera, the Marconi CCTV camera type V321.

Ideally after conversion or major repairs—see later—the camera amplifier should be "swept". This process is exactly the same as sweeping the tuned circuits in an i.f. amplifier but uses much more sophisticated equipment. For this reason this generally means returning the camera to the manufacturer.

Other amplifiers use a nuvistor or nuvistor/transistor or cascode input stage. The nuvistor is a miniature triode valve with a metal envelope measuring approximately ¾in. high. It combines the high input impedance of the valve with excellent signal-to-noise ratio and small size—it will be familiar to radio hams, particularly those who operate at high frequencies. It needs a heater and h.t. supply of course and this makes the equipment a little more complicated. Separate head cameras must have an adjustable nuvistor heater supply in the same manner as is required for the vidicon. This should be checked from time to time, particularly when a new valve is fitted or the cable length changed.

Some basic head amplifier circuits are shown in simplified form in Fig. 2.

Valve cameras operate on the same principles as transistorised units. They are becoming increasingly rare due to their larger size and power consumption. Valve cameras are specified for remote handling and observation in nuclear power stations and other atomic plants however since radiation which would ruin transistors (it affects them directly, causing increased leakage currents) has little effect on valves.

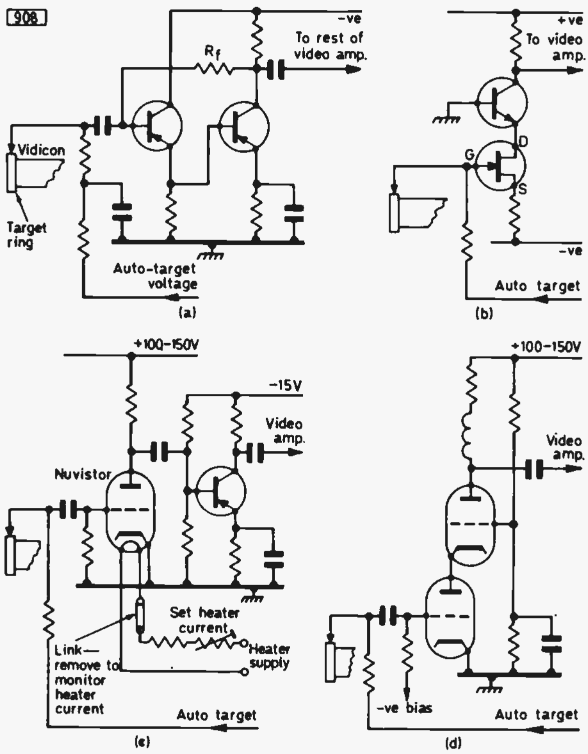


Fig. 2: Typical head amplifier circuits (simplified). (a) The feedback pair. The feedback resistor Rf may need optimising if the transistors are changed. (b) Cascode amplifier with f.e.t. input stage. (c) Valve/transistor hybrid circuit. (d) Valve cascode circuit—typically uses two nuvistors (heater circuits omitted).

Frequency Response

The frequency response of the video amplifier may extend from close to d.c. to over 10MHz and needs to be substantially flat over this range. The first few stages play an important part in determining the correct frequency response and random component changes must not be made. Frequently the transistors at the front end, together with their gain determining feedback components, are a matched set and must be changed for a similar matched set (from the maker) in the event of failure of one of them. The temptation to twiddle variable inductors and capacitors "to see if I can peak up the picture" or, worse, the "I wonder what this does" approach must be firmly resisted. The preset controls in this area are set up with a sweep generator at the factory and unskilled adjustment will ruin the response. The front end is probably the most reliable part of the whole unit however.

Servicing

Ninety per cent of noise and instability problems in the camera (these show as "snowstorms" on the monitor or "waving grass" patterns on the video output waveform) are caused by poor target connections or bad earthing around the tube faceplate. The target connection must be kept clean and tight. If trouble is experienced in this area strip the target ring clamping assembly (the method of clamping the target ring to its connector varies with make) and clean both the target ring and the target connection (in very bad cases they can be lightly rubbed with fine emery paper—a packet of ladies emery boards can make a useful addition to the tool box). When reassembling take care that all the parts are put back in the right order and the correct way round. The clamp should be tightened firmly but no more as this could lead to stripped threads or a damaged tube. Some cameras have a special tool provided (the "vidicon tool"). This should be retained and used—screwdrivers and pliers are no substitute.

Care must also be taken when removing the tube from the scanning yoke. There is usually a recommended way of getting it out—and this is not by prising the glass base up from the socket. Familiarity sometimes makes this seem the easiest way however and the author to his acute embarrassment once ruined a tube in front of its owner by putting a screwdriver through it! Not a recommended practice! Fortunately it was not a brand new tube.

The earthing round the vidicon faceplate must be sound. Check, clean and remake any suspect connections. Check earthing screws and printed circuit earthing points (often a mounting pillar) for tightness. If necessary they can be lifted and cleaned by scraping with a knife or gently rubbing with an emery board.

A less common fault is instability caused by the lens not being properly tightened in its socket, thus producing an incomplete earth to the metal lens body.

If it is necessary to replace either the target connection or any of the earthing leads in this area (they tend to be on the fragile side, particularly the target connection which is dislodged every time the tube is changed) the same type of wire should be used and the same path as the original connection followed.

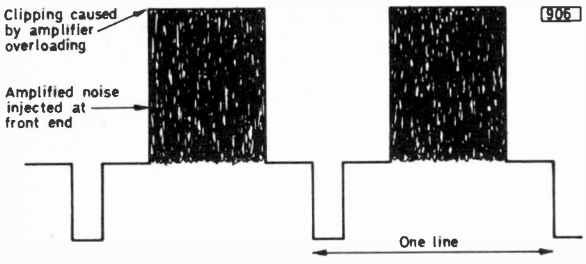


Fig. 3: Section of the output waveform.

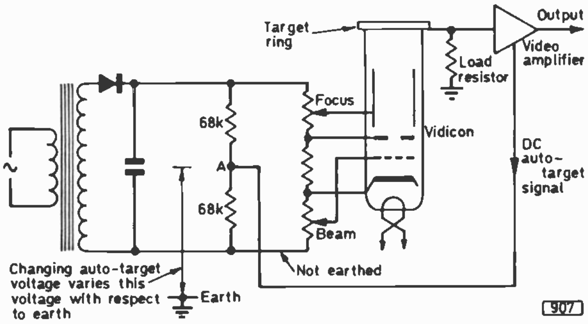


Fig. 4: Auto-target circuit based on the use of a floating power supply (i.e. neither side earthed).

Check too for dry-joints in and around the head amplifier.

No Picture

A frequent fault is no pictures at all. In equipment as complex as a CCTV camera this may be caused by a wide variety of faults or misadjustments. The whole video amplifier can be given a quick check by holding a finger on or near the target connection or the first stage of the video amplifier. Take care—some cameras have the target voltage which may be as much as 100V above earth applied at this point. This is not dangerous (it is a high-impedance supply) but it could give you a jolt! The finger will inject noise into the amplifier and grossly overload it. If the amplifier is working the monitor picture will brighten and show a collection of random patterns caused by instability in the amplifier. The video output waveform viewed on the scope will show as a series of blocks where the amplifier is limiting (see Fig. 3). If this result is not obtained there is most likely a fault in the video amplifier. This is a very useful test on an apparently "dead" camera.

Auto-Target Techniques

As we saw in previous articles the video amplifier develops the auto-target signal to control automatically the vidicon's sensitivity. We have already shown one way in which the auto-target voltage is applied to the vidicon—in series with the load resistor. There are two alternative methods.

The first technique is the simplest of all. It consists of a very high value (1,000MΩ is typical) resistor in series with the target supply. As the scene illumination increases, the average signal current flowing through this resistor causes a voltage drop which reduces the effective target voltage. This stabilises the signal current level.

The other method (Fig. 4), probably the most sophisticated of the three, keeps the target voltage right away from the front end of the amplifier so that the target can be held very close to earth potential, simplifying the circuit and improving the stability and frequency response. The power supplies for the rest of the vidicon electrodes (cathode etc.) are obtained from a floating power supply—that is, neither side is connected to the camera earth. The vidicon electrodes are fed from a potential divider chain which is across this supply and fixes the relative voltages between the electrodes. The auto-target voltage (which changes with respect to earth) is connected to the centre (point A) of another potential divider as shown. As the auto-target voltage varies, the entire power supply is driven up and down with respect to earth. Suppose for example that the auto-target voltage varies from zero volts to +60V and that the voltage across the power supply output is 300V: the voltage across the two power supply output lines will remain at 300V but the whole supply can rise 60V above earth (i.e. the target). If the auto-target voltage increase is caused by an increase in scene illumination then the electrode gun will be more positive with respect to earth and also with respect to the target. This means that the effective anode-cathode voltage is decreased and the tube's sensitivity is less. Decreasing the auto-target voltage increases the the anode-cathode voltage by making the cathode more negative with respect to the target, thus increasing the tube's sensitivity.

CONTINUED NEXT MONTH

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FERGUSON 3619

The following faults are present on u.h.f. only. After a short while the field hold fails and the picture rolls. This usually stops by itself but can be put right by adjusting the hold control. Sometimes the picture vibrates, as if the camera is shaking: this usually lasts for a short while only. Then on occasions the verticals deform, the top of the picture tearing to the left. —T. Harrison (Thirsk).

Since you are having trouble with both the line and field synchronisation the trouble is likely to be in either the video amplifier or sync separator circuit. We suggest you first try a new PCL84 video amplifier valve, then check all associated resistors, particularly the 47kΩ bias stabilising resistor between the screen grid and cathode. In the sync separator stage check the value of R38 (43kΩ), the upper resistor of the potential divider which supplies the screen grid. (BRC 850 chassis.)

PHILIPS G25K512

The picture is reasonable on this colour set but the definition is poor. The voltages in the luminance output and line sync amplifier stages are high and in the sync separator stage low—the luminance output valve grid voltage is about −1V instead of −3·8V. The resistance from h.t. to chassis is 9·5kΩ: is this low?—L. Dormer (Wolverhampton).

Video pentode and sync separator control grid voltages vary widely according to signal strength and have little bearing on picture definition. The focus setting of a colour set is much more critical than that in a monochrome receiver however, so if the test card gratings seem blurred etc. the most likely cause is that the focus is not at optimum. To adjust, tune tc a 625-line programme and set the focus control R4045 for the sharpest line structure. Check the chain of high-value resistors on the earthy side of the focus control since these can change value or go open-circuit resulting in poor focus. Incorrect luminance output stage control grid voltage would affect the brightness level rather than the definition: if necessary check the d.c. restorer circuit. You need a high-resistance meter of course to get accurate readings in the high-resistance control grid circuit. The h.t. resistance to chassis depends to a great extent on the meter employed. If you think the h.t. consumption is excessive the best course is to compare the actual current with the figures given in the manual, but if the picture size etc. is normal we would assume the current to be within the correct limits (Philips G6 chassis.)

FERGUSON 3640

The fault on this set consists of vertical striations which cover approximately half the right-hand side of the screen, not the left-hand side as is more usual. The striations—there are about ten—are present on both systems. The performance is otherwise good.—R. MacPhail (Ormskirk).

We take it you have tried replacing the PL504 line output valve. The next step is to check its screen grid decoupling capacitor C103, then the grid stopper resistor R129. If these are in order check the capacitors in the control grid circuit—the coupler C104 and feedback capacitor C106—then the width control and the associated high-value resistors. (BRC 950 chassis.)

PAM 5141

There is sound but no raster. The e.h.t. rectifier does not light up and there is no heater voltage at the valveholder. The line whistle is absent on both systems. R119 which is in series with the high-voltage capacitor C94 in the feedback line from the line output transformer to the line oscillator has overheated. All line timebase valves have been replaced.—O. Hardy (Norwich).

C94 could have shorted, in which case it may have damaged the PCL84 (triode section) line oscillator. More likely however is that R119 has simply gone high-resistance, it often does on this chassis. Its correct value is 270kΩ and we suggest you use a 1W type—make sure the replacement does not touch the line output transformer cover. (Pye 11U series.)

PHILIPS G26K522

When test card F is displayed severe pincushion distortion of the verticals on the right-hand side is seen—the symmetry of the rest of the test card is good. Adjusing the line linearity coil L5547 produced a slight improvement but since doing this there are four vertical light bars on the left-hand side, more prominent on dark scenes.—J. Sullivan (Burgess Hill).

You have over-adjusted the line linearity control —return it to about its original setting then adjust the raster correction coil L4482. It may be possible after doing this to make some readjustment of the line linearity control for optimum results. A slight amount of pincushion distortion has to be accepted. (Philips G8 chassis).

FERRANTI T1123

This set works perfectly on 405 lines but a short time after switching to 625 lines the sound and raster disappear. On switching the set off we noticed that the c.r.t. and valves were all alight. The h.t. cannot be checked under the fault condition however because on switching on again the set works perfectly.—R. Elway (Harrogate).

The trouble is almost certainly due to lack of h.t. voltage. When the fault occurs turn the brightness and contrast down and, with the set still on, check the h.t. line (at the smoothing block) with a meter. You will almost certainly find a dry-joint around the dropper or h.t. feeds.

ULTRA 6715

I would like to fit a sound muting switch to this set so that the sound can be removed without having to readjust the volume control continually. Do you think it would be advisable to add a two-way changeover switch in the 90Ω loudspeaker circuit to switch the audio output to a 90Ω 5W resistor when required instead of the loudspeaker?—R. Harrap (Ongar).

We feel that the safest way to achieve the effect you require would be to insert an on-off switch in series with the 100Ω resistor R405 which feeds the supply voltage to the audio output stage. The control must be well insulated. Any other method could result in surge damage or hum pick up. R405 is the 5W resistor mounted in the top right-hand corner of the field/sound board. (BRC 3500 chassis.)

PHILIPS 19TG152A

The problem with this set is intermittent field collapse—to a thin white line across the screen. This has occurred on several occasions but clears before tests can be made to find the cause of the trouble.—T. McGuire (Reading).

The most likely cause of the trouble is that one of the field timebase valves—the PCL85 or the ECL80—is intermittently failing. The two preset field linearity controls at the edge of the timebase panel are a source of intermittent trouble however on this chassis: pressure applied to them will indicate whether the fault lies here. The edge contacts are also suspect. If the white line is wavy it is more likely that the scan coils are going open-circuit intermittently.

FERGUSON 705T

This set is fitted with a 625-line converter. On 405 lines the picture is perfect but when the set is switched over to 625-line operation there is a 1-1½in. gap at the sides: the picture then gradually fills out but after about twenty minutes it creeps back in again, also the picture gets weaker.—R. Sadler (Hanwell).

Although the width is sufficient on 405 lines the variation in and out on 625 lines strongly suggests that the PL36 line output valve is below par and unable therefore to constantly supply the increased loading on 625 lines. First change this valve then, and the PY81 boost diode if the width tends to come in more on the left- than the right-hand side of the picture. A new ECC82 line oscillator valve may also equalise the width on the two systems. If necessary check the resistors in the width circuit and the boost reservoir capacitor C89.

PHILIPS 19TG171A

The problem with this set is the top of the raster: if the linearity is set for correct line spacing there is a ½-¾in. gap at the top. The top linearity control can be used to fill the screen but elongates the top of the picture. The field timebase valves have been replaced, also the output stage cathode components. The main smoothing electrolytics have also been changed. Another fault is a watery gurgling noise in the background on 625 lines—all valves in the sound channel have been replaced.—G. Perterson (Hayes End).

The main fault appears to be in the field linearity feedback circuit so R436, C430, R440 and C422 will have to be checked—the latter two are the more likely ones to be defective. If the resistor values are correct on a meter, make capacitor substitutions. Check the PCL85 triode anode voltage: if low check R446, R428 and C414 in the height control circuit. This kind of fault is difficult to clear since there are usually no significant voltage changes. Unfortunately the field output transformer could be the cause of the trouble: if so it will have to be replaced. The 625-line sound i.f. circuits in this chassis do tend to drift, introducing distortion and incidental noises. The coils to adjust, at 6MHz (can of course be done on signal), are L208, L207, L206, L234, L203 and L211/210 (in that order). First however make sure that the ratio detector diodes have equal low forward resistance and that the detector balance control R228 is set for best results. (Philips Style 70 chassis.)

BUSH TV161U

There appears to be an h.t. short on this set as the mains fuse blows whenever it is switched on. All valves have been renewed, the components on the power supply tagstrip below the timebase board checked, also the electrolytics, and thorough checks made with a multimeter without however locating the source of the trouble.—G. Nelson (South Harrow).

Replace the 0·1μF mains filter capacitor 3C47 which is wired across the on-off switch and is situated by the fuse at the bottom righ-hand side. Use a capacitor rated at 1kV working. The existing capacitor will probably read all right on a resistance test but break down when the mains a.c. is applied to it.

GRUNDIG 6010

The picture on this new colour set is good except for a slight pinkish area over the right-hand squares of the test card.—H. Baker (Hanwell).

This model is fitted with a 110° colour tube. Slight trouble has been experienced with these by Continental setmakers because the shadowmask warps slightly with high beam current (i.e. high dissipation in the shadowmask). This gives the pink effect you describe. Careful setting of the purity and slightly reduced brightness and contrast control settings should go a long way to alleviate the problem.

GEC 2000

On several of these sets we have experienced a fault which appears to be in the a.g.c. circuit. The contrast starts to vary rapidly from high to low. This can be triggered off or stopped by a change of camera or picture content. It can also be eliminated by reducing the setting of the contrast control to nearly minimum. —A. Calder (Selkirk).

The trouble is probably due to C26 (0·22μF) which decouples the a.g.c. feed to the first i.f. amplifier being low capacitance. If the fault is particularly prevalent on 625 lines you may find it a help to increase the value of this capacitor to 0·47μF.

PHILIPS 23TG170A

The picture sometimes has an annoying flicker, rather like a film projector running too slowly. This seems to be worse in the upper half of the picture and on the weaker signal here. It is particularly bad on some films, and varies in degree during a programme—the degree of flicker alters with a change of scene. When the set is first switched on there is slight pulling to the right at the top of the picture. —J. Bowyer (Bristol).

The fault could be nothing more than the contrast control being advanced too far. If this is not so try a new PFL200 video valve and check the associated components and connections, also try a new EF183 i.f. valve (V204) and check the BA115 d.c. restorer diode (X205). (Philips Style 70 chassis.)

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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 KB Model SC042 (ITT VC200 chassis) suffered from intermittent brightness which was affected to some extent by the brightness control setting. Beyond a certain setting the brightness increased only slightly and the picture width decreased. The symptom was virtually the converse of that resulting from poor e.h.t. regulation, where the picture expands rapidly as the brightness control is turned up until it eventually disappears. To prove that some circuit quirk was not responsible the PL504 line output valve, PY88 boost diode and TV20 e.h.t. rectifier were checked by substitution. The fault condition remained however. It was also found that the h.t. voltage was correct at all settings of the brightness control and that the sound channel was unaffected by the fault.*

A voltage-dependent resistor (R156, E298ED/A265) is connected in series with the width control in the control grid circuit of the PL504 and produces a d.c. voltage which depends on the amplitude of the line flyback pulse fed back to it from the line output transformer and hence on the line output stage loading. This d.c. voltage regulates the PL504 biasing according to the load requirements.

The v.d.r. and the other resistors associated with the width control, also the coupling circuit from the oscillator, were all found to be in order yet when testing for bias on the PL504 signal grid with a 20kΩ/V voltmeter it was found that both the picture width and the brightness were restored and the brightness control operated normally.

Why was this, and what component could have been responsible? See next month's Television *for the solution and for a further item in the Test Case series.*

SOLUTION TO TEST CASE 137

Page 331 (last month)

A common cause of sync troubles with transistor sync separators is the high-value resistor (R220 4·7MΩ in this case) used to apply base bias to the transistor from the h.t. rail. This proved to be in order however and the trouble in the Decca colour receiver in question was eventually traced to a fault in the coupling from the video emitter-follower (TR202, BC158) to the sync separator (TR204, BC117). The 0·47μF coupling capacitor (C210) was found to be of significantly reduced value and while it was passing a fair level of line sync signal it was severely attenuating the field sync signal. Replacing it cured the field roll and the slight line pulling noted by the service technician.

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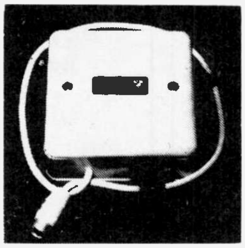

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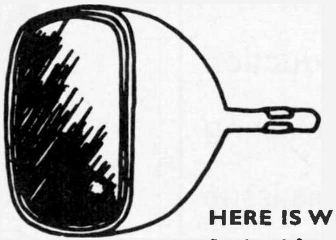

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