PRACTICAL TELEVISION

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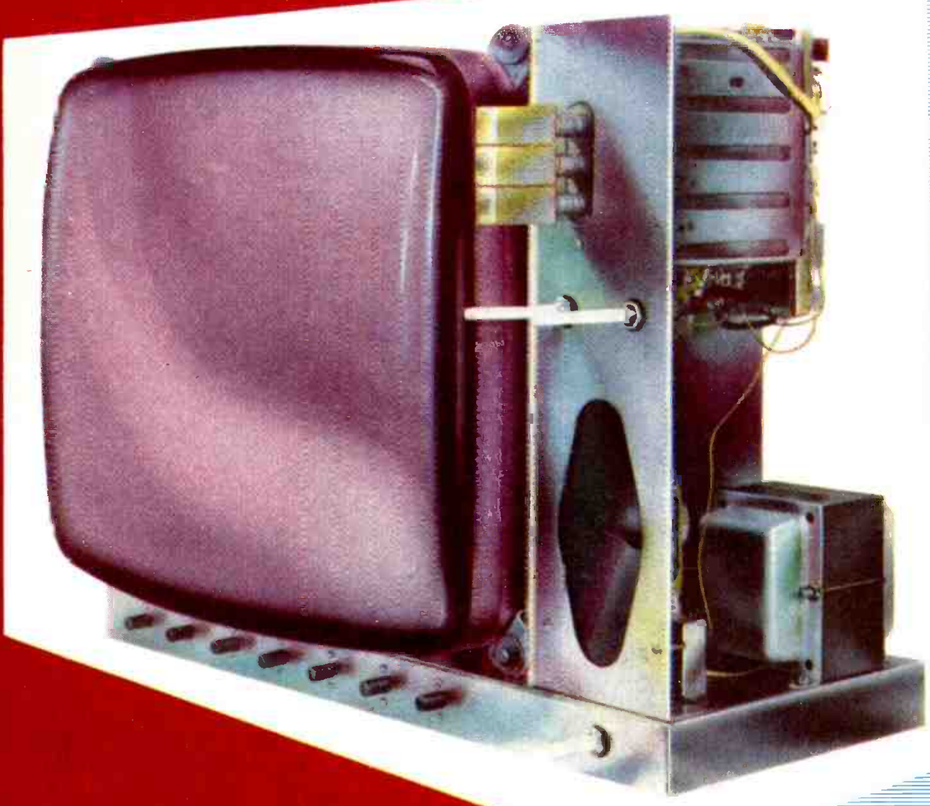
MARCH 1970

BUILD THIS 625-LINE RECEIVER



also:

CIRCUIT NOTES

FAULT-FINDING PITFALLS

SIMPLE UHF SLOT AERIAL

PRACTICAL
TELEVISION

VOL 20 No 6
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MARCH 1970

VIDEO CASSETTES

THE air is again full of buzzes on pending developments to put video recording and playback within the reach of at least the more affluent homes. "The next status symbol after colour TV" is the catchphrase.

This may well become true but the scene at the moment is rather confused. One headline catcher is the EVR system of CBS. This is a playback system (black-and-white only at the moment) using film. A flying-spot scanner processes the master film from which EVR positives are reproduced, and the output of the EVR black box feeds into the TV receiver for display on the c.r.t. Rank-Bush-Murphy holds the UK licence and plans to produce 1,000 EVR units per week by the autumn and to make a million cartridges a year in its Basildon plant, expected to be in full production by the summer. Costwise this is primarily a professional marketing operation: an hour of film will cost around £5.

The latest idea to emerge is the Selectavision system of RCA. This is a tape player based on lasers and holography in which a plastics hologram is recorded on to inexpensive vinyl recording tape. It is aimed to get the Selectavision system in production in the USA by 1972, with the basic box costing around £170. The tapes, which will reproduce in full colour, are expected to cost around £4 for a 30 minute run.

This system is also geared for the professional or semi-professional market and while it would like the EVR system be suitable for applications in industry and education, such as in the proposed 200-odd study centres of the "Open University", it also is a playback-only proposition and as such is restricted in its appeal to the home user.

It seems to have been left to the Japanese to concentrate on the domestic scene and they have developed equipment along more conventional lines. Toshiba produced a prototype domestic video recorder some years ago and has been followed since by companies such as Matsushita and Sony. The most likely firm to bring videotape recording to the home first seems at the moment to be Sony. A machine for under £200 appears to be imminent on the USA market and this one uses tape cartridges which run for 90 minutes in colour and will cost about £8. Agreements have been reached between Sony, Grundig and Philips

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THE NEXT ISSUE DATED APRIL WILL BE PUBLISHED MARCH 20

TELETOPICS

CBS EVR SYSTEM

Columbia Broadcasting System Laboratories announce that the advanced electronic video recording system they have developed will be made under license in the UK by the Bush-Murphy Division of the Rank Organisation. Deliveries are expected to start about July. Motorola Inc. have been licensed to produce the EVR players in North America.

The EVR cartridge will be seven inches in diameter and hold up to 52 minutes of programme material. Programmes are reproduced on a domestic receiver by slipping the cartridge into the EVR playback system which is connected directly to the set's aerial input socket. The film is threaded past an electronic sensor which converts the film image to an electrical signal that is fed into the set along with the associated sound. CBS were recently given the IR-100 award for the system, which was selected as one of the 100 most significant new American products of 1969.

COLOUR COVERAGE EXTENDED

BBC-1 and ITA on colour are now available from the Rowridge, Dover and Black Hill transmitters. **Rowridge** BBC-1 is on channel 31 and ITV (Southern Independent Television) on channel 27, both horizontally polarised (aerial group A). **Dover** BBC-1 is on channel 50 and ITV (Southern Independent Television) on channel 66, both horizontally polarised (aerial group C). **Black Hill** BBC-1 is on channel 40 and ITV (Scottish Television) on channel 43, horizontally polarised (aerial group B). In addition the BBC-1 u.h.f. service with colour has now started from the **High Wycombe** relay station on channel 55 with vertical polarisation (aerial group C).

The BBC-2 colour service has been extended to Saddleworth and Keighley. **Saddleworth** BBC-2 is on channel 45 with vertical polarisation (aerial group E) while **Keighley** BBC-2 is on channel 64 with vertical polarisation (aerial group C).

ITV 1970 HANDBOOK

The annual handbook of Independent Television for 1970 is now on sale (10s. 6d. per copy) and reflects the commencement of ITV colour transmissions during 1969. Both the page size and the number of pages have been increased with this edition. The book is a standard reference work on the organisation of ITV, the programmes, programme companies, technical developments and the control of advertising. The coverage maps show the ranges of the existing transmitters, those coming on-air during 1970 and the prospects for the mid-1970s. The book is distributed by Independent Television Publications Ltd., 247 Tottenham Court Road, London W1P OAU.

ICs FROM RADIOSPARES

Two linear integrated circuits, types 709-OPA and 710-OPA, have been added to the Radiospares range of components. The 709-OPA is a differential-input operational amplifier and the 710-OPA a differential-input voltage comparator.

COLOUR TV DELIVERIES CONTINUE TO INCREASE

The number of colour sets delivered to the trade during October showed an increase of 47% over the previous month, rising to 25,000, according to the BREMA Economic and Statistical Division. Of the 102,000 sets delivered in the first ten months of 1969 almost half were delivered during the months August-October. Deliveries of monochrome receivers during October amounted to 197,000, the general trend with monochrome sets running at 4% below the previous year.

LOW-LIGHT LEVEL TV CAMERA

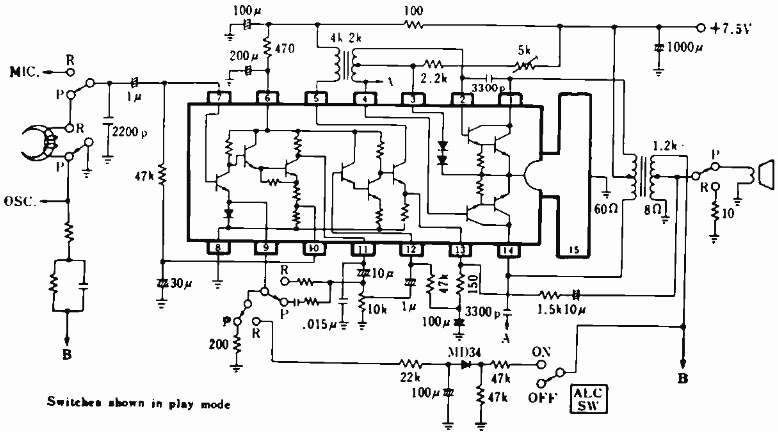
A new low-light level TV camera has been announced by STC, type GTNV-1, using a vidicon tube in conjunction with a three-stage image intensifier. The camera provides pictures under conditions equivalent to starlight, the minimum scene illumination required being about 2×10^{-5} ft. candles.

MORE TV DETECTOR VANS FROM VOSPER

Vosper Electric announce that they have already started work on a repeat order for a further 18 television detector vans plus two sets of spares. The new detectors have been developed by Vosper from a prototype operated by the Post Office for the Ministry of Posts and Telecommunications. They are installed in standard Commer 2500 series vans specially adapted for the purpose by Vosper in order to carry the new equipment. Major modifications to the roof structure include roof plate, aerials, and aerial drive equipment.

The electronic detection equipment is housed in a console behind the front seats and consists of a receiver covering the frequency range 470 to 860 MHz which is fed from a pair of wideband aerials the spacing between which is automatically adjusted

Right: Suggested circuit for a tape recorder record/playback amplifier using the M5101P integrated circuit. An emitter-follower couples the first and third stages, the latter being capacitively coupled via connection 11 to the 10k volume control. This feeds a super-alpha pair coupled to a further common-emitter stage in the collector circuit of which a driver transformer is connected (via connection 5). This external transformer drives the push-pull output stage which consists of a pair of transistor elements in each arm connected in the super-alpha configuration



as the receiver is tuned. This aerial system has a known directional characteristic and can be used to receive signals from either side of the vehicle, thus facilitating the scanning of buildings on both sides of the road. The receiver output is displayed on an oscilloscope. As the vehicle moves slowly past a chosen house the oscilloscope display, on a repeater screen, is photographed by an instant-developing Polaroid camera. Special sight-line indicators at the windows of the van enable the operator to pin-point the boundaries of the property, and by pressing a button he can indicate these on the photograph. In this way the operator is able to determine the approximate position in the house of the television receiver and the channel in use can be identified from the frequency to which the detector receiver is tuned. The frequency range covered by the detector allows it to be tuned to the local oscillator of television sets operating in Bands IV or V, and to harmonics of the local oscillator in television receivers operating in Bands I or III and sound receivers in Band II.

NEW 7IN. PORTABLE

The **Standard** 7in. portable Model TV7AUK is now available from Telerenters Ltd., Highview House, 167 Station Road, Edgware. The set, which operates on channels 21-70, has a recommended retail price of £71 17s. 6d. and can be operated from an a.c. mains supply or car battery.

MOTOROLA SEMICONDUCTOR DATA BOOK

The fourth edition of "The Semiconductor Data Book" from Motorola is now available in the UK from the Modern Book Co., 19 Praed Street, London W.2. The new edition has 2,160 pages and is aranged in alphanumeric sequence. Over 12,700 types are listed with details of their characteristics. The price is £3 plus 6s. postage.

AUDIO IC FOR THE CONSTRUCTOR

A 1W audio amplifier integrated circuit for use as a single a.f. amplifier or as a tape recorder record/playback amplifier is one device in a new range of i.c.s available from Ultra Electronic (Components) Ltd., Microelectronics Division, 35-37 Park Royal Road, London, N.W.10. The i.c., type M5101P, is designed for use with a V_{cc} up to 12V and with the addition of a fin will dissipate 1·8W. A plastic dual in-line encapsulation is used and the price quoted is 25s. 5d. cash with order. Our diagram shows a suggested tape recorder amplifier circuit using this i.c. As can be seen, the i.c. provides the functions of record and playback amplification. An automatic volume control circuit is externally connected.

TV RENTAL ASSOCIATION

The trade organisation representing the major television rental companies has changed its name from the Electronic Rental Association to the National Television Rental Association (NTVRA). The change has been made to avoid any possibility of confusion in the public's mind as to exactly what the organisation does.

WIDEBAND BOOST AMPLIFIER

A masthead booster has been added to the extensive range of TV distribution equipment available from Teleng (Teleng Ltd., Teleng Works, Arisdale Avenue, South Ockenden, Essex). The transistorised amplifier, Type AX5341, has separate v.h.f. and u.h.f. aerial inputs which are then diplexed together. Two trap filters covering 70-170MHz are incorporated in the v.h.f. input circuit. Power is provided by a separate power unit, Type SX5342, which can be installed in any position where there is a convenient 200-250V a.c. mains supply.

THORN EXTEND COLOUR TV PLANT

The British Radio Corporation (Thorn Group) is to build an additional colour TV factory at Bradford in an attempt to double its present output of colour sets by 1971. The new plant, expected to be complete by next autumn, will be an extension of the Radio Rentals Bradford factory where Baird brand colour TV sets are produced. It will cover some 75,000 sq. ft. and cost over £300,000. Thorn Group colour sets are at present being produced at the Enfield and Bradford plants. BRC produce the Ferguson, HMV, Marconiphone and Ultra brand TV sets as well as the sets for the Thorn Group of rental companies, Radio Rentals, DER, Multibroadcast and Vista.

CIRCUIT NOTES

H. K. HILLS

Transistor Protection

TRANSISTOR sync separators operate in a similar manner to their valve counterparts, being cut-off during picture information but conducting as heavily as possible during sync-pulse periods. Until quite recently they have been used almost exclusively in solid-state portable receivers as the high-amplitude pulse feed required for valve oscillators could only practically be provided by valve sync separators.

However advances in semiconductor design now permit transistor sync separators to be fed from an h.t. voltage similar to that used for valves. The circuit shown in Fig. 1 is used in the Pye-Ekco range of colour TV models and utilising an npn BC107 transistor is typical of current trends. Video feed via C1 from the preceding phase-splitter develops a substantial reverse (negative) bias which holds the transistor cut-off except during the sync pulse periods. The slight positive bias from the potential divider R1, R2 is only to ensure full conduction on the pulses and during picture information is heavily outweighed by the reverse base potential.

Abnormal reception conditions or circuit surges could however raise this reverse bias to an excessive value. By including a diode in the transistor's emitter lead this reverse voltage is then mainly developed across the diode's reverse resistance to proportionally reduce that across the transistor's base-emitter junction and thus prevent it from exceeding the maximum permissible value. During sync-pulse periods the diode acts as a low-resistance link to chassis and for all practical purposes can be ignored.

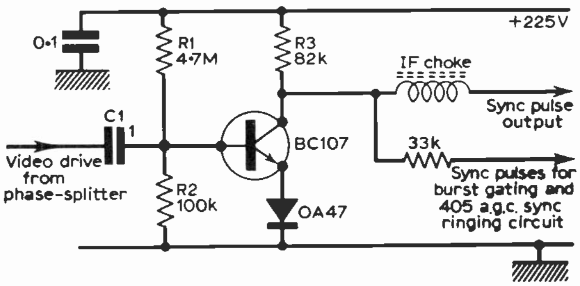


Fig. 1: Diode used in Pye-Ekco colour receivers to protect the transistor sync separator from excessive reverse bias.

"Colour on" Indicator

FOLLOWING general design practice in transistor chroma amplifiers, the second chroma stage in the GEC-Sobell dual-standard colour chassis is "turned on" only during colour reception. This is done by the application of forward bias derived from the rectified ident output. This arrangement ensures that monochrome pictures are free from spurious colour content caused by video frequencies within the chroma passband infiltrating through the chroma circuitry.

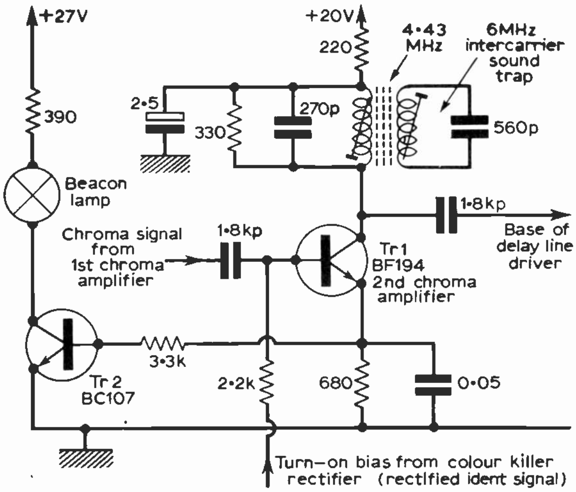


Fig. 2: The second chroma amplifier (Tr1) of the GEC 2028 series, showing the bias feed to the beacon switch transistor (Tr2) which passes current to the beacon lamp on colour reception.

The second stage circuit is shown in Fig. 2 and it will be seen that until forward bias is applied to Tr1 and produces emitter current there will be zero voltage developed across the 680Ω emitter resistor. On colour reception the emitter potential rises to +5V and this then biases Tr2 on, producing sufficient emitter current in this transistor to light the indicator lamp in series with the collector lead.

As well as giving positive indication that a colour signal is being received, the lamp assists correct tuning and can be a valuable aid to servicing when tracing loss of colour. When lit it indicates that the chroma amplifier, burst channel, a.p.c. detector and ident stages are all working satisfactorily since the ident amplifier is fed from the d.c. amplifier between the a.p.c. detector and the colour reference oscillator.

Mullard Transistor AF Output Circuit

MANY single-standard monochrome and colour receivers are now using the Mullard TAA570 integrated circuit to fulfil the functions of 6MHz i.f. amplifier/limiter, f.m. detector and audio preamplifier. With an output of about 600mV it is fully able to load a PCL86 or a transistor circuit of equal gain and output.

A suitable transistor circuit designed by J. C. Beckley of the Mullard Application Laboratories is shown in Fig. 3, employing three transistors fed from a 40V positive line to give a 2W output with

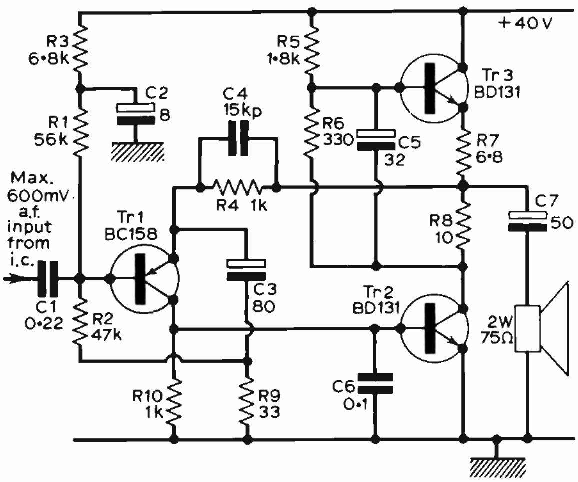


Fig. 3: Transistor a.f. amplifier designed to follow the Mullard TAA570 i.c. sound channel unit.

a total current consumption of 130mA.

The first stage, a pnp BC158, does not as might be expected drive the npn push-pull pair, but only Tr2 by direct collector-to-base coupling. Tr2 then drives Tr3, as the voltage across R8 in its collector lead is effectively applied across the base-emitter junction of the latter.

Feedback via R4 and C4 is applied to the emitter of Tr1 from the output stage. This transistor serves also as a d.c. comparator to set the mid-point voltage at the junction of R7 and R8.

Tr2 and Tr3 are biased to the Class A position so that the current demand will remain constant irrespective of volume levels and will therefore impose a constant load on the l.t. source, a valuable feature when other and possibly voltage-sensitive stages may be operated from the same supply.

The -3dB bandwidth or frequency range extends from 70Hz to 14kHz.

The output impedance of the TAA570 i.c. is 5·6kΩ and the input impedance of the associated a.f. amplifier should be at least 10kΩ to minimise loading. Due to the operating conditions of Tr1 and the degree of negative feedback applied this circuit has an input impedance of 30kΩ.

BRC 3000 Autotransformer Feeds

AUTOTRANSFORMERS have been used in monochrome TV receivers for some years and are almost universally employed in colour TV models. Although the types used for colour receivers always include a separate winding for the shadowmask tube heater supplies, they are still basically autotransformers as all the principal feeds are tapped from the one chassis-connected winding.

H.T. and l.t. supplies from autotransformers in the past have been via single rectifiers giving half-wave output and therefore requiring considerable smoothing. However in the latest BRC 3000 single-standard colour chassis the neutral connection is tapped into a point some way up from the earthy end of the winding permitting full-wave rectification of a 30V supply as shown in Fig. 4. The 1,000μF electrolytic is the reservoir capacitor and the supply is then taken via an SP8385 series stabiliser transistor. This transistor operates in conjunction with

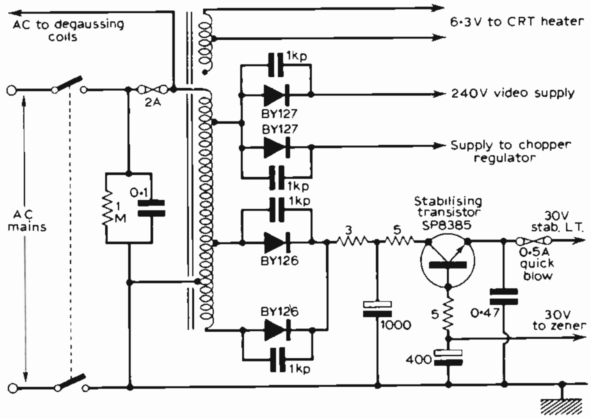


Fig. 4: Autotransformer arrangement providing one full-wave and two half-wave d.c. supplies as used in the Thorn-BRC 3000 series single-standard colour chassis.

a zener diode which holds its base potential constant.

Two other d.c. supplies are used in this model, a 240V rail for the video output transistors and what is referred to as a "chopper supply" for the line, field and sound output circuits. This completely original circuit employs a series power transistor

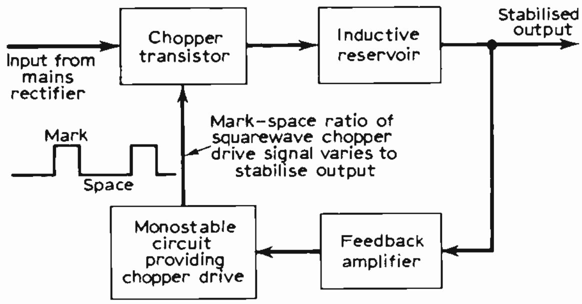


Fig. 5: Block diagram of the power stabiliser arrangement used in the Thorn-BRC 3000 single-standard colour chassis. The chopper transistor only conducts and feeds the reservoir when switched on by the monostable drive circuit. Stabilisation is achieved by varying the mark-space ratio of the drive waveform.

which feeds pulses of current at line frequency to an "inductive reservoir" which in turn feeds the load. The output voltage is stabilised within very close limits by a feedback loop which varies the mark-space ratio of the pulse train used to drive the base of the series power "chopper" transistor if current demand or mains voltage varies, the reference voltage being the 30V stabilised supply.

Transistor AGC Delay

WHETHER the r.f. and i.f. stages use valves or transistors it is standard design practice to maintain the signal-to-noise ratio at optimum by keeping the r.f. gain at maximum on small signal inputs and applying a.g.c. to the r.f. stage only when the signal strength rises sufficiently to warrant a reduction in front-end gain to avoid the risk of overloading or cross-modulation. This arrangement ensures that the input signal strength can swamp the mixer stage noise.

With valves, delay in applying the a.g.c. to the

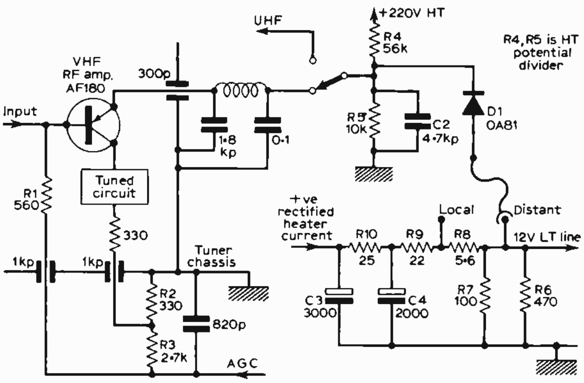


Fig. 6: GEC-Sobell transistor a.g.c. delay system. Under low-signal conditions the r.f. amplifier is fed from the h.t. rail, while on high-signal conditions it is fed from the l.t. rail.

r.f. amplifier is achieved by means of a biased diode which "holds off" the front-end a.g.c. till the a.g.c.-potential attains a predetermined value, indicating that a strong signal is being received.

Biased diodes are also used with transistors but, due to the completely different characteristics of semiconductors compared to valves, in totally different arrangements.

An ingenious, effective but often not fully appreciated method was employed in many GEC-Sobell and Bush-Murphy receivers which functioned by applying the full a.g.c. to both the r.f. and i.f. stages but fed the r.f. transistor from the *h.t.* rail via suitable resistors when the signal strength was low. When the signal strength is high the r.f. transistor is fed from the *l.t.* rail, in common with the i.f. and other transistors.

To appreciate how this system operates it must be realised that the collector current for any given transistor depends not only on the applied voltages *but also on the resistance of the current source.* When a transistor is fed from an l.t. supply via low-value collector and/or emitter resistors the collector current is almost wholely determined by forward bias applied to the base. However when the transistor is fed from an h.t. source via comparatively high-value resistors, variations in transistor conductance caused by base bias changes are small in relation to the total circuit resistance.

Thus increasing the forward bias applied to a transistor fed via low-value resistors will cause a far greater increase in emitter current than when the transistor is fed from a high-resistance path from a high-voltage source.

Transistor gain in television receivers is varied by forward a.g.c. action, i.e. on no-signal the transistors are biased for maximum gain but when the signal strength rises the a.g.c. bias is increased to raise the emitter current and thereby reduce the amplification. The idea is to arrange things so that maximum gain is achieved at minimum emitter current to reduce the effect of noise at low signal strengths.

When a transistor is biased for maximum gain, either increasing or decreasing the emitter current can reduce the gain. In television receivers the first method—forward a.g.c.—is used for several reasons, (a) because weak signals are then handled at minimum transistor currents and vice versa, thus ensuring optimum signal-to-noise ratio, (b) because the control achieved in this way is more gradual and linear, causing less distortion to strong signals than the other technique of reverse bias, and (c) because forward a.g.c. imposes least change on the transistor input characteristics.

Figure 6 shows the basic circuitry of the GEC-Sobell system and it will be seen that the pnp r.f. transistor is fed from the h.t. rail via the potential divider R4 and R5. As its collector is returned to chassis, reducing the base potential to chassis is equivalent to increasing the base-emitter potential and thus as signal strength rises the positive a.g.c. potential is reduced so as to increase emitter current.

Now with low- and medium-strength signals the effective increase in forward bias produces only a small increase in the r.f. amplifier collector current, but on strong signals the resulting voltage change across R4 is sufficient to reduce the voltage at the junction of R4 and R5 and therefore at D1 cathode to below its anode voltage. Once this occurs the diode conducts and the transistor is fed from the l.t. rail. Subsequent a.g.c. increases will then increase the r.f. stage collector current as much as they increase the i.f. stage collector current.

The point at which the r.f. transistor is supplied from the l.t. rail is determined by the diode's anode voltage. This can be set at two values by means of the local/distant tapping points, the distant being at slightly lower potential than the local to keep the transistor tied to the h.t. rail to a slightly greater extent.

Naturally for correct operation of the circuit the values of R4 and R5 must be as specified, so if lack of gain or inability to fully reduce gain becomes evident check their values.

TO BE CONTINUED

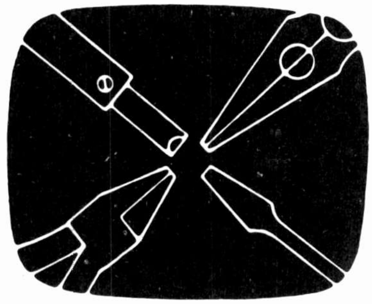
—continued from page 243

for the standardisation of tape cartridges, a most desirable event remembering the confusion at the outset of the audio tape cassette/cartridge days which even now has not entirely resolved itself.

So at least three different types of videotape systems exist or are planned to go into production. Two of these are basically professional or industrial, but there is a good deal of overlap between these applications and the domestic scene. If more different systems (and the three mentioned here are absolutely incompatible with each other) come on the scene then not only will there be another undesirable commercial battle but potential users will become confused and perhaps disillusioned. There must be the maximum possible standardisation: a videotape recorder must be as simple to use as the ordinary record player.

Our opinion is that the recording and playback material should be magnetic tape. The EVR 9mm. film is said to be good for 500 replays and film is cheaper, but it is more easily damaged and deteriorates. Although more expensive, tape is more durable and is essential if both playback and recording facilities are required—a must for the home entertainment field. Film playback through a TV screen in the home seems to be an unnecessary complication when the process can be done more cheaply using conventional photographic projectors.

W. N. STEVENS, *Editor*



SERVICING television receivers

L. LAWRY-JOHNS

PHILIPS 210 CHASSIS—continued

Line Timebase Faults

It is not unusual for the line output valve to overheat in most receivers. This is usually due to lack of line drive from the line oscillator, in these receivers an ECC82, V2004. This latter valve is therefore the first suspect. There are times, however, when there is plenty of line drive to pins 1 and 2 of the PL500 (PL504) and removing the top cap of the DY87 (to prove whether this is shorted) doesn't make any difference. Removing the top cap of the PY800 could well prove the boost capacitor to be shorted if the line timebase suddenly comes to life, but more often it will merely stop the circuit functioning altogether. So what is causing the PL504 to overheat? Shorted turns in the line output transformer? Possibly, or even the deflection coils, but have you tried replacing the PY800? You should, because the writer's face is still red remembering the time when he omitted to.

Lack of width can be due to a weak PL504 or PY800 but quite often the resistors R2166 and R2167 are at fault, rising above their rated value of 8.2MΩ. This was of course a frequent cause of lack of width on the earlier 170 series.

Weak or no line sync is often due to V2003 (also an ECC82) becoming defective and this should be the first suspect. It is worth bearing in mind however that R2136 (screen feed to the sync separator) can be changed from 680kΩ to 330kΩ with the result of better line sync.

Field Timebase

The troubles to be expected here vary from a single white line across the screen to denote total field collapse to insufficient height, bottom fold up and lack of reliable lock. Most of these conditions can be justly blamed on the PCL85 valve. This is a very poor valve and we can only hope that the PCL805 which is the direct replacement will prove more reliable.

Whenever it is found necessary to replace the PCL85, resistors R4036 and R4037 should be checked, if only to prove they are there! These are of course drop-off resistors. Top compression will result if one is absent, bottom compression if one is low and no scan at all if both are missing (unless C4011 shorts to chassis).

Lack of height can also result from R2165 going high or C2067 shorting to h.t. Perhaps the most awkward one is when the field output transformer develops a fault. This may result in no scan at all, if the primary L1607 becomes open-circuit, or arcing around the PCL85 base if the linearity winding L1608 becomes defective. This latter trouble results in terrific field distortion as well as the arcing referred to. A quick "get you home" device here is to wire a capacitor of 0.01μF 1kV from pin 6 of the PCL85 or one end of L1607 to R4027 with the connections to L1608 removed. This is also practical when there is arcing between the windings inside the transformer and until a replacement transformer can be obtained.

Video Stage

The PFL200 valve does not appear to be nearly as troublesome now as it used to be when it first appeared but nevertheless it should be the first suspect when poor contrast or weak sync are the symptoms, as indeed it should be when sound is in order but there is no picture on an otherwise normal raster. If the contrast and the sync are poor but the valve is in order check the capacitors C2047 and C2048. These have a profound influence upon the sync and to a lesser extent upon the contrast.

It may be wondered where the anode circuit resistors R4050 and R4051 are since they are not near the PFL200. As they are drop-off resistors they are to be found on the vertical field timebase panel to the right of the hold control.

The Transistorised Stages

All amplification from the aerial to the video and audio stages is carried out by transistors. Although very little trouble is experienced with these stages there are times when things do go wrong and a few words on the subject of fault tracing may not be out of place.

First of all never probe around with anything which can short adjacent points together because a transistor can be ruined in a split second.

Secondly always consult the circuit to see what the voltages should be. In nine cases out of ten, properly carried out voltage readings will locate a fault quicker than any other method on a transistorised panel.

Let us assume that the fault is lack of vision signal. Checks on the PFL200 stage may lead us to believe that the fault is earlier—for example 405 sound is in order but 625 sound is absent as well as vision. From the circuit it can be seen that all voltages are positive with respect to chassis and that all i.f., the transistors concerned, are npn types.

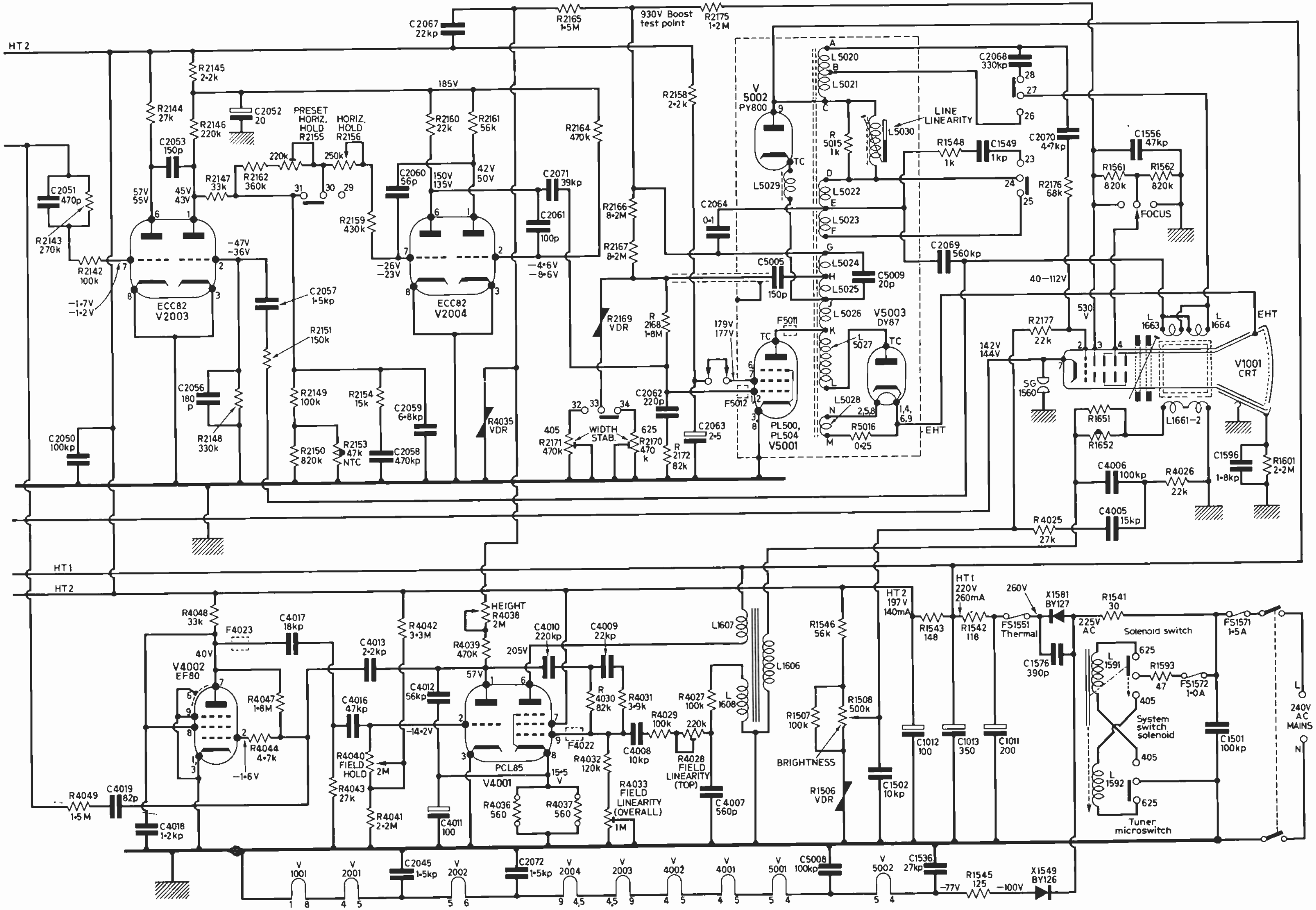


Fig. 6: Circuit diagram of the timebases, power supply and picture tube circuitry. In some sets R2175 is 680kΩ with R2175A 560kΩ in series. V4002 control grid and V4001 triode anode voltages vary with the setting of the height control. V2003 and V2004 grid voltages taken with the line hold control reset to synchronise the timebase with a transmission.

ADJUSTMENTS

The system switch can be adjusted by loosening the locking screw on the coupling bar between the solenoid crank and the switch slider and setting the length of the bar so that the switch contacts are made correctly on both systems when the solenoid is moved by hand.
To adjust the preset line hold control switch to 625, lock the picture with the main hold control, switch to 405 and lock the picture with R2155.
To adjust width connect a high-impedance d.c. voltmeter between the boost test point (see Fig. 3) and chassis and adjust R2170 and R2171 for 930V on both systems. **Warning:** High voltages are present.

VOLTAGES

The readings given on the circuit diagrams were measured with no signal and 240V a.c. mains input and the contrast, brightness and volume controls at minimum, using a 100kΩ/volt meter.

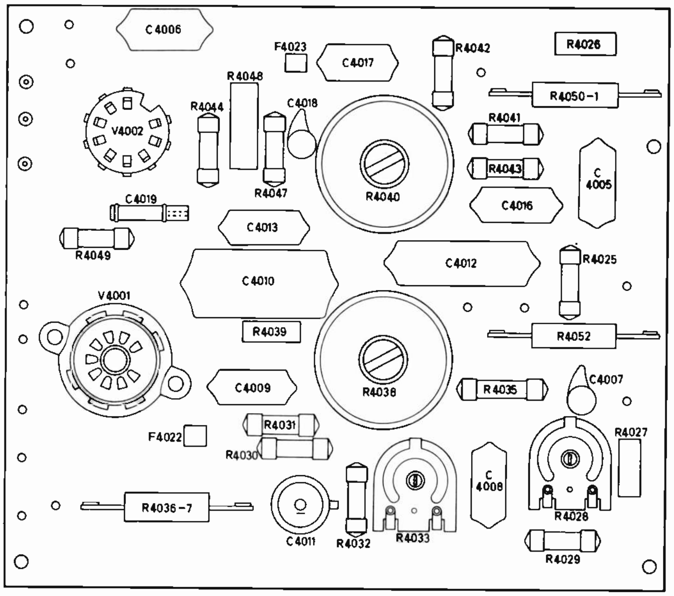


Fig. 7: Layout of the field timebase panel, viewed from the component side

T2189 is a pnp type but this is an a.g.c. transistor not an i.f. amplifier.

Let us assume that the readings are all in order except for those around T2187. We should find 11·5V at the collector. If this is absent we would check the feed from R2112 through L2598-L2597 to the collector, probably finding a break in the circuit. If however we find 12V (no voltage drop across R2112) this would indicate that the transistor is passing no current and our readings at the base (4V) and the emitter (2·8V) should with a continuity check through R2110 put us on the right track as the latter voltage will almost certainly be wrong, there being little or no reading at this point. Remember that we have already checked the other stages which include the base of T2186 which is on the same a.g.c. line as T2187, so the base reading cannot be far out. Under these circumstances it is fair to assume that T2187 is faulty (probably fractured inside) and that a replacement could restore normal conditions.

A different set of conditions could (and does) happen in the following stage. T2676 is inside can A. Fortunately the transistor has not been found at fault although the base voltage at Point A has been found low enough to cause weak contrast. We have found in this case that the capacitors C2591 and C2592 inside the preceding coil can can become leaky, thus detuning L2601 as well as destroying the base voltage of T2676.

Tuner Removal

Remove the large fixing screw which is immediately below the preset system selector knobs at the rear of the tuner. Disconnect the four-way tuner connector from the i.f. panel, the earth connector from the left-hand side of the chassis and the leads to the micro-switch. Loosen the two screws securing the aerial panel to the main chassis and detach the panel. The tuner, complete with connecting leads, may now be removed. This is how the tuner is to be returned to the makers for service when necessary.

Main Chassis Removal

Remove the tuner as above then pull off the volume control and brightness knobs. Unscrew and remove the two 4BA fixing nuts and locking washers securing the control panel and withdraw. Disconnect the speaker leads, pull off the c.r.t. base socket and remove the e.h.t. connector. Unplug the c.r.t. earthing lead and the deflection coils from the i.f. and timebase panels. Release the mains lead from the clip on the left-hand side of the cabinet. Unscrew the woodscrew which passes through the supplementary chassis fixing bracket and secures the left-hand chassis mounting bracket. Unscrew the large captive screw at the top of the chassis. Lift the chassis off its locating lugs and withdraw, releasing the e.h.t. connector if this has not already been done.

IF Panel Removal

Remove chassis from cabinet and unsolder all leads to the panel. Remove the three fixing screws along the edge of the panel nearest the c.r.t. taking care not to lose the three plastic spacers between the chassis and panel member. Remove the circlip from the pin on the system switch slider and disengage the coupling bar from the solenoid. Pull the panel towards the rear of the receiver to finally remove.

Line Output Transformer Removal

Remove chassis from cabinet and unsolder the eight leads to the transformer tag panel. Pull off V5001 and V5002 top cap connectors and unclip the c.r.t. e.h.t. connector from the chassis. Withdraw the two screws securing V5003 holder. Rotate the chassis 90° to reveal underside and unscrew the two slotted nylon bushes beneath the transformer. Remove transformer and V5003 holder. To obtain access to the underside of V5003 holder prise off the top of the moulding.

NEXT MONTH BUSH/MURPHY TV161U/V1910U SERIES

VISION DETECTORS

M.G.HULL

THE vision detector should produce an output across its load resistor which faithfully follows the carrier modulation, is as free as possible of i.f. content and with a high degree of rectification efficiency. At audio frequencies these requirements present no problem, but the many conflicting demands imposed by high modulation frequencies being impressed on a high i.f. inevitably lead to some compromise in TV design. Fig. 1 shows the basic vision detector circuit and its main features.

Circuit Efficiency

Take first the question of efficiency: for maximum output with minimal circuit loss the diode forward resistance should be as low as possible while its reverse resistance should be as high as possible. Diode forward resistance, whatever its value, can be largely offset by using a high-value load resistor, since being in series they form during conduction a potential divider with a voltage across each dependent on their relative values. (In valve radio circuits detector loads of 0·5MΩ are common, making the diode forward resistance negligible.) But, as we shall see later, the necessity of maintaining good h.f. response in a vision detector prohibits the use of load resistors exceeding a few kilohms in value, so low diode forward resistance becomes vital.

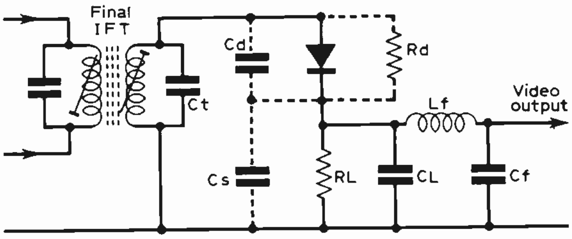


Fig. 1: Basic diode detector circuit. Time-constant Rd × (CL + Cs) determines the response to signals rapidly rising in amplitude while RL × (CL + Cs) determines the response to signals falling in amplitude. Lf, Cf form a low-pass filter to remove the i.f. component, with values chosen to give some resonance boost to top video frequencies.

Furthermore although the load shunting capacitance must be minimal for good h.f. response, if it is reduced to a very small value three difficulties arise. First the output will have a strong i.f. content, secondly current flow will continue during most of the conducting half-cycle to impose increased loading on the last i.f. stage, and finally the efficiency will be reduced. During non-conducting half-cycles, the diode anode-cathode capacitance is effectively in series with the load capacitance and if it is comparable with the latter this results in appreciable output being developed across the load *CR* combination. When an a.c. signal is applied to two capacitors in series the voltage developed across each is inversely proportional to their relative values. The anode-cathode capacitance of thermionic diodes is 2·5-3pF while that of a semiconductor diode is about 1pF. So if the load shunting capacitance is only a few picofarads, this can materially reduce the efficiency for ideally there should be neither resistive nor capacitive feed through the diode during its non-conducting half-cycles.

These and many other factors have to be taken into consideration when designing vision detector circuits, and in fact many circuits are partly decided upon by empirical methods.

Signal Load

However, commencing with the signal load, if we assume that the realistic shunt capacitance required for i.f. filtering, etc., is 20pF, let us determine the maximum value the resistor can be to satisfactorily respond to the top video frequency of 5·5MHz on 625. To be capable of following this frequency the load time-constant must be less than the duration of one cycle of signal but longer than the duration of one i.f. cycle, otherwise the output will have a high i.f. content. The duration of one cycle at 5·5MHz is 1/5·5μsec or about 0·182μsec, while the duration of one cycle at the standard u.h.f. vision i.f. of 39·5MHz is about 0·026μsec.

The time-constant of the detector load should therefore be approximately midway between these figures, and 0·08μsec would appear to be a fair, round compromise figure. To determine the value of load resistor required we can use the formula $R_L = (T \times 10^6)/C$ where T is the time-constant in

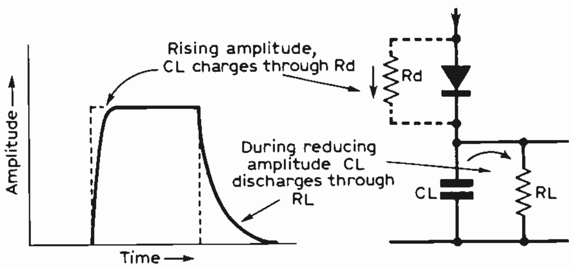


Fig. 2: Effect of circuit time-constants on pulse response. On positively-modulated 405 transmissions the rate-of-change of the pulse leading edge is greater than that of the trailing edge. On 625, where under no-signal conditions the carrier is at maximum amplitude so that the presence of modulation will produce a negative-going pulse, the opposite time-constant conditions apply.

FAULT CHART

Fault	Effect
R_L low	Weak picture contrast. Fault often occurs due to burn-up caused by an internal short-circuit in a directly-coupled video pentode.
High-resistance diode	Weak picture.
C_L or C_f open-circuit	Background patterning.
L_f open-circuit	Very weak picture.
C_t open-circuit.	Mistuning and loss of gain.

μsec and C the shunt capacitance in pF. By applying the above figures we obtain $R_L=(0{\cdot}08\times10^6)/20$, or 4k$\Omega$. And this of course is the average value used as a load resistor in modern dual-standard receivers.

A further complication is that diode detectors really have two time-constants, (a) when the amplitude is rising and charging the load capacitance through the diode's low forward resistance, and (b) when the signal amplitude is falling and the load capacitance discharges through the much higher load resistance. The charging time-constant is thus therefore much shorter than the discharging time-constant, giving a sharper response to a signal suddenly rising in amplitude than to one equally suddenly falling. The effect is illustrated in Fig. 2.

To cater for the 405 positively-modulated and 625 negatively-modulated transmissions current dual-standard designs adopt one of three courses, (a) to reverse the diode polarity on system change, (b) to use separate diodes for each system, or (c) to feed the detector output in the same phase on both systems to a transistor phase-splitter which then provides outputs in the required sense from its emitter or collector. Method (c) is becoming the most popular due to the several other advantages it confers.

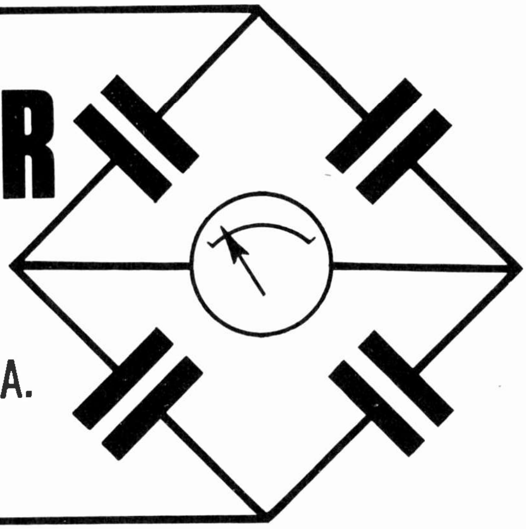
IF Filtering

I.F. filtering is accomplished by means of a low-pass filter employing a small coil as a series impedance. In many instances the inductance of this coil in conjunction with the stray capacitance gives h.f. boost to the video signal in similar fashion to the compensating coils used in video output stages.

IF Stage Loading

Finally let us look at the loading imposed by the detector on the final i.f. stage. First consider the diode action with only a reservoir capacitor and no load resistor in circuit. Once this capacitor has charged to the peak applied voltage, conduction will cease and the circuit will impose zero loading on the i.f. amplifier. On the other hand if only a load resistor with negligible capacitance is used, conduction will occur throughout the entire conducting half-cycle with the energy taken from the i.f. amplifier dissipated in the I^2R losses of the load resistor. With capacitance in circuit sufficient to maintain a measure of charge during the non-conducting half-cycles but small enough to follow the top video frequencies, the diode only conducts when the instantaneous values of conducting half-cycles exceed the charge on the capacitor. ■

CAPACITOR TESTER



MARTIN L. MICHAELIS, M.A.

PART 2

THE basic bridge used in this instrument is a simple modification of the Wheatstone bridge. One branch VR1, R2, R3 consists of resistors in the normal manner whilst the other branch contains two capacitors, one a reference capacitor, C1 to C4 selected by S1A, and the other the unknown capacitor *C*x, which is always in parallel with another internal fixed capacitor C5 to C8. The purpose of this second bank of fixed capacitors is to make each range commence from zero capacitance which is necessary for reasons which will be explained later.

A bridge of this kind is balanced when the ratio of the resistance arms of one branch is equal to the ratio of the capacitive reactances in the arms of the other branch. Let us call the resistance between the slider of VR1 and the top and bottom ends of the track *t* and *b* respectively, and the capacitive reactances on the top and bottom sides of S1A *Xt* and *Xb* respectively. Then the balance condition is:

$$\frac{Xt}{Xb} = \frac{R2 + t}{R3 + b}$$

Now capacitive reactance is inversely proportional both to capacitance and to frequency so that the ratio of two capacitive reactances, which is all that is involved in the bridge balance condition, is independent of frequency but inversely proportional to the ratio of the respective capacitance values. Thus although we must operate this bridge with a.c. to pass current through the capacitive branch it does not matter in principle what frequency we use. Neither does it affect the balance point in any way if a mixture of frequencies is used, i.e. any arbitrary waveform we like.

RANGE LIMITS

VR1 is the bridge potentiometer. If its slider is moved to the top end *t* is zero and *b* 100kΩ so that with the values R2 10kΩ and R3 1kΩ the balance point is obtained for $Xt/Xb = 1/11$, i.e., the unknown capacitor connected to the *C*x terminals in parallel with the selected one from bank C5 to C8 must be 1/11 of the capacitance selected from the top bank C1 to C4 to obtain a balance point with VR1 slider at the top of the track. Now the capacitor in bank C5-C8 is always slightly greater than this fraction of the capacitor in bank C1-C4, so that a balance point is obtained in every range with the slider of VR1 just before the top end of the track and with no capacitor at all connected to *C*x. This is the zero point of the common scale for VR1.

If the slider of VR1 is moved to the bottom end of the track *b* is zero and *t* is 100kΩ so that the balance point is now obtained with $Xt/Xb = 110$. This means that *C*x must now be 110 times as large as the reference capacitor selected in bank C1 to C4, and the fact that it is actually in parallel with 0·1 times the value of the top bank capacitor is negligible at this end of the range because it shifts the balance point by less than 0·1%.

Summing up, each range covers *C*x values from zero up to 100 times the value of the fixed capacitor chosen in the bank C1 to C4. The smallest value of *C*x which can be measured in practice is the minimum required external capacitance which will give a clearly noticeable displacement of the balance point from the zero position of the scale. This is almost entirely determined by the sensitivity and stability of the balance detector system. The arrangement adopted here will clearly detect a shift of balance through 5% of the bottom-bank capacitance (or 0·5% of the top bank capacitance) at the zero end of the scale, so that in practice each range is usable from $Cx = 0{\cdot}05C$ up to $Cx = 1000C$ where *C* is the fixed capacitance selected in the bank C5 to C8. VR1 is accordingly calibrated with a single scale from 0·05 to 1000 and S1 is marked with the selected values of the C5-C8 bank, which are the valid multipliers for the numerical scale readings at balance. The zero point is also marked on the scale, and the stops at each end to assist correct angular remounting of the pointer if it has to be taken off for repairs or works loose.

LOGARITHMIC LAW WITH LINEAR POTENTIOMETER

The described arrangement covers more than four decades in each range. Even more would be possible if the respective values of R2 and R3 are reduced accordingly, but the values chosen give the maximum

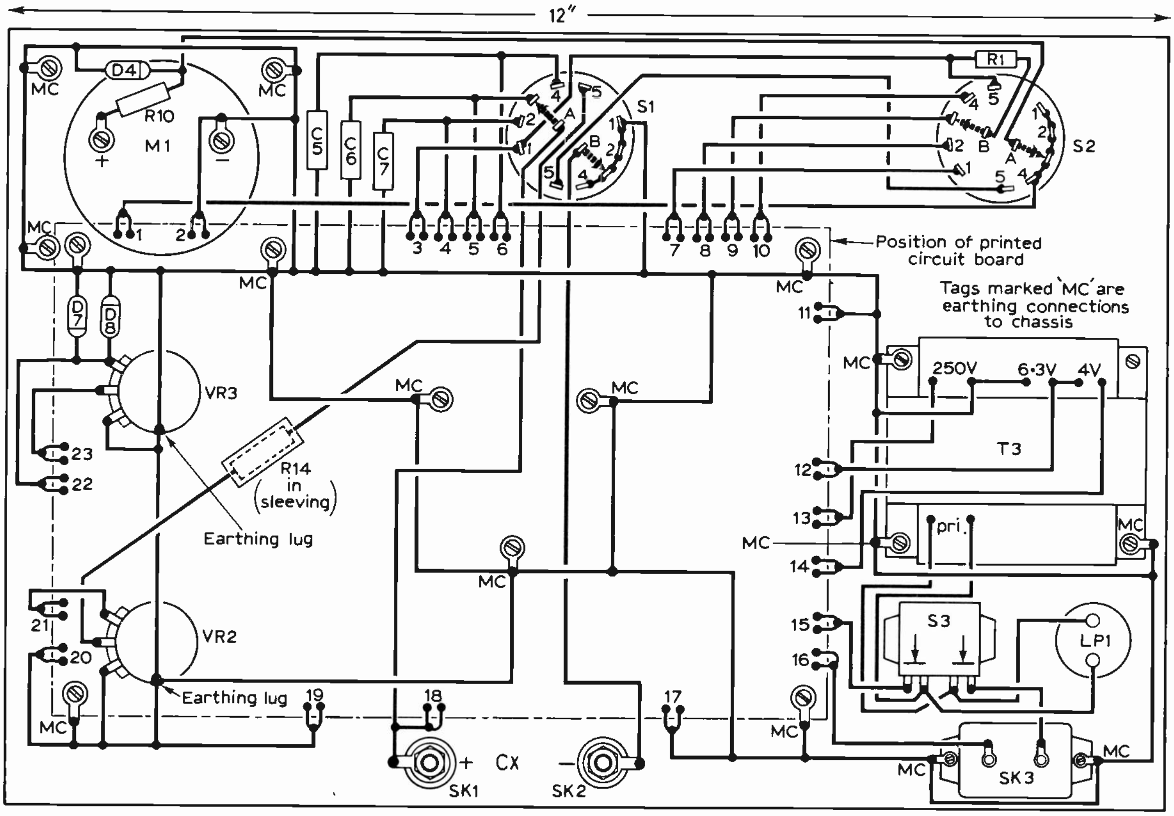


Fig. 3: Layout and wiring on rear of front panel.

usable range excursion in this design without sacrificing the very clear and definite balance readings which are an outstanding performance feature.

Evidently the scale law is pseudo-logarithmic where more than four decades are covered, yet a linear potentiometer is used for VR1. This of course means that one decade around the centre of the track will follow a virtually linear scale law because the end-cramping effects are there felt least of all. The logarithmic transition then takes place towards both ends of the scale. R2 and R3 restrict this cramping to still usable limits at the scale ends, because without these resistors cramping would be infinite at each end of the scale.

It is very desirable to have a large swing in each range yet an ordinary logarithmic potentiometer is undesirable for this purpose because most cheap types are not really logarithmic but possess two linear track sections, one low resistance and one high resistance, with a rather indefinite transition region which is very difficult to calibrate properly. But even cheap linear potentiometers possess a substantially uniform, easily calibrated track. It is advisable to choose a potentiometer with a fairly large diameter case but it is not necessary to use an expensive close-tolerance component. Even large tolerances of the actual track resistance will be taken into account in the course of matching as described later.

THE BALANCE DETECTOR

Reactance bridges have in the past generally used a magic eye to indicate the balance condition which is given where there is no a.c. potential difference between S1A wiper and VR1 slider. A magic eye possesses an input impedance of one or several Megohms so that loading problems are slight with it. In keeping with the modern trend however the present instrument is an all-semiconductor design using a meter as balance indicator. In conjunction with a high-gain balance amplifier this gives superior sensitivity but also introduces a number of problems.

To reduce stray injected signals at the amplifier input (such unwanted signals can confuse or even shift the balance point) it is necessary to connect one side of the amplifier input to chassis, and also one of the *C*x terminals. Unless the expense of a push-pull balanced input amplifier with all its attendant troubles of balance shift due to relative gain drift of the two sides is resorted to, this calls for an input isolating transformer to resolve the dead short circuit on the bridge which the conflicting chassis connection demands would otherwise produce. With an input transformer for the amplifier the impedance is restricted to tens of kΩ and loading of the bridge is more serious.

BRIDGE BALANCE LOADING

This does not shift the balance point but it affects the sensitivity. When the bridge is off balance and there is thus an a.c. potential difference present between S1A wiper and VR1 slider any load impedance connected between these points (amplifier input transformer) acts to reduce the potential difference, i.e. to try to rebalance the bridge by drawing compensating currents through the respective arms. This

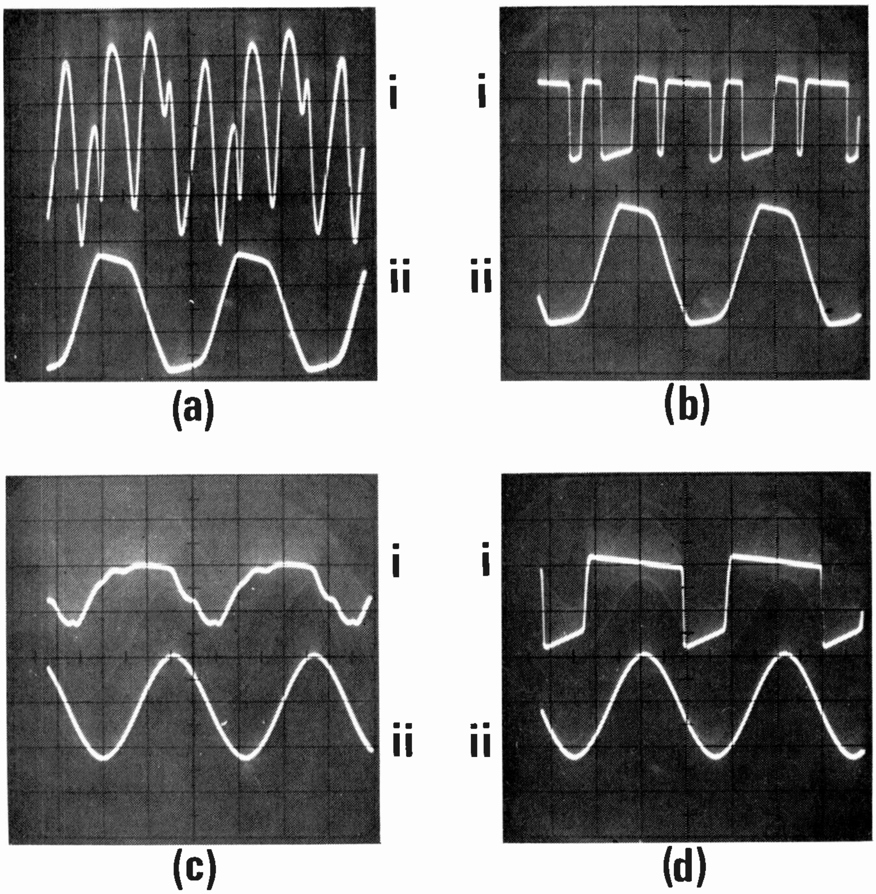


Fig. 4 (left): Operating waveforms. (a) and (b) on range 1 (very small capacitances) with Cx zero (no capacitor connected), bridge well off balance. (c) and (d) on range 4 (very large capacitances), Cx with 50μF connected, bridge well off balance. Traces (ai) and (ci) meter reading 20–40% f.s.d.; (bi) and (di) greater than 60% f.s.d. All traces (i) taken at Tr2 collector, (a) 0·5 V per raster square, others 2·5 V per raster square. All traces (ii) are the bridge drive waveform (50 Hz mains) across D1 and D2 at 2·5 V per raster square. (a) and (b) for small capacitance values approximately 7·8 V p-p clipped; (c) and (d) for large capacitance values rather less than 7·8 V p-p sinusoidal drive waveform.

does not shift the balance point because at balance there is no potential difference between the amplifier input points anyway and not even a dead short-circuit between these points would disturb the balanced condition. If however the load impedance is very low the bridge will be unbalanced a long way before a clear unbalance reading is obtained. Thus determination of actual balance points is diffuse and unclear, the dip of the meter reading being spread out over a large sector of VR1 scale with only gradual changes.

OPERATING FREQUENCY

The actual criterion is the relationship between the bridge impedance and the balance detector input impedance. The greater the latter is with respect to the former, the better the performance. Thus for a given acceptable sharpness of minimum reading, the finite balance detector input impedance actually restricts the highest capacitive reactance, i.e. the smallest capacitance value, which can still be satisfactorily measured with the bridge.

We can overcome this trouble to a great extent by using a higher operating frequency, since this reduces the capacitive bridge impedance for given capacitance values, without significantly affecting the amplifier input impedance. For this reason conventional bridges generally do not excite the bridge with the 50Hz mains frequency but incorporate an a.f. oscillator running at 250Hz to several kHz.

After some consideration in the present design, for which a budget limit was set to keep it attractive for readers not wishing to invest in excessive outlay, it was decided to devise a good balance amplifiei rather than to provide a separate oscillator as well. Realising that the balance condition for the bridge is frequency and waveform independent, higher effective excitation frequencies are easily obtained by distorting the mains sinewave through clipping with a pair of zener diodes—D1 and D2. This alone is not as good as a separate oscillator because the generated mains harmonics are of quite low amplitude. However a simple trick provides the necessary boost. C12 is necessary anyway to block the d.c. polarising voltages injected via R1, and if its value is chosen to give series resonance with T1 at mains harmonic frequencies these are considerably boosted across T1 primary and the amplifier receives good drive. This system works very well and as the oscillograms show dominant drive components are obtained at 150Hz and at 250Hz in this manner.

The bridge will function very well down to net *C*x values of 1000pF in this arrangement but becomes unsatisfactory for still smaller values. Thus the swamping bank C5-C8 was introduced to maintain a common scale for all ranges but now permitting *C*x values to be measured by *shift* of balance instead of as absolute bridge capacitances. This trick extends the usable range down to 50pF.

ELECTROLYTICS

It was found that some electrolytics and other large-value roll capacitors with a considerable inductive component led to balance splitting under these

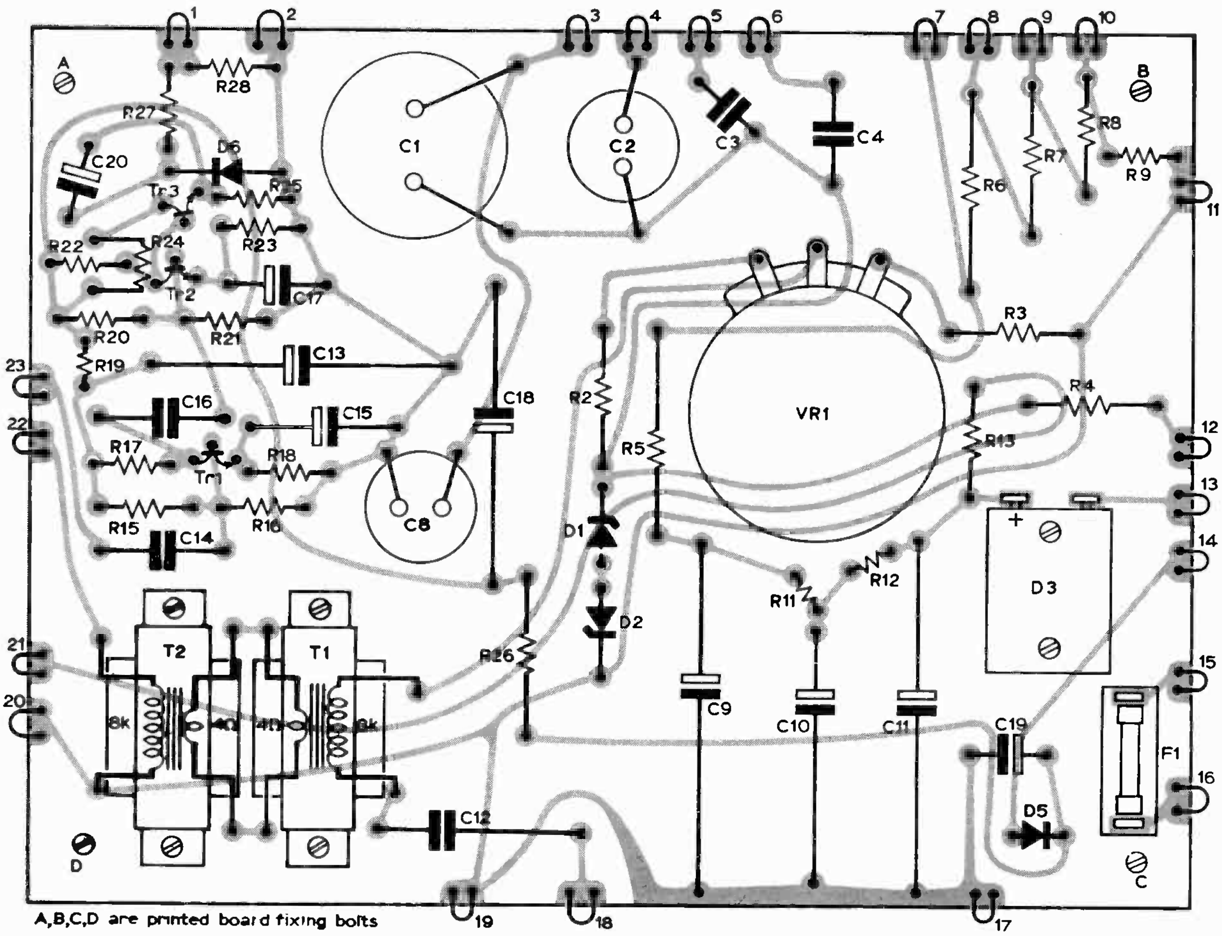


Fig. 5: Layout of the printed circuit board, viewed from the component side. Actual size 8 x 6 in.

conditions, this effect appearing only above about 10μF. The reason is that the inductive strays slightly shift the balance point for the respective harmonics present so that within the main dip we get a succession of closely spaced small wiggles of the meter pointer in place of a single sharp minimum. Thus for very large capacitance values where the bridge impedance is low anyway and it is unnecessary to use a drive frequency higher than 50Hz it is desirable to revert to dominant 50Hz drive. At this low frequency inductive components have negligible influence, and the various compensating controls customary in conventional bridges and included in the present design at an early stage were removed because they were never needed in a series of tests with typical capacitors.

The reversion to 50Hz drive can be made automatic for large capacitance values by appropriate choice of the value of R4. Imagine the bridge to be disconnected so that R4 sends a certain current through the zener diodes D1, D2 on all sinewave peaks. The resulting peak clipping persists as long as the now reconnected bridge draws less peak current than the open-circuit zener current determined by R4. When C1 and C8 are in circuit there comes a point, with Cx equal to about 5μF or greater, at which the bridge impedance has dropped so low that the bridge draws all the current R4 will give, even on the sinewave peaks, without reaching the zener voltage of D1, D2. Thus the sinewave is no longer clipped and the bridge is now excited with a pure 50Hz sinewave. This state is shown by the second pair of oscillograms. The transition should commence visibly at about $Cx = 5\mu F$ and be complete at $Cx = 25\mu F$ (highest range only). The 150Hz/250Hz conditions should persist throughout all other ranges. If an oscilloscope is available select R4 accordingly otherwise by trial and error for best balance clarity with large electrolytics.

INPUT TRANSFORMERS

Various arrangements can be used for the input transformers T1 and T2 according to availability. A single transformer with about 8 to 20kΩ primary and secondary, i.e. 1 : 1 ratio, may be used if available, or possibly a small step-up intervalve transformer in which case it may be necessary to increase VR3 to 50kΩ log. It is necessary to make the primary (of T1 or the single transformer) resonate flatly somewhere between 150Hz and 250Hz with C12. This means that the effective inductance of the primary should be about 10 to 20 Henrys, and C12 must be chosen to suit between about 0·15μF and 0·5μF.

Two transformers connected back-to-back in cascade were used in the prototype simply because the author had just bought a package of several dozen surplus miniature output transformers 8kΩ/4Ω/100mW at about 6d each. These components function very well in this circuit and it was found possible to cancel residual hum pickup by selection of the polarity of interconnecting the two low-impedance windings. Note that these transformers are mounted close together and as far as possible from the mains transformer. Residual magnetic induction from the mains transformer is then cancelled by selecting the antiphase interconnection of the low-impedance windings. The cores must be at right angles to the mains transformer core.

RESIDUAL HUM

It is important to keep the hum level reaching the amplifier on other routes, apart from a proper bridge out-of-balance signal, very small, because this determines the maximum usable gain and thus the ultimate sharpness of the balance readings. Excessive stray hum in the amplifier can also *shift* the balance points, especially in the low-capacitance ranges where input signals are particularly low. If there is significant stray hum the minimum meter reading is not obtained at the true bridge balance but slightly to one side, where the out-of-balance signal is equal but antiphase to the residual hum.

This to some extent inevitable effect is included in the final calibration so that steps must be taken to preserve constant geometrical and mechanical conditions of assembly. Above all it is quite essential to use a metal cabinet. Balance point *shift* through stray hum is really noticeable only at the extreme low-capacitance end of the ranges. After completing calibration and matching with the cabinet closed, so that zero *C*x gives correct reading at the zero point in the lowest range, and a 1000pF capacitor connected to the *C*x terminals gives a sharp balance correctly at reading "1" on the scale, these conditions are completely upset when the panel assembly is removed from the metal case and operated standing loose on the table. No balance is obtainable then when *C*x is zero, because the balance point has shifted down off the scale, while a 1000pF capacitor reads "0·5," i.e. only 500pF. The effect is of course negligible higher up the scale.

This disturbance is not a stray-capacitance effect but stray hum injection into the amplifier, which increases erratically when the metal case is removed. The actual hum voltage involved is exceedingly small, less than 1mV, but the amplifier possesses a large gain and can operate with wanted signals in this range. Thus make quite sure to calibrate the instrument in the closed state. The calibration will then remain accurate and stable.

THE BALANCE AMPLIFIER

Tr1 and Tr2 provide very high voltage gain so that an input signal of less than 1mV at Tr1 base provides saturation with about 4V peak-to-peak signal at Tr2 collector. The transistor types for Tr1 and Tr2 are not critical but these components must be silicon npn types and possess current gains of at least 100, preferably several hundred.

Tr3 is an emitter-follower impedance step-down stage which is connected so as to repeat the collector potential of Tr2 (less the silicon threshold) across R25. In the no-signal state this charges C20 through the meter (or R28) and R27. Diode D6 does not conduct here.

Now consider the situation when a signal is applied. On the first negative-going flank which reduces the potential at Tr2 collector the charge voltage across C20 is very rapidly reduced to the minimum peak value reached by Tr2 collector, because this can take place via D6 and the low source impedance of Tr3, thus almost instantaneously following the negative-going excursion of the signal waveform. When the negative peak has been passed and the signal waveform returns towards zero and goes to its positive peak, D6 is cut off and C20 tries to recover its charge by drawing current through the meter. The time-constant with R27 is long enough to prevent C20 recharging completely, and any charge gained during the rest of each previous cycle is removed again by brief conduction of D6 on each negative peak of the signal waveform at Tr2 collector and Tr3 emitter. Consequently C20 remains approximately steadily charged to the lowest (still positive) voltage reached by Tr3 emitter on the negative signal peaks, and the fully d.c. restored positive-sense peak-to-peak signal waveform is applied across R27 and the meter.

The effective d.c. component is almost equal to the peak-to-peak signal amplitude, in fact about 3V, so that with R27 2·2kΩ and the meter circuit impedance being about 1kΩ with 1mA f.s.d. movement the reading is nearly full scale. For smaller signal amplitudes not driving Tr3 to saturation the meter reading is smaller in proportion, and vanishes in the absence of a signal because C20 can then return to the mean collector potential of Tr2.

Optimum sensitivity is given when the gain control VR3 is adjusted to give a meter reading between 20% and 50% f.s.d. The balance readings are clearest when the gain is adjusted so that the meter dips to 20% f.s.d., not to zero, at the balance point. These are merely guiding rules which are not to be taken critically. This circuit gives deep, sharp dips. Hum conditions are very critical, so that it is advisable not to depart from the tested layout and smoothing capacitor values as published.

AMPLIFIER STABILITY

Depending on the type and arrangement of input transformers used and other factors, various forms of instability may result in the amplifier. It is unlikely that the amplifier will oscillate continuously, but it may be prone to severe ringing (bursts of 10 to 50 cycles of r.f. oscillation around 2MHz triggered off on certain flanks of the low-frequency drive signal). This effect is usually absent at low signal amplitudes and then starts abruptly when the drive exceeds a particular level fairly close to output level saturation. The symptoms noticed on the meter are abrupt jumps of the reading away from the balance point, especially when adjusting the volume control. This effect does not normally impair the performance as far as accuracy and balance sensitivity are concerned, but it is irritating and can be cured by shunting an 0·05μF microfoil or other small capacitor across R22. Check for absence of the described fault with an oscilloscope if available.

Another trouble which may arise in this high-gain amplifier is low-amplitude motorboating at some very low frequency of about 2Hz. This effect is especially provoked when the gain control VR3 is set to low values so that the amplifier does not lose gain by saturation and the bridge is well off balance. The feedback seems to be via S2A, and the trouble, if encountered, is cured completely by connecting a 50μF 15V electrolytic across R28 (negative to chassis). Do not use a larger value otherwise the meter pointer will not follow sharply every movement of the bridge potentiometer but will creep. The motorboating symptom is a slow pulsation of the reading over about 5% of the scale and can be very irritating when searching for the exact balance minimum.

Two other possible forms of instability are also cured with the 50μF electrolytic connected across R28. The first is an irregular slight unsteadiness of the meter reading due to d.c. amplification of mains voltage fluctuations through from Tr2 base. The second is rapid quivering or buzz from the meter movement if the pointer happens to be able to respond at 50Hz. Some meter movements show this trouble but most do not. First try without the 50μF electrolytic across R28, because the reading then follows the bridge potentiometer quickest and best, but add it if any of the described symptoms appear.

Diodes D7 and D8 at the amplifier input are essential to prevent destruction of Tr1 when large voltage surges appear, e.g. when switching over large d.c. polarising voltages from S2B.

OPERATING WAVEFORMS

Figure 4 shows typical amplifier operating waveforms when the bridge is well off balance. The photographs were taken with a conventional oscilloscope and a two-channel chopper unit connected ahead of it. The top trace is always the signal at Tr2 collector and the bottom trace is the bridge excitation waveform at 50Hz fundamental frequency at the junction of D1 and R4. The voltage settings are the same for all traces on all photographs (2·5V/cm.) except for (ai) where the deflection sensitivity was made five times greater to show up details of the 150-250Hz waveform at good display amplitude without saturating the amplifier.

The photographs (a) and (b) are for small capacitance values, when the bridge excitation waveform is seen to be clipped as already explained. In (b) the gain control VR3 has been turned up to give amplifier saturation, and it is seen that the dominant operating frequency is 150Hz because there are three full amplifier excursions of the saturated waveform in the top trace for each 50Hz cycle in the bottom trace. However when the gain was reduced, as in (a), the waveform possessed five minima between successive minima of the 50Hz waveform, i.e. a considerable 250Hz component is present but is lost as soon as the amplifier is saturated. For this reason the gain should be set neither too high nor too low for optimum sensitivity of balance detection, but this is not in any way critical.

The waveforms (c) and (d) were taken with large *C*x values in the highest range, for which the bridge excitation has ceased to be clipped and is now a pure sinewave from the mains. In (ci) we see that the dominant amplifier signal is now also 50Hz, and when the gain is turned up beyond saturation in (d) the waveform is a 50Hz rectangular wave.

Note that it is perfectly normal for the amplifier to give a considerable meter reading even when the bridge is perfectly balanced if the gain control is turned to maximum. This maximum possible reading at balance should be greater than half scale and is normally in the saturation region, so that the meter always stays put near full scale if the gain control is set to maximum. The meter reading should always drop to zero and stay there under all conditions if the gain control is turned to zero. With a logarithmic gain control potentiometer the proper operating setting lies somewhere in the upper half of the track, usually at about a quarter of the angular range from the top. It is not critical and does not need continual readjustment except when very different capacitance values are measured in succession.

MANUAL CONTROLS

The two switches at the top centre and top left determine the function and range. For leak testing both must be set to "leak", and for capacitance measurement both must *not* be set to "leak". For leak tests the lower control below the meter serves as voltage control and the gain control directly below the meter has no effect. For capacitance measurements the gain control is effective but the voltage control below it is now out of circuit.

When a balance point has been located the numerical scale reading multiplied by the range unit value selected by the top centre switch gives the capacitance of the capacitor connected to the *C*x terminals. The setting of the top left switch is then immaterial and without effect for all except the highest capacitance range, but it must be set to one of the voltage positions. In the highest capacitance range only the corresponding voltage is applied simultaneously as d.c. polarisation of *C*x during the capacitance measurement.

The same two insulated sockets are used for all functions for *C*x. These sockets are arranged below the main scale. Electrolytics should always be connected with positive pole to the red right-hand socket. The black left-hand socket is the negative pole and is connected straight through to chassis in the capacitance function, but via the meter to chassis in the leak function.

NEXT MONTH: CALIBRATION

FILM SHOW

Free tickets are now available for the *Practical Television/Practical Wireless* Film Show. Write to: FILM SHOW, Practical Television, Fleetway House, Farringdon Street, London, E.C.4.

The Film Show will be held on Friday, March 6th, 1970 at 7.15 p.m. for 7.30 p.m. The title of the film is **Something Big in Microcircuits.**

The lecture will be given by Ian Nicholson.

Free refreshments will be served during the interval.

DX TV

CHARLES RAFAREL

A MONTHLY FEATURE FOR DX ENTHUSIASTS

WHAT a pleasant surprise! At least at my location the better SpE conditions noted last month have been maintained and have even increased during the month of December. Strangely enough December 1969 has been better for me here than any December for the past nine years. Usually there have been some widely spaced openings with many completely "blank" days, and we have come to accept this as normal. Not this time however; throughout the month there have been openings each and every day!

Admittedly many of the signals received were of short duration, between say 1 and 5 minutes. I have omitted in the log below any reference to bursts of signal of seconds only (there were many of these as well). Equally however there were good long duration openings too, notably on 22/12/69 to Finland E2—once again a very good signal—and on the 13th and 24th to USSR and Poland on R1. These were at least as good as anything that we had during the summer.

Another interesting point was the number of openings to the N.E., to Scandinavia, Norway, Sweden and Finland, and to the E. to the USSR, Poland, Hungary and Czechoslovakia, with almost complete absence of signals from the south except for Spain on the 3rd, 22nd and 23rd. It seems we should look to the north and east if we want Winter SpE this year.

Generally speaking the Trops have once again been just awful apart from the usual French stations. The only thing of any note here was BRT Ruiselede Belgium E2 on the 3rd, 21st and 25th as a typically weak but steady Trop, an almost regular station for East Anglian DXers but always rare here in the south. It was also seen on the 1st and 3rd as a short-skip SpE signal.

Possible F2 propagation in the form of the 38-40MHz USSR Forward Scatter Network was about on Christmas Day the 25th.

I should confess that perhaps I have in the past been a little lax in my vigilance during the slack period for SpE at this time of the year. But with the improved conditions during November I was this time spurred on to greater efforts during December. This has "paid off" quite well so may I suggest to other DXers that extra effort could be in their interests too?

Now to the SpE log here for the period 1 to 31/12/69:

1/12/69	Norway E2, Sweden E2, Switzerland E2 and E4, Belgium E2 (SpE).
2/12/69	West Germany E2.
3/12/69	Sweden E2, Norway E2, West Germany E2, Spain E2 and E4, Belgium E2 (SpE).
4/12/69	Sweden E2 and E4, Norway E2 and E4.
5/12/69	Sweden E2 and E4, Poland R1.
6/12/69	Sweden E2, Norway E2.
7/12/69	Sweden E2.
8/12/69	West Germany E2 and E4, Czechoslovakia R1, Poland R1.
9/12/69	West Germany E2 and E4.
10/12/69	Sweden E2, Czechoslovakia R1, Poland R1.
11/12/69	Sweden E2, Czechoslovakia R1.
12/12/69	USSR R1, Czechoslovakia R1.
13/12/69	Czechoslovakia R1, USSR R1, Hungary R1, Sweden E2, West Germany E2 and E4.
14/12/69	Poland R1, USSR R1, Sweden E2 and E4.
15/12/69	Sweden E2, Norway E2, West Germany E2.
16/12/69	Sweden E2, West Germany E2.
17/12/69	Norway E2, West Germany E2.
18/12/69	Sweden E2, Norway E2.
19/12/69	West Germany E2, Czechoslovakia R1.
20/12/69	West Germany E2, Sweden E2, Czechoslovakia R1, Poland R1.
21/12/69	West Germany E2, Poland R1.
22/12/69	Spain E2, West Germany E2, Czechoslovakia R1, Finland E2.
23/12/69	Sweden E2, Czechoslovakia R1, USSR R1, Spain E4.
24/12/69	USSR R1 and R2, Poland R1.
25/12/69	Sweden E2.
26/12/69	Poland R1.
27/12/69	Sweden E2, Poland R1.
28/12/69	USSR R1.
29/12/69	Czechoslovakia R1.
30/12/69	Poland R1.
31/12/69	West Germany E2.

During the period no channel E3 or IA signals were logged at all. I wonder why? One possible explanation is that they have to be pretty strong to overcome local B3 interference.

New transmitters now listed include the following: *France:* Montpellier St. Boudille Ch. 50 1000kW horizontal and Abbeville Limeux Ch. 57 420kW horizontal. The first is in the South of France and is therefore not very likely. The second is in the North near Amiens and looks like a certainty in Southern England.
West Germany: Hochrein Ch.52 170kW horizontal and Minden Ch. 57 420kW horizontal.

Thanks once again to R. Bunney we now have the Meteor Shower dates for 1970: Quanterids January 3-4 peaking 3rd; Lyrids April 20-22 peaking 22nd; Perseids July 27-August 17 peaking August 12th; Orionids October 15-25 peaking October 20th-21st; Taurids October 26-November 16 peaking November 1st-7th; Leonids November 15-17 peaking

—continued on page 279

waveforms in COLOUR receivers

PART 9

GORDON J. KING

In Part 8 we looked at the signals in the burst channel, phase detector and subcarrier generator stages of a colour receiver. We also discovered that the swinging colour bursts result in a so-called "ripple signal" at the output of the phase detector. This month the aim is to investigate the signals in the ripple channel and to follow them through to the control circuits in which they are used.

Colour Control Recap

However, let us first have a brief recap. Fig. 1 shows the fundamental area at issue. Here is shown the phase detector which consists basically of a couple of diodes arranged in a circuit something like an f.m. detector stage. This phase detector receives the burst signals after they have been amplified and the picture information suppressed, and also a sample of the signal from the subcarrier generator. A characteristic of the phase detector is that it produces a d.c. output geared to the phase difference between the two sets of input signals—in this case the difference (if any) between the colour bursts and the sample subcarrier generator signal. The plan is of course to ensure that the phase of the locally generated subcarrier signal exactly matches that of the transmitter's subcarrier signal (which is suppressed at the V and U modulators prior to the chroma information being integrated with the luminance signal).

Absolute subcarrier phasing is essential to ensure that the displayed colours correspond to the hues as "seen" by the camera. If the phasing is wrong then the colours will be wrong at the receiver picture tube, while a phase drift tendency will cause the colours disconcertingly to change over the rainbow at the receiver. If the phasing of the subcarrier generator signal is completely "unlocked" from the transmitter's subcarrier signal, the displayed colours will have no coincidence at all to the picture elements and the effect on the display will be rather like lost line hold on a monochrome set, but in terms of colours instead of luminance. It will be understood of course that the picture will remain on the screen since it is constructed of luminance or Y signal, the chroma parts merely "brushing in" the colour relatively roughly on the monochrome display, so to speak. A fault like incorrect phasing

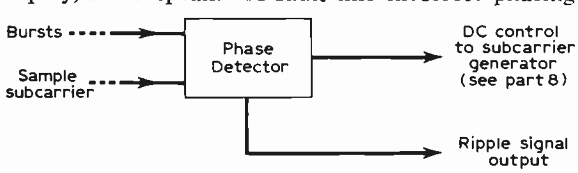


Fig. 1: Apart from providing the d.c. control potential for the capacitance-diode in the subcarrier generator circuit the phase detector also produces a ripple signal as a result of the burst signal swings.

or indeed complete phasing failure need not affect the monochrome performance of the set, for all the user needs to do in a case like this is to turn down the colour control to zero or turn off the colour switch, depending on the set's design. This will allow him to continue using the set in black-and-white only until he can get the colour circuits restored to normal working.

The *frequency* of the set's subcarrier generator is very well controlled by a quartz crystal, but while the frequency is so controlled the *phasing* relative to the transmitter's subcarrier can still drift. Moreover the phase of the locally generated subcarrier can be easily shifted plus or minus relative to the correct phase datum by the tuned circuits associated with the subcarrier generator and phase detector. Phase control, rather than frequency control, is achieved by regulating the capacitance associated with the quartz crystal. Such regulation has of course to be "locked" to the phase change tendencies of the subcarrier generator signal, so an "electronic capacitance" which can be controlled by a d.c. voltage is used.

A common variable electronic capacitance arrangement is the reactance valve or transistor stage. This can reflect either capacitance *or* inductance across the tuned circuit (i.e. the quartz crystal) of the oscillator, the former decreasing and the latter increasing the frequency with increasing parallel capacitive or inductive reactance. Such a scheme is found in early colour sets, especially those of American origin.

With the advent of solid-state electronics however a new type of electronic capacitance has emerged. This is the capacitance-diode known as a variator or varicap. The basis of this is that when a junction diode is biased in the reverse sense the depletion layer at the junction, across which a capacitance exists, widens, thus varying the junction capacitance. In the forward direction of course the depletion layer (sometimes called "potential barrier") collapses and no capacitance—just a low resistance—is exhibited across the terminal or lead-out wires. Thus the greater the reverse bias the smaller the capacitance, and a fair capacitance swing is possible from some capacitance-diodes, depending on their design. It is this sort of control that is used with the quartz crystal in many contemporary colour sets, the reverse-bias being obtained from the phase detector as we saw last month. To give the necessary control swing and to facilitate the reverse biasing two capacitance-diodes are commonly used with the crystal circuit.

Use of the Burst Signal

Because the swinging bursts are derived from the transmitter's subcarrier generator they carry information relating to the absolute phase of that signal.

This information is used at the receiver to secure the correct phasing of the locally generated subcarrier signal, the correct phase datum being established after phase-locking by the tuned circuits (and other phase-shifting artifices) already mentioned.

When the subcarrier signal is produced at the receiver by so-called "passive" means (see Part 8) the phasing is automatic since the subcarrier signal is actually created from the colour bursts by passing them through a very high-Q circuit which effectively nullifies the line spacing between them. We shall return to this new system later as we explore the ripple signal.

Burst Signal Swings

This brings us neatly back to the ripple signal. We have already examined the nature of the swinging bursts. The burst *frequency* is of course exactly that of the transmitter's subcarrier, while the *average phase* of the bursts is exactly as required to phase-lock the receiver's subcarrier generator signal. This latter factor often worries some technicians: they reason that if the burst phase is swinging then the regenerated subcarrier phase must swing similarly. In reality the regenerated subcarrier phase remains very constant, taking up a position between the plus and minus swings—that is, right in the middle of the swings since they are plus and minus 45 degrees relative to the −U (i.e. −180 degree) axis. This is better seen diagrammatically—see Fig. 2. Here it is shown that on one line (line N) the burst phase is plus 45 degrees from the −180 degree axis while on the next line (N+1) it is minus 45 degrees from the −180 degree axis. The average phase thus settles where it should along the −180 degree axis, between the swings. The phase detector operates relative to this average phase and so produces a d.c. control which is also geared to this average phase.

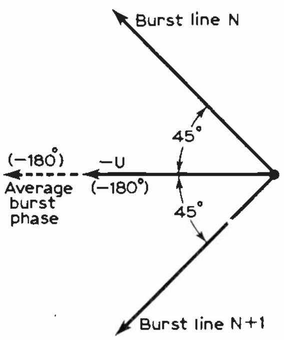


Fig. 2: In spite of the fact that the burst signal swings ±45 degrees relative to the −U axis, the average or mean phasing remains along the −U axis as this diagram shows. Because of this the burst swings do not affect the a.p.c. loop, though the a.p.c. detector output contains a ripple signal component.

In other words, the swinging bursts have no detracting influence on the receiver's subcarrier phase control. However, they do cause a reaction in the phase detector! This is designed for and wanted. One way of looking at the phase swings of the bursts is in terms of phase modulation of the nominal subcarrier frequency. Phase-modulation is incidentally rather like frequency-modulation and since the phase detector (or indeed any detector of this nature) is sensitive to this kind of modulation—like the detector in the 625-line sound channel—its action will tend to demodulate the signal, leaving only the modulation components. What are the modulation components?

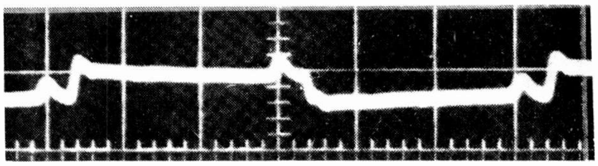


Fig. 3: Ripple signal at the phase detector output. Amplitude scale 500mV/cm., time scale 20µsec/cm.

Well, these are geared directly to the line-by-line changes in burst phase. On one line the modulation can thus be considered as a positive-going squarewave and on the next as a negative-going squarewave. The *rate* of phase change is a function of the modulation frequency which in this case is the line frequency (i.e. 15,625Hz), while the phase *deviation* is a function of modulation amplitude—just like f.m.

Formation of Ripple and Ident Signals

Thus across the "load" of the phase detector we get line-by-line changes in potential produced by the positive and negative half-cycles of squarewave. The nature of the signal is shown by the oscillogram in Fig. 3. The first half-cycle is positive-going and the second negative-going. The X-axis scale here is 20µsec/cm., which shows that *each half* of the waveform occupies the time of one line scan (approximately 64µsec). Thus the ripple signal is at half line frequency (i.e. 15,625/2), which is 7,812·5Hz, generally rounded off to 7·8kHz, and is used to produce the identification (usually shortened to "ident") signal which controls the PAL V-chroma switching. The ripple signal thus has to undergo some modification after which it is termed the ident signal, but more about this in a minute.

First, let us get back to this frequency consideration. Fig. 3 shows that the complete waveform comprises one positive-going half cycle and one negative-going half cycle occupying a total time of about 128µsec. This time period is the time taken by one complete squarewave signal cycle. It is important to remember this. We can easily discover the repetition frequency of such a waveform by dividing 1,000 by 128, the answer then being in kHz. This little sum thus reveals that the squarewave repetition frequency is a little in advance of 7·8kHz, which is close to the ripple signal frequency.

This then shows in part how the line-by-line phase swings of the colour bursts produce a squarewave signal whose repetition frequency is close to 7·8kHz. However, we are not all that interested in a squarewave signal; what we want is a sinewave signal at 7·8kHz for V-chroma switching indenti-

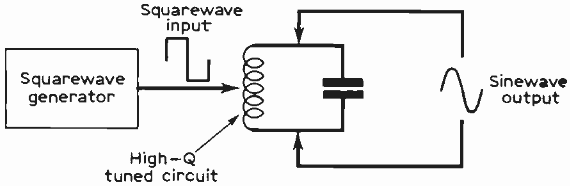


Fig. 4: If a squarewave is applied to a high-Q tuned circuit corresponding to its fundamental frequency, the output is a sinewave at that frequency.

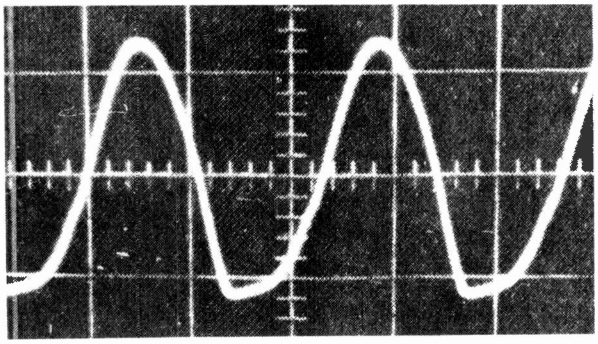


Fig. 5: The 7·8kHz signal after filtering. The amplitude scale is 5V/cm. and the time scale 50μsec/cm.

fication and for the various chroma channel controls mentioned in Part 7 (January).

This 7·8kHz sinewave signal is very easily created from our ripple squarewave merely by filtering. A squarewave is composed of a fundamental sinewave (equal to the squarewave fundamental frequency) and an integration of sinewave signals in specific phase relationship equal to the third, fifth, seventh and etc. harmonics of the fundamental. These are known as odd-numbered harmonics. A sawtooth waveform on the other hand consists of a multiplicity of both even- and odd-numbered harmonics, but this is getting a bit off the point!

Let us move on to Fig. 4. Here we have a squarewave generator feeding signal into a high-Q tuned circuit corresponding accurately to the fundamental frequency. A wonderful thing happens at the output: the squarewave changes into a sinewave of frequency equal to the fundamental of the squarewave. The action is quite straightforward, resulting merely from the high-Q tuned circuit passing only the fundamental while heavily attenuating the harmonic components. Thus the higher the Q of the tuned circuit the better the shape or quality of the resulting sinewave.

This technique is used quite a bit in colour television, not only in the production of the ident signal from the squarewave ripple, which we shall see better in a moment, but also in the passive subcarrier generator system.

However, let us return to the generation of the ident signal. In many sets the ripple signal proper is fed to the base of a transistor whose collector circuit is loaded with a 7·8 kHz tuned circuit or filter (sometimes called a "ringing choke"), the output signal then being converted from the squarewave shown in Fig. 3 to the quasi-sinewave shown in Fig. 5. The X-axis scale related to this signal is 50μsec/cm., which reveals that the frequency is close to the 7·8 kHz fundamental of the ripple. Actually of course the frequency corresponds precisely to half line frequency.

Ident Channel

Figure 6 shows the ripple/ident channel. The ripple from the phase detector is fed, often via a d.c. amplifier, to a transistor circuit tuned to 7·8 kHz (approximately), the output then being d.c. restored to give it a base datum. Restoration is commonly handled by a diode at the base circuit of the transistor stage. Figure 7 shows the signal

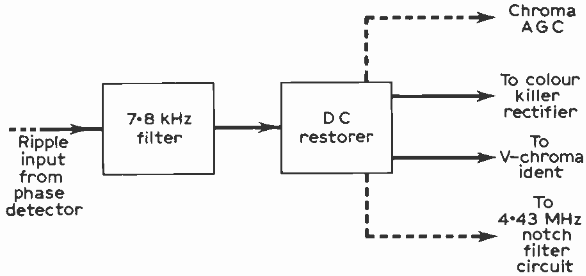


Fig. 6: Block diagram of the ripple/ident channel.

after d.c. restoration; both the X-axis time scale and the Y-axis amplitude scale are the same as with the signal in Fig. 5 (i.e. X is 50μsec/cm. and Y 5V/cm).

The d.c. restored signal at the output of the restorer is then passed to the various control channels of which there are two main ones. These are the colour killer and the bistable circuit of the PAL V-detector switch. Secondary controls activated from the signal are the chroma a.g.c. (commonly called automatic chroma control—or a.c.c. for short) and subcarrier notch filter control in the Y channel. We shall be looking at these controls in greater detail next month.

Passive Subcarrier Generator

To conclude this article a word more about "ripple" production from the passive type of subcarrier system would not be amiss. Last month we saw (Fig. 10) that the swings are effectively deleted from the bursts by a switched 90 degree phase shifter connected in series with the burst channel on alternate lines. Now we have already seen that the swings applied to the bursts at the transmitter constitute a kind of phase modulation. Similar phase modulation is introduced by the switching effect of

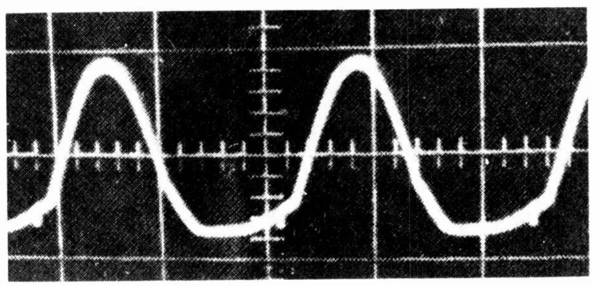


Fig. 7: Ident signa after d.c. restoration. The amplitude scale is 5V/cm. and the time scale 50μsec/cm.

the 90 degree phase shifter operating in the receiver to "cancel" the burst swing effect, and since this modulation coincides with that produced by the transmitter swinging bursts and as the two phase modulation components are in antiphase (i.e. 180 degrees out-of-phase), there is complete cancellation. This is in fact why it is possible for a passive filter to produce an average phase subcarrier from the swinging bursts.

Subcarrier signal from the passive filter thus occurs only when the signal is colour-encoded (i.e. when it carries bursts) and, most important, when the phase switching at the receiver is correct. When the phase switching is on the incorrect count, the

—continued on page 272

SINGLE-STANDARD 625-LINE RECEIVER FOR THE CONSTRUCTOR

PART 1

KEITH CUMMINS

The recent advent of 625-line colour television broadcasting using grouped u.h.f. channels has not only brought colour on all channels but also enables a single-standard monochrome receiver to be used in areas covered by u.h.f. The advantages to be gained from single-standard working are that costs are reduced and reliability improved. The receiver featured in this series is designed for single-standard u.h.f. working and employs a 20in. rectangular cathode-ray tube as currently fitted to production receivers.

Features and Specification

The advantages to be gained by the construction of one's own receiver should be reflected in terms of performance for price. While the receiver should be economical to construct, it should not necessarily be very cheap. A block diagram of the receiver is useful at this stage in order to provide a basic idea of the approach adopted. This is shown in Fig. 1. Circuit details are provided for the various parts as the series progresses. In laying down the specification the following points were considered. They are not necessarily placed in order of importance.

(1) Integrity of design: No potentially difficult circuitry should be included. Sophistication of technique can by all means be employed, but basically the equipment should reflect fundamental good practice at all stages.

(2) Safety: It has been decided for several reasons which we shall consider later to employ a mains transformer which isolates the equipment completely from the mains supply. The chassis can in fact be earthed directly.

(3) Video presentation: The receiver should be capable of accurate video presentation including stability of black level, and for this reason d.c.

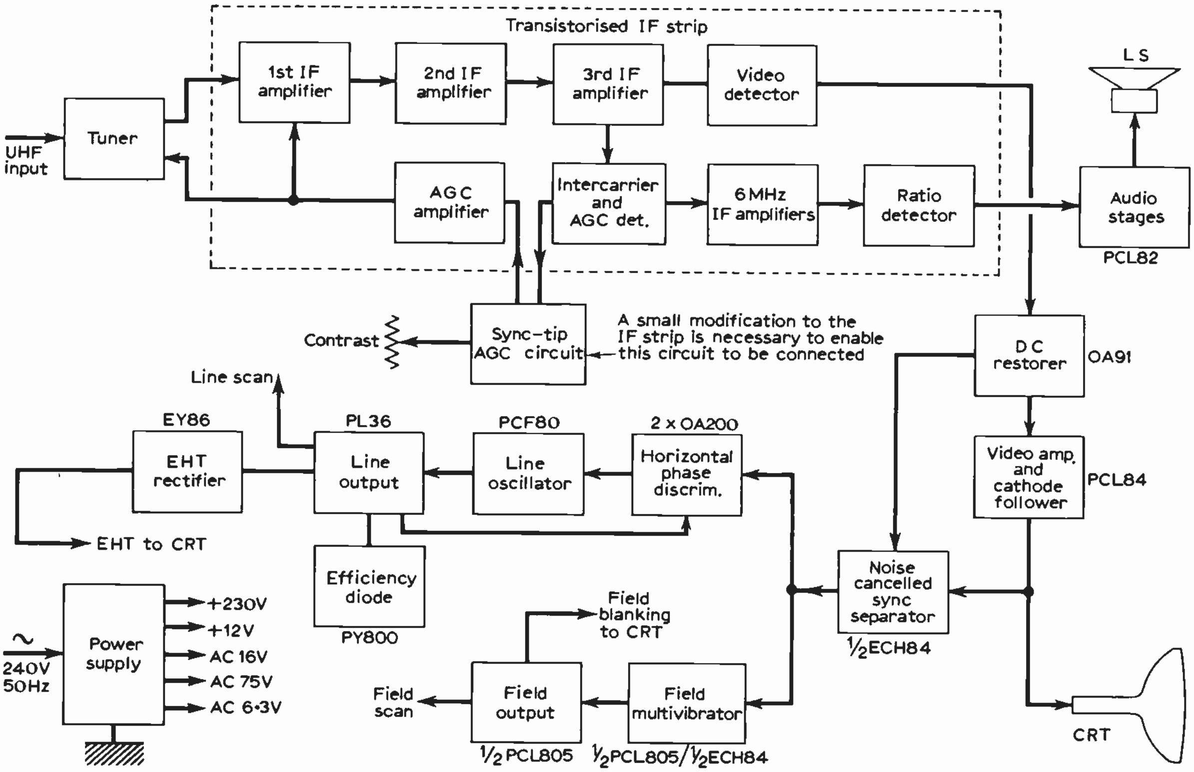
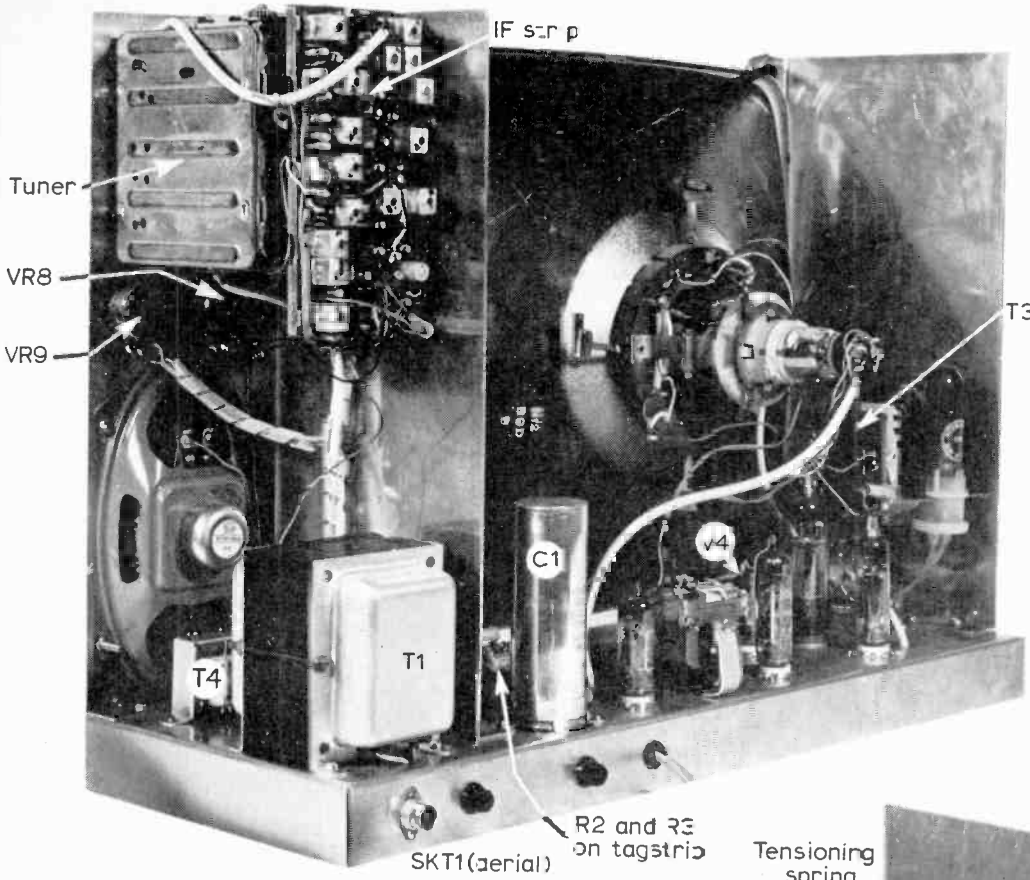
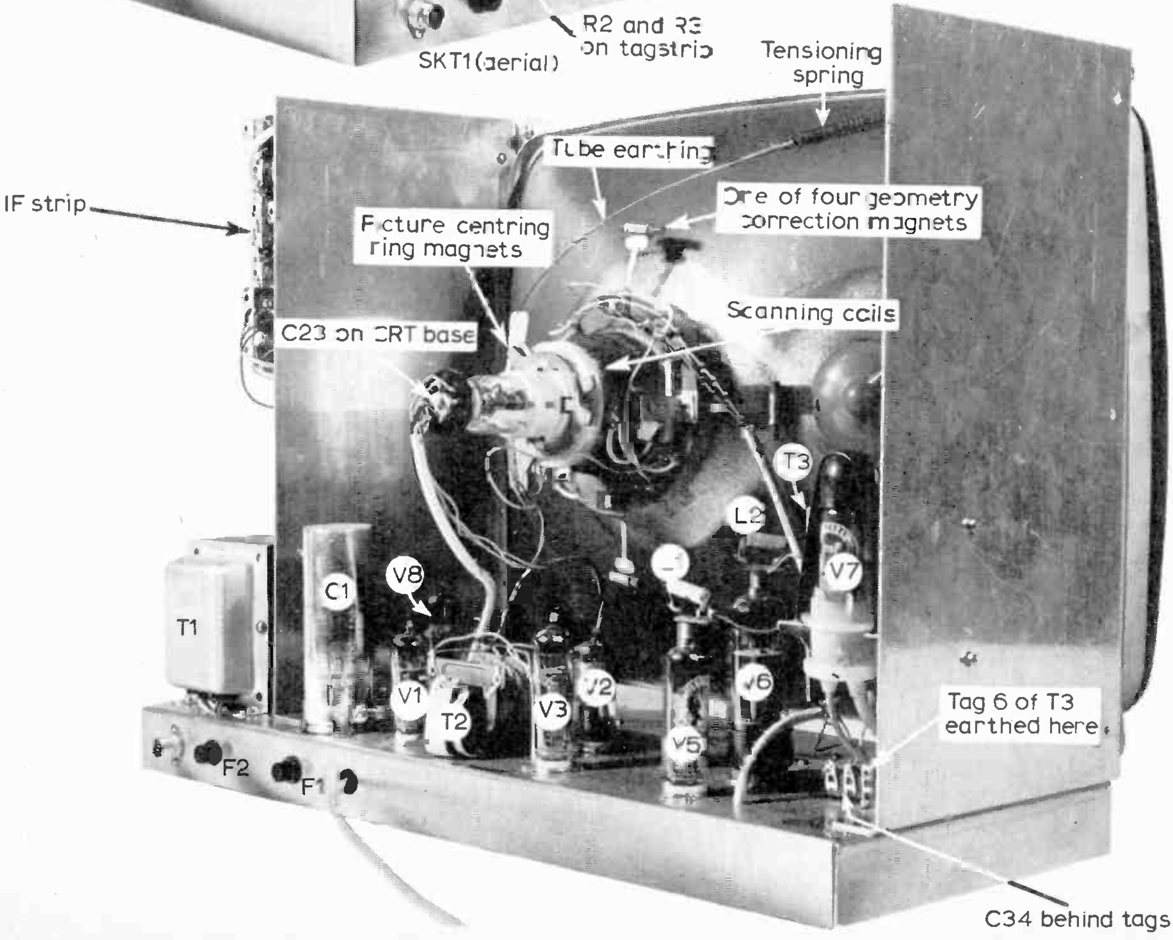


Fig. 1: Block diagram of the receiver.


IF strip
Tuner
VR8
VR9
T3
C1
V4
T4
T1
R2 and R3
on tagstrip
SKT1(aerial)


Tensioning
spring
Tube earthing
IF strip
One of four geometry
correction magnets
Picture centring
ring magnets
Scanning coils
C23 on CRT base
T3
L2
L1
V7
V8
C1
T1
V1
T2
V3
V2
V6
V5
F2
F1
Tag 6 of T3
earthed here
C34 behind tags

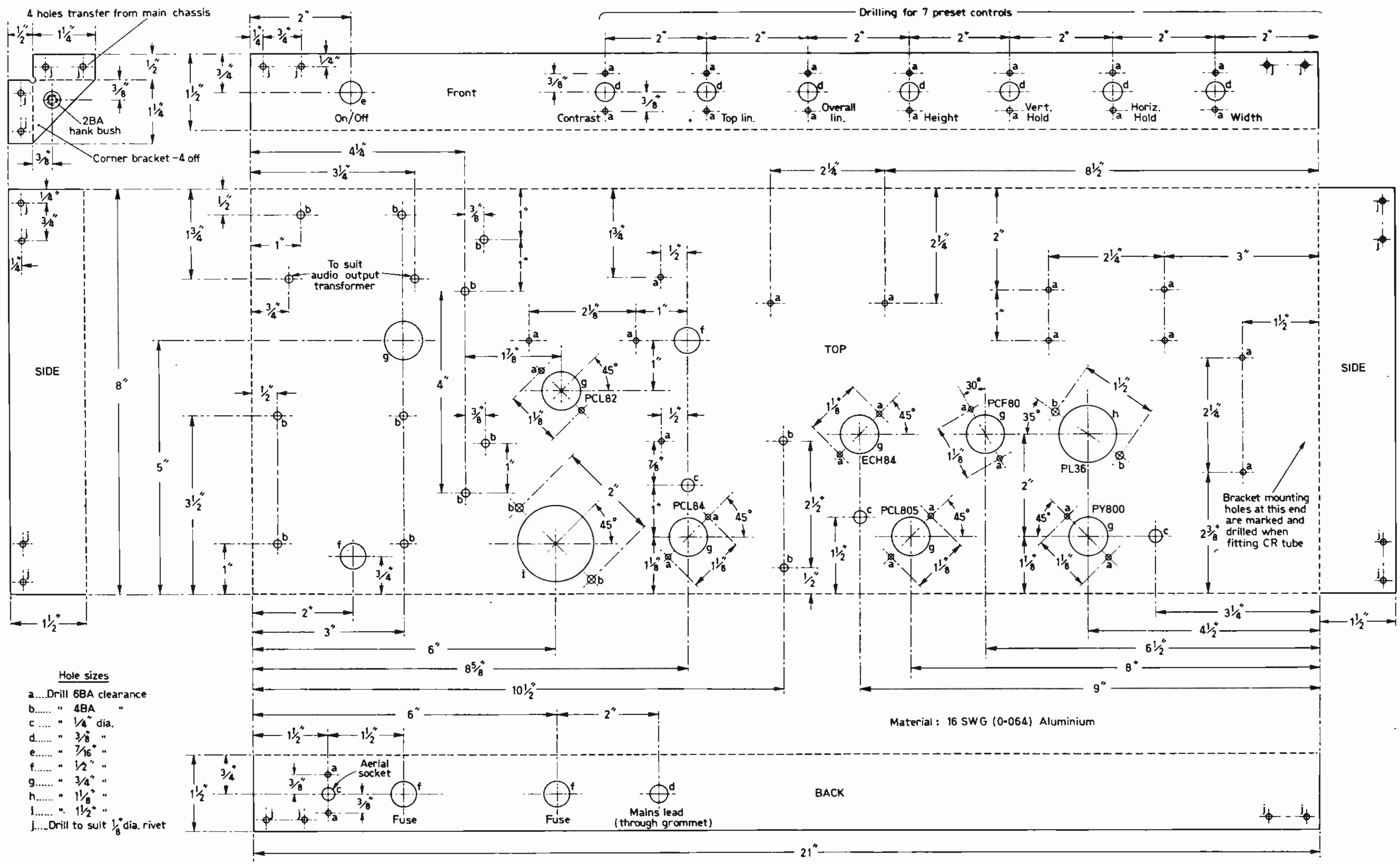


Fig. 2: Drilling details and dimensions of the main chassis.

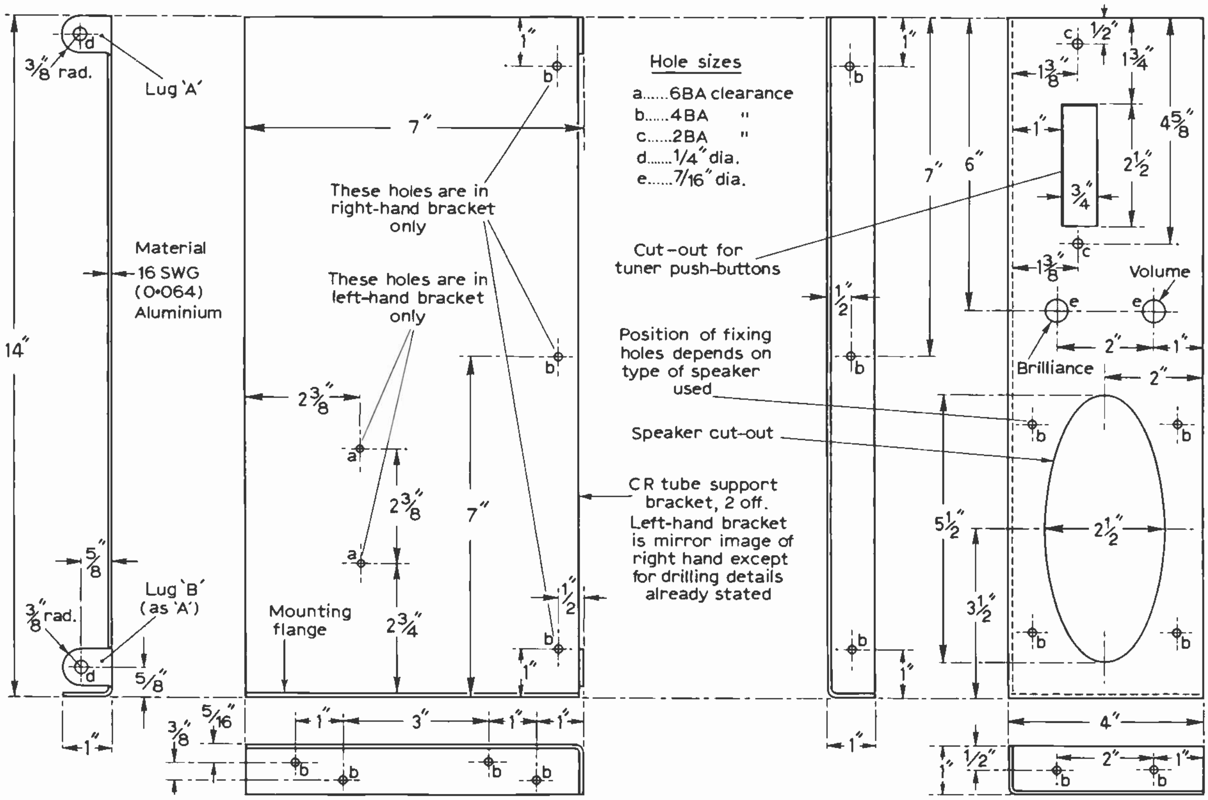


Fig. 3: Details of the side and front panels.

restoration, sync-tip a.g.c. and d.c. coupled video techniques are employed.

(4) Noise immunity: Despite the fact that u.h.f. noise levels are lower than those at v.h.f., a noise-cancelled sync separator is employed to minimise disturbance by interference pulses. Flywheel line sync is also included.

(5) Ease of setting up: Tuners and i.f. strips are currently available very reasonably on the surplus market. Since the setting up of these parts of a receiver presents the constructor with most difficulty, it is a great advantage to be able to purchase a transistorised tuner and i.f. strip which with a few modifications will give excellent results.

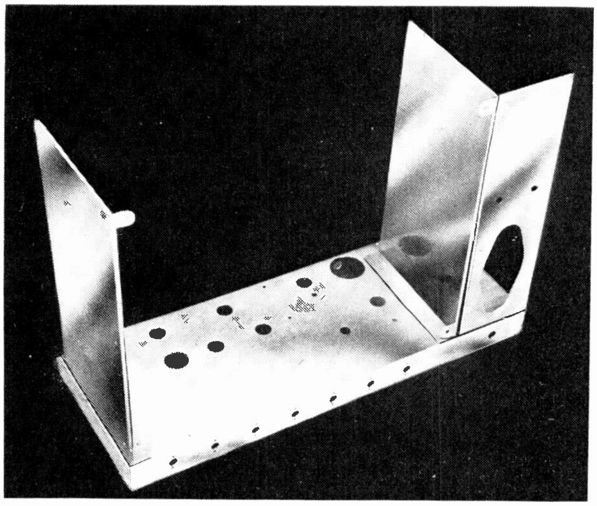
(6) The use of easily available components: The line and field transformers and scanning coils are readily available from the quoted suppliers along with the tuner and i.f. strip mentioned above.

(7) Ease of construction and sensible layout: The chassis is designed so that the valves are all mounted vertically in the conventional manner. The form of construction is such that the whole receiver can be inverted, complete with c.r.t., to gain access to the underside of the wired chassis.

(8) Reliability: No components should be over-run, and heat dissipation should be kept to a low level with the layout of components arranged so that temperature effects are minimal. Mounting the valves vertically also contributes towards reliability by avoiding the hazard of grid sag, a potential problem when valves are mounted horizontally.

Power Supply Arrangements

When the basic receiver form is being thought out various aspects have to be decided from the outset. One of these is the type of power supply. As mentioned earlier, a mains transformer is employed. This provides complete isolation of the receiver from the mains so that the chassis can be earthed. Immediately this decision is taken attendant advantages appear. The aerial connection does not have to be isolated from the chassis, the c.r.t. rim-band lugs can be bolted directly to the chassis and



Photograph of the chassis used on the prototype. Note that not all holes had been drilled at this stage.

★ components list

Resistors:

R1	21Ω 5W
R2	100Ω 5W
R3	560Ω 5W
R4	15Ω
R5	68Ω 1W
R6	4·7kΩ
R7	100kΩ
R8	8·2kΩ 5W
R9	15kΩ 1W
R10	47Ω 5W
R11	350Ω 5W
R12	10kΩ
R13	100kΩ
R14	1MΩ
R15	47kΩ 1W
R16	100kΩ
R17	2·2MΩ
R18	100kΩ
R19	330kΩ
R20	1MΩ 1W
R21	150kΩ
R22	120kΩ
R23	1kΩ
R24	470Ω
R25	220Ω
R26	15Ω
R27	100kΩ 1W
R28	2·2MΩ
R29	1MΩ
R30	47kΩ
R31	10kΩ
R32	100kΩ
R33	100kΩ 1W
R34	47kΩ
R35	470kΩ
R36	470kΩ
R37	470kΩ
R38	47kΩ
R39	10kΩ
R40	1MΩ
R41	1kΩ
R42	15kΩ 1W
R43	1kΩ
R44	150kΩ
R45	47kΩ 1W
R46	100kΩ 1W
R47	330kΩ
R48	10kΩ 1W
R49	1·5kΩ 5W
R50	470Ω
R51	2·2MΩ
R52	470kΩ 1W
R53	220kΩ 1W
R54	1MΩ 1W
R55	1MΩ 1W
R56	120kΩ
R57	10MΩ
R58	47Ω
R59	100kΩ
R60	2·2kΩ 1W
R61	470kΩ
R62	560Ω 5W
R63	1·5kΩ
R64	3·3kΩ

All ½W unless otherwise indicated

Potentiometers:

VR1	500kΩ lin. Field hold
VR2	2MΩ lin. Height
VR3	1MΩ lin. Field linearity overall
VR4	100kΩ lin. Field linearity top
VR5	100kΩ lin. Line hold
VR6	2MΩ lin. Width
VR7	2MΩ lin. Contrast
VR8	100kΩ lin. with ¼ in. shaft, Brightness
VR9	100kΩ log. with ¼ in. shaft, Volume

Semiconductors:

D1-D4	REC53 (Radiospares) 300Vr.m.s., 1·1A, or BY127
D5-D8	OA200
D9	OA91
D10-11	OA200
D12	OA91
D13	OA200
Tr1	OC45
Tr2	AC127
Tr3	BSX21

Valves:

V1	PCL84
V2	ECH84
V3	PCL805
V4	PCF80
V5	PY800
V6	PL36
V7	EY86
V8	PCL82
V9	A50-120W/R (Mullard)

Coils and Transformers:

L1, L2	Suppressor chokes
T1	Primary: 0-200-240V 50Hz Secondaries: 240V 250mA; 75V 300mA; 16V 750mA; 6·3V 300mA Fitted with interwinding screen
T2, T3, L3	Manor Supplies
T4	Radiospares "Standard" audio output transformer (6·6kΩ pri., 3Ω sec., 47:1)

Miscellaneous:

F1	630mA
F2	315mA
SW1	Double-pole single-throw on-off switch

Thermistor TH1, type VA1015
Varistor E298ZZ/06
3Ω elliptical speaker; 3 27-way tag strips; 6 B9A ceramic valveholders; 1 octal ceramic valveholder; 1 B8H valveholder; 2 top-cap clips; 2 20mm. fuse carriers; 1 coaxial aerial socket.

Capacitors:

C1a	100μF } 275V Radiospares multiple electrolytic
C1b	100μF
C1c	300μF
C1d	16μF
C2	1000pF Ceramic
C3	1000pF Ceramic
C4	1000μF 35V El.
C5	1000μF 35V El.
C6	1μF Polyester
C7	0·01μF Ceramic
C8	0·1μF 400V Polyester
C9	0·01μF 400V Polyester
C10	1000pF 400V Polyester
C11	1000pF Ceramic
C12	33pF Ceramic*
C13	0·1μF 400V Polyester
C14	0·1μF 400V Polyester
C15	0·047μF 400V Polyester
C16	0·01μF 400V Polyester
C17	2500μF 35V El.
C18	120pF Ceramic*
C19	0·1μF 30V Ceramic*
C20	10μF 15V El.
C21	0·1μF 30V Ceramic
C22	0·1μF 400V Polyester
C23	0·01μF 400V Polyester
C24	1000pF Ceramic
C25	1000pF Ceramic
C26	0·01μF 30V Ceramic
C27	0·47μF Polyester
C28	100pF H.S. Mica*
C29	0·01μF 400V Polyester
C30	120pF Ceramic*
C31	1μF 500V El.
C32	0·1μF 600V Polyester
C33	0·1μF 1000V Polyester
C34	0·15μF 400V Polyester
C35	68pF 12kV Pulse ceramic
C36	220pF Ceramic
C37	0·01μF 400V Polyester
C38	8μF 450V El.
C39	0·1μF 400V Polyester
C40	25μF 25V El.
C41	220pF Ceramic
C42	0·1μF 400V Polyester
C43	0·047μF 400V Polyester

* or polystyrene

no problems exist with the coupling of audio signals to an external amplifier, loudspeaker or deaf-aid earpiece. There are several other advantages in the use of a mains transformer.

First no dropping of the mains voltage is required since the transformer can have windings appropriate to all requirements. An obvious source of heat is thus immediately removed. Secondly full-wave bridge rectification of the h.t. supply is possible, so doubling the ripple frequency, reducing the ripple current in the smoothing capacitors and easing the smoothing problem generally. It follows that the problems of asynchronous transmission working will be eased. Thirdly a transformer winding can be provided for the c.r.t. heater alone, so eliminating the possibility of a heater-cathode short. Lastly the use of an inter-winding screen in the transformer prevents the transmission of interference by the mains, both to and from the receiver.

Readers when confronted with these considerations will probably wonder why a mains isolating transformer is such a rare device in television today. So far as the writer is concerned the problem confronting the setmakers is simply one of cost, and this does not stop at the mains transformer. For example how many receivers are available which provide black-level stability?

While it is true that the mains transformer is a fairly expensive item, and has been wound especially for this receiver, its cost is more than offset by the low cost of the tuner and i.f. strip. Also, resistance smoothing (dissipating only 4W in the main section) eliminates the need for an expensive smoothing choke. The transformer is mounted at the extreme right rear of the chassis, keeping the distance between it and the picture tube as large as possible. In practice no interaction has been noticed.

Chassis Layout

The overall chassis layout has been designed to provide a logical arrangement of valves and components, with good ventilation for the valves and smoothing resistors. The c.r.t. specified is a Mullard 20 in. type designed for direct viewing and fitted with a rimband which has mounting lugs attached. The tube is bolted directly to the chassis by its lugs, no further support being needed. The scan coils are clamped to the neck of the tube and supported by it.

The chassis is fitted with two vertical side plates which serve to support the tube. Attached to the left-hand plate by its bolts is the line transformer. The large area of metal acts as a heatsink, absorbing heat from the line transformer and keeping its working temperature low. This naturally contributes towards the long-term reliability. The line transformer is supplied complete with valveholder and top cap for the EY86 e.h.t. rectifier and e.h.t. lead with c.r.t. connector for direct attachment to the tube.

The illustrations on page 265 show the general arrangement. The loudspeaker, tuner unit, i.f. panel and main controls are fitted on a forward-facing panel to the right of the tube. This panel is bolted to the main chassis and to the right-and vertical plate which supports the c.r.t. It will be noticed that the presence of the side plates enables the complete receiver to be inverted if required, in order to gain access to the underside of the main chassis.

At the front of the main chassis, below the tube, are mounted seven preset controls for horizontal and vertical hold, width and height, field linearity (top and overall) and contrast. The accessibility of these controls from the front is a great advantage when setting up the receiver.

The rear of the main chassis is fitted with the u.h.f. aerial socket, two fuses for mains and h.t., and the three-core mains lead. Optionally a bracket can be attached to the side plate carrying the tuner etc. fitted with sockets for external audio connections.

Figs. 2 and 3 show the complete drilling and dimensional details of the chassis and its fittings, which are fabricated from 16 gauge aluminium. Great care should be taken in the construction of the chassis. The job is eased considerably if a guillotine, folder and vertical drilling machine are available. If the constructor is at all unhappy about undertaking this part of the job it is recommended that the task is carried out by a professional. The prototype chassis was produced by C. G. James Electronics (G3VVB), Staines Road, Feltham, Middlesex to whom inquiries may be sent.

Assembly is straightforward provided the holes are accurately positioned; failure to pay attention to this point can result in subsequent stages of construction becoming very difficult.

When the chassis has been made, basic assembly of parts can begin. First, the valveholders, tag strips and transformer can be fitted. Note that some of the securing screws hold a component on both sides of the chassis. Fig. 2 shows the orientation of components. The parts necessary to complete this phase of the construction are: One line output transformer; one field output transformer; one mains transformer; one audio output transformer; a complete set of metal work; six B9A low-loss valveholders; one octal low-loss valveholder and seven preset potentiometers.

Shopping List

At this stage it is useful to obtain the above components, plus some others which can be conveniently ordered at the same time. The complete list is as follows:

1—Line output transformer
1—Field output transformer
1—Set scanning coils
(Above components for Thorn 850 chassis.)
1—Transistorised tuner
1—Transistorised i.f. strip

} Available from Manor Supplies, 64 Golders Manor Drive, London, N.W.11. Quote "Practical TV 625-set" when ordering.

1—Chassis and attachments (see above for supplier)
1—Audio output transformer
6—Low-loss valveholders, B9A
1—Low-loss valveholder, octal
1—Mains transformer, see components list for details. Prototype was supplied by Olympic Electronics Ltd., 224 Hornsey Road, London, N.7.
3—27-way tag strips
1—500kΩ Preset pot
1—1MΩ Preset pot
3—2ΩM Preset pot
2—100kΩ Preset pot

When completed this first stage of construction provides a logical point for the commencement of wiring and fitting the small components.

For the benefit of those constructors wishing to acquire all the components from the outset the *complete* components list (including components set out in the previous short list) is also included.

CONTINUES NEXT MONTH

PROGRESS WITH SOLID-STATE DISPLAY TECHNIQUES

New phosphors coated on Texas solid-state light-emitting diodes have been used at the Bell Telephone Laboratories to give brilliant displays in the three primary colours and a full range of colours in between. The new phosphors are illuminated from the infra-red end of the light spectrum, giving much higher conversion efficiency than when conventional phosphors are irradiated at higher frequencies than visible light.

An integrated circuit numerical display device is under development by Hitachi. This consists of light-emitting diodes fabricated on a single arsenic phosphate gallium crystal slice. A 16-segment version can display the complete alphabet. The switching time is 1nsec, operating voltage 1·75 V and consumption 50 mA or 85 mW per numerical digit.

UNDERNEATH THE DIPOLE

DUST! DUST! DUST!

The dust would settle if the engineers would allow it to do so. Fortunately they don't. Dust is the bugbear of television studios (particularly within the sacred precincts of videotape and motion-picture film). It has always been so but is even more so with the wide introduction of colour, the sophisticated editing of videotapes and the trend towards the use of 16mm. colour film. Even 8mm. film has been under consideration in its "super eight" form, which is now able to display on this gauge an increased picture-area per frame; about 50% more area of information than on "standard" format 8mm. film.

Of course the size of specks of dirt varies from large smuts to the smallest of specks depending on whether it originates from fungus, mildew, soot, dross, dandruff or just common or garden earth. Large specks (like big fleas) break into smaller specks which to some extent again break into another smaller generation of dust. Or so you might think. Film laboratory technicians who develop and print small-gauge motion-picture films for professional or amateur use wage a constant battle and some tend to recognise a prolific scum on their film of "standard size" dirt which affects their methods of handling the smallest film gauges. These concern the ventilation systems (which include elaborate filter and cleaning systems), clean clothes, overalls and shoes and various cleansing devices such as ultrasonic cleaners. All these precautions are necessary for videotape too, and for all the advanced computer instrumentation, radar and other devices essential for a clean result with no sparkle, drop outs, scratches and other physical interferences. Obviously the smaller the film or magnetic tape gauge, the larger the blemishes. It is a case of relativity—Einstein at it again!

WEAR AND TEAR

But though dusty communication media may be regarded by operational engineers as a sin it is not an original sin, for which the magnetic tape suppliers, film stock manufacturers and film processing laboratories might be held responsible. Nor should the blame be placed upon the operational engineers of the BBC and ITV stations.

In the case of colour videotape the non-technically minded producers, directors and editors treat this marvellous instrument of communication with over-confidence, to the extent that thirty or forty showings of tape are sometimes made even before electronic editing or A and B roll transfers are carried out. Further titivating and amendments are then made, any one of which might introduce dust or cause abrasions. Of course, ultrasonic cleaning can remove loose dust and dirt from tape or film, but it can't replace divots! The logical answer to this problem is of course to discourage producers and directors from viewing their taped masterpieces more than say five times before they go through the subsequent processes of editing, transferring, dubbing, etc.

IS IT ART OR WHAT?

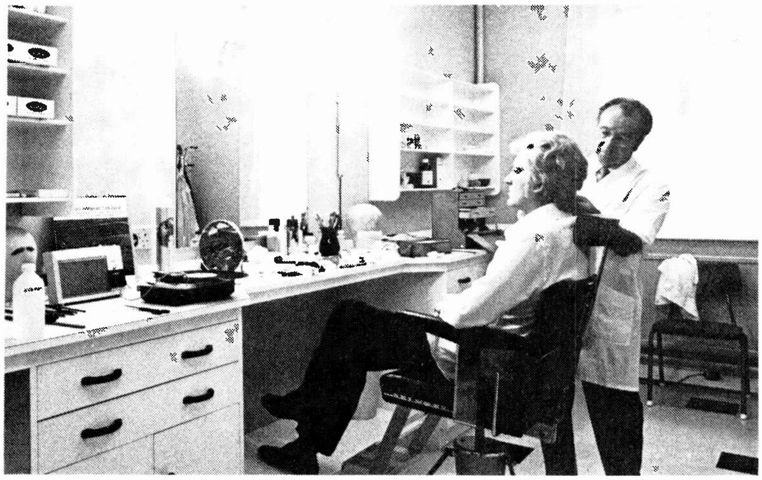
The sophisticated technology of magnetic recording, especially when used for colour television, can be cruelly mistreated in the quest for gimmicky effects. This form of prostitution of the art is carried out every day in films and still pictures for the press and advertising. It is not new. In a lecture at the Photographic Salon, London, in 1909 George Bernard Shaw said: *"Many faults are common to both photography and painting. For the most part they are due to untruthfulness in the former due to wilful neglect of simple photographic qualities, and in the latter to the inability of the modern painter to paint."* "G.B.S.", who knew a lot of things about the photographic processes of that year, amusingly followed this up by referring to oil painting as being *"a lost craft because the Royal Academicians do not put paint on as a carriage-painter does!"* To suggest that the gifted portrait painters and artists of 1909 should be apprenticed to the highly-skilled horse-carriage painters of the day and ought to be paid on a time basis was at that time more than somewhat sarcastic. But in the present age anything goes as long as it's gimmicky, including grotesque noises, abstract shapes and non-talent non-art. Engineers are logical, however, but it must not be assumed that technology is solely a craft, not an art form in which discreet artistic deviations are acceptable. This applies especially to their appreciation of the skin texture and bone structure of the human face.

MAKE-UP FOR TELEVISION

There is no doubt in my mind that engineers and producers in television studios realise that the accurate reproduction of the human face, whether in black-and-white or in colour, is the most important achievement they can offer. This has always been the point of view of television studios' make-up departments, as it has been for their opposite numbers in film studios. Make-up for television is even more critical than for films because of the greater use of close-ups as compared with feature films. Nevertheless facial cosmetics and make-up are required for both films and television, and their use is a real art which conceals art by its very application!

Nothing looks worse for instance than an announcer with a six-o'clock shadow on his chin and jowl, particularly in black-and-white television. Put heavy make-up on him to hide the first beard sprouts and it looks even worse, particularly on colour television. Clearly adjustments have to be

Billy Partleton, make-up artist, in his make-up room at Pinewood Studios with David Warner.



made, adjustments which have to take account of the types of lighting, the character to be presented and the absolute absence of any corrective cosmetry.

Billy Partleton, one of the leading make-up artists in this country, has told me that "corrective make-up" should not entirely eliminate the suggestion of a beard on a man. This might also eliminate the masculine effect desired. For women cosmetics are normal but can be over-exaggerated unless very, very carefully handled. Mr. Partleton, well-known in top feature film circles, has also been concerned with filmed television series and has been watching BBC-1, BBC-2, and ITV in colour with great interest. What he divulges to the audience at a BKSTS lecture will be noted by the film, television and television "commercial" producers with great interest. I must add that of all these the television filmed commercial makers should pay special attention to make-up instead of being infatuated with trick kaleidoscopic shots and contra-counterpoint film cutting. Ugh!

HOLLYWOOD OBSERVATIONS

Pertinent observations on these subjects have been made by Arthur Florman, a prominent member of the American Society of Cinematographers. Writing in the *International Photographer*, an American journal, he said that though he may *"jar some film cameramen and give them the guts to argue the aspect of good technique with so-called directors and producers,"* he drew attention to the fact that a whole new generation of film-makers has grown up believing that sunsets must be shot directly into the sun, that girls with long hair must always run in slow-motion, that bare light bulbs must always be shot with star-halation filters, that more than one zoom in ten minutes should be forbidden together with psychedelic lighting, blurry swift movement, ultra wide-angle and fisheye lenses, intentional under-lighting, shuddering hand-held cameras, etc., etc. Mr. Florman wound up on this subject by referring to "tricky Italian shots, changed focus, intentionally sloppy operation which became a photographic mess of jelly."

I must agree with Arthur Florman that these tricks become tedious by repetition. But used with great discretion they have their value and impact. After all the harmonic and counterpoint rules of music composition *can* be broken, but only if properly justified. Such off-beat shots should be used sparingly and with appropriate motivation. Television commercial producers and BBC off-beat directors please note! In any case there are too many BBC television directors in this category.

RED MEAT

It has taken surprisingly few weeks for colour television to settle down. The offerings now presented to viewers on BBC-1, BBC-2 and ITV add up to an almost embarrassing flood of entertainment, horror, education, art, non-art and sheer rubbish. One man's meat is another man's poison, I know, but at least all the meat on all the channels is red, and what is more not an over-saturated red as presented by some networks and many of the television stations in the USA.

It is quite remarkable how well the British networks match up even allowing for individual quality variations in videotape, 35mm. film, 16mm. film and of course live television. Sporting events stand out and are far more exciting in colour than in black-and-white. The blueish haze introduced when high-intensity arcs illuminate evening rugger or soccer matches seems to add to the drama and excitement. Even the commercials seem to bubble over with a beckoning impact which adds a new flavour to Babycham and other revitalising victuals.

Managements of cinemas, theatres, clubs and pubs observe this phenomenon with jaundiced eyes, excepting the hostelries which display well-tweaked and set-up colour television receivers, which have low-loss feed-in cable from good aerials pointing precisely in the right direction! Reflections have to be overcome. This can't always be achieved and in many cities, towns and country places with hills and high buildings the wired television system firms will increase their number of customers.

The same colour test cards—with individual identifications—are transmitted on all channels in the UK, a facility which is not carried out in the USA. There each of the main networks has its own test card, for internal use only. At any rate during my visits to both the West Coast (Los Angeles) and the East Coast (New York) I did not see a single test card on a television receiver in a hotel, home or a radio shop. The radio stores were notable for the terrible receiver adjustment, the dazzling ambient lighting and the weight and flamboyancy of the cabinets. Colour television in the UK is progressing fast by engineering standards, but slowly by viewer-rating standards—oh so slowly!—due to the national financial squeeze, the commercial TV levy, S.E.T., Corporation tax, increased licence fees and so on. How does the government expect colour TV to be a success under these trying conditions?

Iconos

simple UHF slot aerial

G. S. PIDD

WITH all three television programmes being transmitted on u.h.f. there is a need for a simple indoor u.h.f. aerial which will receive with a level response over a range of about ± 10 per cent of its nominal centre frequency. The slot aerial described in this article achieves this and also eliminates reflections from inside the room where it is used.

Construction

The aerial is made out of an empty one-gallon oil can of size $11 \times 6\frac{1}{2} \times 4\frac{1}{4}$in. The first step is to make a $\frac{1}{4}$in. diameter hole as shown at A in Fig. 1 without distorting the tin. This can be done by using a sharp nail or drill. Next make the cut as shown in this same side of the tin. A pair of old scissors can be used to do this.

A length of coaxial cable should then be passed through the spout of the can and then through the $\frac{1}{4}$in. diameter hole, leaving about a $\frac{1}{2}$in. length protruding. The run of the cable is shown in Fig. 2. Next bend in the edges of the slot cut in the tin but do not fold right back the edge in the hole side until the coaxial cable has been secured in position. This edge is then bent over the coaxial cable to make a quarter-wave matching transformer, also helping to secure the cable. A short piece of tinned copper wire is then soldered to the end of the coaxial cable centre conductor and can be attached to the end of the slot by means of a piece of string. The piece of tinned copper wire acts as a coupling probe and its length is not critical.

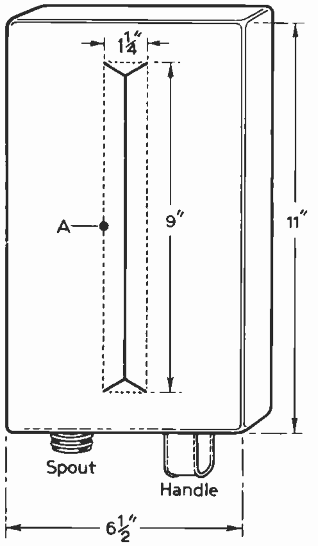


Fig. 1.

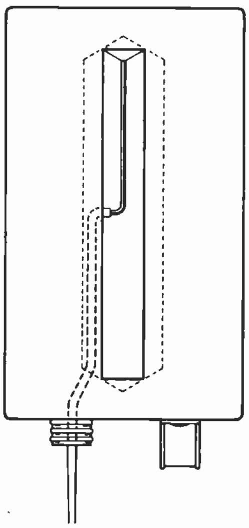


Fig. 2.

Principle

The slot of the aerial can be visualised as a solid magnetic rod of diameter equal to the width of the slot (however the magnetic and electric fields are interchanged). The impedance measured across the middle of the slot is 600Ω without a reflector but 1000Ω with a reflector—which in this case is formed by the tin. The piece of tinned copper wire in effect converts the slot into a folded dipole with an impedance of 250Ω. This is still too high to match the standard 75Ω coaxial cable so the screen of the cable is loosely coupled by the fold of the tin.

The aerial has a wide bandwidth so that the length of the slot need not be precisely a half wavelength. The dimensions given—$9 \times 1\frac{1}{4}$in.—are suitable for 550MHz. For higher frequencies, i.e. for those stations using the middle and higher Band V frequencies, the dimensions should be reduced accordingly.

Mounting

The aerial must be mounted with the slot vertical for the horizontally polarised transmissions of the main u.h.f. stations (the satellite stations use vertical polarisation). The aerial can be wall mounted using slotted holes near the top. The place where it is fitted should be chosen for optimum results—and appearance. It can be covered with a plastic material such as Fablon to improve the appearance. If you haven't got central heating tell everyone it is the control unit—but in this case it would be advisable to remove the oil-can handle!

This type of aerial is cheap to make and avoids the need to climb the roof. Being indoors it is not subject to corrosion or wind loading which can have disturbing effects on colour transmissions. Also a long feeder is not needed.

It will be noticed that there is no direct electrical connection to the tin, an additional protection against possible connection via the set to the electrical supply voltage.

References

C. E. G. BAILEY, "Slot Feeders and Slot Aerials," *Journal of the I.E.E.* 1946, **93,** Part IIIA No. 4, page 615.

G. D. MONTEATH, B.SC., "Wide-band Folded-slot Aerials," *Proc. I.E.E.* 1950, Paper No. 1044. ■

WAVEFORMS IN COLOUR RECEIVERS

—continued from page 263

filter output falls to zero, and it is this change in condition which can be used to identify the bistable count for correct PAL V-chroma phase switching. We have not yet dealt with this area of the set in any detail, but as a general illustration the output from the filter produced by a colour-encoded transmission can be used to switch on the bistable which, if starting on the correct V-phase count, will continue switching normally. However if starting on the incorrect count the bistable will switch off and then try again, continuing this action until correct V-phase synchronisation is achieved.

I shall be progressing more into this action after we have investigated the signals in the normal bistable circuit.

TO BE CONTINUED

FAULT-FINDING PITFALLS

VIVIAN CAPEL

A PRINCIPLE which experienced engineers often try to drill into the heads of junior apprentices is that in television and radio servicing one must never jump to conclusions. Things are often not what they seem. As many engineers will testify, the journey up the garden path often starts from the workshop bench! There are numerous pitfalls waiting to trap the professional engineer and amateur experimenter alike. The only way to avoid or at least minimise the chances of getting caught is to check everything and in some cases double check before coming to a positive conclusion.

Troubles with Valves

Usually the opening gambit in looking for a fault is to change appropriate valves. This is easy, quick and in many cases proves to be a cure. Sometimes however the fault returns later. Further investigation then brings to light a defect which may be quite unconnected with the valve. This could quite likely be mechanically induced, such as a print fault or loose wire in a wire-ended component, or a cracked resistor, and removing the old valve and inserting the new one has merely disturbed the fault and cleared it temporarily. Naturally the engineer assumes that the valve was at fault and is quite happy that the trouble has been cured—until a repeat call is received.

One way of preventing this happening is to check the old valve on the valve tester. Any positive fault such as electrode leaks, grid current or low emission will confirm the diagnosis, but no detectable defect should put the engineer on his guard. A simpler check is to just replace the old valve in the set to see if the fault symptom returns. If it does and then clears once more as the new one is refitted the chances are that the valve is the culprit. We say "the chances are" because even then it is possible to be misled. In one case there was a dry-joint on a valvebase. The pins of the new valve were slightly splayed and forced the joint into contact. When the old valve was refitted the joint parted and so the fault symptom returned.

The results of valve testing can often by misleading and this is something the amateur needs to watch as he often has to rely on taking valves to local dealers to be tested because he has no stock of replacements to try. Valves can often show faults which have little effect on the performance. I.F. valves of the EF80 class for example often show leaks from the control grid to other electrodes but with the low-impedance input circuit offered by an i.f. transformer secondary winding such leaks make little difference. Certain types of boost rectifiers show low emission on the tester yet work as well as a new one.

Some valves on the other hand test all right but are decidedly inferior to new ones in performance. Some field output valves for example are pushed to the limit in the circuit in which they are used. The emission may fall, be still within acceptable limits on the tester, but will be insufficient to give full scan with good linearity. Many engineers have had the experience of being asked to test a full set of valves brought into the shop by a customer and finding three or four or even more that need replacement. Having duly bought these the owner returns later to report that the fault remains. Indiscriminate valve testing is thus very much a hit-or-miss business. Testing must be combined with a knowledge of what could cause the symptoms—and what could not.

Valve Bases

With wired chassis identifying valve pins in the holders is usually quite straightforward as the gap between pins one and nine or one and seven can be clearly seen. In many printed circuits however another printed connection may appear near the gap to give the impression of being a valveholder pin. Thus finding the gap to start counting the pins is not easy. Mistakes can easily be made and if there is no voltage where it is expected quite a lot of unnecessary testing can be carried out before it is discovered that the measurement was made on the wrong pin. If identification is uncertain ease the valve out of its holder a little way to see where the actual pin gap is (if this is not convenient it is sometimes easier to pick up the heater voltage on pins four and five and count from there).

Certain pin connections are frequently found on many different types of valves such as pin two for control grid, pin three for cathode and pin six for anode. Unfortunately there are several departures from this arrangement and these are growing with new types coming out. It is no longer wise to rely on memory for valve base connections (unless one is blessed with a photographic memory) as this can be a source of fruitless testing. Follow a base diagram and be sure.

Identifying Valve Functions

Yet another misleading factor with valves is the way many double types are paired up. One naturally concludes that both sections of a multiple valve are either in the same circuit or at least in a related one. While this is often the case, occasionally things are not what they seem. The sync separator of one early receiver shared an envelope with the a.f. amplifier which frequently gave rise to buzz-on-sound. In another set that had twin panels, one for the timebases and the other for the receiver,

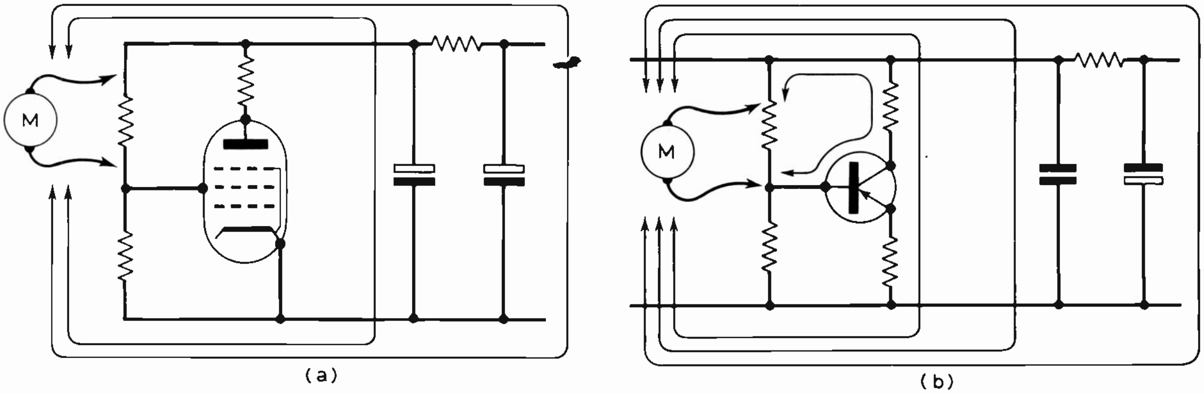


Fig. 1: (a) Parallel paths through the h.t. circuits will affect the reading of a bleeder resistor value in, here, a sync separator circuit. (b) Multiple paths in a transistor circuit through the supply circuit and the transistor itself.

one section of the field multivibrator was over in the receiver panel in the same envelope as the video output! It can be imagined the fun and games that could be experienced looking for field faults without a service manual!

If preliminary checks fail to run the fault to earth it usually pays to look up the service manual if available so that any such possibilities are not overlooked. Some engineers feel it is an admission of incompetence on their part to consult a manual unless the fault is a sticky one. However this is not so: some manufacturers are fond of misleading tricks such as these and unless one is familiar with the particular model the manual can save a lot of time and exasperation.

Of course manuals are not always to hand, especially in the case of the amateur. If this is so identification of the function of particular valves can often be made by rocking them gently in their valveholders. Unless the valve pins have recently been cleaned (purposely or through removing and refitting) this rocking will produce a disturbance that will identify the valve's role. Crackling on sound indicates a sound valve; picture breaking up a vision valve; field contraction and jumping a field valve, and so on. If this is inconclusive the valve can be pulled right out of its holder to see which function ceases immediately while the others die away. As a general rule however this practice is not recommended because all the valves above it in the heater chain will have the full mains voltage applied between their heaters and cathodes, leading to possible heater-cathode breakdowns. However while this is in theory possible the writer has not had a single case of this happening over a period of many years' servicing, so the risk is not as great as is sometimes made out.

Transistors

With the increase in transistor and hybrid circuits service problems have increased. A quick replacement as with valves is not possible as most transistors are soldered in and some, such as the lockfit types, have no wires to dissipate the heat of the iron so that great care must be taken when unsoldering to avoid destroying the transistor.

A source of confusion with many transistor circuits of recent origin is the mixture of npn and pnp types used. One misleading example concerns the series of silicon transistors bearing the type letters BC. Until recently these have all been of the npn type, such as the BC108, BC109, etc. A current Philips i.f. panel however uses several npn BC types but one transistor, in the a.g.c. circuit, is the BC186. This proves to be a pnp type and further investigation in this year's Mullard data book reveals that there are now several pnp BC types available. When we first encountered the BC186 we assumed without consulting the manual that it was an npn type as all the rest in the set were, and of course the voltage readings didn't make sense. Once more the golden rule is proved: don't assume anything; prove everything! Look up the data on any unfamiliar semiconductor before jumping to conclusions.

Circuit Diagnosis

There are various ways one can be misled in circuit testing and diagnosis. It is a common practice to bridge a capacitor across one that is suspected of being open-circuit and then if the fault is cleared to remove the old one and fit the new one properly. In most cases this works well and saves time removing the old one before it is known to be faulty. Sometimes however the symptoms are relieved to some extent by the extra capacitance of the new capacitor bridged across the old one so that when the old one is removed and the new one fitted the results are the same as before. An example of this is the cathode bypass capacitor in the field output circuit. Bottom cramping of the picture may be somewhat improved by extra capacitance and mislead one into thinking that the original capacitor is open-circuit or low capacitance whereas the fault may lay elsewhere.

When a fault apparently clears on bridging a capacitor do not immediately remove it and fit the new one; disconnect one end of the old capacitor and try again with the new one connected.

A common trap for the unwary, and one which the experienced engineer is always on guard against, arises from measuring resistances in circuit. More often than not there will be a parallel path which will reduce the reading. Sometimes this path will equal the resistor under test, which if open-circuit will thus appear to be in order.

Some parallel paths are quite obvious but others may not be so. If for example one end of the resistor being measured is connected directly or indirectly to chassis while the other end is returned to the h.t. line, we will also be measuring the leakage resistance of the smoothing, reservoir and any other decoupling capacitors on the h.t. line. Thus it is not possible to measure directly any one of a bleeder network (see for example Fig. 1).

The use of transistors has reduced the number of in-circuit resistance measurements that can be made. With valve circuits any resistor that terminates at a valve electrode, such as a grid stopper or screen resistor, is "safe" since the electrode is a dead end when the valve is cold. This is not so with a transistor however and those who have had years of trouble-shooting in valve circuits can sometimes overlook this fact. Another factor is that electrolytic coupling capacitors are widely used with transistor circuits and these unlike the paper or polyester valve coupling components have a leakage resistance. As a general rule then there are few resistance readings that can be taken without disconnecting the resistor, and this is especially so where transistor circuits are concerned.

The clear lacquer that is used on many printed circuits can also prove troublesome when making voltage or resistance checks. As the lacquer is invisible it looks as though the foil is bright, clean and exposed, and when no readings are forthcoming faults are looked for that do not exist, with the resulting waste of time and nervous energy. If therefore there is no reading where one would be expected, twist the test prod in order to penetrate any protective coating that may exist. Also try a reading elsewhere to make sure that the meter and its leads are in order.

Interconnecting Wires

With the wide use of modules and complete printed receiver sections more inter-unit wiring is found. A number of wires are bunched together and run sometimes for quite a distance. Often these meet other bunches to form a mammoth bundle. Trying to trace an individual wire can be quite a problem, as usually there are several of the same colour in the bundle. Some manufacturers use coloured wire with a second colour marked on it to help identification; this is certainly welcome.

Trying to trace a wire visually is almost impossible because sooner or later it will disappear from view within the bunch and it is all too easy to pick up another wire of the same colour that has a similar lay. About the only way of avoiding mistakes is to pull the wire carefully and trace the movement along to the end. Once identified, the wire can be pulled back to its original position.

The writer once encountered a wire that was coloured red on one side and blue on the other. This no doubt was intended to aid identification but the trouble was that it lay with only one colour showing until it reached a grommet. Then on passing through the chassis the other colour was uppermost. This caused no little confusion until pulling the wire positively proved that the same wire emerged in a different colour to when it went in!

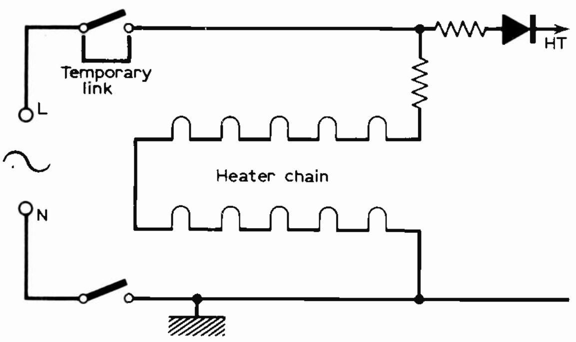


Fig. 2: When one pole of an on/off switch is bridged the chassis can become live through the heater chain when the other pole is switched off.

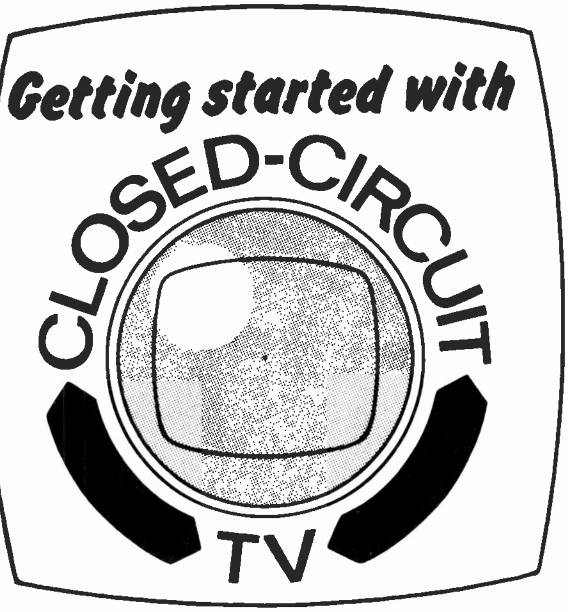
Watch the Mains!

Not all pitfalls are connected with diagnosis: some concern personal safety and so are even more important to avoid. Most engineers phase a chassis so that it is connected to the neutral side of the mains when a two-pin plug is fitted. When a three-pin plug is fitted such phasing should be unnecessary—if the plug has been properly connected. This however is a conclusion one must not assume. Incorrectly wired plugs are often encountered which produce a live chassis. An engineer who usually phases his chassis correctly will be more vulnerable than others in such a case as he will be used to working on a neutral chassis and will not be prepared for the dangers arising when handling aerial connections and earthed equipment. Never assume that a chassis is neutral. Check in every case, whether a three-pin plug is fitted or not. If the chassis is found to be live, do not carry on with the resolve to be careful—change the plug connections right away.

Another assumption which could result in trouble is that the mains switch is working properly. Not infrequently a switch goes open-circuit and someone bridges it as a "temporary" measure. Sometimes, too, a switch will fail in the on position and the owner will thus be in the habit of switching off at the switch-socket. The engineer, however, being unaware of this, may switch off at the set in order to change a component. As the sound has disappeared because the control is turned back he may easily believe that the set is in fact switched off, especially if the room is bright and the valve heaters cannot be seen easily. This could have dire results especially if work on the supply circuits such as the mains dropper or rectifier is involved.

Even when only one pole has been bridged the set will be switched off by the other but if it happens to be in the neutral lead of the supply the chassis will become live through the heater chain (see Fig. 2).

It can be seen then from these few examples (and no doubt most engineers could cite many more) that one should never jump to conclusions. Methodically test and check everything as a basis of sound fault-finding practice. ■



PART 5 I.R.SINCLAIR

PROFESSIONAL grade monitors are expensive pieces of equipment. The c.r.t. has a particularly flat face, the spot size is smaller than in the TV receiver tube, and the dimensions are more accurately held. Much more attention is paid to the geometry of scanning, linearity is of greater importance, and there must be no trace of pincushion or barrel distortion. The video amplifier of the monitor is capable of accepting 1V peak-to-peak video signals at bandwidths up to 12MHz, with or without composite sync pulses, and very careful attention is paid to cable matching.

Few amateur builders or users of CCTV are likely to be fortunate enough to own a professional grade monitor and various shades of butchery are usually practised on an ordinary TV receiver. This part of the series deals with the conversion and use of TV receivers as monitors and shows what modifications are possible.

Choice of Receiver

Obviously such major steps as the use of a monitor c.r.t. or scanning yoke are out except for those with good friends in the right places, and what work is done on the set must use to a great extent what is already there. The most useful material for conversion is the 10-12in. portable set, preferably a BBC-2 convertible type since that will incorporate 625-line scanning equipment. The scanning geometry of such small tubes is generally very much better than that of the overblown wide-angle tubes used for larger receivers. Price may be a problem here, for any set capable of receiving BBC-2 commands a higher price, especially now that the switchover to 625-line working for the other programmes is proceeding. On the other hand portable sets are seldom used as rental installations so there is less incentive for dealers to keep them going to the bitter end as is the case with the larger sizes. If 625-line operation is not of great importance many of the older 14in. table models had very good scanning geometry.

This choice has to be made early on. If the monitor is to be built from an old set which uses a 90° scanning angle or less then 405-line operation is necessary, because the line output transformer and scan coils are unlikely to withstand 625-line scanning and later types of coils are unlikely to fit the older tubes. Conversion is not impossible, but the CCTV enthusiast seldom has time to undertake lengthy experiments in rewinding scan coils.

Scanning Geometry

Given a receiver and a choice of line standards the next step is to improve the scanning geometry. Practically every TV set ever made runs in a perpetual state of misadjustment, and small alterations in height, width and linearity controls can make a considerable difference. Check that none of these controls is at or near the end of its track, indicating the need for component replacement. Adjust the picture so that the raster just fills the mask area, or underscans slightly, and adjust the centring magnets on the scanning yoke (carefully, since the yoke is *live*).

Next examine for pincushion or barrel distortion and correct by placing small magnets near the face of the tube. This is a tedious trial-and-error business but it can have a remarkable effect on picture quality. Suitable small magnets can be obtained from Radiospares or may be already fitted to the tube.

Check the focus of the tube; most tubes made in the last 6-7 years use electrostatic focusing but the range of voltage provided on the focus control seldom seems to have much effect on the tube. This is because the tube is designed to have a focus voltage which is near the cathode voltage, but the control has no means of applying a really wide range of voltages both above and below cathode voltage. In many cases a notable improvement can be obtained by using a supplementary focus coil taken from an older set.

With all this done, scan linearity is the last remaining problem and is usually the most difficult. The test pattern can be used to check scan linearity roughly, if the r.f. and i.f. portions of the set are working, but a dot generator is infinitely preferable. Such a generator is outlined in Fig. 1; it uses a high-frequency oscillator, switchable in frequency so as to sync to the 405- or 625-line rates, and delivering sharp pulses at 64 times line frequency. These pulses are also counted down in three counting stages

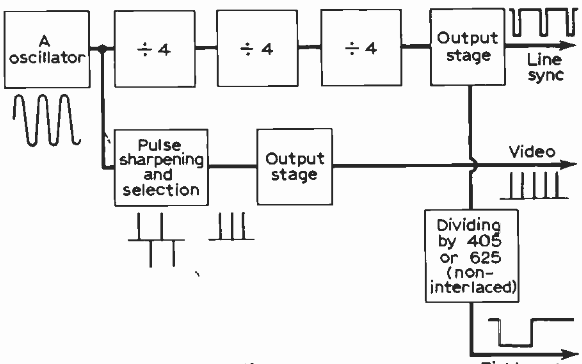


Fig. 1: Dot generator outline.

to line frequency, which is then used to synchronise the line timebase.

With the high-frequency pulse generator feeding the video and the line frequency used as sync, the displayed pattern is a set of rows of bright dots which should be evenly spaced. Uneven horizontal spacing indicates poor line linearity but the field linearity cannot be checked unless the generator is elaborated by further counters to provide a sync output at field rate. For CCTV purposes the line linearity is often of more importance since it affects the appearance of scenes when the camera is panned. Field linearity, though likely to require more attention than line linearity, is less critical to the eye and can be set up on a test card. Typical field linearity controls are shown in Fig. 2.

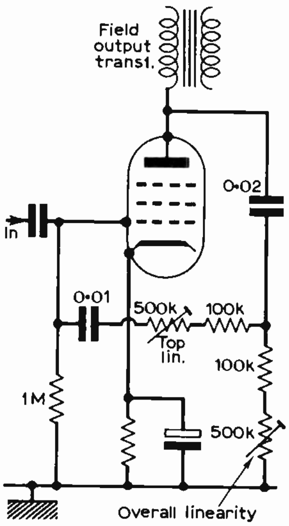


Fig. 2: Typical field linearity control circuit—a feedback loop from anode to grid of the field output pentode.

Line linearity is usually corrected by a metal sleeve positioned under the deflection coils so as to act as a shorted-turn to the highest frequency components of the sawtooth signal.

Other sets use a coil with adjustable core in series with the line deflection coils to provide line linearity adjustment.

In passing it is worth noting another method of checking linearity. If a piece of nylon gauze is stretched on a frame and viewed along with an identical piece so that light passes through both on the way to the eye, a set of patterns will be seen as one piece of gauze is rotated. These patterns are called *moiré* patterns and they show in a very sensitive way any "linearity" faults in the weave of the gauze. If a "linear" gauze can be obtained, whether cloth, metal or simply a set of parallel lines on transparent plastic, then this can be used to check the set's linearity by forming a *moiré* pattern with the raster. This is by far the most precise method of all if a suitable master gauze can be obtained.

Video Amplifiers

The video amplifier of a TV receiver consists of a pentode, occasionally with a triode cathode-follower interposed between the pentode anode and the c.r.t. cathode. On older sets using early type valves this is hardly adequate for 2·5MHz bandwidth, though modern valves in a suitable design can stretch this to 5MHz for BBC-2 use. At this point another decision must be made. Most amateur CCTV circuits will use non-interlaced scanning because of the complexity of design of sync generators for interlaced scanning. If a 3MHz bandwidth is to be used the picture will be to a 202-line, 50-*frame* standard. For 405 lines, 50 *frames*, 6MHz is needed, for 312 lines 50 *frames* 5MHz, and for 625 lines 50 *frames* 10MHz. The whole point of interlace of course is that it allows us to use smaller bandwidths, but in amateur practice bandwidth is more easily bought than is interlace.

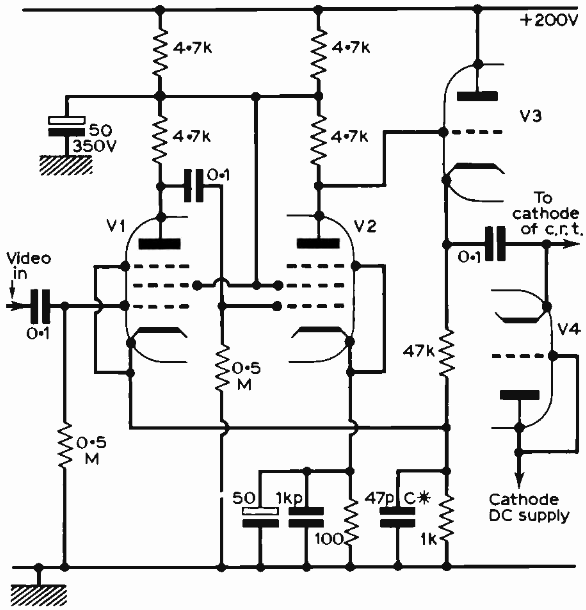


Fig. 3: Valve video stage suitable for driving a c.r.t. from a 1V input signal. Approximate values are given for PCL84 valves with the triode portions used as cathode-follower (V3) and d.c. restoring diode (V4). Other valves will need different values of bias components for V2 and possibly a different V1 anode load. C should be adjusted to give a level response to the desired frequency.*

For any given valve there is a quantity called the gain-bandwidth product which expresses the maximum amount of the gain multiplied by the bandwidth (at the higher frequencies). For most modern video pentodes this gain-bandwidth product will be more than 100MHz, indicating that a gain of 1 can be achieved with 100MHz bandwidth (assuming a gain-bandwidth product of 100MHz), a gain of 5 with a 20MHz bandwidth, a gain of 10 with 10MHz bandwidth, etc.

When two valves are used together the gains are multiplied but the average bandwidth is halved if both valves are used as voltage amplifiers. Two valves each singly capable of gains of 10 with a 10MHz bandwidth will produce when one is coupled to the other a combined gain of 100 with a bandwidth of 5MHz. Note though that we cannot apply the gain-bandwidth formula directly to two stages and argue for example that by reducing the gain of the whole amplifier to 50 we shall have a bandwidth of 10MHz. In fact each stage would have a gain of 7·1 ($7{\cdot}1 \times 7{\cdot}1 = 50$ approximately) and a bandwidth of $100/7{\cdot}1 = 14{\cdot}14$MHz so that the combined bandwidth would be about 7MHz.

Using modern valves a circuit such as that shown in Fig. 3 can provide a gain of about 50 (so that a 1V video signal should drive a c.r.t. fully) with a bandwidth of about 10MHz. Note that the inductive peaking circuits so common on receivers have not been used. This is because they are difficult to set up at such bandwidths and are often more trouble than they are worth in terms of ringing and phase shift.

On some older sets, particularly some KB models, a heater transformer is fitted so that 6·3V heater valves can be used. This type of set lends itself very well to the sort of rebuilding operations which we have been discussing as there is no need to renew the heater line dropping resistor every time a new stage is added, and use can be made of the 6·3V heater valves used in the very wideband video amplifiers of oscilloscopes.

Note that a cathode-follower between the video output stage and the tube is undesirable unless low-value cathode load resistors can be used. This is because the time-constant of the cathode resistor and the output capacitance may cause the cathode-follower to cut off when the grid is driven negative.

Power Supply

Using a video amplifier of the type described the former TV set can with some modifications to the sync circuits be adapted for use as a monitor. In common with all but the most veteran sets though the chassis will be connected to one side of the mains. This is completely unsafe for a monitor which is linked to a camera, and *the chassis must be isolated*, either by rebuilding the power pack using a double-wound transformer, or by feeding the whole monitor from an isolating transformer such as those sold by Radiospares. Such methods enable us to earth the chassis so that we can use any camera or other attachment straight into the input of the video amplifier. It is worthwhile building the power pack on a self-contained chassis so that it can be tried in several different locations inside the cabinet, for some hum-modulation of the scans may be caused by the presence of the mains transformer. Remember to check the appearance of the raster before fixing on the position of a power pack or an isolating transformer.

Using RF Outputs

If narrowband video is to be used (202 or 312 lines) some saving is usually possible by retaining the TV circuitry, power supply and all, and using the set purely as a receiver of r.f. signals. The adaptation of a TV set to wideband r.f. is almost out of the question: a very high frequency carrier in Band V would be needed along with a complete redesign and rebuilding of the r.f., i.f. and video stages.

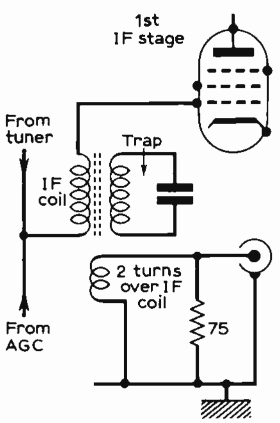


Fig. 4: Feeding the camera signal in at i.f.

The use of r.f. may not be completely straight-forward when 312-line operation is used because 625-line sets generally switch to the u.h.f. tuner and open-circuit the Band I/III aerial socket when BBC-2 is selected. The generation and modulation of u.h.f. signals in the camera is undesirable, and the easiest way out is to generate at i.f. and feed in at a separate socket (see Fig. 4). This should be done only if shielding is good, to avoid interference with neighbouring sets whose i.f. traps are not all that they might be. The alternative is to modulate at a Band I/III frequency and modify the switching in the receiver so that the v.h.f. tuner is still in use when BBC-2 is selected. Note that the receiver switching also changes the connections to the detector, as noted in a previous part of this series. The modulation in the camera should be positive for 405 (202) and negative if 625 (312) lines are being used.

When r.f. or i.f. camera outputs are used in this way, whether into the tuner at an unused Band I/III frequency or straight into the i.f. amplifier, the amplitude of the signal will probably be considerably more than the first stage can handle so that attenuation will be needed. In addition the a.g.c. line of the receiver should be removed because it prevents a full contrast range being used. The a.g.c. is derived from the sync separator grid in most sets and provides a bias which depends on the average video signal level. Without a.g.c. the true black level can be obtained in a signal. We have arrived at a stage of TV receiver design where only TV engineers and CCTV enthusiasts know what a picture with true black level looks like.

Sync Circuits

The sync separator of a typical TV receiver consists of an unbiased stage to whose grid is fed a negative-going composite video signal; that is, a mixture of video and sync pulses with the peak white of the video negative. With this arrangement the valve conducts only on the sync pulse tips thus separating the tips of the sync signals from the video and not affecting the video signal. The anode circuit of the sync separator contains two time-constants (Fig. 5), one a differentiating time-constant which sharpens both line and field sync pulses into negative spikes, the other an integrating time-constant which produces a sizeable pulse only when a long field pulse or a train of closely spaced field pulses appears in the signal.

In the normal broadcast TV signal the field sync consists of such a train of pulses which are half the width of the line sync pulses and the integrator builds up the pulses to a single long pulse. The integrator, along with the action of the valve, behaves as a smoothing circuit for a rectifier, and it is the smoothed rise of voltage at the output of the integrator which acts as the sync for the field timebase.

When composite syncs are used in CCTV they may be provided by an external sync generator and may be interlaced; or they may, as is much more likely, be generated in the camera and non-interlaced. Using interlaced syncs the conditions at the sync separator are exactly similar to those encountered with a broadcast signal, with the advantage that there has been less dispersion of the signal to round off the pulses. With non-interlaced syncs the field sync consists usually of a wide field pulse mixed with line pulses; the line pulses are often added to the amplitude shown in Fig. 6. This should provide a rock-hard sync for the field timebase, free of any slipping problems.

It is worth pointing out that any interruption of the signal means zero voltage at the grid of the sync

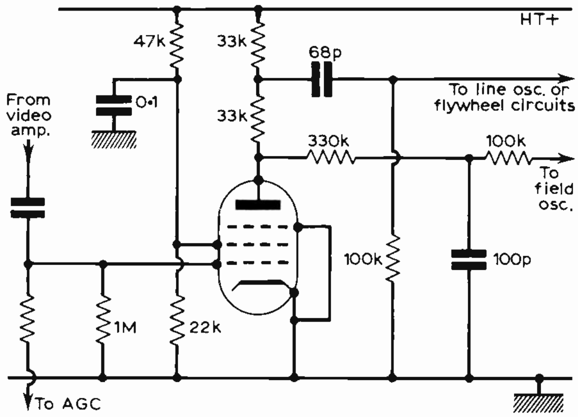


Fig. 5: Typical sync separator circuit.

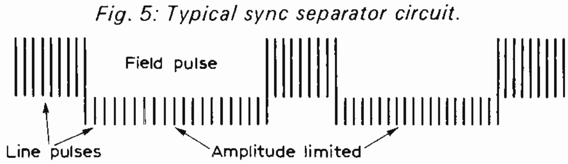


Fig. 6: Non-interlaced field sync pulse.

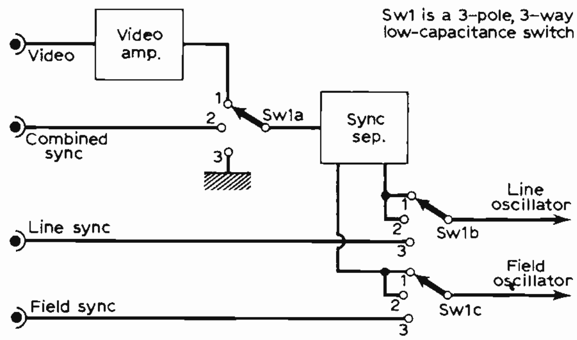


Fig. 7: Comprehensive sync switching scheme. Switch positions: 1, for composite video and sync; 2, for combined sync separate from video; 3, for separate line and field syncs and video.

separator and so conduction for the period of interruption. This period of conduction will cause a fall in the voltage at the anode of the sync separator and when the signal is restored the rise of voltage will act as a field sync pulse. This is the cause of field roll when pictures are switched and is difficult to avoid unless sync and video can be handled separately, the video alone being switched.

Separate Syncs

It is fairly straightforward to provide for separate syncs inside a monitor, for all that is required is a pair of connections leading to the timebases. The monitor should of course have an earthed chassis. If the existing connections to the sync separator are to be retained the sync pulses fed in will be distorted by the sync separator circuits unless the source impedance is low. Generally the syncs will be obtained from a 75Ω cable fed from a cathode- or emitter-follower so that the impedances *will* be low, but any video disturbances will still affect the syncs through their effect on the sync separator. For this reason it is better to isolate the sync separator by a switch or by using contact-breaking jack plugs. The scheme illustrated in Fig. 7 shows a complete sync system which permits the use of combined video and sync, separate video with combined sync or completely separate video and syncs to each timebase according to the switch position.

Assorted Points on Monitors

The working e.h.t. on most older tubes can be raised to give better resolution though the manufacturer's working limit should not be too greatly exceeded. Working at much more than 18kV is undesirable because of the hazard of X-rays from the tube and from the e.h.t. rectifier. These are always present but their penetrating power increases rapidly as the e.h.t. is increased. If a monitor is being completely rebuilt it may be worthwhile to use two line output stages, one driving the line coils and the other providing only e.h.t., in which case the e.h.t. can be stabilised by one of the forms of non-linear resistor that are available.

Screening the circuitry of a monitor by lining the cabinet with earthed aluminium foil is a very worthwhile precaution, particularly if high-gain video amplifiers or signals modulated at i.f. are being used.

TO BE CONTINUED

DX-TV

—continued from page 260

16th; Geminids December 9-14 peaking 13th; Ursids December 20-22 peaking 22nd.

It has happened at last in this area. As predicted in last month's article BBC-1 and ITV have opened up on u.h.f. channels, 31 and 27 respectively. After some initial delay they appeared on 10/12/69. The situation is grim but could have been even worse. Whilst BBC-1 and ITV are on the air I have lost Chs. 31 and 30 from BBC-1 and Chs. 27 and 26 from ITV. However the vision signals do not spread further than this even with the aerial directed towards them for Holland and West Germany. What has turned out better than expected is the sound channel interference: the 6·0MHz separation as opposed to the 5·5MHz European separation has meant that any adjacent channel trouble is only marginal.

I have even gained a new station. With BBC-2 Rowridge Ch. 24 closed down for the alterations I found that I was still getting BBC-2 on Ch. 64. I had thought that this was a queer harmonic of Ch. 24 but it turns out to be Mendip Forest and is not a bad signal at all here. It certainly gives me hopes for the h.f. end of the band.

As predicted my French u.h.f. local Caen Ch. 25 has survived. I had it on the first day of BBC-1/ITV operation in spite of bad conditions. The aerial direction for it is happily at the nul point for the locals.

We have a very interesting set of F2 trans-equatorial skip reports from Mr. Butler of Hamburg, West Germany. Whilst he was living in Southern Rhodesia he received good pictures and sound from Spain E2 and Italy IA and he repeated the performance from an even greater distance when in Luderitz, S.W. Africa. On a rare occasion he had Spain E2 again from a ship in Cape Town harbour, all excellent. As yet South Africa has no TV service so we cannot hope for similar things in the opposite direction, but with the projected television service there our turn could come.

YOUR PROBLEMS SOLVED

Whilst we are always pleased to assist readers with their technical difficulties, we regret that we are unable to supply service data or provide instructions for modifying equipment. We cannot supply alternative details for constructional articles which appear in these pages. WE CANNOT UNDERTAKE TO ANSWER QUERIES OVER THE TELEPHONE. The coupon from page 283 must be attached to all Queries, and a stamped and addressed envelope must be enclosed

EKCO T433

After this set has been on for an hour the bottom of the picture creeps up and leaves a half-inch gap. I have replaced the PCL85.—H. Westerly (Hampshire).

Check the grid coupler to the PCL85 grid and also the varistor which is clamped to the scan coils. This may be incorrectly positioned.

FERGUSON 3641

The e.h.t. voltage trebler has failed after approximately one year and a replacement has failed after approximately one month. When fitting the replacement I checked all voltages which appeared to be satisfactory. The only doubt was that the line deflection was only just adequate with the width control nearly at maximum. The linearity was satisfactory and there do not appear to be any e.h.t. splashes to earth.

Could you advise on any special points to look for before replacing the third unit, and can you say which back-numbers dealt with this BRC 950 Mk. 2 chassis?—M. James (Somerset).

Your experience is not unusual by any means. A new e.h.t. tray can become defective within a very short time with no external cause. You should however check the 100pF (high voltage) capacitor which connects to the width circuit v.d.r. and the v.d.r. itself.

The issues of PRACTICAL TELEVISION in which the details of the 950 Mk. 2 chassis appeared are April and May 1969.

REGENTONE 10-4

The trouble was very critical line and field hold. All the timebase valves were changed and this resulted in the line lock being fairly acceptable, but the field rolls at the least provocation. Field judder sometimes appears with the picture "bouncing" up and down.—D. Andrews (Nottinghamshire).

The usual cause of the trouble you describe is an alteration in the value of the two resistors connecting to pin 8 of the ECL80 (V6). These resistors are R37 100kΩ and R39 8·2kΩ. Also check C38 (0·05μF) to pin 9. The main electrolytics could be failing.

STELLA ST2019A

There is a good picture and sound on ITV but on BBC-1 there is no sound—only a hum in the speaker, and the picture has line distortion. I have changed the PCC189 and PCF86 tuner valves, the ECL80s, PCL85, PCL83 and PL83. BBC-2 is perfect. —S. Khan (London, W.13).

It appears that the BBC-1 channel is incorrectly adjusted on the tuner front-end. This would result in picture distortion and hum on sound due to vision signal breakthrough. It is also possible, of course, that the i.f. alignment is wrong. If you have been altering trimmers or adjusting transformer cores, suspect this too.

SOBELL TPS180

A black line appears at the bottom of the picture and progressively moves up during the first two hours. I have tried replacing the field output valve and the cathode resistor and capacitor.—M. Chambers (Stafford).

This symptom is basically caused by d.c. resistance in the field scan coils as the set heats up. However, it can be aggravated by leakage on the field timebase board from a conductor adjacent to that connected to the control grid of the field output pentode; also by leakage in the capacitor on the control grid of this valve. In many cases it is necessary to overscan slightly so that the shrinkage at the bottom is not subjectively disconcerting.

ULTRA 1781

I have fitted this receiver with a motorised tuner and the mixer oscillator valve in it—a 30C17—is causing trouble. The triode section anode glows red but I am unable to find the cause. The cathode is strapped to earth. I have lifted the anode feed capacitor off and it still glows. All the voltages appear satisfactory and the grid is not positive. At the moment the valve has to be replaced every couple of minutes.—A. Wells (Wiltshire).

Ultra give the valve for the mixer-oscillator position as a 30C15 and not a 30C17 as you appear to have fitted. This should be replaced. If the fault remains check the anode dropper R13 (6·8kΩ) and the grid leak resistor R11 (10kΩ).

ALBA T721

The picture is negative and distorted, sometimes with line pulling. I have changed the vision detector diode and checked the vision i.f. and video amplifier valves. The receiver also has the fault of being short at the top of the picture. I have changed the timebase panel and the two capacitors and resistors on the field output transformer. The time-base panel makes a very loud hum and the picture waves from the sides.—A. Lawson (Cheshire).

The first fault to clear on your receiver is the hum, which may well be accentuating the other faults or even causing them on your Alba T721. The smoothing electrolytics are C57 and C58 (100 and 400μF). These are the large can capacitors mounted on the chassis next to the PY32 rectifier (V15). The rectifier should be the next to check if the capacitors are OK.

If after curing the hum the other faults remain, check the cathode components of the video amplifier V5 (EF80). These are R13 (330Ω) and C14 (500μF). Also, you say that you have changed the video detector. Make sure you have connected this the right way round.

EKCO T365

Unless the contrast control is turned up to nearly maximum the picture flickers rapidly bright and dim (like a stroboscopic light) whenever a scene changes to one with a large area of whiteness. Turning the contrast control further towards maximum makes outlines of the white areas become blurred but the flickering ceases. Reducing the brilliance restores the outlines but changes the picture into a flat grey without contrast.—L. Rawlings (Surrey).

It would seem that the e.h.t. current is limiting on your receiver.

The most likely cause is the e.h.t. rectifier V15 (U26) losing emission, but it may also be due to one of: efficiency diode V14 (U191); line output valve V13 (30P4); the e.h.t. stabilising metrosil. It could also be the c.r.t. itself that is faulty.

STELLA ST1049A

Picture quality recently became poor so I replaced the r.f. amplifier valve PCC89 and the vision output PL83. I now find that the picture takes almost a minute to appear with full brightness. Also there is a shadow from left to right which only appears intermittently, sometimes on the bottom half and sometimes on the top half of the picture. There is also some flickering and fluctuating of brightness. I have not touched the field valves and the sound remains perfect.

Could you also say which tuner is employed in this receiver.—G. Dancey (Gloucestershire).

The fault you have described on your receiver suggests hum. This is probably due to the failure of one of the smoothing/reservoir capacitors in the power supply. Check C103 (200μF), C104 (250μF) and C107 (250μF). If none of these is faulty check the rectifier X101 (type BY100) and then each valve in the video chain for a heater-cathode fault.

The type of tuner your set uses depends on its age. The earlier tuner uses a PCC89 and a PCF80; the later type a PCC189 and PCF86. The basic circuit is the same in both cases.

FERGUSON 3639

There is loss of line hold two minutes after the picture appears. At this stage it can be reset but after two-five minutes the line hold is lost again. When attempting to reset it for the second time it is very difficult, as though there is no sync pulse coming in. Violent movement of the line hold back and forth will lock it and from then on the line hold remains steady for the remainder of the evening's viewing.—P. J. Stilling (Surrey).

Since the hold can be stabilised after working the control we feel that the control is at fault—with poor connection between slider and track. This could be due to dust in which case you may be able to effect a cure by introducing a few drops of contact cleaner via the shaft, allowing it to dry a little then working the control with the set off for a minute or so.

SOBELL 1010

This receiver has a field fault. The top half of the picture has collapsed whilst the bottom half is restricted. There is also sound-on-vision on the local BBC only. Is there an adjustment on the v.h.f. tuner for this?—C. Brundy (Lancashire).

Check the PCL85 valve and its associated components, and also the field deflection coils if necessary. The sound-on-vision may be due to excessive signal input or incorrect tuning. First ensure that the grey lead from the v.h.f. tuner goes to PC10 with link "A" to PC6. If retuning is necessary, remove the tuner knob and retune the oscillator coil core through the hole with a suitable trimming tool.

HMV 1893

I am having trouble trying to get full height. All I can get is a line across the middle of the screen. I have changed the PCL82 and ECC82. The PL81 gets very hot.—A. Sinclair (Hampshire).

The resistor R113 near the ECC82 is likely to be at fault. Its value is 22kΩ. We suggest that you fit a 1W resistor in this position. Check the boost line voltage to the height control (thence to the PCL82 triode anode) and h.t. to pin 6 of the valve base (this checks the output transformer).

KB KV003

This portable receiver is working all right on other channels but on channel 5 I keep getting horizontal bars about 1in. wide in different shades. These lines slowly roll down the screen and look rather similar to the BBC-2 test bars. Also the brightness has been getting less and less.—E. Vella (Cardiff).

Since only one channel is affected it seems as though the patterning is due to external r.f. interference. We do not feel that the reducing brightness—which could be caused by an ageing tube—has any bearing on the other symptom as it would apply to all channels in this case. It is possible that your aerial is incorrectly tuned (channel 5) or mis-orientated. This should be checked. If the trouble persists it might be as well to call in the Post Office interference investigating department—but before you do this make sure that the aerial system is optimised.

INVICTA 123

There is insufficient width (¼in.) at each side. Otherwise the set is in good order.—E. Lanham (Wiltshire).

We suggest that you check the h.t. voltage as the rectifier seems to be failing. If this is not so check the screen resistor of the PL81 and the line drive from the PCF80. Check the PY81 if necessary.

PYE VT17

The field timebase of this receiver seems to run at half speed. The field control is very sensitive and only locks—with difficulty—half way across the screen with the bottom half of the picture in the upper half and the top part of the picture in the lower half.

I have tested both field timebase valves by substitution. The CG10E and WX6 diodes have been replaced as has R102.—L. Headley (Hampshire).

The trouble would appear to be due to R101 changing value. Also C79 (0·01μF) could be leaky.

HMV 2635

It is virtually impossible to entirely eliminate sound-on-vision on BBC-1 by use of the fine tuner or the oscillator behind the selector knob. The sound-on-vision is much worse on BBC-2 and whenever programme titles are superimposed, or almost any writing appears, a loud buzz masks any other sound. Sometimes a diffuse horizontal line or dark band about three inches wide rolls slowly around the screen from top to bottom.—B. Connett (London).

We would advise you to replace the main smoothing electrolytic on the right-hand side. Leakage between the sections of this unit could cause the trouble mentioned.

COSSOR 945F

This receiver has a black band dividing the picture. I cannot eliminate it by rotating the horizontal hold control which I have replaced. I have renewed the ECC82 and most of the components connected with it.—J. Little (Cumberland).

The trouble you describe could be in the discriminator circuit between the PCF80 sync separator and the ECC82. An oscilloscope would quickly lead you to your trouble, but failing this you could try bypassing the flywheel unit with a small amount of direct sync.

PETO SCOTT 738

When the set is switched on there is a black band top and bottom of the picture. As the set warms up it takes 15 minutes to fill the screen. I have changed the PCL85 field output valve but no improvement has been noted. — A. Benison (Nottinghamshire).

We would have thought that replacement of the PCL85 would have solved the problem. However if you are sure that the new valve is good check the boost supply line, R72, C54, etc., and the network of resistors and capacitors associated with the height circuit.

MASTERADIO 4003DST

The height of the picture has slowly reduced so that with maximum adjustment there is still a band of 1in. at the top and bottom of the picture. It is also difficult to stop the picture from rolling.

The PCL85 was running very hot and though a replacement improved the height it was also very hot and so has been removed.—J. Thompson (Northumberland).

The overheating of the PCL85 is probably being caused by incorrect d.c. conditions on the valve. Check that R80 on pin 2 is 47kΩ; P2 field hold control 250kΩ; P3 height control 1MΩ and R81 (anode resistor) 680kΩ. Also check the field scan charging capacitor C90 which should be 0·05μF.

COSSOR CT1964A

There is severe sound-on-vision and ringing on BBC-1. I would be most grateful if you could tell me how to rectify it. Reception on ITA and BBC-2 is perfect.—W. Bates (Essex).

The fault you describe could be in the 405 tuner channel 1 biscuit. If this is the case you may be able to get better results by tuning up channel 2. Failing this suspect a poor connection at the head end of your BBC-1 aerial system.

INVICTA 7195U

This receiver performs well on Bands I and III but not on the u.h.f. band. On initially switching to the u.h.f. band and increasing the brightness control a small distorted raster appears on the screen. The image gradually increases in size and fades from the screen. The timebase and video amplifier valves have been replaced with no improvement.

With the u.h.f. aerial connected the u.h.f. sound is normal and there is some picture content on the distorted raster before it fades from the screen.—D. Wildman (Northamptonshire).

The symptom you describe results from incorrect line timebase operation on 625 lines and this could be caused by a fault in one of the line standard change switch sections related to the line output stage. You may in fact find that one section changing a capacitor over has been burning. If the switch is all right check the capacitor which is switched in the line scan coil circuit. This could be open-circuit or low value. Also check any other switched components around the line output transformer.

STELLA ST2023

When switched on from cold everything works OK for about a minute then the picture vanishes. The sound meanwhile remains normal. After a further couple of minutes the picture comes back perfectly. I have noticed that there is a sort of vertical streak in the centre of the screen when the picture goes off. I have tried switching off after the set has warmed up then switching on again but the fault does not occur when the set is warm—only when cold. I should add that it is the raster that is lost.—H. Pedler (Garstang).

The most likely source of the trouble is a valve. One of the two in the screened section or the ECC82 line oscillator are the suspects to check first.

MURPHY V250

The following faults have developed in this receiver: lack of width (2¼in. either side with controls at maximum) and the left-hand side of the picture is curved in the shape of a half-circle. There is lack of height and insufficient sound. I have replaced V11, C53 and C77 but to no avail. The field hold also needs critical setting and there is weak vision on Band III.—S. Courtney (Middlesex).

We suggest that the main trouble with your receiver is low h.t. voltage. Check the h.t. rectifier, the smoothing capacitors and the reservoir capacitor connected to the rectifier positive point. This could account for the impaired sensitivity as well as the lack of width. However you may also have to replace the line output valve and boost diode; and sometimes the sensitivity falls due to deterioration of the small i.f. decoupling capacitors in the vision and sound strips.

PYE 40F

There are wavy verticals throughout the picture, waves of regular shape about half height apart either moving from bottom to top or from top to bottom. The sound remains normal.—A. Greenaway (Hertfordshire).

Suspect hum in the video amplifier. This could be caused by failure of one section of the main smoothing block or a heater-cathode leak in the PFL200. This later would show up worse on 625 lines.

FERGUSON 992T

There was no e.h.t. and all checks proved negative. Then I disconnected the e.h.t. lead to the tube and the e.h.t. came to life. I decided that the tube (MW36-44) must be at fault and tried another with the same result. However I did notice sparks on the outer glass of the tube, between it and the metal casing which encloses the scan coils and touches the tube.

Next I cleaned the glass of the tube and round the e.h.t. connection but the results were the same. I tried another tube (MW36-80) with the same result so I tried operating without any connections to the tube (only e.h.t. lead connected) and also removed the scan coils with still the same result.

If I put a neon screwdriver on the glass of the tube it glows.—S. Cummins (Surrey).

The trouble you describe is almost certainly caused by a cathode-anode leak in the e.h.t. rectifier. Try replacing this valve.

QUERIES COUPON

This coupon is available until March 20 1970, and must accompany all Queries sent in accordance with the notice on page 280.

PRACTICAL TELEVISION, MARCH 1970

TEST CASE

88

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 Philips 501 colour set was said by its owner to be suffering from bad ghosting. Subsequent investigations proved this basic diagnosis and thinking that there had been some change in a structure locally to incite multipath interference (i.e. signal reflections) the set was taken as a check to a different site and aerial system, both known to be free from the trouble. However the trouble persisted.*

Careful analysis of the off-screen symptom revealed that it was not the normal type of monochrome ghosting, for when the colour was turned right down the effect disappeared. It was then seen that as the colour was turned up so the "ghosting" effect became apparent due to the colour failing to register exactly with the monochrome or luminance parts of the picture.

What was the most likely cause of this symptom? See next month's Practical Television *for the solution and for a further Test Case item.*

SOLUTION TO TEST CASE 87
Page 237 (last month)

Since the i.f. channel was proved to be properly aligned and free from peaks it would have been obvious to the service technician that the tuner was to blame, especially in view of the effects brought on by moving the coaxial lead at the rear of the set.

A faulty valve is a common cause of the symptom but it will be recalled that these were replaced. Another common cause is failure of one (or more) of the small ceramic decoupling and/or bypass capacitors. Unfortunately these are extremely difficult to get at, but when trouble of this kind is suspected it often pays to replace them all in the tuner. It it most important to make sure that the *correct* replacements are used and that they are fitted with the same lengths of lead-out wires as the originals. Failure to observe these points will result in severe misalignment of the tuner, realignment of which is generally outside the scope of the enthusiast.

In the Test Case in question the responsible capacitor was the 1kpF decoupling the screen grid of the PCF80 valve.

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3000mfd	30v.	8/6d.
5000mfd	30v.	9/3d.
25mfd	50v.	1/7d.
50mfd	50v.	1/10d.
100mfd	50v.	2/3d.
250mfd	50v.	3/4d.
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10mfd	18v.	1/6d.
16mfd	18v.	1/6d.
25mfd	18v.	1/6d.
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68	,,	8·2K	1M
82	,,	10K	1·2M
100	,,	12K	1·5M
120	,,	15K	1·8M
150	,,	18K	2·2M
180	,,	22K	2·7M
220	,,	27K	3·3M
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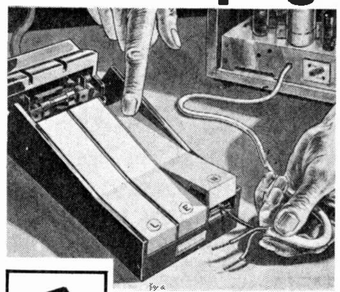

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