PRACTICAL

TELEVISION

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DECEMBER 1969

LINEAR TIMEBASES

ALSO

SERVICING THE BRC 1400 CHASSIS

TV FILTERING CIRCUITS

TEST EQUIPMENT LIMITATIONS

PRACTICAL TELEVISION

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CONSTRUCTOR'S CHARTER

AMONGST the purposes of *Practical Television* is the publication of reliable equipment designs for the constructor and we recognise all too well that this is a field that has not received the attention it deserves in recent months.

There are problems that make it difficult to do justice to this interest. To start with the commercial product is sold in a highly competitive market and costed on a mass-production basis. This makes it hard for the constructor to come up with something that doesn't cost a lot more in the end—especially if he takes into account the cost of his own time spent. Then there is the question of the availability of parts. To build a TV set at reasonable cost it's almost essential to use some surplus parts, but how long will supplies last? It's no use us having a design worked out, built, written up and drawn out and then published only to find that component stocks have dried up.

However, we know that there are possibilities, and have good news for the constructor: a number of projects are being worked on and during the next twelve months at any rate *Practical Television* will not be short of constructional features. Next month to start the ball rolling we give details of a 17in. 625-line receiver built for about £6. Then we have a 20in. single-standard receiver on the way, a series of "building block" circuits that will enable a fully-transistorised dual-standard set to be built, articles on what can be done with readily available surplus conversion kits, and the usual test equipment features including a capacitance bridge which will come very shortly. Later next year we hope also to publish full details of a field-sequential colour converter to make possible colour reception on black-and-white sets. We have not so far managed to come up with a full colour receiver: the costs and complications are still rather daunting. However, there will doubtless come a time and meanwhile we promise you your soldering iron will stay warm.

W. N. STEVENS—*Editor*.

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TELETOPICS

RCA SELECTAVISION SYSTEM

The RCA Laboratories at Princeton, New Jersey have now shown a laboratory model of a low-cost colour TV tape player system based on the use of lasers and holography. The intention is that it can be attached to any standard colour TV receiver and will play full-colour programmes which are recorded on clear, inexpensive plastic tapes. It is claimed that these tapes will cost about one-tenth as much as conventional film, that they will have countless replay capabilities and be virtually indestructible under normal conditions of use. The present aim is to start production in the US in 1972 with a price in the region of £170. Material for replay would be available at about £4 for a half-hour programme.

DUAL-SOUND TRANSMISSION

NHK Japan is planning to undertake full-scale experimental dual transmission of television sound over its Educational Service. The technique involves an additional sound channel on the existing video and sound transmissions. The viewer would then for example be able to choose when viewing a foreign film either to listen to the sound in the original language or dubbed into Japanese. This experimental dual-transmission of sound has been planned for use during Expo '70 to enable overseas visitors to listen to Japanese television programmes in their own language, or to hear TV relays of concerts in stereo.

The second sound channel is multiplexed on to the ordinary TV sound and an adaptor using about eight transistors is required. Several larger firms are planning to go into trial manufacture of the adaptors, so that there is a likelihood of high-quality stereo television sets with such adaptors in them being introduced before long.

VTRs AT STUTTGART

Blaupunkt, Grundig, Philips and Telefunken all showed videotape recorders at prices in the region of £200 at the Stuttgart 1969 Radio Exhibition. Viewers can use these to record off-air for playing back later on their TV sets, but special connections to the sets are necessary. NordMende showed their Colorvision equipment, a console unit with a TV receiver and colour cine playback device enabling cine film to be reproduced on the TV screen. The equipment uses a flying-spot film scanner with a c.r.t. and continuous film run, and can be stopped to reproduce frames still without overheating. It is similar to the EVR system but uses normal Super-8 film, with sound on a casette-tape player. The Colorvision equipment is expected to be available at about £400 some time next year.

BBC REDRUTH TRANSMITTER

The BBC-2 u.h.f. service from Redruth, on channel 44, is expected to start in the autumn of 1970. The transmitter will serve most of Cornwall to the west of St. Austell. BBC-1 transmissions on channel 51 will follow in 1971. Both transmissions will be horizontally polarised.

TRANSISTORISED TV CAMERA

A new transistorised TV camera using a standard 1in. vidicon tube and with no external controls other than mechanical focusing, intended for broadcast, industrial, commercial and educational use, is announced by KGM Vidiaids Ltd., Clock Tower Road, Isleworth, Middx. The camera, Model 113, costs from £250 for the standard unit without lens and tube to £312 15s. for a unit fitted with a sync generator and video processing board, optical focus driving motor and operation from line and field drive.

TALKING ABOUT COLOUR TV

The latest filmstrip produced by the Mullard Educational Service is entilted "Talking about Colour Television" and is based on a series of lectures given by Ian Nicholson at Mullard meetings for the radio and television trade throughout the UK. Intended for those with a working knowledge of monochrome TV, the filmstrip will however also interest others with little technical knowledge.

About half the filmstrip's 65 frames are in colour. Copies of the filmstrip and a 54-page teacher's book are available from: The Slide Centre Ltd., Portman House, 17 Brodrick Road, London, S.W.17 at 35s. for a single-frame filmstrip, 40s. for a double-frame filmstrip and 50s. for a double-frame slide set. Extra copies of the teacher's book, at 5s. each, can be obtained from the Mullard Educational Service, Mullard House, Torrington Place, London, W.C.1.

MINIATURE CCTV EQUIPMENT

Seer TV Surveys, a subsidiary of the civil engineering contractors William F. Rees, are to make available their Falcon subminiature CCTV system. The system is based on a torch-sized fully-transistorised camera which has a wide range of screw-on attachments. Also available are forward viewheads with built-in rheostat lighting, remote focus control and a variety of lenses; a right-angle viewing head controlled by a miniature electric motor which makes possible close inspection of welds, faults or fractures in tubes with as small an internal diameter as 1¾ in.; and introscope attachments to enable pictures to be taken inside tubes down to ¼in. diameter; and, depending on diameter, probes extending to 60ft. The system operates from 240V a.c. mains or a portable generator and complete systems cost from £1,300 upwards depending on the facilities required.

J-BEAM UHF AERIAL KITS

Two new u.h.f. aerial kits have been introduced by J-Beam (J-Beam Aerials Ltd., Rothersthorpe Crescent, Northampton), the Multibeam MBK30 for use in fringe areas where the field strength is down to 1mV/m, and the Parabeam PBK9 for use at close to medium range. New chimney lashing brackets are also available: ML6 (6in.), ML9 (9in.) and ML12 (12in.), suitable for masts up to 1¼, 1½ and 2in. diameters respectively. Prices are 24s. for the ML6, 29s. for the ML9 and 40s. for the ML12. Aerial prices are 112s. for the MBK30 and 80s. 6d. for the PBK9.

TIDAL FADING

In connection with the BBC-2 Craigkelly TV service (see map in *Teletopics*, September) the BBC point out that under certain conditions the reception of u.h.f. signals across sea paths can be severely degraded by fading associated with the rise and fall of the tide and that experiments have shown that part of the south coastal area of the Firth of Forth will be affected in this way when u.h.f. transmissions are received from Craigkelly. The effect is most serious on the coast where there is an unobstructed path across the sea in the direction of the transmitter, and dies away rapidly inland. Alternative u.h.f. services are available from Black Hill or Angus in the area affected.

NEW RANK CCTV EQUIPMENT

New from Rank are the Rank Nivico TKC6300 video mixer and TKE1 effects generator, at £125 10s. 0d. and £125 respectively. The mixer enables three video inputs to be mixed and faded in or out, with push-buttons for direct fading. The effects generator can split a picture diagonally, vertically or horizontally and is suitable for use with the mixer.

BRC GLASGOW DEPOT MOVES

The British Radio Corporation (Thorn Group) Glasgow Service Depot has moved to the following address: British Radio Corporation Ltd., 155 Shieldhall Road, Glasgow, S.W.1. Telephone number 041-882 4512.

BASIC OSCILLOSCOPE FOR SCHOOLS

Mitre Electronic Products of 22 Powis Terrace, London, W.11, announce a new basic oscilloscope type EA0699-1 intended mainly as a basic class oscilloscope in schools. It features a 2¾in. diameter tube, d.c. to 100kHz Y bandwidth, better than 100mV/cm Y sensitivity at maximum gain with full Y shift, automatically synchronised timebase with range 100msec/cm to 10μsec/cm approximately and 1V/cm X input with full X shift when the timebase is off. The price for single scopes is £24 10s. 0d., with a discount for schools.

Also available from Mitre Electronic Products is a small, portable battery-operated calibrator unit which provides a squarewave with accurately controlled voltage output and period. The output period is 1msec with an absolute accuracy of better than 2%; the output voltage level is switchable to 5V, 1V, 0·5V or 0·1V with an overall accuracy of $\pm 1\%$. Mainly intended as an oscilloscope calibrator, it has a useful role in any application requiring a precisely defined input voltage (load resistance to be not less than 200kΩ). Price is £19 ex works.

PYE COLOUR EIDOPHOR

Pye Telecommunications have demonstrated to BBC and ITA engineers a large-screen colour TV projector which has a maximum projection field of about 30 by 40ft. The Eidophor is used in TV presentations as a back projector and the firm's sales engineers think that the equipment may find applications at conferences and in teaching hospitals. The price is around £60,000.

BBC NEWS MOVES

BBC TV News is now operational in its new headquarters at the Television Centre, Shepherd's Bush, after 15 years at Alexandra Palace.

SEC TV CAMERA

Westinghouse have announced an improved s.e.c. (secondary electron conduction) TV camera, type STB609, designed for use at extremely low light levels. The limiting horizontal resolution is 700 lines and minimum signal-to-noise ratio 37dB at a faceplate illumination of 5×10^{-3} foot candles.

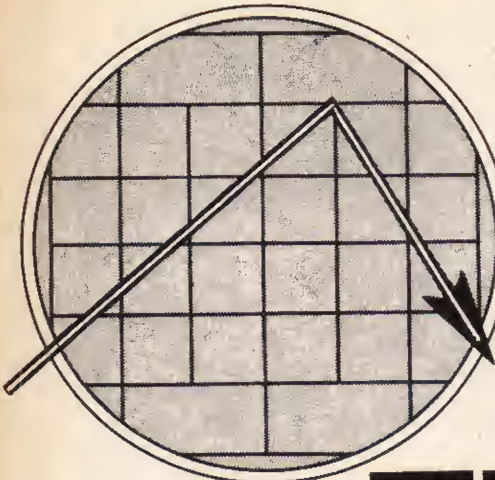
BRIEFS FROM ABROAD

Anticipating the start of TV in South Africa a Cape Town company are making preparations to assemble 100,000 sets from parts imported from Italy . . . Present TV set manufacturing capacity in India is still below 30,000 a year and the Government have given licences to two further consortia to start manufacture next year . . . The French TV industry produced some 1,500,000 TV sets last year of which 60,000 were colour ones. There has been no noticeable improvement so far this year in spite of considerable reductions in the prices of colour sets. If sales do pick up it is thought that some manufacturers may find components in short supply as this is a problem throughout Europe at present.

SET NEWS

A summary of the sets recently released is given in tabular form on page 131. The new BRC/Thorn range of single-standard monochrome models are fitted with their new 1500 chassis.

In an attempt to get sales of colour sets moving, Currys are offering a new Ekco 19in. single-standard colour model at 199 gns, some £23 below the manufacturer's recommended price.



LINEAR TIMEBASES Part 1

K.T.WILSON

THE circuits known as timebases in the UK and sweep circuits in the USA are common to a great variety of electronic devices such as TV cameras and receivers, oscilloscopes, radar sets and digital measuring equipment. The principles used in the design of timebases are not hard to understand but many circuits are so elaborate that it is very hard to disentangle the part which each component plays. This article is intended to unravel a little of the mystery of the timebase, with the emphasis on linear timebases for instrument rather than TV receiver use.

Basically a timebase is a ruler for measuring time. When we measure distance with a ruler we match the distance to the distance between two marks on the ruler and read off the number of marks in between. We can measure time in this way also using a stop clock, but for short times electrical methods are better and we must use electrical marks. The most convenient of these "marks" is voltage since it is easily indicated. If we arrange a circuit so that the voltage output is zero until we start timing, then rises steadily as time passes, a measurement of voltage output is a measurement of the time which has passed since we started timing. The starting time is called the firing time or the triggering time, and a linear timebase is the type just described, in which the voltage rises steadily with time. This means that if the voltage rises from 0 to 5V in 1msec then it will have reached 10V in 2msec after triggering, 15V in 3msec, etc. The word *linear* comes from the fact that a graph of voltage against time for this timebase would be a straight line. Not all timebases are linear.

Linearity

A voltage which keeps rising *indefinitely* is impossible and undesirable, and for most electronic purposes we wish the rise of output voltage to stop at some point and return to zero. The total time taken to rise (Fig. 1) is called the sweep time and the time needed to return to the starting voltage the flyback time. There may be in addition an interval or waiting time between sweeps. The linearity of a timebase is measured by the voltage difference between the actual timebase waveform and a perfectly linear timebase as a percentage of the voltage at which the measurement is taken.

The voltage timebase is the one most commonly used in oscilloscopes, where the deflection of the spot is achieved by applying a *voltage* difference to the deflector plates. In TV sets, TV cameras and radar sets magnetic deflection by deflector coils is used and it is the current in the coils which controls the position of the spot on the screen. In these cases current timebases must be used and generally these are not linear because of the non-linear characteristics of the scanning components.

The achievement of a linear timebase waveform is a two step operation. First a squarewave must be generated, and this may be done by any of the accepted methods—by squaring a sinewave, by direct generation in a multivibrator or flip-flop circuit or by a series of switching circuits. The second step is to convert this squarewave into a sawtooth, or linear sweep, a process known as integration because the same circuits in an analogue computer perform the mathematical operation known as integration. In many radar circuits the squarewave generators and the integrating circuits are quite separate and the working of the complete timebase is much easier to understand than is the case in some oscilloscopes where the two types of circuit are closely connected. Paradoxically the simple timebase (the Miller) which is used in so many home-constructed oscilloscopes is

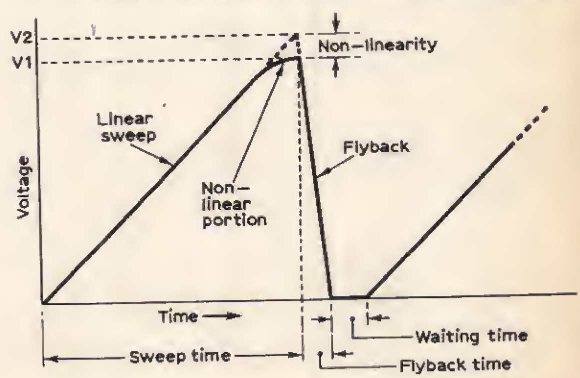


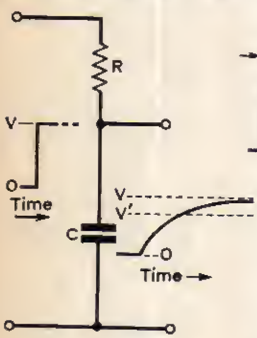
Fig. 1: Voltage/time graph of a timebase waveform (as might be viewed with an oscilloscope) showing common terms used. Percentage non-linearity at end of sweep =

$$\frac{V2 - V1}{V1} \times 100$$

certainly the most difficult to understand. Except in the case of circuits where the squarewave generator and linear sweep operations cannot be disentangled we shall look at the sweep circuits only.

Simple Sweep Circuits

If the circuit shown in Fig. 2 is set up and a voltage applied to the resistor input the output is as shown, a rising voltage which starts at a steady rate but tails off and approaches the amplitude of the input voltage only very slowly. This type of waveform is termed an exponential one and it is typical of a system where the rate of change depends on the force applied. In our case the rate of change is the rate of rise of voltage, and the force applied is the difference between the output and input voltages so that the charging rate is fast at first when the capacitor is uncharged and has the whole input voltage across it and slow later when the capacitor voltage is close to the input voltage. Exactly similar graphs are found for chemical reactions, air drag on missiles and scores of other systems; this enables us to solve many problems by setting up an electrical circuit instead of operating directly on the problem—it is easier to twiddle a potentiometer than to juggle with the thrust units of a missile!



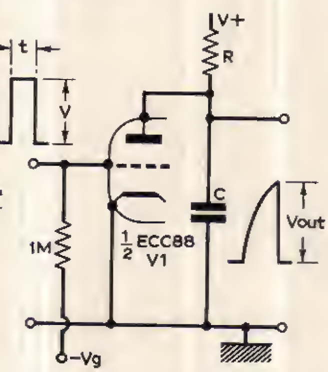


Fig. 2 (left): Exponential sweep circuit. V' is approximately 66% V and is reached in time CR seconds where C is in μF and R MΩ. Fig. 3 (right): Sweep and flyback. −Vg is a negative voltage sufficient to keep V1 cut off at any voltage up to V+. V is slightly greater than Vg and causes V1 to conduct for time t microseconds. The peak voltage of the timebase is given by

$$2{\cdot}3 \log (V+ - V_{out}) = -\frac{t}{RC}$$

where R is in MΩ and C in μF. If Vout is less than $\frac{1}{10}$ of V+ there is little error in taking

$$V_{out} = \frac{t}{RC} \times V+.$$

In a transistor circuit the flyback time decreases as V is made larger.

The exponential curve is not a linear timebase, however, though it is very near to one over the first part of its range. Sweep circuits based on the charging of a capacitor must therefore either use only a small portion of the charging curve or arrange for the charging rate of the capacitor to be unchanged as the voltage varies.

There are two basic methods of keeping the

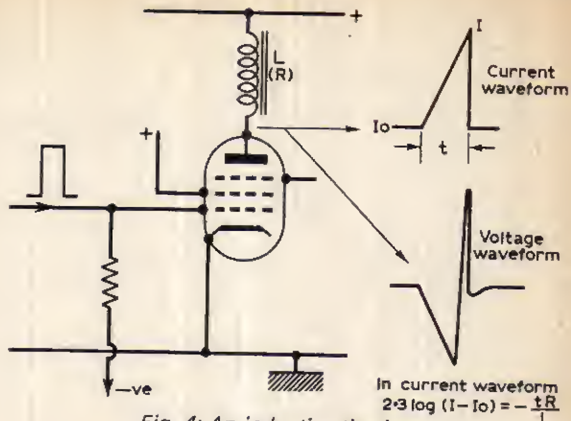


Fig. 4: An inductive timebase.

charging rate constant. One is to replace the resistor by some device which passes a constant current no matter what voltage is across it, unlike a resistor whose current is always the voltage across it divided by its resistance. If this constant current is passed into a capacitor with no leakage path the voltage across the capacitor will rise at a perfectly steady rate whose value (volts per microsecond) depends on the amount of the steady current and on the size of the capacitor. The other method which accomplishes the same end of a constant charging current is to keep the resistor but to increase the input voltage at the same rate as the output voltage changes so that the voltage across the resistor is constant, ensuring a constant current.

There is another requirement for a timebase generator apart from the provision of a sweep, and that is the provision of a flyback. Where a capacitor is being charged through a resistor or any other device, flyback means returning the voltage across the capacitor to its original value; this must usually be accomplished much more rapidly than the sweep time. This is nearly always done by shorting the capacitor by a switching circuit such as a valve or transistor placed across the capacitor and switched into conduction by a pulse at the grid or base (Fig. 3). If the valve or transistor could have zero resistance the capacitor would discharge instantly (if this were possible) and there would be zero flyback time; in rèality the resistance of the switching circuit causes a definite flyback time. In some timebases the flyback is caused by switching *off* and is slow because the capacitor must discharge through a resistor.

Note that the circuit of Fig. 3 is a complete timebase, requiring only a squarewave to drive the input of the switch, though the output is not linear for long sweeps. As the sweep time (=distance between flyback pulses) becomes longer for a given capacitor the sweep becomes less linear, though of higher voltage output. In a simple timebase of this kind there is always a conflict between the requirements of linearity and voltage output. A similar arrangement (Fig. 4) can be used to provide a current sawtooth. If an inductor is placed in the anode circuit of a valve or the collector circuit of a transistor then the current through the inductor will increase exponentially when valve or transistor is switched *on.* The resistance in this case is the resistance of the wire of the inductor windings.

The basic circuit of the simple *CR* timebase is found in the grid circuits of blocking oscillators and of multivibrators and is responsible for the timing of the output from these circuits. These waveforms, although sometimes used in TV receivers to drive inductive timebases, are far from linear and of little use.

Synchronising and Triggering

A *synchronised* timebase is one which normally runs freely until pulses are received which alter the repetition rate of the timebase until it matches the repetition rate of the pulses. The free running of the timebase is essential if the scanning must be continuous, as in a TV set where the interruption of the received sync pulses from the transmitted signal must not stop the tube being scanned.

At one time all oscilloscopes used synchronised timebases due to the possibility of damage to the phosphor of the cathode-ray tube by a stationary electron beam. Modern practice however is to have the beam blanked off except when scanning so that this restriction then no longer applies and *triggering* is now used instead. In a triggered timebase there is no switching pulse and no scan until a trigger waveform is received. This waveform is derived, in the same way as a sync pulse, from the received waveform being viewed, or from a separate source (external trigger). The great advantage of a triggered timebase is that the locking is perfect despite variations in the repetition rate of the trigger pulse. There can be no greater irritant to the user of a scope than a display which slips or jitters while it is being measured and a good triggered timebase never shows such faults.

Constant-current Stages

As we have seen one method of ensuring that a capacitor is charged at an even speed is to use a constant charging current. At one time a pentode formed the ideal constant-current generator since the current through a pentode is constant as long as the grid-to-cathode voltage is held steady. It is difficult to use a pentode to replace the resistor in Fig. 3

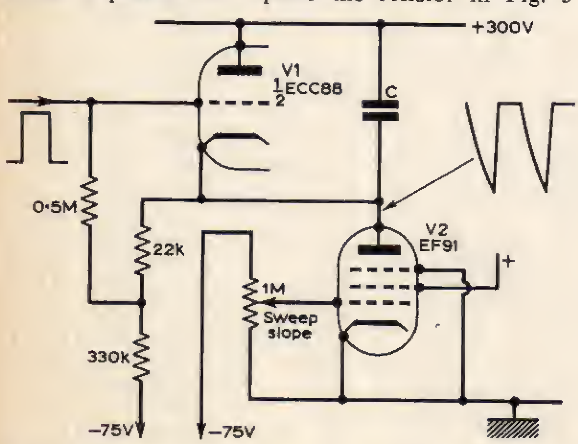


Fig. 5: Timebase with constant-current pentode. As in most simple timebases the amplitude of the timebase waveform will vary with the time of the sweep (or sweep slope). Values given are typical. C might range from 100pF to 1µF.

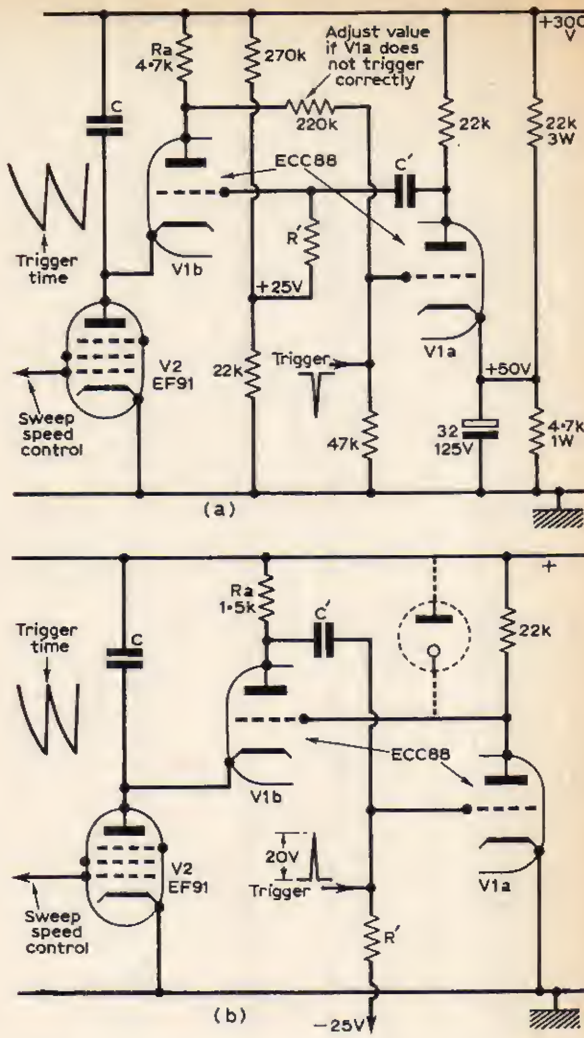


Fig. 6: (a) Constant-current pentode with shut-off circuit. The time-constant C'R' must be small compared to the sweep time in this circuit. Typical values C 0·01µF, C'470pF and R 220kΩ. This and the timebase shown in (b) are versions of the well-known Puckle circuit. Ra should be as small as possible to avoid lengthening the flyback unduly. (b) In this version the time constant C'R' must be large compared to the sweep time. Typical values C 0·05µF, C'0·5µF and R'1MΩ. Again Ra should be kept as small as possible. The amplitude can be further stabilised by the inclusion (shown dotted) of a stabiliser valve, but this is effective at low speeds only.

because as the capacitor charges the voltage on the cathode of the pentode would rise and it would be difficult to ensure that the grid-to-cathode and screen-to-cathode voltages remained constant.

When a pentode is used as the constant-current device it is better to use it to charge the capacitor at a constant current as shown in Fig. 5. In this timebase a positive pulse on the grid of the triode shorts the capacitor to h.t. and so discharges it. When the triode cuts off again the current in the pentode lets the voltage across the capacitor increase steadily as the lower plate charges to earth voltage, and the next positive pulse on the triode grid causes flyback.

Shut-off Circuits

In this circuit the speed of the sweep depends on the amount of current passing through the pentode and this is governed by the bias on the pentode grid. At a low anode voltage the pentode current is no longer constant so the flyback should start before the pentode anode voltage has fallen to about 25-30V. This can be done automatically by a *shut-off circuit;* a typical example is shown in Fig. 6(a) in which the shut-off circuit has been combined with the flyback switching. The grid of V1B is held at a voltage of about 25V by the potential divider (270kΩ and 22kΩ). During the time of the timebase sweep the cathode voltage of V1B is above the grid voltage so that V1B is held shut off and V1A, because its grid is direct coupled to the V1B anode, is held on. The capacitor coupling V1A anode to V1B grid is small so that the grid of V1B is controlled more by the resistors than by the waveform of V1A anode. When the voltage at the cathode of V1B drops to about 26-27V V1B conducts and its anode voltage falls; V1A and V1B then behave as a flip-flop (monostable multivibrator) with a short time-constant due to the small coupling capacitor. The conduction of V1B discharges the capacitor C so that the timebase stroke can start again as soon as V1B switches off again. Note that in this circuit the timing capacitor C′ also determines the time of the squarewave (generated by the monostable multivibrator action) which carries out the switching so that this is an example of a timebase in which the squarewave generator and the sweep generator are connected. The circuit can be triggered by applying a negative-going pulse to V1A grid. In the version shown in Fig. 6(b) V1B is normally conducting and V1A non-conducting and the sweep is initiated by applying a positive-going pulse to V1A grid.

A transistor is also a constant-current device, its collector current depending very much more on base current than on collector to emitter voltage. The transistor also has the advantage that there are no extra electrodes whose voltage must be kept constant

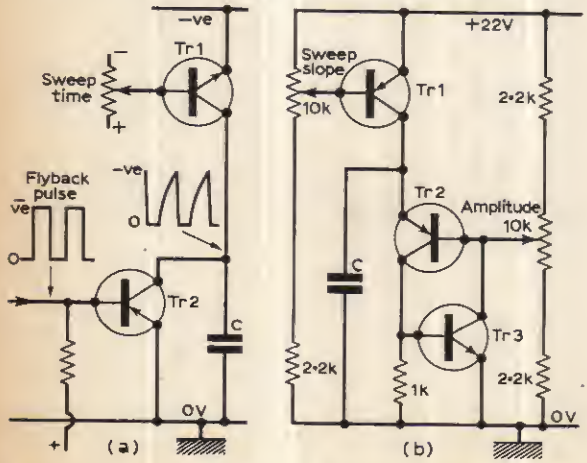


Fig. 7: (a) Simple constant-current transistor Tr1 and discharge circuit Tr2. (b) Constant-current transistor with auto shut-off circuit (typical values).

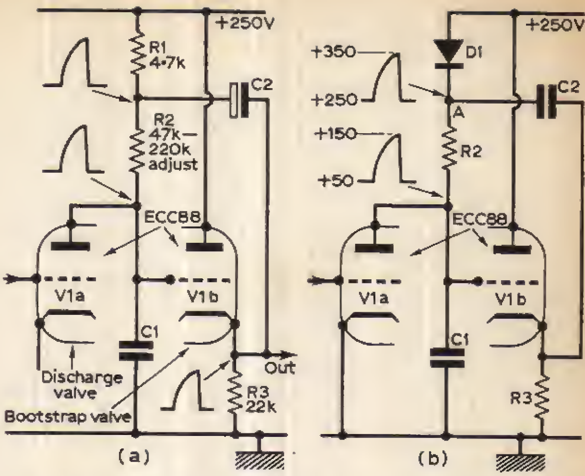


Fig. 8: Bootstrap timebase circuits. (a) C1 and R2 determine the slope, C2 is the bootstrap feedback capacitor (must have very low leakage) and R1 is the load for C2 signal. (b) Use of a diode permits the voltage at A to rise above HT+ without leakage problems; C2 can be smaller.

so that it can be used "floating", with no electrode grounded.

Figure 7 shows two modern sweep circuits in which a transistor is used as a constant-current device. Here the base current controls the emitter current which in turn controls the sweep speed. When an automatic turn-off circuit is used the voltage at which the automatic turn off operates decides the amplitude of the output waveform, so that the bias on the turn-off transistor is the amplitude control.

Bootstrap Circuits

As mentioned earlier an alternative method of making a constant current flow in a resistor is to keep the voltage across the resistor constant. This implies that if the voltage at the capacitor end of the resistor is rising the voltage at the input end must rise at the same rate. Figure 8(a) shows how this was first accomplished. The rising voltage across the charging capacitor C1 is directly connected to the grid of the cathode-follower V1B, an identical voltage appearing at the cathode of this valve. This is coupled by capacitor C2 to the top of the charging resistor R2 (which now cannot be connected directly to h.t.). Providing the time-constant of C2, R1 is much greater than that of C1, R2 the waveforms at each end of R2 are identical and so the current in R2 is constant.

An improvement on this is to replace R1 by a diode (Fig. 8(b)) so that the voltage at the junction of R2 and D1 can start at h.t. as the cathode-follower cuts off the diode, producing a sawtooth waveform at point A. This modification provides a higher sweep amplitude and rather better linearity, especially at low sweep speeds. Ideally the coupling should be direct all round, but care must be taken that practically no current is drawn from the charging capacitor C1 and the gain of the amplifier is exactly unity.

An interesting possibility is the circuit shown in Fig. 9(a) in which the transfer of the sweep waveform to the top of R1 is achieved by means of a long-tailed pair (V2A-B). Since the sweep voltage

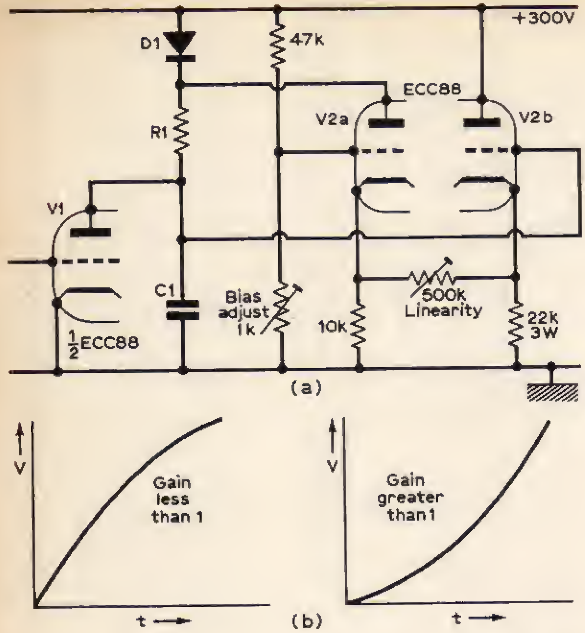


Fig. 9: (a) Bootstrap circuit using long-tailed pair. (b) Change of linearity with gain of the long-tailed pair, left where the gain is less than 1 and right where the gain is greater than 1.

is fed in at one grid and taken out at the other anode the coupling can be direct all round and the gain can be adjusted to unity by means of a variable resistor between the cathodes. Variation of this resistor causes considerable changes in the waveform, as shown in Fig. 9(b); too much resistance causes the gain to be less than unity producing an exponential waveform, while too little resistance over-corrects to the hyperbolic shape shown. Alternatively the gain of the second portion of the long-tailed pair can be set by negative feedback.

This type of timebase is not easy to reproduce with transistors due to the requirement of zero current drawn from the charging capacitor. Even a compound emitter-follower will require some base current which will be large compared to the charging current of a small capacitor. Insulated-gate field-effect transistors (m.o.s.f.e.t.s.) can be used to good advantage here since the input impedance is extremely high: Fig. 10 shows a bootstrap type timebase using a m.o.s.f.e.t.

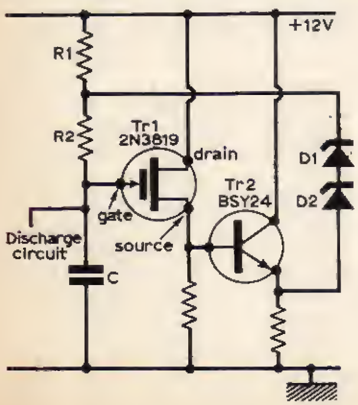


Fig. 10 (left): Bootstrap circuit using a m.o.s.f.e.t. (Tr1) and zener diodes. Circuit values depend on type of f.e.t. used.

The rising voltage on the capacitor C is applied to the gate of the m.o.s.f.e.t. Tr1 causing its source voltage to rise at the same rate. This in turn drives the emitter-follower Tr2 which works at a higher current and transfers the rising voltage through the zener diodes D1 and D2 to the top of the charging resistor R2.

This circuit is capable of considerable elaboration. The source resistor of the m.o.s.f.e.t. can be replaced by a transistor so that the effective source resistance to signals is very high, while the emitter-follower can be compounded to make its voltage gain closer to unity so that excellent linearity is obtained.

TO BE CONTINUED

TEST EQUIPMENT LIMITATIONS

TELEGENIC

IT IS reputed that Napoleon once said " Luck is what happens when preparation meets opportunity ". So it may well be on the battlefield, but in the war in the workshop it could perhaps be rewritten as " The correct reading is what happens when the right instrument meets the correct situation ". So much of what a meter pointer or an oscilloscope trace indicates is taken at its face value and can be very misleading.

Unless the instrument is faulty the reading will not be *wrong*; it's just that the situation in which it is used may require modification before the reading is of any value.

The Multimeter

Take the simplest case and the one most servicemen are well aware of, the use of a multimeter at high-impedance points in a circuit. The highest impedance normally obtainable from such an instrument is about 20,000 ohms per volt on d.c. (a.c. impedances are generally lower). Say the d.c. voltage on the grid of a valve is being measured and a reading of 5 volts is obtained: the loading of the multimeter would then be 100,000Ω (5 x 20,000). Now the input impedance of the valve at the grid may well be 500,000Ω or higher, in which case the meter would read 80% low.

This kind of loading error is quite commonly made. The easiest way to check a loading effect if one is suspected is to change range on the meter. If the meter is loading the circuit the reading will be higher every time the range is increased.

The frequency response of most multimeters does not exceed 6kHz although a couple give almost true readings up to about 10kHz. Generally speaking therefore audio test frequencies can be measured with a fair degree of accuracy although caution must usually be exercised if measuring such things as 8kHz on azimuth test on a tape deck. Bias on a tape deck *cannot* be accurately measured with a multimeter.

The Valve Voltmeter

The valve voltmeter overcomes the biggest disadvantage of the multimeter—its loading effect. This it effectively does by presenting a very high impedance across its terminals, produced by the input impedance of a valve stage. And to allow d.c. measurements d.c. coupling is used.

The frequency response of a valve voltmeter can be as poor as the worst multimeter or as good as 5MHz—it depends almost entirely on the bandwidth of the internal amplifiers. The appropriate manufacturer's handbook should be consulted in each individual case. Here again however many manufacturers quote frequency response only for a particular range on the instrument whereas the response can vary widely from range to range.

This effect differs between types of meters depending upon whether they use attenuators in the signal path or vary the feedback factor of the amplifiers. Even two examples of the same model tend to exhibit different frequency responses—at least marginally.

Another factor which can greatly affect measurements with a valve voltmeter is the use of probes. Many meters are supplied with probe assemblies and measurements made when not using the probes, or with a shortened probe lead, or with leads from the probe to the measuring point are inevitably inaccurate. These probes are carefully designed both in their capacitance and in their cable impedance to precisely match the input impedance of the instrument itself.

Probes for r.f. work can often be supplied and these greatly extend the use of a valve voltmeter—particularly for television work. Again an upper frequency limit is given, this being determined by the self-capacitance of the rectifier used in the probe head.

Difficulties are sometimes encountered in adjusting the electrical zero on some valve voltmeters, this being a problem in the design of stable d.c. amplifier systems. Often too an instrument will require re-zeroing when a range change is made. For accurate measurements therefore the zero should be checked every time a reading is to be taken, and a reasonable warm-up time should be allowed before attempting to zero the instrument at all.

Most valve voltmeters are relatively unaffected by overload although solid-state meters are sometimes damaged by the careless application of too high a voltage for the range selected. It is a good habit to return the range selector switch to its most insensitive position immediately a reading has been taken, for even if the circuit is undamaged the meter movement may be affected—and an inaccurate instrument is a useless one.

The Oscilloscope

Often ill-recognised as by far the most useful instrument a workshop can have, the oscilloscope is also the least understood. These two probably go hand in hand.

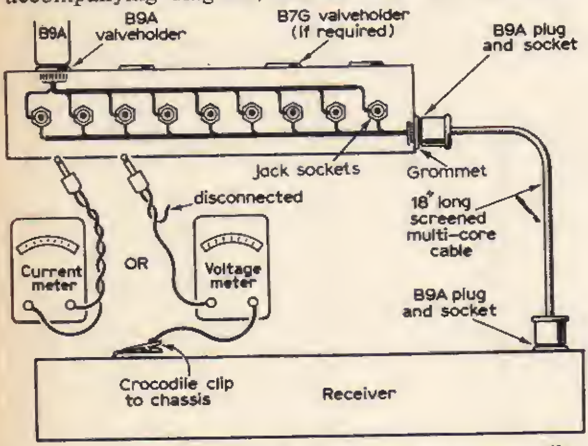
The requirements for an oscilloscope for television work are: (1) An accurate calibration signal should be available to check the vertical (Y) amplifier. (2) The frequency response should be adequate *not only* at the terminals of the oscilloscope but at the connection point of the probe as well. Adequate for normal servicing purposes need only

—continued on page 135

letters

VOLTAGE ANALYSER IDEAS

After reading your feature on the voltage analyser (August issue) I am wondering whether readers would be interested in a similar idea I have been using for some time. This analyser, shown in the accompanying diagram, can be used for valve test-



ing and voltage and current measurements. The extension B9A plug is connected via multicore cable to nine jack sockets which are in turn connected to a B9A socket on the analyser. With a jack plug connected to my Avo I can now plug into any of the jack sockets and get a current reading which I can use for valve testing or just as a measurement. Each socket can also be used to take voltage readings. If I suspect a valve I remove it from the B9A socket and fit a new good one in its place so that readings can be compared.—**M. J. P. Smale** (*Abingdon, Berks*).

I would like to express my thanks for the article on the voltage analyser (August) which I consider the simplest but most useful constructional item I have seen in any magazine.

The question of not being able to test valves fitted with top-caps started me thinking and I wonder whether other readers would be interested in the way I managed to incorporate this feature in my own analyser. In place of the suggested tagboard I used a Bulgin C124 ten-way board and wired the tenth position on the selector switch to the tenth bus-bar. I then mounted two 4mm. sockets, one on the top panel between the B9A and IO valvebases and the other on the side panel with the input bases. Both these sockets were then wired to the tenth bus-bar.

Next I made a 6in. lead with a 4mm. plug at one end and a plastic-covered top-cap socket at the other (taken from an old set). Finally I made up a 3ft. lead with a 4mm. plug on one end and a standard jack plug, plastic insulated (guitar type) on the other. The main screening contact is covered with rubber sleeving as shown in the accompanying

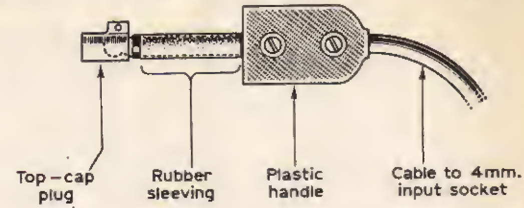


diagram and I found that the jack plug fitted superbly well into the top-cap socket in the sets I've tested, increasing the value of the analyser a great deal.

I do hope you can find space to suggest this idea to the very many readers who, like me, find PRACTICAL TELEVISION informative, useful and altogether a very worthwhile magazine for the money.—**A. N. C. Stacey** *(York)*.

INADEQUATE HEIGHT

I have followed *Service Notebook* with much interest as I am in the trade. The fault symptoms and cures suggested usually tally very closely with those of my own experience.

On the subject of inadequate height however I would like to add a cause that you have not mentioned although I have found it quite common—this is the field oscillator charging capacitor. Modern capacitors in this position rarely give trouble but I have found that on older sets height faults are often caused by the Hunts 400V black pitch-covered capacitors which seem to decrease in value with age. The Sobell T193, T194, T195 range in particular, which use an 0·05μF capacitor of this type in the charging position, often develop insufficient height or more commonly height shrinkage when hot—without any noticeable linearity distortion—and this is nearly always cured by replacing the 0·05μF charging capacitor between the field oscillator anode and chassis (or the output valve cathode). I have had very little trouble with the series resistors in the height circuit in these sets. If I have one of these receivers in for repair with the original charging capacitor still present I usually change it as a matter of course.

Your other comments about the boost voltage etc. are of course common causes but I think the innocent-looking charging capacitor deserves a mention also!—**C. Avis** (*Exeter*).

George Wilding comments: Lack of height, especially if it gets worse as the set warms up, is generally but not always due to decreasing insulation in the capacitor. It is an astonishing fact that whereas slight increase of conductor temperature will slightly raise its resistance, possibly by a few per cent, a similar temperature rise applied to an insulator can reduce its resistance by up to 80 or 90%.

These charging capacitors are fed via a high-resistance path from h.t. so that even a very small capacitor leak can reduce the anode voltage of the generator sufficiently to reduce the height considerably. In several models such as the ones mentioned the field circuit components seem to be subject to considerable heat and I have had exactly similar experiences to those mentioned by Mr. Avis.

YOUR PROBLEMS SOLVED

I have come across the fault mentioned by Mr. Hogwood (*Your Problems Solved*, September) on the Peto Scott Model TV960 many times. This fading on BBC-2 has in every case been due to a failing PC86 (u.h.f. mixer). The vertical hold fault is also a common one on this model and is due to C516, 0·01μF, being faulty (the circuit is basically the same as that used on the Defiant 9A61U series, see *Servicing Television Receivers* February and March 1969, the corresponding capacitor being C335, Fig. 6). Although this coupling capacitor is common to both 405 and 625 the fault it gives is uncontrollable rolling on 625. The capacitor should be replaced with one of the same value but a slightly higher working voltage rating.

In the October issue I see two faults mentioned on Philips Style 70 receivers. A common cause of lack of width on 405 is R427 and R457 (both 8·2MΩ) going high-resistance. These resistors are in series with the e.h.t. stabilising v.d.r. As the scan on 625 is a bit wider than on 405, lack of width is first noticed on 405. Distorted sound on 625 is also common on these models and can be cured by adjusting L211 (ratio detector transformer secondary) if adjustment of R228 (ratio detector balance) does not clear the trouble.—**G. Dudley** (*Welling, Kent*).

BUSH TV128 SERIES FAULT

I have experienced the same problem with a Bush Model TV125 as outlined in *Your Problems Solved* on page 44 of the October issue and I think you will find that the trouble lies in the line output valve. In my case the valve was all right when tested on a valve tester but interference on nearby transistor portables, on both a.m. and f.m., was unbearable. Replacing the valve cleared the trouble.—**W. J. Gadsby** (*Sanderstead, Surrey*).

PYE V220 FIELD CRAMP

A troublesome case of field cramp was recently encountered in a Pye Model V220. The grid capacitors in the blocking oscillator and output pentode stages, the resistors in the oscillator anode feed circuit and the field coils and output transformer were checked without the source of the trouble being found. The waveforms at the grid and anode of the oscillator and the grid of the output pentode were then compared with those in an identical receiver, and were found to be of correct shape and almost correct amplitude. The pentode anode waveform however showed evidence of flattening at one end of the sawtooth indicating incorrect output stage bias.

Attention was then turned to the boost rail, from which the triode oscillator is fed, and although the voltage at the anode of the triode was within 2V of that in the comparison set the boost rail itself was found to be down to 300V. Checks in the boost circuit failed to solve the problem so the first anode connection to the c.r.t. was disconnected. The boost rail voltage then returned to 400V. The first anode current was measured and found to be 0·5mA instead of the 10-15μA manufacturer's rating, and replacing the c.r.t. effected a complete cure.

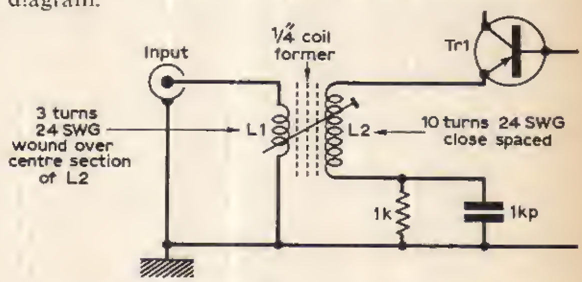
The fault was misleading because of the normal circuit voltages and waveforms. Incorrect output stage bias was the indirect result of the low boost feed to the triode oscillator. An unusual fault: I hope this report will save other readers some headaches on other occasions.—**M. Thomas** (*Bristol*).

DX AERIAL PREAMP

I have constructed the DX aerial preamplifier featured in the August issue but have not been able to obtain amplification: instead it is acting as a frequency converter and when used with an omnidirectional aerial gives very good BBC-2 pictures. The BBC-2 vision is on channel 3 with sound on channel 4 with hiss and very good on channel 5. Previously when receiving DX stations I thought the sound received on the next lower channel was an interfering a.m. radio station but on more careful examination I find that it is definitely TV f.m. sound.

Could you tell me why the preamp is acting as a converter in this way?—**D. L. Wyber** (*Belfast*).

Roger Bunney comments: I assume that when the local channel 27 is off your preamp still does not work. If you find that when the local channel is off the unit does work the problem is due to cross-modulation from channel 27 presenting the transistors with too much u.h.f. signal. Assuming that you have fitted the v.h.f. choke and 5pF capacitor across the input the solution would be to introduce a tuned circuit in the input as shown in the accompanying diagram.



If on the other hand you find that the unit does not work when the local channel is off this could be due to several reasons. Assuming that the wiring is OK and the collector and emitter connections have not been reversed I suggest you check the voltages. These should be about 9V at the collector, 2·7V at the base and 2·3V at the emitter. Should you find that in one section the two latter readings are wildly out and find that the associated components are OK the transistor may be faulty and may be returned to Mullard Ltd., Service Dept., P.O. Box 142, New Road, Mitcham, Surrey explaining what you think is wrong with it.

If the voltage readings are OK possibly your AF186s require more decoupling, especially the base. So try an extra 1,000pF. In my experience the AF186 is a transistor very difficult to make stable and given the chance will take off or produce weird results. It is therefore essential to make sure that the emitter

—*continued on page 129*

TRANSISTOR AND DIODE ANALYSER

MARTIN L. MICHAELIS, M.A.

PART 3

Systematic procedure for determining data for an initially completely unknown transistor

IT is assumed that neither its connections, whether it is a pnp or a npn type, whether it is a germanium or a silicon type, its operating frequency range, whether it is intact or defective, nor its intended operating currents and current gain are at the outset known. The following systematic sequence of measurements will determine all this information and more, neither data sheets nor other information being required. However if some information is already known the procedure may be shortened accordingly.

The systematic testing procedure is non-destructive, i.e. if carried out correctly it can never lead to damage or destruction of the transistor. However, first read carefully the complete text of this article to make quite sure that you are familiar with the basic functions and operating procedure of the transistor analyser. Wrong settings of this instrument could well cause destruction of the transistor being tested.

For tests 1, 2 and 3 use the diode test function set S3 to 10mA and VR1 to 120% f.s.d.

Test 1

If the transistor possesses only three connections proceed straight on to Test 2. If the transistor possesses four connections, one lead is connected to the case or some internal shield. To determine this earth lead proceed as follows: Find out which lead, when paired with *any* other one, never gives any meter deflection, neither in the pnp nor in the npn polarity setting. This is the earth lead. Mark it accordingly and then investigate the other three leads by Test 2 and following.

Test 2

To determine the base connection: Find out which pair of leads (out of the total of three possible

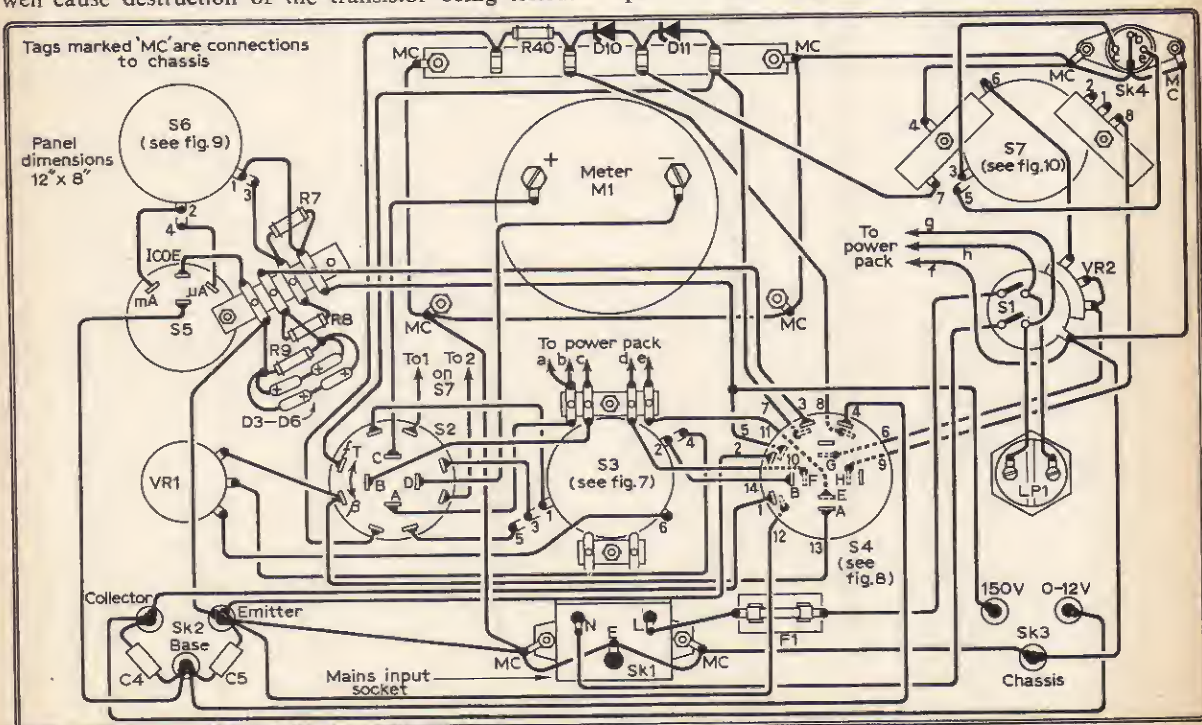


Fig. 11: Wiring on rear of front panel. Leads 2 and 12 from S4 must be run separately to Sk2 emitter socket to preserve single grounding point and thus prevent parasitic oscillation on static tests.

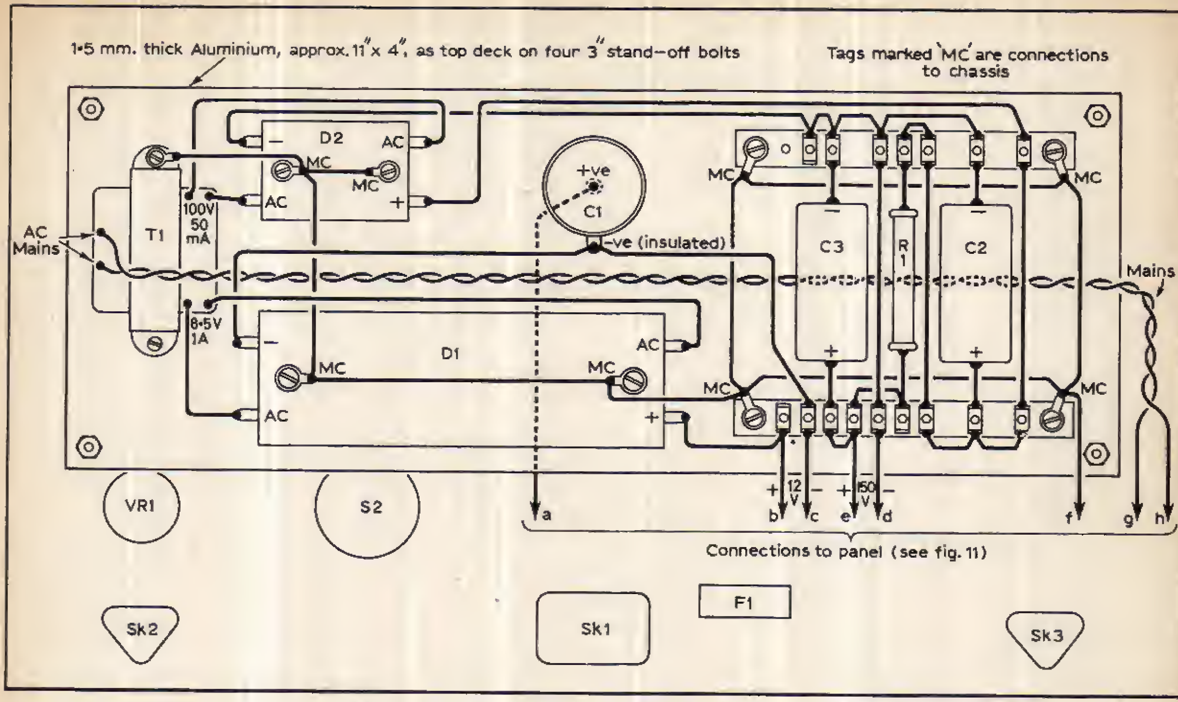


Fig. 12: Layout and connections to the power pack chassis.

pairings) gives no meter deflection, or only a meter deflection *much less* than full scale, in the pnp as well as in the npn polarity setting. The third lead, not belonging to this pair, is the base connection. Mark it accordingly.

To determine whether an electrode fault is present: Even if the first pair of leads tried happens to satisfy the above condition for determining the base connection, nevertheless also investigate both other possible pairings because this will reveal any electrode fault if present.

For any healthy transistor *only one* pairing (emitter and collector) gives no or low meter deflection in *both* polarities, whilst in the other two pairings the reading is full scale in one polarity and zero or low in the other polarity. For a healthy transistor *no pairing* gives large or full scale reading in both polarities.

Faults: (a) *Open-circuit base:* All three pairings give no or low readings in both polarities. (b) *Open circuit emitter or collector:* Two instead of only one pairing give no or low readings in both polarities. (c) *Short-circuit between any two electrodes:* Corresponding pairing gives full scale deflection in both polarities.

Test 3

To distinguish between pnp and npn type: Connect the just-determined base lead to the "diode anode" test socket and either one of the other two leads (leaving the third one blank) to the "diode cathode" test socket.

Transistor is a pnp-type if meter now reads full scale in pnp polarity setting and low or zero in npn setting.

Transistor is an npn-type if meter now reads full scale in npn polarity setting and low or zero in pnp setting.

For the following test use the test beta function and leave S3 and VR1 in the previous settings.

Test 4

To distinguish the emitter and collector connections: With the polarity switch set to the type determined in Test 3 arbitrarily *assume* one lead is the emitter and the other one is the collector and with the known base lead connect up to the three "test beta" sockets.

Advance the base drive current S6 from zero first in the μA switch (S5) range then if necessary in the mA switch range until about full scale deflection is obtained on the meter. Note the magnitude of the applied base drive current for this condition. Now interchange the "emitter" and "collector" and repeat. If the required base drive current is now *smaller* then the *new* connections are the correct ones, if *larger* then the *former* connections were the correct ones, and if *about the same* then the device is a unijunction for which the collector and emitter are equivalent and interchangeable.

For the following test use the test beta function, set S4 as determined in Test 3, set S3 to 100μA and leave VR1 set at 120% f.s.d.

Test 5

To distinguish between silicon and germanium type: With the transistor correctly connected to the test beta sockets, the base mode switch at μA and the base drive current switch S6 at zero: if *meter reading is zero the* transistor is a *silicon type,* if *meter reading is large* the transistor is a *germanium type.*

If *meter reading is small* (a few μA only) switch over base mode switch to Icoe. If *meter reading now vanishes* the transistor is a *high-beta silicon transistor.* If *meter reading becomes smaller*—but still does not vanish—the transistor is a *low-beta germanium transistor.*

For the following test use the test beta function, set S4 as determined in Test 3, leave VR1 as before and set S3 as detailed below.

Test 6

To diagnose any internal poor contacts in a functioning transistor, or excessive noise.

If the device is a silicon transistor, set the meter to the 100μA range. Increase the base drive current starting from zero in the μA range until the meter reading is near full scale. Observe the meter needle. If it quivers in a fairly rapid random manner the transistor is very noisy or suffering from internal poor contacts (but check the external contacts made!).

If the device is a germanium transistor, switch to the 1mA or if necessary the 10mA meter range to read actual I_{co} for zero base drive current in the "μA" base-mode setting. Now apply increasing base drive current in the μA range or if necessary in the mA range to double the initial I_{co} reading. Then observe the meter needle and diagnose as before.

Transistors failing Test 6 should not be used in an early stage of any amplifier and are unreliable because the fluctuating current effect is often a precursor to early complete breakdown.

For the following test use the test MHz function (Sk4) and S2 set to f_T. Set S4 as determined in Test 3. Connect the transistor correctly to Sk4. The S3 setting is unimportant.

Test 7

To determine the frequency range and applications of the transistor: Check meter reading obtained in each one of the five frequency settings 0·5, 2, 15, 50, 100MHz with the oscillator attenuator control first at minimum (mains switch just clicked on) and again with the attenuator control at maximum attenuation (right-hand stop). Diagnose according to Table 2 which lists frequencies for which meter readings are obtained in each case.

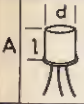
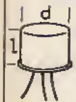
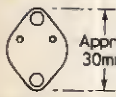
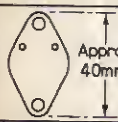
For the following test use the test beta function,

Table 2: Transistor applications according to frequency capability

Category	*Minimum attenuation, approximately full-scale deflection obtained for frequencies:*	*Maximum attenuation, appreciable deflection obtained for frequencies:*	*Transistor suitable for:*
(a)	No deflection in any setting	No deflection in any setting	D.C. amplifiers, audio amplifiers, TV field timebase circuits
(b)	0·5MHz	No deflection in any setting	Some TV line circuits, slow-speed switching logic
(c)	0·5MHz	0·5MHz	TV line circuits, medium-speed switching, l.w. r.f. stages and oscillators, a.m.-radio i.f. stages
(d)	0·5, 2MHz	0·5MHz	High-gain a.m.-radio i.f. stages, some m.w. r.f.-stages
(e)	0·5, 2MHz	0·5, 2MHz	M.W. r.f.-stages and oscillators, colour TV switch circuits, high-speed logic
(f)	0·5, 2, 15MHz	0·5, 2MHz	49M-band r.f.-stages and oscillators, CCTV video amplifiers
(g)	0·5, 2, 15MHz	0·5, 2, 15MHz	S.W. r.f.-stages and oscillators, v.h.f.-f.m. radio i.f. stages, TV sound i.f. stages, broadband video amplifiers, oscilloscope amplifiers, colour chroma circuits
(h)	0·5, 2, 15, 50MHz	0·5, 2, 15MHz	Some vision i.f. stages
(i)	0·5, 2, 15, 50MHz	0·5, 2, 15, 50MHz	Vision i.f. stages
(j)	All settings	0·5, 2, 15, 50MHz	Band I TV tuners
(k)	All settings	All settings	V.H.F.-f.m. radio tuners, may be tried in v.h.f./u.h.f. TV tuners and preamplifiers

Notes: (1) In general transistors are usable for all lower grade purposes.
(2) These diagnoses are based on maximum operating frequency for which the gain is still sufficient to produce oscillation. They serve only as rough guides, not as rigid rules, since other factors—especially the static current gain in relation to collector current as investigated below in Test 8—also play a decisive role in determining whether a transistor will function in an envisaged circuit under given conditions of frequency, current and impedance.

Table 3 : Maximum safe power and current based on transistor physical characteristics.

	PHYSICAL APPEARANCE	GERMANIUM	SILICON
A	 Diam. d = 4–6 mm. Length l = 5–9 mm.	MAX. POWER : 40mW MAX. CURRENT : 50mA EXAMPLE OC303 Base : Icoe, Ico, 2, 20, 200, 1000µA Coll. : 10µA, 50µA, 100µA, 700µA, 8mA, 57mA β : —, —, 25, 32, 40, 57	MAX. POWER : 60mW MAX. CURRENT : 100mA EXAMPLE BC108C Base : Icoe, Ico, 0·05, 1, 10, 50, 100µA Coll. : 0, 4µA, 29µA, 0·5mA, 5mA, 25mA, 50mA β : —, —, 500, 500, 500, 500, 500
B	 Diam. d = 4–6 mm. Length l = 10–16 mm.	MAX. POWER : 60mW MAX. CURRENT : 100mA EXAMPLE OC71 Base : Icoe, Ico, 5µA, 50µA, 1mA, 2mA Coll. : 20µA, 250µA, 500µA, 3mA, 50mA, 72mA β : —, —, 50, 60, 50, 36	MAX. POWER : 100mW MAX. CURRENT : 100mA RARELY FOUND IN SILICON
C	 Diam. d ≏ 8mm. Length l = 6–9 mm.	MAX. POWER : 100mW MAX. CURRENT : 150mA EXAMPLE 2N1193 Base : Icoe, Ico, 0·05µA, 0·5µA, 5µA, 50µA, 500µA Coll. : 3µA, 75µA, 78µA, 125µA, 625µA, 6·8mA, 62mA β : —, —, 60, 100, 110, 135, 124	MAX. POWER : 600mW MAX. CURRENT : 250mA EXAMPLE BSY51 Base : Icoe, Ico, 0·5µA, 1µA, 2µA, 50µA, 1mA Coll. : 0, 0, 3µA, 8µA, 20µA, 1·2mA, 60mA β : —, —, 6, 8, 10, 24, 60
D	 Approx 30mm.	MAX. POWER : 1W MAX. CURRENT : 0·5A EXAMPLE L004C Base : Icoe, Ico, 0·1mA, 1mA, 10mA, 20mA Coll. : 0·2mA, 4mA, 8mA, 44mA, 400mA, 800mA β : —, —, 40, 40, 40, 40	MAX. POWER : 3W MAX. CURRENT : 1A EXAMPLE BD107 Base : Icoe, Ico, 0·05, 0·5, 5, 50, 500µA, 1, 5mA Coll. : 0, 0, 1·5, 17, 190µA, 2·6, 50, 100, 600mA β : —, —, 30, 34, 38, 52, 100, 100, 120
E	 Approx 40mm.	MAX. POWER : 3W MAX. CURRENT : 1A EXAMPLE 2N257 Base : Icoe, Ico, 0·1mA, 1mA, 10mA, 20mA Coll. : 0·4mA, 3mA, 6mA, 48mA, 400mA, 700mA β : —, —, 30, 45, 40, 35	MAX. POWER : 3W MAX. CURRENT : 1A EXAMPLE 2N3055 Base : Icoe, Ico, 1µA, 10µA, 100µA, 1mA, 10mA Coll. : 0, 0, 2µA, 63µA, 2·8mA, 73mA, 700mA β : —, —, 2, 6·3, 28, 73, 70

set S4 as determined in Test 3 and connect the transistor correctly to Sk2.

Test 8

To determine the current gain in relation to operating point: Always commence with meter range 0·1mA (if necessary 1mA for germanium transistors), base mode switch at *I*coe, the base drive current switch and VR1 at zero.

Then turn up VR1 to 120% f.s.d. and read *I*coe (collector leakage current with no base drive current, but base shorted to emitter). Switch base mode to µA, leaving the base drive current switch at zero and VR1 at 120% f.s.d. Read *I*coe (collector leakage current with no base drive current but base open circuit).

Turn VR1 to zero, switch desired base drive current (µA or mA range) and then advance VR1 in steps of 20% f.s.d. starting from zero, noting meter reading at each step. At first the meter reading will be equal to total % f.s.d. setting of VR1 but ultimately the meter reading will lag behind. Stop when VR1 setting is about 20-30% f.s.d. higher than the meter reading. If the meter reads full scale before dropping behind VR1 setting return VR1 to zero, switch to the next higher meter range and try again.

When VR1 setting is 20-30% f.s.d. above the meter reading approximately 1V is being impressed between the collector and emitter. This is normally fully adequate for proper saturation on the characteristic and very convenient because the meter reading in mA is then numerically equal to the power actually being dissipated in the transistor, expressed in mW. It is most important to keep a check on the power dissipation when testing transistors. Proceed as follows, with reference to Table 3.

For an unknown transistor determine in which group A to E its dimensions fit nearest and read off the maximum power and current which are safe in general for this group. When operating VR1 as specified above take care not to advance to any mA meter reading numerically greater than the specified maximum power in mW for the group in question.

The maximum power and current values tabulated for the respective groups are conservative, i.e. many actual transistor types in each group will handle much larger powers and currents, in particular if cooling arrangements are attached. If the actual maximum power dissipation for the given transistor happens to be known VR1 operation as above may be used up to the same numerical meter reading (mA=mW) if this is less than the nominal maximum current for the group. Otherwise do not exceed the nominal maximum current, or the actual maximum current rating of the particular transistor if known.

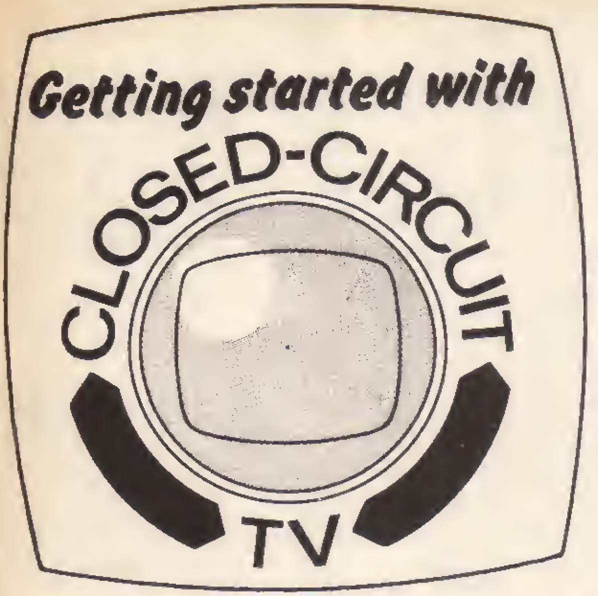
The *integral current gain* of any transistor is defined as the collector current divided by the applied base current whereby only that part of the actual collector current which is produced by the applied base drive current is to be taken. Thus if *I*c is the total collector current, *I*co the collector leakage current with no base drive but open-circuit base, and *I*b is the applied base drive current, the integral current gain is:

$$\beta = \frac{Ic - Ico}{Ib}$$

For some transistors β is constant irrespective of the value of *I*c which may be changed through many powers of ten. In this case the differential current gain is also constant irrespective of *I*c and equal to β. The differential current gain at a given *I*c is defined as a small change of *I*c around the prevailing value divided by the change of base drive needed to produce this change of *I*c:

$$\beta d = \Delta Ic / \Delta Ib$$

—*continued on page 122*



PART 2

I. R. SINCLAIR

THERE is much which the amateur can do to modify the performance of a CCTV system but three vital components which determine the performance of the whole chain are completely beyond all modification. They are the camera lens, the vidicon and the monitor c.r.t. In this part we deal with the lens and the vidicon.

The Lens

The purpose of the lens is to focus an image of the scene being televised on to the target of the vidicon; the path taken by light rays through the lens in doing so is shown in Fig. 1. Any convex lens will focus light in this manner but whether the results will be satisfactory or not depends very much on the lens design, since the behaviour of light passing from air into glass is not so simple as reflection in a mirror.

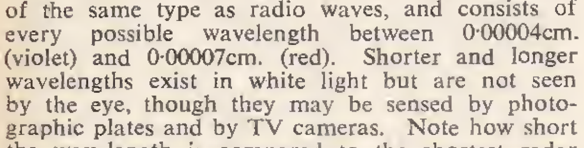


Fig. 1: Paths followed by light rays from object to image through a lens.

To start with white light is a mixture of radiation of the same type as radio waves, and consists of every possible wavelength between 0·00004cm. (violet) and 0·00007cm. (red). Shorter and longer wavelengths exist in white light but are not seen by the eye, though they may be sensed by photographic plates and by TV cameras. Note how short the wavelength is compared to the shortest radar wavelengths in use, of a few millimetres.

Because of the short wavelength these waves to all intents and purposes travel in straight lines, but the direction in which they travel may be changed when the waves pass into a different substance. This is the basis of the action of a lens but it is complicated by the fact that different wavelengths (colours) travel at different speeds in transparent materials such as glass, and in consequence also travel in different directions. This is an identical effect to the different attenuation of different high radio frequencies in cables, and is called *dispersion*. The effect of dispersion in a lens is that different wavelengths of light (meaning different colours) focus in slightly different places so that a blurred image is produced, especially if the camera is sensitive only to black-and-white. This fault is called *chromatic aberration*.

In addition to this the focus is in one plane only for rays of light which pass very close to the centre of the lens, and those which use the edges (needed if the amount of light is small) focus at different places, again causing a blurred image. In this case the effect is due to the shape of the lens being part of a sphere instead of a more complicated shape which can be computed but which is difficult to make, requiring glass grinding equipment which is controlled directly by a computer. This form of blurring of the image is called *spherical aberration*.

These two principal faults in lenses can be corrected to a very considerable extent by the use of more than one piece, or *component*, of glass in the lens. For example chromatic aberration may be eliminated for two colours at opposite ends of the range by using two components made of glasses which have different dispersions and which are made into lenses of different focal lengths, one converging the light and one diverging it, but to a lesser extent (Fig. 2). Spherical aberration is minimised when the angle through which light is turned by the front surface of each lens component is equal to the angle through which it is turned by the rear surface. All this indicates that a good lens should consist of several components some of which may be "cemented" together, others separate. The number of components may be very large; a zoom lens may use 25 components to achieve its range of focal length without excessive aberration.

Even with these main aberrations corrected other sources of image distortion remain: astigmatism is a difference in the plane of focus for horizontal lines as compared to vertical lines so that only one set can be perfectly focused at a time; curvature of field causes the centre of a picture to focus before the edge, or vice versa; and barrel and pincushion distortion exist just as they do for TV images where electron lenses are used. A good lens however will show less of these effects than the electronic system does.

Effects of Focal Length

The focal length of a lens is a vital factor in determining its suitability for any application. Referring to the ray diagrams of Fig. 3 we can see that for a fixed distance between the lens and object the focal length of the lens affects the distance between lens and image (the image in our case being at the vidicon target), the width of field (how much of the object's width is visible) and the depth of field (how much is in focus in front of and behind the object). A long focus lens (telephoto) has a small depth of field and a small width of field, but can produce a large image of an object at a long distance

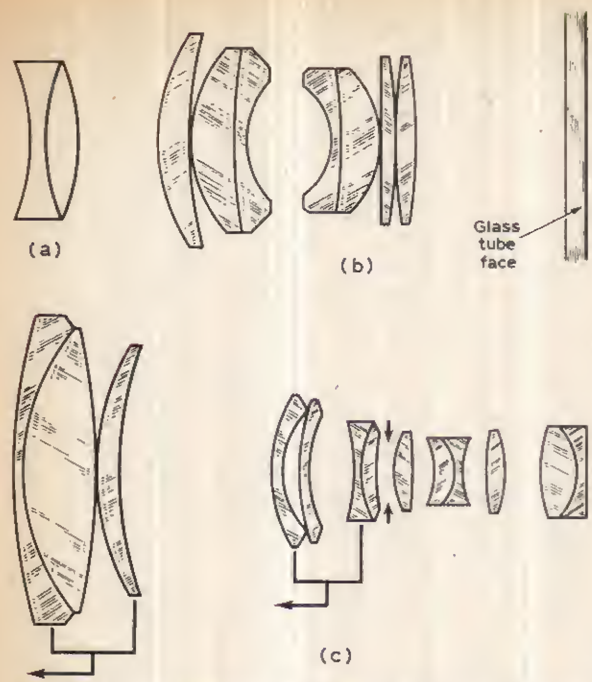


Fig. 2: (a) Combination of concave and convex lenses using different types of glass to eliminate chromatic aberration between two colours. (b) A modern CCTV lens, the Rank Vidital 3cm. f/1·4. (c) A zoom lens, the Rank Studio Varotal f/1·8, focal length 2½—8cm. The components marked with a horizontal arrow move in the zooming operation, the movement of the front components being much less than that of the rear components. Details by courtesy of Rank Precision Industries, Broadcast Division.

from the camera. A short focus (wide-angle) lens has a large depth of focus and width of field but must be close to the object if the object is not to be dwarfed by its surroundings. For most indoor work a lens whose focal length is about the diameter of the vidicon target is correct; this diameter is usually about 16-20mm. Table 1 summarises the widths and depths of field obtainable with lenses of various focal lengths.

Note that when vidicon mountings are being designed the distance between the centre of the lens and the vidicon face is given by the formula $1/v = 1/f - 1/u$, where v is the distance from lens to vidicon, f is the focal length of the lens and u is the distance of object to lens. Some care is necessary when this formula is applied to a lens of several components since the distance from the lens can no longer be measured from the centre; in such a case the distance can be measured to the rear face of the lens without serious error in the case of lenses available to the amateur. A good rule of thumb is to mount the lens so that when the focus ring is set

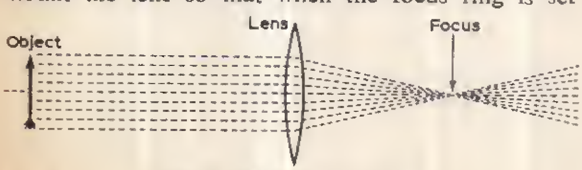


Fig. 3: The focus of a lens.

Table 1 (A): Width of view, using various lenses
To use the table, select the lens to be used and refer to the length L between camera and subject. D is the width of the *diagonal* of the subject to be televised. L and D are in feet.

$f = \frac{1}{2}$in.		$f = \frac{3}{4}$in.		$f = 1$in.		$f = 1\frac{1}{2}$in.	
L	D	L	D	L	D	L	D
1′	1′4″	1′	11″	1′	7½″	1′	5″
2′	2′8″	2′	1′10″	2′	1′3″	2′	10″
5′	6′10″	5′	4′8″	5′	3′1″	5′	2′1″
10′	13′8″	10′	9′4″	10′	6′3″	10′	4′2″
20′	27′5″	20′	18′8″	20′	12′6″	20′	8′4″
25′	34′2″	25′	23′3″	25′	15′9″	25′	10′6″
30′	50′	30′	28′	30′	18′9″	30′	12′6″

Note: Values have been rounded off. Intermediate values can be found by addition. For example: Width for ¾in. lens at 6ft. is width for 5ft. plus width for 1ft. = 4ft. 8in. + 11in. = 5ft. 7in.

Table 1(B): Depth of field, using various lenses
Procedure: Find the focus factor H from the table. If the camera is now focused on an object at distance L feet the nearest object in focus is at $\frac{H \times L}{H + L}$ feet and the farthest is at $\frac{H \times L}{H - L}$ feet. If H is greater than L then *all objects beyond* L are in focus (focusing to infinity).

f	*Values of H for Lens apertures*					
	$f/1$	$f/1{\cdot}4$	$f/2{\cdot}8$	$f/4$	$f/5{\cdot}6$	$f/8$
½in.	42	30	15	10	7½	5½
¾in.	63	45	22	16	11	9
1in.	84	60	30	21	15	11
2in.	168	120	60	42	30	22
3in.	252	180	90	63	45	33

Note: These figures have been rounded off.
Example: A lens of focal length ¾in. is set at $f/4$ and focused on an object 15ft. away. The nearest point of focus is $\frac{H \times L}{H + L}$ where H is from the table 16. The nearest focused point is therefore $\frac{16 \times 15,}{31}$ about 8ft., and the farthest point of focus is $\frac{16 \times 15,}{1}$ 140ft., which for practical purposes is an infinite distance. In such conditions, then, everything should be in focus from 8ft. to infinity.

to infinity (∞) the lens is spaced one focal length from the target of the vidicon.

The lenses used for CCTV are usually very similar to those used for 16mm. cinephotography and many useful ex-Government lenses can be obtained at prices which are only a fraction of their cost. This is of some importance since lenses for CCTV are often required to work at wide *apertures* (see below) and the more expensive types of lenses work better under such conditions than the cheaper varieties.

Aperture and Light Transmission

For any type of camera, whether CCTV or photographic, it is undesirable to pass all the light which

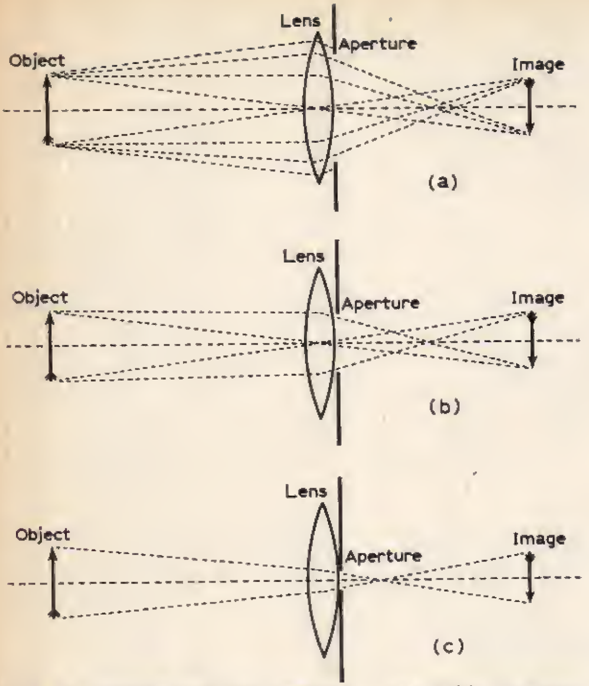


Fig. 4: Principle of the aperture. (a) Wide aperture, most light rays pass through. (b) Narrower aperture, only light rays passing through the centre portion of the lens form an image. (c) Very narrow aperture, image is formed almost as much by the aperture as by the lens. There is very little dispersion of light in the lens, so minimum aberration.

enters the lens to the sensitive surface of film or vidicon. In either case there is a definite amount of light which is required for correct exposure and more or less light will cause a deterioration in the quality of the image. In a film camera this is complicated by the effect of the processing of the film after exposure, but the camera exposure itself is controlled by the speed of the shutter and the amount of "aperture" of the lens which is used. In a CCTV camera the "shutter speed" is fixed by the field repetition rate and so the aperture of the lens is the only direct control of exposure which can be used though, as we shall see, the target voltage of the vidicon also exerts some control and the contrast of the picture is affected also by the gain of the video amplifiers.

The use of different apertures in a lens is shown diagrammatically in Fig. 4, where apertures of different size are placed between lens components. These perform two functions; they cut down the amount of light passing through the lens and they restrict the light which does pass to the centre region of the lens where distortion is least. It is an advantage then to work at high light levels because this enables us to use a lens at a small aperture producing an image of good fidelity.

The effect of the aperture size depends on how large it is compared to the focal length of the lens, and for this reason the aperture is usually quoted as a fraction of the focal length, *f*/2, *f*/2·8, *f*/4, *f*/5·6 etc. The reason for the odd series of numbers is that doubling the number which divides the focal length implies halving the diameter of the aperture so that an aperture of *f*/4 is half the diameter of an aperture of *f*/2. However halving the diameter means reducing the area to a *quarter,* since the area of a circle depends on the diameter multiplied by itself (diameter squared), so that an aperture of *f*/4 allows only one quarter as much light to pass as an aperture of *f*/2. The series of numbers is designed so that each is $\sqrt{2}$ times the previous one so that each step up in *f*/number represents half as much light passing through the lens. Thus *f*/2·8 allows half as much light to pass as *f*/2.

Most moderately priced lenses perform very poorly at low *f*/numbers but short focus lenses for a given *f*/number are liable to be better pound for pound because the *actual diameter* of a short focus lens for a given *f*/number is much less due to the relation between *f*/number and focal length. For example a 100mm. focal-length lens of aperture *f*/2 must have an effective diameter of 50mm. at its narrowest point and will probably be of considerably greater diameter at the front face, but a 20mm. lens of *f*/2 need have a minimum diameter of only 10mm. and is therefore cheaper to make.

Bloomed Lenses

Before we leave the subject of lenses it is worth noting that light is reflected from each air-to-glass or glass-to-air surface during its journey through the lens, and this reflection represents a loss of light to the camera since the reflected light does not end up at the sensitive surface of film or target. A two-component lens with separated components has four such surfaces and will lose light by reflection at each surface; in a complex lens this loss can be as much as 25-30% of the light entering.

This loss can be greatly reduced by *blooming,* that is coating the glass surfaces with a thin film of transparent substance whose ability to change the direction of light is less than that of glass and which is only one quarter of a wavelength of light thick (0·000125mm.). This process contributes enormously to the efficiency of lenses and is recognisable as a blue film on the surface of the lens when light is reflected from one of the surfaces though it cannot be seen by looking through the lens. The glass surface of bloomed lenses must not on any account be touched and the surface must never be wiped to "clean" it. A very soft brush may be used if it is absolutely necessary but the less the lens surface is touched the better. It is good practice to keep lenses capped when they are not in use and interchangeable lenses should be capped at both ends when they are not mounted on the camera.

The Vidicon

The vidicon is the second major component of a CCTV system which must be bought and whose design cannot be altered. The vidicon has been the subject of previous articles so we shall provide here just a brief note on its operation. The vidicon (see Fig. 5) has a target section consisting of a glass plate coated with a transparent conducting film which in turn is coated with a photoconductive substance whose resistance decreases considerably when light falls on it. There is also a scanning section consisting of an electron gun and the means of focusing the electron beam on to and scanning it over the target.

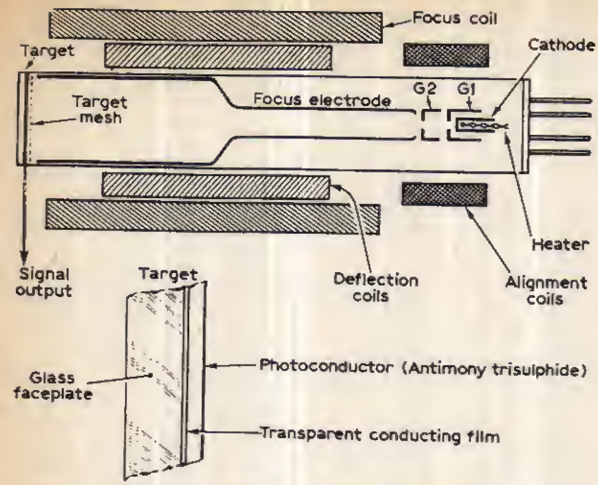


Fig. 5: Cross-section of the vidicon.

In use the transparent conducting film (the target contact) is held at a voltage of about 40V positive to the cathode of the electron gun, so setting the voltage on one side of the photoconductive layer. Since this layer is resistive this voltage will appear at the other side of the layer whether the target is illuminated or not. The whole target, and each portion of it, behaves like a capacitor with a high value variable resistor in parallel. When the electron beam strikes any portion of the target it effectively connects that portion to the cathode and current flows in the load resistor which is in series with the 40V supply. This *signal current* flows because one side of the portion of target has been suddenly reduced in voltage and the other, as with any capacitor, follows this change (Fig. 6). After the electron beam has passed on, the conduction of the target causes the voltage on the beam side of the target to rise again so that a *steady current*, proportional in size to the total amount of light striking the target, passes. This steady *charging* current must not be confused with the *momentary* discharging current which constitutes the signal. A good comparison is that of a sync separator stage where the pulses at the grid cause conduction so that a negative bias appears at the grid; at the same time, signal pulses are present and can be taken from the anode.

Because the target has a time-constant (resistance × capacitance) the voltage of an element usually does not have time to return to 40V after scanning before it is scanned again. Increasing the illumination of the target element has the effect of reducing the resistance and so reducing this time-constant.

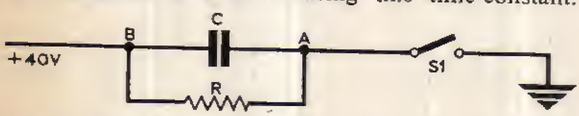


Fig. 6: Equivalent circuit of a portion of the vidicon target. The action of the electron beam is to close S1 momentarily so that side A of capacitor C is earthed. Current flowing through resistor R restores A to +40V but not before S1 has been closed again by the beam. The voltage reached at A depends on the value of R and so on the light received. Whenever S1 is closed and A discharges to earth, a current flows to plate B. This current is the output of the vidicon.

In a brightly illuminated area of the target the voltage on the beam side will rise faster after scanning, due to the lower resistance of the photoconductor, and will therefore be nearer to 40V when scanned again than will a dimly illuminated portion. In this way the light variations which form an image are turned into current variations which form a video signal. This video current signal is small, about 0·2μA on a scene with average illumination, and so a considerable degree of amplification is required, as will be pointed out in a following Part. Before we leave the target portion of the vidicon, however, the mounting and bias arrangements deserve consideration.

Mounting and Bias

The vidicon is usually mounted inside an insulated tube which carries the focusing and deflection coils and which has a circular spring contact which engages with the target connection of the vidicon, a metal ring which also serves to join the target portion of the vidicon to the rest of the glassware. It is important that this connection should not have a large stray capacitance to earth and this point should be noted if the vidicon mountings are to be home made. Wherever possible the connection between the target and the video amplifier, or at least its first stage, should be as short as possible. It is usually possible to mount an npn emitter-follower stage right up at the target and to take a cable connection to the rest of the amplifier.

As mentioned previously the steady current to the target depends on the average amount of light falling on the target and is high when the light level is high. This can be used as a method of automatic contrast control if the value of the target load resistor is high or if the target load resistor is in series with a high-value decoupled resistor. An increase in illumination causes an increase in the steady current which causes an increased voltage drop across the series resistor. This drops the target voltage so that the contrast of the output signal is less since the voltage to which the target is charging is now less. This method of automatic exposure control is admirably simple and useful for applications where light levels vary and no camera operator can be used but is unsatisfactory where the highest quality of signal is required.

The Scanning Section

The voltage requirements for the vidicon gun are summarised in Table 2. The maximum d.c. supply voltage required is about 300V for the accelerator electrode, at a very small current. The ranges of voltage shown for grid cutoff and for beam focus are the widest limits permitted in manufacture, but the controls should allow for the whole of this range since many of the vidicons which fall into amateur hands may have been rejected at the factory for being outside the usual range of bias or focus voltage.

The blanking pulses required to cut off the beam during flyback to avoid a video signal appearing in this period can be applied to either grid or cathode. When applied as positive pulses to the cathode much smaller pulse amplitudes are needed because a positive pulse at the cathode is equal to a negative pulse at every other electrode and is therefore more

Table 2: Typical voltage requirements of vidicon Type 9677
(Reproduced by kind permission of EMI Ltd.)

Parameter	*Typical voltage limits*
G1	−35 to −75V
G1 cutoff	−60 to −100V
G2	300V
Anode G3	280 to 300V
Mesh G4	420 to 450V
G1 blanking pulses	−75V min.
Cathode blanking pulses	10V min.
Target voltage	25 to 40V good lighting 30 to 60V poor lighting
Signal current	0·3μA good lighting 0·2μA poor lighting

Note: Older type vidicons with mesh G4 attached to G3 do not require a 450V supply.

Tube Prices

Type	*Description*	*Price*
9677C	General industrial use	£45
9677M	Relaxed blemish specification	£25
9677 Amateur	Low grade for experiments	£15

All the above use a 6·3V 95mA heater. Tubes at the same prices using 6·3V 300mA heaters are coded 9728 with the same identifying letters as shown above.

Type	*Description*	*Price*
10667M	6·3V 600mA heater, combined mesh	£12

This last tube has the mesh and G3 combined, as explained in the text, and is available only while stocks last.
Scan and focus coils for use with transistorised cameras are also available at a price of £7.
The vidicons above are covered by a guarantee.
Address for enquiries: Sales Department, EMI Electronics Ltd., Valve Division, Hayes, Middlesex.

effective than a negative pulse at the grid only. In commercial CCTV outfits the grid bias potentiometer is usually labelled *beam current* and the G3 voltage control *beam focus.*

Scanning and Focusing

Most CCTV operators will buy the focusing and deflection coil assembly because of the formidable problems of winding such an assembly. For those willing to experiment with focus windings, however, the requirements are about 3,000 to 4,000 turns of wire over a solenoid about 5in. long and taking about 100mA. The direction of the current should be such that the north-pointing end of a compass needle is attracted to the front (target) end of the focus coil. In addition to this a set of alignment coils of about 1,000 turns should be mounted at right angles to the focus coil and to each other, usually within the focus coil. These centre the beam so that the undeflected beam is central and ensure that the beam strikes the target exactly at right angles to its surface regardless of how the beam is deflected.

The deflector coils can be constructed only by trial and error: one possibility is to unwind an old set of narrow-angle TV tube deflection coils to about ⅓ of their original number of turns. Commercial deflection coils for transistorised cameras require about 6V drive on the field coil and about 40V on the line coil at 625-scanning rates.

Practical Hints on Using Vidicons

As the target material is a semiconductor the usual rules about avoiding high temperatures apply. Most manufacturers advise that tubes should be stored in darkness at temperatures between 25°C and 35°C, meaning to us in the living room and not too near a fire or radiator. The tube should never at any time be held or stored face down, since particles which can detach themselves from the cathode might fall on and damage the mesh and target. The temperature of the tube during operation must be kept within the 25°C-35°C limits, and a still picture such as a test pattern should not be applied for more than a few minutes otherwise it may be retained on the target for very long periods.

When setting up the grid should be biased off and the lens capped before switching on and warming up for five minutes. With the target at about 25V (which can be marked on the target voltage control potentiometer) the lens is uncapped and the grid (beam current) adjusted to give a monitor picture, assuming a correctly adjusted monitor.

The beam focus is set for best resolution, followed by magnetic focus, and then by lens focus; this sequence is repeated until no further improvement of picture resolution can be seen. The alignment is then set so that the centre of the picture does not move when the beam focus control is varied, and the focus controls are checked again.

Reject Vidicons

About two out of every three vidicons made are rejected for studio use because of spots. For studio use no spots visible on the monitor are permitted on an area of the target which is a circle of about ½in. diameter around the centre of the faceplate. For industrial CCTV rather more are permitted but tubes are generally rejected at a spot count which is still acceptable for amateur CCTV use, in fact for any purpose where close inspection of the picture is unnecessary. In general a spot-reject vidicon is a good buy, but vidicons rejected for such faults as short- or open-circuit internal connections, flash-overs, low emission or gas are useless. Vidicons selected for amateur use are available from EMI Ltd.; prices and address are noted at the end of Table 2.

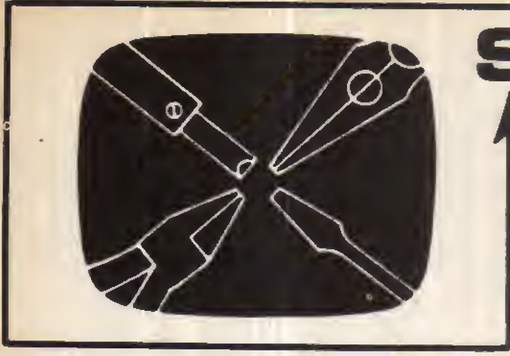
Electrostatic Vidicons

Vidicons are now available which are electrostatically focused and deflected. Though this eliminates the cost and complexity of scanning assemblies, the cost is at the moment prohibitive to all except professional users.

Combined Mesh Vidicons

Most vidicons now have separate connections to the mesh and to the focus electrode but a few of the older type using a combined connection may be encountered. The difference in price may be significant but supplies are limited and will cease when present stocks are exhausted. For this reason cameras should be designed around the modern type vidicon.

TO BE CONTINUED



SERVICING television receivers

L. LAWRY-JOHNS

THORN 1400 CHASSIS

THIS is the latest and probably the last fully valved (except of course for the u.h.f. tuner) chassis from the Thorn group. It is employed in a large number of models under the Ferguson, Ultra, HMV and Marconiphone banners. Examples of commonly encountered models are the Ferguson 3646, Ultra 6649, HMV 2639 and Marconiphone 4621.

It is a very easy chassis to work on, presenting the print side to the rear and swinging open with the removal of two screws on the right side to allow access to valves and components. The chassis may be lifted off the left-hand hinges completely when swung open sufficiently. The v.h.f. tuner is of the valved type but the u.h.f. tuner is transistorised.

Points to Note

The top dropper has six sections. It should be remembered that only the two sections on the right (as viewed from the rear) carry a.c. The four sections on the left are the d.c. smoothing resistors. We will have a little more to say about these sections later.

The boost line smoothing capacitor C104 is usually shown on circuit diagrams as being $0{\cdot}1\mu F$. This was quite correct for early production runs but was later changed to $1\mu F$ in order to delay complete collapse of the field scan and thus provide a measure of protection against the possibility of a spot being burnt in the centre of the screen in the event of a line timebase failure. A $1\mu F$ capacitor should be fitted when C104 is found shorted (the makers say that this modification should be made to all chassis) and should be rated at 500V.

The series heater chain is fed through a silicon diode (W10) providing a negative-going, rippled d.c. current which cannot be accurately measured with a normal moving-coil meter. For example a d.c. voltmeter applied across pins 1 and 8 of the tube (heater) will show about 4V instead of 6·3V. Perhaps a more useful reading is at the d.c. side of W10. This will normally show a trifle over 80V (negative with respect to chassis). The reason for this suggestion will be explained later.

There is no cathode bias for the field output valve. The bias is obtained for the grid from the negative-going heater line. This is important to remember and ties in with the previous note.

Examination of the circuit and valve line up shows a marked similarity to the earlier 950 series. However the makers have introduced a 30FL1 and a 30PL1 in the circuit: the reason for this is not easy to see.

A five-unit electrolytic capacitor can is fitted, C120-124, forming the smoothing block. As this unit has the habit of leaking, the solenoid operating section of the system switch can suffer as it is immediately below (S2A).

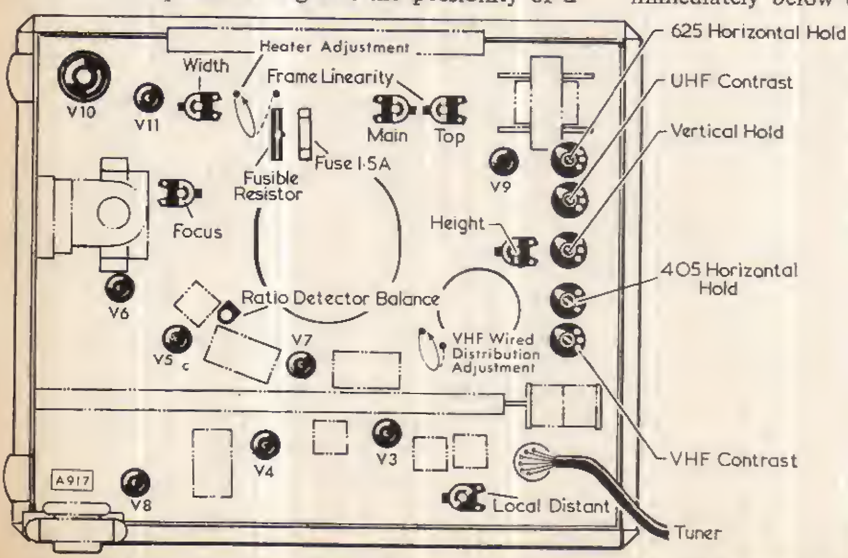


Fig. 1: Main chassis hinged open to show valve positions and preset adjustments.

It should also be noted that there is no voltage adjustment provision in the usual sense. Instead there is a shorting link provided for connection across tags 32 and 33 for use where the applied mains voltage is consistently less than 220V.

Line Timebase

Perhaps the most common fault the writer has experienced is collapse of the line scan on 405 only, the 625 picture remaining normal. The cause of this has been C108 ($0{\cdot}3\mu F$) in every case. This capacitor is located on the lower right edge as viewed from the rear, in the closed position. Sometimes this capacitor gives up quietly, sometimes it blows up!

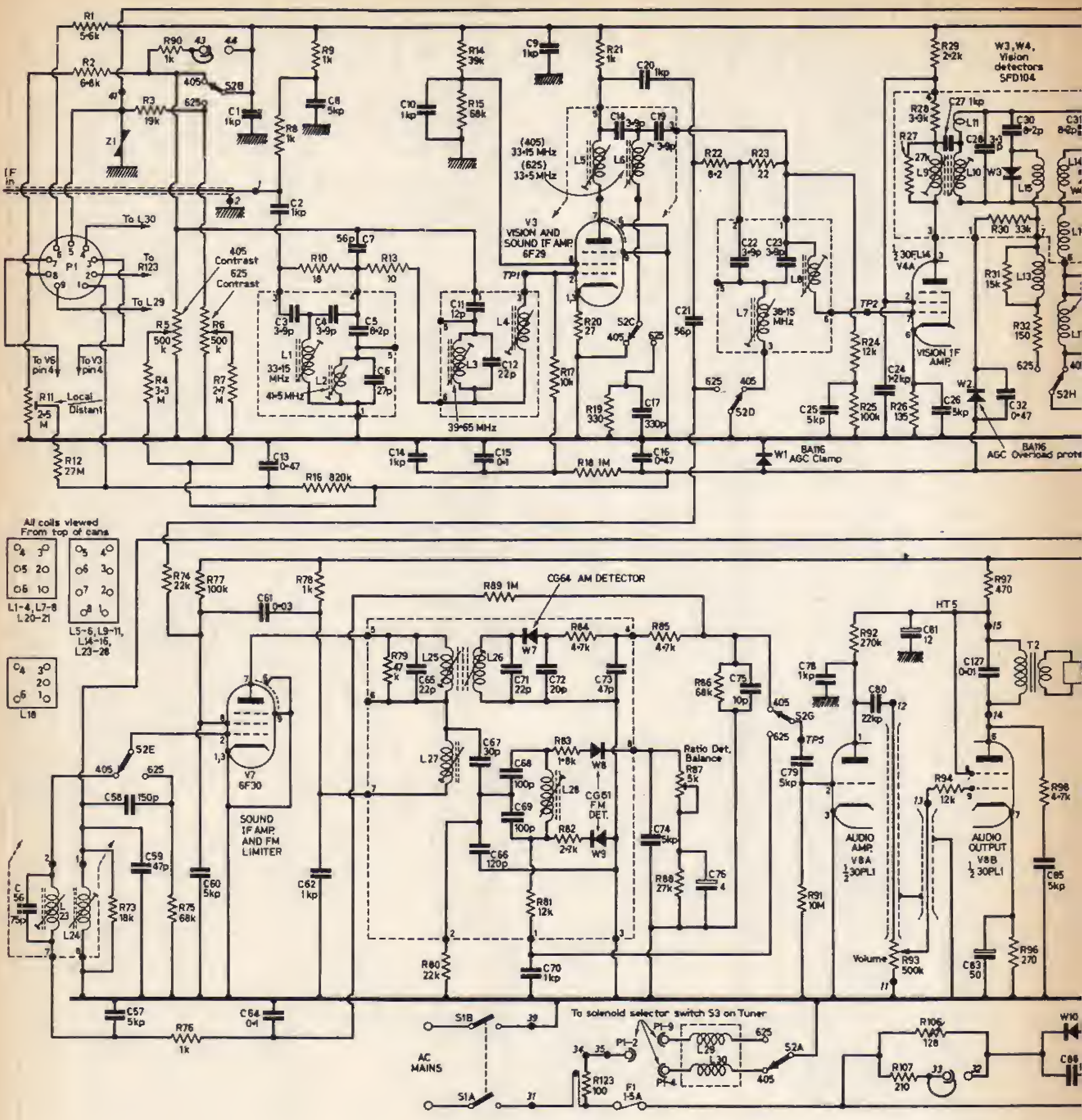


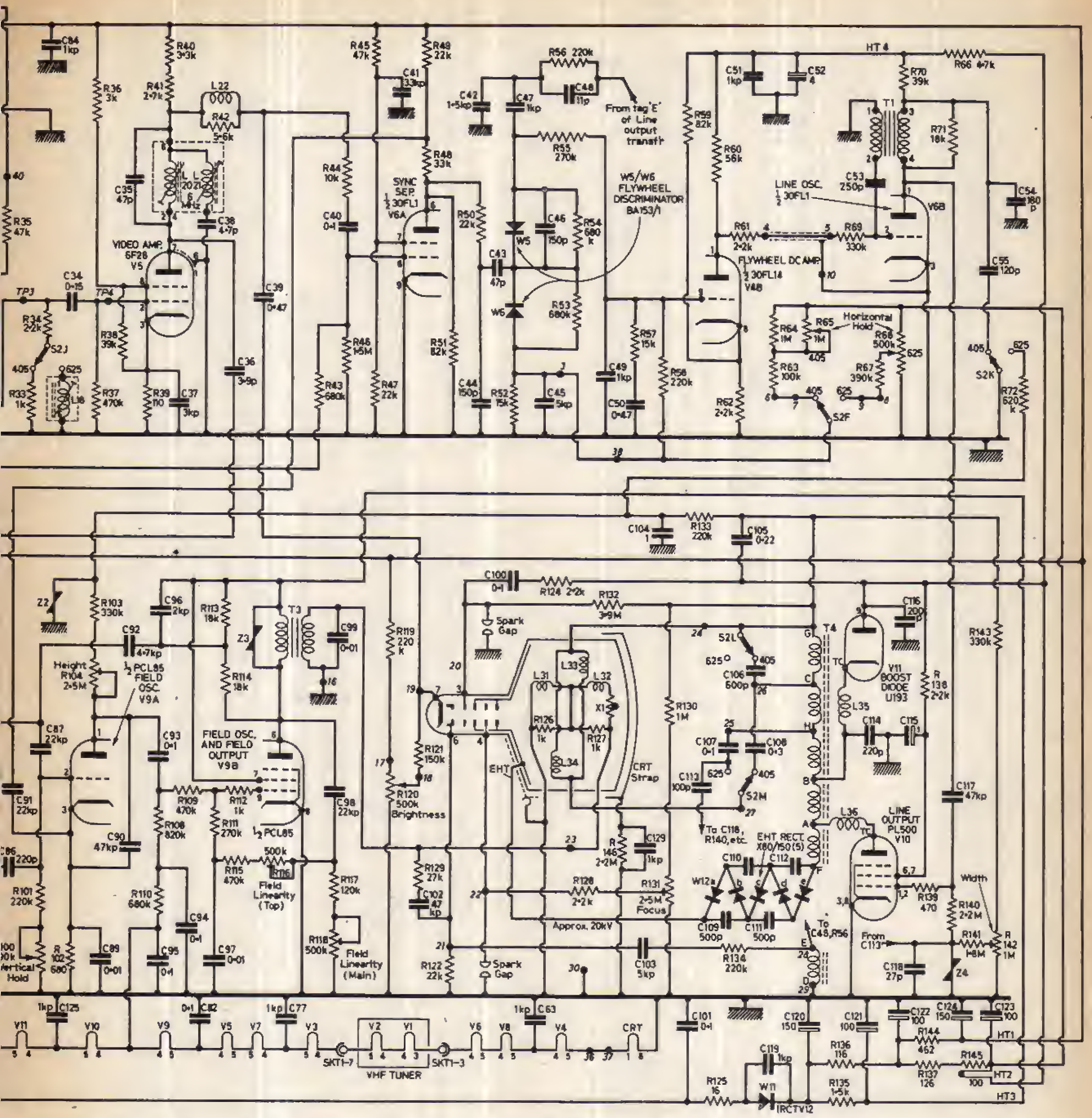
Fig. 2: Circuit diagram of the Thorn 1400 chassis used on many HMV, Fergu

Lack of width can be due to a low-emission PL500 (PL504) and usually is. However the U193 (PY801) and the width circuit resistors R143, R141 and R140 should be checked in stubborn cases and it should be remembered that leakage through C113 (100pF) can damage the v.d.r. (Z4, MU01) leaving lack of width after C113 has been replaced.

The PL500 screen feed resistor is R138. A faulty PL500 can cause this to overheat and although the resistor may survive the solder on the panel may be impaired and the resultant improper connection may lead to intermittent line output and sparking at the point of poor connection.

Line Hold

It is quite common for the line hold to be suddenly lost with an abrupt change of line speed. Before checking the valves (30FL1 and 30FL14) and components check the screened cable between R61 and R69. The inner may be found shorted to the outer if the cable is pinched or has been subjected to heat. Apart from this R69 can often change



Marconiphone, Ultra and Baird models (a complete list will follow next month).

value (going high), C53 can leak and the discriminator diodes W5 and W6 (double unit BA153/1) can become unbalanced.

The EHT Tray

The e.h.t. for the tube is derived from a voltage multiplier fed from the jelly-pot line output transformer. This multiplier consists of five pencil-type rectifiers set in a tray with their voltage doubling capacitors. The tray is clipped to the transformer and is easily detachable. A faulty rectifier can cause some unusual effects quite apart from the more common symptoms of "blowing up" etc. For example the picture may be quite acceptable at low brilliance but as the brightness is increased—either by operating the control or by the picture content—the line structure is "sizzled" horizontally, the degree of disturbance depending upon the brightness level. Whilst it is possible to replace individual "pencils" the writer (being of a lazy disposition) replaces the tray for a complete cure.

—continued column two overpage

NEXT MONTH IN

Practical TELEVISION

DEVELOPMENTS IN TV RECEIVERS

Much has been changing inside TV receivers in recent years; and now with single-standard operation and the appearance of the first i.c.s in TV sets the pace of change is quickening. Next month K. Royal takes a detailed look at these developments and illustrates changing circuit techniques.

DO-IT-YOURSELF 625-LINE RECEIVER

David Robinson set out to convert a 405-line set for 625-line operation and ended up by building an almost new receiver. Next month he describes his experiences—including the introduction of black-level stabilisation in the video stage—and the circuits he finally settled on using. Complete circuit details are given of this low-cost project.

TRANSISTOR LINE DRIVER STAGES

Line output driver stages are unique to fully-transistorised receivers and present some intriguing design problems. H. W. Hellyer takes a detailed look at this critical section of a transistor line timebase and describes the techniques used to obtain successful operation.

SIMPLE GADGETS FOR THE REPAIR SHOP

Next month in *Workshop Hints* Vivian Capel describes a number of simple gadgets that can save much time and effort in the repair shop.

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Shorted Heater Circuit Diode

This is probably the most commonly encountered fault of all. The original type of diode fitted in the W10 position was a very small one which seemed to short at the slightest provocation and the writer usually fits a BY100 or BY126 in this position.

The obvious symptom of this rectifier failing is uncontrollable field roll as the negative bias for the PCL85 is replaced by an alternating voltage. The less obvious sign of a shorted rectifier is that the tube and valve heaters are being over-run. The negative voltage output of the rectifier (about an indicated 80V) becomes something under 200V a.c.

Fortunately the rectifier is in an easy position for replacement and there is plenty of room. Carefully observe the polarity of the replacement as a positive output will play havoc with the PCL85.

Next month: Field timebase—quick fault-finding guide—modifications—printed panel layout—voltage data—tuner circuit—complete list of models.

TRANSISTOR AND DIODE ANALYSER

—continued from page 113

Obviously it is βd, not β, which determines the performance of the transistor in an amplifier at the operating point represented by Ic. For some transistors β varies strongly with Ic so that βd is no longer equal to β and also varies strongly with Ic. In this case βd must be measured at the intended Ic.

The procedure described for determining β at 1V collector voltage is almost universally valid for ascertaining the extent to which β is constant or varies with Ic because its variation with respect to the collector voltage is normally very small in all cases. This can be checked by moving VR1 setting through 20 to 40% f.s.d. and noting any change of meter reading.

To determine the *differential current gain* at an operating point Ic of interest proceed as follows: Select the lowest meter range containing the desired operating point current. Read off from Table 3 the maximum permissible power dissipation on account of geometric dimensions. Turn up VR1 according to the power dissipation table on the front panel (see Fig. 6) or to maximum (200% f.s.d.) if this still corresponds to a lower power dissipation than the maximum permissible one. Next apply increasing base drive in μA or mA switch ranges until two base drive current settings are found such that they are adjacent and one gives an Ic less than and the other more than the nominal Ic for the envisaged operating point. Divide the difference of the two Ic readings by the difference of the two base drive currents. The result is the differential current gain βd for the investigated operating point.

Apart from possible strong variation with Ic and slight variation with Vc, β and βd also drop with increasing signal frequency. For most experimental purposes it may be assumed that the static d.c. values determined as above hold for any signal frequency up to the maximum frequency setting in the "Test MHz" function for which oscillation does not stop (meter reading still finite) when the oscillator attenuator is set to maximum attenuation. (See Test 7.) β and βd drop drastically at higher frequencies.

TO BE CONCLUDED

FILTERING CIRCUITS

H.K.HILLS

FILTERS can be designed to remove, attenuate or pass almost any required band of frequencies from a wider applied range, or alternatively can remove the a.c. component from a varying but "unidirectional" output. The latter type of signal is developed across the loads in valve anode and cathode circuits or in transistor emitter and collector circuits where the output is superimposed on the no-signal d.c. feed.

Filters can be multiple *LCR* arrangements, simple *RC* or less frequently *LR* combinations and differ from wavetraps, dealt with recently in these pages by S. George, in that the latter are *LC* and therefore tuned to a relatively narrow frequency band while filters generally respond to a wide frequency range. As an example, a tuned circuit in a record amplifier can remove a sharply defined "scratch" frequency while a series *RC* filter across a load resistor or transformer primary will progressively attenuate the higher unwanted frequencies as a form of tone control.

FILTER ACTION

Simple two-component *RC* or *LR* filters can be regarded as potential dividers with a frequency sensitive characteristic, the direction of attenuation depending upon the component from which the output is taken. With a purely resistive potential divider connected across a.c. or d.c. the output across either resistor is always proportional to its value related to the total. With an *RC* combination on the other hand the proportion developed across the capacitor reduces as frequency increases to leave a correspondingly higher proportion across the resistor. The reverse is true of an *LR* combination where rising frequency produces a rising proportion of output across the inductor. This is because the reactance of a capacitor decreases with rising frequency while that of an inductor increases.

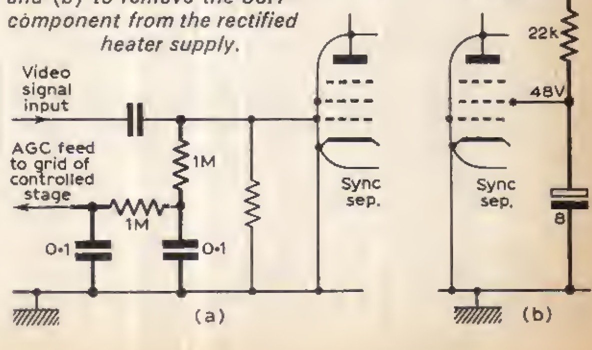
Series *RC* combinations are of course used in many other applications, most notably as the grid or base feed network in r.f. and a.f. amplifiers, and this gives rise to the question "why don't they function as filters in this use also since the frequency range covered could extend from 50Hz to 10kHz?" The answer is that such *RC* feeds *are* frequency sensitive and a higher proportion of the signal *is* developed across the capacitor at l.f. than at h.f., but by choice of component values with regard to circuit impedance this loss can be minimised.

The effectiveness of filters is dependent on their reactive in relation to their resistive value and the impedance of the associated circuit. For example an 0·1μF capacitor has a reactance of 31,840Ω at 50Hz, which we can assume to be the lowest a.f. signal, and rounding this figure to 32,000Ω enables us to estimate its reactance at the highest a.f. frequency of say 10kHz—50/10,000=1/200, and 1/200th of 32,000Ω is 160Ω. Thus we have over the audio frequency range a variation of from 160Ω to 32,000Ω, but when this is related to the high value of the resistor used as the grid leak in valve circuits, typically about 0·5MΩ, there should not be too great a roll-off at l.f. especially after linearisation by negative feedback.

When it comes to transistor common-emitter stages with an input impedance of possibly only about 1kΩ however the base resistor is shunted by this low figure and unless the capacitor is of high value most of the signal would be developed across it instead of across the input to the transistor. For this reason coupling capacitors in common-emitter stages are several microfarads in value, a common value being 2·5μF which has a reactance of close to 1,280Ω at 50Hz reducing to only 6·4Ω at 10kHz. Although gain at very low frequencies will still therefore tend to fall off this does not usually assume too great a significance when related to average speaker response.

Let us first consider the filters used to remove the a.c. component from a varying unidirectional signal, taking as a first example the removal of the video content from the grid voltage developed by the sync separator. A pure d.c. potential is required for a.g.c. purposes but because the actual current feed is negligible (in valve circuits) the resistor can be of high value and the capacitor of medium value providing the time-constant of the a.g.c. loop as a whole is within design limits. Figure 1(a) shows a typical arrangement with component values: even at 50Hz when the reactance of the 0·1μF capacitor has risen to 31,840Ω it is still very much less than the resistor value (1MΩ). Furthermore in most receivers—as in the example shown—two-stage filtering or decoupling is employed to provide a very pure d.c. output.

Fig. 1: Two examples of filters designed to remove the a.c. component from a varying unidirectional signal. (a) To remove the video signal at the sync separator grid and (b) to remove the 50Hz component from the rectified heater supply.



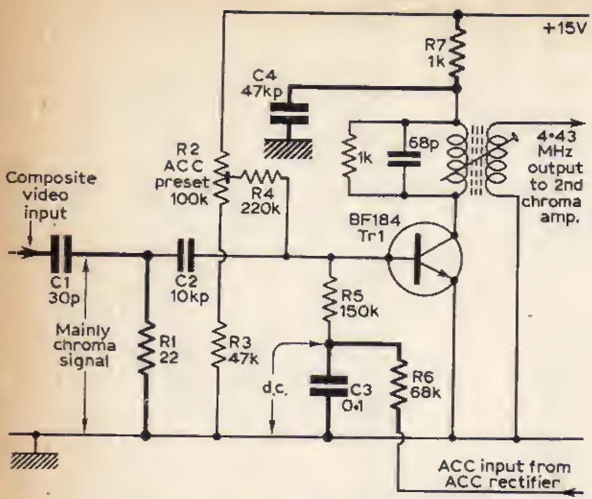


Fig. 2: RC filters in the first chroma amplifier stage in the Pye dual-standard colour chassis. The chrominance input is taken from across R1 in the filter R1, C1 while the a.c.c. input is taken from across C3 in the filter C3, R6. Filter R7, C4 smooths the collector supply.

In contrast consider the value of the components used to filter out a 50Hz component when current must be taken into account as in Fig. 1(b) which shows the sync separator screen grid feed in some Bush-Murphy receivers. In these models, as in many others, the valve heater supply is taken via a rectifier to reduce the dropper resistor value and thus the power consumption and cabinet heat dissipation. However if the rectifier develops a short-circuit all the valves and the c.r.t. will be grossly overrun and apart from increased brilliance and contrast the user would be unaware that a major fault existed. To prevent reception in such circumstances the h.t. supply for the sync separator screen grid is tapped from a point in the heater chain. Thus rectifier failure will result in a small a.c. instead of correct d.c. voltage being applied to the sync separator screen grid, causing continuous field slip.

The d.c. feed must be well smoothed—or filtered—but the series resistor cannot be of very high value or there would be too great a voltage drop across it. Similarly the capacitor must be of sufficient value to be able to absorb the positive half-cycle "charges" with negligible instantaneous voltage rise and be able to maintain the screen current without undue voltage drop until the next positive half-cycle arrives. In this particular receiver these conditions were best met by a 22kΩ feed resistor and 8μF shunting electrolytic.

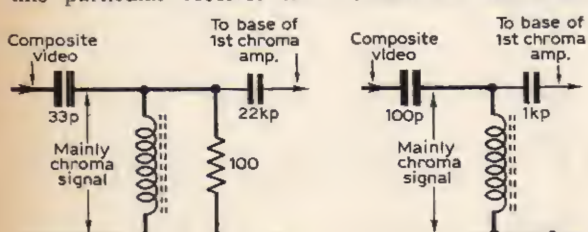


Fig. 3: Input filters for colour TV chroma input stages, (a) GEC, (b) Decca, designed to attenuate the lower frequency luminance component of the composite video signal.

CHROMA FILTERS

To turn next to colour TV circuits Fig. 2 shows the filters employed in the first chroma amplifier stage in the decoder of the Pye dual-standard colour receiver. It will be seen that there are two filters in the base circuit. Filter R6, C3 in the a.c.c. bias circuit performs the same sort of function as the filters in Fig. 1(a) but instead of removing the video component removes a 4·43MHz signal since the a.c.c. is derived from the colour burst signal which is at this frequency. Filter R1, C1 has a completely different purpose: it is connected so that the signal developed across the resistor and not that across the capacitor is utilised. Tr1 being the first chrominance stage it is fed with the composite video signal and this input filter is designed to attenuate the lower frequency (luminance) information so that it is the higher chroma frequencies centred on 4·43MHz (and with only a ±1MHz bandwidth) that are mainly applied across Tr1 base-emitter junction.

At chrominance frequencies the reactance of C1 is low compared to the resistance of R1 and most of the signal is developed across the resistor. But at the lower luminance frequencies the reactance of C1 is very much higher and a proportionately reduced amount of signal is developed across R1. Thus the lower frequencies are largely filtered out at the input and the tuned transformer in the collector circuit provides an amplified output at the chroma frequency for transmission to the following stage. Incidentally a further filter R7, C4 smoothes the collector feed to Tr1.

It will be seen that the signal developed across R1 is capacitively fed to Tr1 base via C2 with d.c. return to the a.c.c. rail via R5, apparently forming another feed filter. However the reactance of C2 (10kpF) is so low compared to the total input impedance of Tr1 that the combination is not frequency selective to any appreciable extent.

While on the subject of the first chroma amplifier stage in colour TV receivers Fig. 3(a) and (b) shows two different input filters designed to attenuate the luminance frequencies. These are used in (a) GEC models and (b) Decca receivers. In both cases rising coil reactance with rising frequency accentuates the selective nature of the filter, the 100Ω shunting resistor in the GEC chassis broadening the response to the required degree in similar fashion to resistor loaded tuned circuits.

LOW-PASS FILTERS

These are of course high-pass filters but almost all other monochrome and colour TV receiver filters are low-pass ones and either remove an h.f. signal present with the wanted l.f. signal or pass only the d.c. component of a varying waveform. H.T. and l.f. are relative terms however, for what is high frequency in one circuit may be low in another.

The principal low-pass filters in TV receivers remove the following: (a) the i.f. content from the detected video and sound signals, (b) the video and a.f. content from vision and sound a.g.c. rails, (c) the subcarrier from colour TV synchronous detector outputs, (d) the 7·8kHz component from the rectified ident output used as colour-killer bias and sometimes as the source of a.c.c., (e) the subcarrier from the rectified burst signal where this is used for a.c.c.

purposes, (f) the signal content from the d.c. drive to a.g.c. amplifying transistors, (g) the instantaneous variations in flywheel sync and the various a.p.c. systems in use and (h) the 50Hz ripple on h.t. and l.t. supplies.

Some of these requirements demand more effective filtering than can be achieved by simple two-component *RC* combinations so pi filters and variations are widely used. The most common arrangement comprises two capacitors linked by a resistor, inductor or rejector tuned circuit through which the wanted signal passes, the three variations being illustrated in Fig. 4.

Example (a) shows a typical h.t. smoothing circuit supplying one common h.t. rail, an iron-cored choke being used to minimise the voltage drop caused by the total current demand. When multiple h.t. feeds are used as is common in modern receivers each rail is separately decoupled by an *RC* combination. This latter system has the advantage that circuits requiring a very high level of smoothing, e.g., timebase generators and first a.f. stages, can be fed separately from those that require maximum possible voltage, e.g. line output stages.

Example (b) shows a rejector tuned circuit used in place of an untuned choke as a stopper for the 4·43MHz subcarrier accompanying the output from colour receiver synchronous detectors. A tuned circuit can be profitably used as the series impedance in this instance since the unwanted frequency is fixed and can be tuned to with small value components. It would on the other hand be impractical to tune to 50Hz.

Example (c) shows a resistor used as the series impedance in a 405-sound detector circuit—this arrangement is most widely used for other filtering applications.

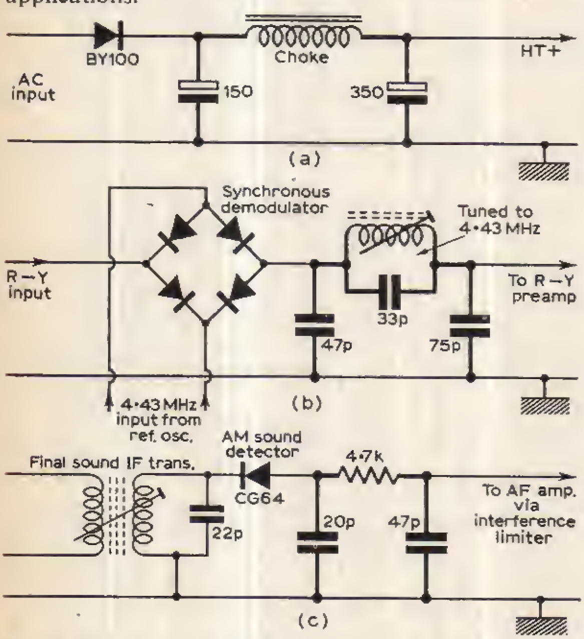


Fig. 4: Three types of pi filter. (a) Choke series element used for h.t. smoothing (STC). (b) Tuned circuit series impedence used to filter the 4·43MHz component from a colour signal (Decca). (c) Resistor series element used to filter the i.f. component from the a.m. sound signal (BRC).

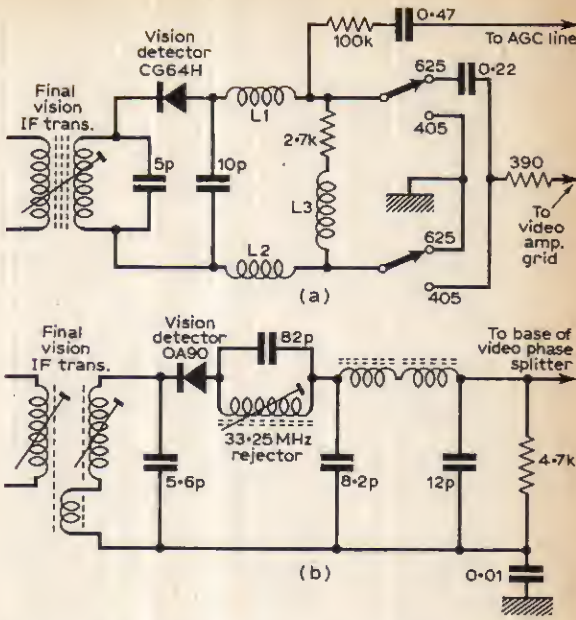


Fig. 5: Typical dual-standard vision detector circuits, (a) using switched diode for opposite polarity outputs on v.h.f. and u.h.f. (STC) and (b) giving negative-going output on both systems for application to a phase splitter (Bush-Murphy).

These filters operate basically on the principle that the reactance of the first capacitor shunted across the signal path is low compared to the impedance of the series component and therefore offers an easy path to the unwanted frequency. The small proportion of unwanted signal that does pass through the series component then leaves a negligible percentage across the second capacitor since this also offers a low reactance to the signal.

Removing all frequencies from a signal (i.e. obtaining a d.c. output) is easily achieved but removal of the i.f. component from the vision detector output is particularly difficult since the top video frequency on both systems is so high. On v.h.f. the standard vision i.f. is 34·65MHz and with a top video frequency of 3·5MHz this gives a frequency ratio of about 10 : 1, while on u.h.f. with a standard i.f. of 39·5MHz and a top video frequency of 5·5MHz the ratio is down to little over 7 : 1. To preserve the all-important h.f. video response therefore miniature chokes are included in the series feed and these in conjunction with circuit capacitance present a high impedance to the i.f. but negligible impedance to all video frequencies. Additionally the circuit may give slight resonance towards the top of the video band in similar fashion to peaking coils in video output stages.

No such problem exists at the 405 sound detector stage for assuming a top audio frequency of 10kHz this gives a frequency ratio of 3815 : 1 between the top audio frequency and the standard sound i.f. of 38·15MHz. Filtering out the i.f. component can therefore be adequately provided by simple *RC* arrangements similar to that shown in Fig. 4(c).

Vision post-detector filtering is therefore always

—continued on page 135

The Highbury College

BAYNHAM HONRI

BIRTHPLACE OF INDEPENDENT TELEVISION IN BRITAIN

In 1950 the Highbury Studios were taken over by a small commercial organisation headed by Norman Collins (former Controller of BBC Television) and Terence Macnamara (previously head of BBC Planning and Installation) which called itself High Definition Films. Under this name an independent group of young electronic engineers was mobilised in the search for an entirely new technical approach to the recording of television pictures on 35mm. motion-picture film. The new system used two or more television cameras on the studio stage, a vision mixer with a number of monitors in a control room, and a special high-quality flat-faced monitor for displaying the resultant picture to the lens of a rather special 35mm. motion-picture camera which produced the master 35mm. negative.

The initial work on this system had been undertaken at Pye of Cambridge under the benevolent and helpful eyes of C. O. Stanley and B. J. Edwards. The first HDF attempt at making an electronically-originated high-quality motion-picture film in fact was done in a most uncomfortable corrugated iron shed at Pye's works at Cambridge. This was a beautifully made fashion film but, though a considerable advance in the direction aimed at, the engineering side was not wholly satisfied. However they were on the right lines towards their ultimate aim, to replace motion-picture by electronic cameras.

It had been established at Cambridge that interlaced scanning produced inherent distortion of moving objects and also that the mass of the film to be transported frame to frame in the film camera could not be pulled down fast enough for every line of the complete picture to be photographed. However technical progress was swift once HDF had set up their apparatus in the disused film studios at Highbury, where they continued in collaboration with Pye.

Sequential Scanning

For the HDF system sequential non-interlaced scanning at a picture rate the same as that of motion-picture film, i.e. 24 frames per second, was used. As the picture did not have to be transmitted to the public it was not necessary to combine the synchronising signal with the picture signals but was displayed, flicker and all (at 24 f.p.s.), to the "line" monitor for photographing. Each picture monitor in the HDF system was provided with separate horizontal synchronising and video signals. For the recording on to film process there was a distinct advantage in that synchronising the timebases is more easily achieved.

The HDF equipment was designed to work at line speeds between 15kHz and 20kHz, corresponding to 625 and 834 lines per frame. The use of sequential scanning with separate synchronising signals allowed the line frequency to be unrelated to the frame frequency. This not only simplified the pulse generating apparatus but, most important at this pioneering period, enabled the number of lines to be varied on test to suit the resolving power of the pick-up cathode-ray tube selected for photographic display. "Spot wobble" could also be applied, which removed all traces of lines.

Closed-circuit Advantages

Of course on closed-circuit systems it is relatively simple to obtain wide video bandwidths. The HDF system had an overall bandwidth of 12MHz—easy to consider today but in 1952-53 an unusual objective to say the least. Phase and high-frequency correction were applied to each camera output in order to be certain that each camera channel delivered the best possible picture, and naturally observation of the waveform and picture monitors was essential for obtaining the best possible matching between cameras. The range over which faithful reproduction of the scene was reproduced was indicated by a step waveform of ten steps which appeared superimposed on the video waveform by the use of the double beam feature of the waveform monitor.

The HDF Television Camera

It is strange to write about television cameras in those dark ages before the image orthicon camera era. BBC Television started in 1936 with insensitive Emitron cameras at the Alexandra Palace studios. Their use was continued for a short time after the war when the Super Emitron and CPS Emitron cameras were introduced, the last-named type being a little more sensitive and having a grey-scale which flattered people's faces even without facial make-up.

Then came the Pye Photicon TV camera, a very good one at that time but given to erratic "moods", and the "shading" faults to which all Emitron-type tubes are prone. Expert operation was necessary—this sometimes consisting of a stylised kick on a corner of the camera control unit for the Photicon. A refinement of this camera, the PES which meant "Photo Electron Stabilised", was modified to sequential scanning along the lines previously related.

Moy-HDF Film Recording Camera

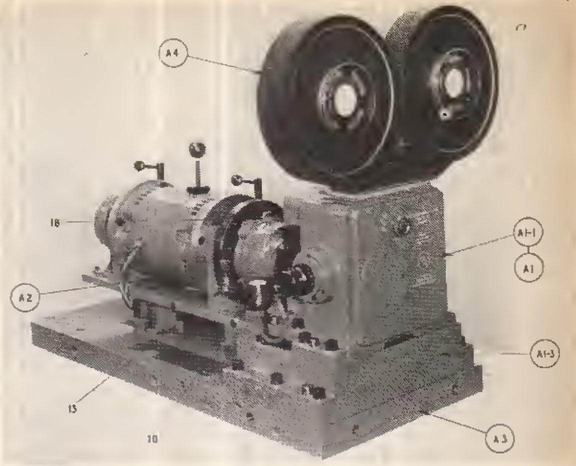
A major technical contribution to the HDF system was the picture recording camera built by Ernest F. Moy Ltd. in conjunction with HDF. This was a beautiful precision instrument, constructed with the Rolls-Royce class of craftsmanship for which Moy's are world famous. The most important part of a motion-picture camera is always its transport mechanism, upon which the steadiness and stability of the motion picture depends. The Moy/HDF camera's mechanism took the form of a claw driven by a triangular cam, mounted on a casting insulated from a substantial box casting on which the lens was mounted and which also carried the masking aperture gate and register pins. These register pins are of special importance. A third housing carried a synchronous motor which drove a mechanical accelerator to speed up the camera pull-down mechanism. The whole camera, comprising three units, was mounted on an exceptionally robust base. In this manner vibration during exposure at the camera lens and masking aperture was eliminated. Versions of this Moy camera are still in use all over the world, particularly for transferring live or taped television pictures to 35mm. film. The steadiness of the camera enables three monochrome colour separations to be individually photographed, red, green and blue, for combining together in printing. The Technicolour Vidtronics system is a successful example of this technique. The BBC and a few independent TV companies also made use of the Moy fast pull-down motion-picture camera.

All this development at Highbury occupied about four years. Great progress was made and a number of very fine subjects were recorded on 35mm. motion-picture film from multiple Photicon cameras. These were mainly half-hour film subjects for television in the USA as well as in the UK. Norman Collins ensured that they were well scripted, directed, lit and acted by good actors: many a good technical advance has failed through the use of inferior story-lines and presentation. The system with its sequential scanning might even today be adaptable for high-quality closed-circuit colour recording on film at up to say 3,000 lines!

The Start of ITV

In his visits to the USA Norman Collins took note of the success of competitive television in that country, led by the NBC, Columbia and ABC networks. It became his belief that television in Britain would make slow progress without the spur of competition and that the BBC monopoly should be ended. He carried his views into the lobby of the House of Commons and pushed hard in parliamentary circles for independent television, to be financially supported by filmed commercials. Some commercials were produced at the HDF studios at Highbury with the cooperation of Colman, Prentice and Varley and in this way genuine commercials of nationally known products were produced long before they were required for broadcasting and were shown to MPs of all parties. The HDF studios at Highbury then quickly became the cradle of independent TV in the UK, the first independent television studio and a "crash course" centre for the training of both producers and engineers. Subsequently Norman Collins developed and piloted through Parliament a plan for commercial television in Britain.

It was at Highbury that the original Associated Broadcasting Development Company was evolved, later becoming the Associated Broadcasting Company and still later Associated Television. The "Highbury



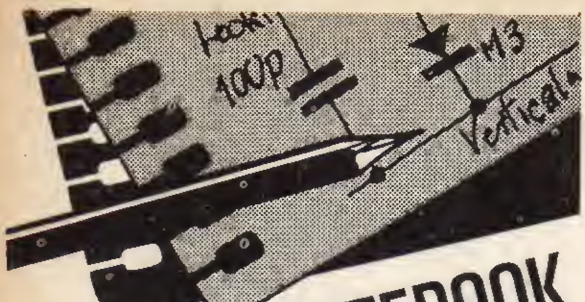
The Moy RP30 35mm. television recording film camera.

College" buildings subsequently became one of the London studios of Associated Television, along with the Wood Green and Hackney Empires which were converted from music halls. This is indeed where "show business" first fused with television.

The Charm School

Where does the author of this article come into the nostalgic "Highbury College" saga? It started with a discussion he had with Norman Collins and Terence Macnamara at the Reform Club. The question was did he know where a reasonable film studio could be bought or leased with all film stage equipment? I had heard that the "charm school" for film starlets at Highbury had been loosing its charm and might be in the market. It was, and thus started one of the most enterprising electronic undertakings. The decision by Collins, Stanley and Macnamara to go ahead led to the beginning of commercial television and made television history.

As a footnote to this story we can quickly look at the varied history of the Highbury Studio buildings. They were built in about 1890 as a Conservertoire of Music at 65A, Highbury New Park, Islington. The rather sombre looking premises comprised a well-planned concert hall (capable of seating about 600 people), a large rehearsal room and numerous other rooms for individual study. It was also used for local social events. It became a gramophone recording studio in about 1926 where Piccadilly white label dance discs and some first class black label classics were recorded. A German recording system was used and the pressings made elsewhere. It was reconstructed in about 1933 as a film studio by Highbury Studios Ltd., with two stages both soundproofed and well equipped, including RCA sound film recording equipment. Films made included "Twin Faces", "Intimate Relations", "Sam Small Leaves Town" and "Romance of Dancing". The studios were later used for elaborate special-effects spectaculars and as a film training centre. It was in this latter capacity that it operated prior to being taken over by High Definition Films as being suitable for adaptation for the electronic developments they had in mind and as a starting point for the Associated Television Company. The Highbury Studios were demolished in 1960: in their place are blocks of flats. ■



SERVICE NOTEBOOK

G. R. WILDING

Slow Starters

QUITE often when attending to one complaint we find or are told that the picture takes a longer time than usual to appear—and in almost all cases the cause is slow development of the e.h.t. If sound also tends to be slow coming to full volume, and if the set is old and uses a PY33 h.t. rectifier, I immediately replace this for a delayed rise to full output is often the first sympton of failing emission in the rectifier. In cases where a strong line whistle develops in normal time but raster appearance is prolonged I would first change the e.h.t. rectifier, especially if there is any tendency for the picture to balloon when the brilliance is advanced excessively. If long warm-up is accompanied by lack of width naturally the line output valve must be the first suspect; but if the raster tends to be cramped on the left-hand side the boost rectifier is probably failing.

Sometimes slow e.h.t. production is due to the line generator only commencing to oscillate when really warm or when a slight circuit surge instigated by changing systems or channels triggers it into operation. We have known line generators only commence to oscillate after the set has been switched off after the initial warming up period and then switched on again. This is very bad practice of course and puts great strain on all the valves, the line output valve and boost rectifier in particular.

I can recall one RGD 19in. set which needed two new line output valves in quite a short time. This we found was because the line oscillator occasionally took a very long time to operate, especially when the mains voltage was low. This was during the winter months and the set owner had accepted these excessive warm-up periods as harmless, if inconvenient, symptoms caused solely by reduced mains voltage. A new line generator completely cured the trouble and the need to replace the PL500 after only several weeks use.

Without line drive a line output valve is without bias and both the anode and screen currents will rise to several times the normal value. Without anode voltage, and with or without grid drive, the screen current will rise sufficiently to make its windings red hot. If you watch a line output valve after switching on from cold you will see that soon after the heater warms up the screen grid winding will begin to glow for a brief period till the boost rectifier warms up. This is due to the fact that because of the extra heater-cathode insulation required boost rectifier cathodes take on average fifty seconds longer than other valves to reach operating temperature. During this period the line output valve is therefore without anode voltage and the screen grid, which is fed from the h.t. rail, takes an excessive current—till the boost rectifier warms up.

For this reason it is particularly important not to place a cold boost rectifier in a warmed-up receiver. If this were to be done the line output valve would be subjected to this strain for the normal valve warm-up time plus the additional fifty seconds. And this can often prove disastrous for an ageing pentode.

Incremental Tuner Fault

CALLED to service a Pye 17in. model recently we found normal ITA reception but virtually nonexistent BBC results. Usually in such cases we suspect aerial trouble. As the fault had suddenly developed an aerial defect would have had to be a complete open- or short-circuit. The aerial was a combined type, but we have known coaxial lead disconnections to them to produce little effect on one Band but make reception on the other Band hopeless. Our first move was to plug in an indoor rod aerial and note results. Again there were good ITA but very poor BBC results, confirming a tuner defect.

Although we had little hope of success we first replaced *both* tuner valves—the frequency changer because you get the odd occasion when a valve will give good conversion conductance on one frequency but not on another, or even fail to oscillate on one Band. There was marginal improvement only, so we replaced both original valves and removed the tuner top cover.

The tuner was an incremental-inductance type with miniature series-connected coils mounted on the central rotor switch section. The contacts looked clean and appeared to be making well, but we wiped them over and applied a little jelly lubricant.

We then noticed that the slug in one coil was almost completely out and closer inspection showed that one end of the coil was unsoldered from its rotor connection. On resoldering it BBC results were restored and we were able to see that the slug had just fouled a component as it rotated, eventually breaking the coil lead. It had not affected ITA as it was in the Band I section of the coil circuit.

A slight readjustment of the core further improved results and completed what at first appeared to be an involved job.

No Field Sync

WE came across an elderly Pye Continental recently that gave an excellent picture with normal line lock but virtually nonexistent field lock. Naturally our first move was to replace the field timebase valves but in this instance with little hope of success since although a defective generator valve will often impair or weaken lock they rarely cause complete loss of sync.

There was no improvement but noticing a couple of miniature diodes mounted nearby we decided to test them both for almost certainly one would be

SYNC FAULT PROBABILITY CHART

Weak line and field sync

(a) Sync separator
(b) Video amplifier
(c) Anode, screen and control grid circuitry of (a)
(d) Cathode circuitry of (b)—check bias

Line only

(a) Generator valve(s)
(b) High-resistance a.f.c. diodes
(c) A.F.C. d.c. amplifier valve where fitted
(d) A.F.C. discriminator circuitry (including sync and line timebase reference pulse feeds)
(e) D.C. amplifier circuitry

Field only

(a) Generator valve(s)
(b) High-resistance interlace diodes
(c) Sync pulse amplifier where fitted (STC)
(d) Video amplifier
(e) Misalignment (check Test Card h.f. resolution)
(f) Impaired h.t. smoothing
(g) Sync pulse amplifier circuitry
(h) Vision i.f. amplifier (fault on u.h.f. only)

part of an interlace filter. Both diodes had excellent forward/reverse resistance readings so they could be discounted.

On removing the base inspection panel we saw a field blocking oscillator transformer and as it is not unknown for their insulation to deteriorate and result in weak locking action we decided it was best to check here before proceeding further. With the aid of a meter test prod we connected an 0·01μF capacitor from the sync separator anode to each of the transformer tags in turn and on contacting one obtained first-class lock but with poor interlace.

Obviously therefore the transformer was all right and the fault was lack of sync pulse input. Having established where the sync should be applied it was a relatively simple matter to check the feed route from the sync separator and we subsequently found a completely open-circuit feed capacitor.

At this point it may be as well to mention the best way of identifying valves when faced with an unfamiliar receiver and without a service manual. The general tendency in the trade is to withdraw the valve sufficiently from its holder to lose contact and note the effect of this on the results obtained. The results will of course be complicated by the fact that so many valves are dual types performing two different functions.

The big snag with this procedure is that it puts strain on the heater-cathode insulation of all valves higher in the heater chain by raising their heater-cathode potential to practically peak value. A more positive and certainly safer method is to contact the anode and/or grid of unknown valve stages with a voltmeter in the normal way and note results. The combined effect of meter resistance and self-capacitance will prove sufficient to affect the performance of any stage to give a positive indication of valve function. If your meter isn't to hand contacting a small to medium size capacitor from these points to chassis will prove equally as informative.

TO BE CONTINUED

LETTERS

—continued from page 109

is screened from the collector by the tin shield as mentioned in the article. The amplifier must be well screened and where possible the earth wiring should be taken to one point. On the prototype Tr2 emitter connection via L3 was taken to a point about 2in. from the earth connection point for the other components: possibly if you have done this the distance is sufficient to cause some form of resonance on u.h.f. and detection is taking place in the second stage. On the prototype there is no such happening and I have since tried feeding in a signal from an 18-element Parabeam aerial but am unable to cause any BBC-2 breakthrough although I am only some 25 miles from the 500kW local station. I have also built a similar preamp with two stages in cascade with the output split via a star network to two further single-transistor stages providing two separate outputs and have had no trouble whatsoever with this other than possibly the excessive gain of about 40dB.

VIDEOSCOPE PARTS

I have had difficulty in obtaining the Mumetal screen for tube type DG7-32 used in the Videoscope. Can you suggest a supplier?—**V. E. Clarke** *(Norfolk).*

The shield, type 001, is obtainable from Magnetic Shields Ltd., Headcorn Road, Staplehurst, Tonbridge, Kent at £3 10s. 0d. when in stock. They are £8 each if it is necessary to make one specially, but £2 7s. 6d. each for an order of 12. Several readers have inquired where they can order the tube itself. This can be ordered from H. L. Smith & Co. Ltd., 287-289 Edgware Road, London, W2 and costs £10 10s. 0d. plus 14s. 6d. post and packing, U.K. only. (Special quotations can be obtained for overseas.)

The exact form of the Mumetal screen is not very critical, the most important point being to position the mains transformer correctly as specified. If available therefore a surplus screen of similar size can be adapted.

Several readers have had difficulty in obtaining suitable diodes. Suitable Mullard types are the BA148 in place of the BAY21 and the BA115 in place of the BAY18.

FOR DISPOSAL

I have the following sets for disposal: Bush TV22, Ekco T217 and Alba T301. All are complete but the line output transformer needs replacement in the Bush set: the others are in working order.

If any reader requires any part please send sufficient to cover postage and an s.a.e. for return of postal order if the part is not available.—**R. Rolison** *(6a Picket Place, Andover, Hants).*

ANY SOUND CONVERSION IDEAS?

I would appreciate any information on the conversion of a new or surplus transistor u.h.f./v.h.f. television tuner and corresponding i.f. strip to a television sound tuner of high fidelity quality. Details such as a.g.c. line connections and power supply requirements would be necessary. Have any readers undertaken a successful conversion of this type?—**A. M. Walsby** (*Camberley, Surrey*).

DX TV

CHARLES RAFAREL

A MONTHLY FEATURE FOR DX ENTHUSIASTS

As I have been on holiday during most of the month our old DX friends Roger Bunney, Maurice Opie and Ian Beckett have kindly stepped in with reports of their experiences and I am glad to say that it is " business as usual" for this section of the column.

Usually when I am away, as I normally am during September, there are some fantastic openings for either SpE, Trops or both. This has apparently not happened this time and things have been pretty quiet. Perhaps we shall be luckier with the Trops at least in October and November, when they should open up. Although it has been a quiet month for SpE there has been some activity for a late period in the season and Ian Beckett had some joy with Trops on 20/9/69 as noted below.

These latest logs only confirm once again that this year has been a rather poor one for DX-TV. However I am sure that for SpE at least 1970 should be better as we move further away from the sun-spot maximum which tends to damp down SpE activity. Given settled weather in the coming winter we should get some good Trop openings—we are certainly due for some!

Now for the combined logs for the period 1-30/9/69, the dates 1-5th include my own results here. SpE log:

1/9/69 USSR R1, Spain E2, Sweden E2 and Norway E2.
2/9/69 Spain E2, E3 and E4, Portugal E2 and E3 and Yugoslavia E4.
3/9/69 USSR R1, Poland R1, W. Germany E4 and Italy IB.
4/9/69 Italy IB.
5/9/69 Nil, except M. Opie USSR R1.
6/9/69 E. Germany E4.
7/9/69 Czechoslovakia R1.
8/9/69 Spain E3.
9/9/69 Spain E3.
10/9/69 Spain E2.
13/9/69 Sweden E3.
16/9/69 Spain E3.
17/9/69 Spain E3 and Sweden E2.
18/9/69 Spain E3.
19/9/69 Czechoslovakia R1.
20/9/69 Czechoslovakia R1, Spain E3 and Italy IB.
22/9/69 Spain E2 and E4.
23/9/69 Spain E3, Sweden E4 and E. Germany E4.
24/9/69 Spain E4.
25/9/69 Spain E3.
27/9/69 Czechoslovakia R1 and Italy IB.
29/9/69 Spain E4.

The Trops: Roger Bunney reports good openings to Eire Dublin Ch.B7 on the 1st, 4th, 8th and 23rd, with Kilkenny Ch.F also on the 23rd and Holland Lopik on the 20th, plus French stations at times. The best opening seems to have been in Ian Beckett's area on the 20th when he had E. Germany Ch.31 and 34, W. Germany Ch.21, 24 (two stations), 25, 26, 29, 30, 32, 33, 35 and 40, Sweden Ch.30 and a new Swedish one on Ch. 24, location as yet unknown.

You will perhaps remember that in last month's issue I mentioned that my wife and I proposed going to Spain, Portugal and Morocco. On our day of departure, at the very last moment, we changed our plans for Scandinavia because of the current typhoid troubles in Southern Spain and Tangiers. I saw a lot of old friends in the way of TV transmitters that we receive here. Just to mention a few we took our morning coffee in Holland under the shadow of the NOS Wieringemeer mast, a real beauty 1,000ft. high, I also saw Bremen-Oldenburg E2, Flensburg E4 and a host of W. German u.h.f. stations, then Denmark Fyn E3 and Copenhagen E4, Sweden Stockholm E4, Orebro E2 and Göteborg E9, then finally in Norway Kongsberg E4 and Bergen E9.

It was fascinating to see the exact sources of our DX signals in England and to view the stations as locals in each country! I shall be able to picture the transmitters now with very happy memories when they next come in over here. I did not take any photos off the TV screens, so there will be no cheating! ! My only sadness during the trip was to see W. German colour 25 in. TV sets at £200 each—it makes one just green with envy!

There are rumours (I hope untrue) that a 625-line negative image with f.m. sound is suggested for Bands I/III after the closure of the 405-line system. This new chain would carry educational programmes but if this should happen it would be a calamity for Continental DX. The alternative could be Taxi/Police sound services. These are already troublesome here in Band III on Ch. F8 and F8a but I would rather live with them than high-power 625-line locals. We can only wait and see.

There has been some trouble over caption identification of Spain and Yugoslavia for some DXers. Normally an RTV caption indicates Yugoslavia but now Spain is carrying the words "Cultural Production de RTV" on some advertisements. This is how the confusion has arisen, with both Spain and Yugoslavia operating on Ch. E3 and E4.

NTS Holland is now a thing of the past. The latest captions read NOS, Nedenlanse Omroep Stichting, a new organisation title for Dutch TV.

The following countries are now operating colour TV systems: Gt. Britain, Holland, W. Germany, Norway, Sweden and Switzerland on the PAL system, France and USSR on SECAM. Just for the record once again the full address for the EBU TV station list is as follows: European Broadcasting Union, Technical Centre, 32 Avenue Albert Lancaster, Uccle, Brussels 18, Belgium. The price of the publication is 200 Belgian Francs, approximately £2 by International Money order.

Our mystery TV captions (see October issue) have now been identified thanks to D. Clarke of East Boldon, Durham. The tongue-twister and the EIRJ caption are he says of Esthonian origin (similar to Finnish so I was not far out after all!) and it means "The book trade of the Soviet Republic" (you could have fooled me!). EIRJ stands for Eesti Raadio i.e. Esthonian Radio. He says he received similar captions himself on 31/5/69 together with the word Talian (Tallin) or R2. D. Clarke and his colleagues are experts on East European languages and Esthonian is the rarest and most difficult. Our grateful thanks to him and them, and may we ask again when in trouble?! He has comparatively recently started DX-TV but his log already covers many countries.

SUMMARY OF TV MODELS INTRODUCED DURING THE 1969 TRADE SHOWS

Make and Model	*Colour or mono*	*Single- or dual-standard*	*Tube size*	*Price*
			in.	£ s. d.
B and O				
1400K	Mono	s-s	24	103 19 0
1400KJ	Mono	s-s	24	110 5 0
1400SJ	Mono	s-s	24	124 19 9
Bush				
CTV182S	Col.	s-s	19	249 18 0
CTV184S	Col.	s-s	22	276 3 0
CTV187CS	Col.	s-s	25	313 19 0
TV181S	Mono	s-s	20	74 17 0
TV183S	Mono	s-s	20	76 19 9
Decca				
CS1900	Col.	s-s	19	245 0 0
CS2200	Col.	s-s	22	295 0 0
CS2500C	Col.	s-s	25	340 0 0
MS2000	Mono	s-s	20	72 19 0
MS2400	Mono	s-s	24	79 10 0
Ekco				
T530	Mono	s-s	20	72 0 0
T531	Mono	s-s	24	79 0 0
(both 169 chassis)				
T532	Mono	d-s	20	79 18 0
T533	Mono	d-s	24	88 11 11
(both 368 chassis)				
Ferguson				
3800	Mono	s-s	20	65 0 0
3801	Mono	s-s	24	73 19 0
3802	Mono	s-s	20	67 10 0
3803	Mono	s-s	17	62 0 0
(all 1500 chassis)				
Ferranti				
T1185	Mono	d-s	20	79 10 0
T1186	Mono	d-s	24	86 10 0
(both 368 chassis)				
GEC				
2040	Col.	s-s	19	—
2041	Col.	s-s	22	—
2042	Col.	s-s	25	—
2043	Mono	d-s	20	—
2044	Mono	d-s	24	87 3 0
2047	Mono	s-s	20	69 9 0
2048	Mono	s-s	24	76 13 0
2063	Mono	d-s	20	—
2064	Mono	d-s	24	—
GEC—*cont.*				
2065	Mono	s-s	20	—
2066	Mono	s-s	24	—
HMV				
2800	Mono	s-s	20	67 10 0
2801	Mono	s-s	24	73 19 0
2802	Mono	s-s	20	70 0 0
2803	Mono	s-s	17	63 12 0
2804	Mono	s-s	24	78 11 0
(all 1500 chassis)				
Invicta				
CT7051	Col.	s-s	22	—
(691 chassis)				
7048	Mono	s-s	24	—
7353	Mono	s-s	20	—
(both 169 chassis)				
KB				
CK401	Col.	s-s	22	287 12 0
CK402	Col.	s-s	22	304 15 0
SV041	Mono	s-s	20	71 15 0
Murphy				
CV1916S	Col.	s-s	19	249 18 0
CV2211S	Col.	s-s	22	276 3 0
CV2516CS	Col.	s-s	25	313 19 0
V2015D	Mono	d-s	20	82 6 8 (wood finish) 83 8 1 (painted finish)
V2015S	Mono	s-s	20	76 19 1 (wood finish) 78 1 1 (painted finish)
V2414D	Mono	d-s	24	94 1 11
V2414S	Mono	s-s	24	88 15 0
V2415D	Mono	d-s	24	91 19 2
V2415S	Mono	s-s	24	86 12 2
Philips				
511	Col.	s-s	22	—
512	Col.	s-s	25	—
0230/01	Mono	d-s	20	81 5 4
0230/51	Mono	d-s	20	82 5 0
0232	Mono	d-s	20	87 0 0
0300/01	Mono	s-s	20	72 9 0
0300/51	Mono	s-s	20	73 9 0
0301/01	Mono	s-s	20	Relay
4230/01	Mono	d-s	24	89 5 0
4230/51	Mono	d-s	24	90 10 0
4232	Mono	d-s	24	99 0 0
4300/01	Mono	s-s	24	79 16 0
4300/51	Mono	s-s	24	81 0 0
4301/01	Mono	s-s	24	Relay
Pye				
CT72	Col.	s-s	22	265 0 0
CT73	Col.	s-s	19	232 0 0
(both 691 chassis)				
80	Mono	s-s	20	72 0 0
81	Mono	s-s	24	79 0 0
(both 169 chassis)				
83	Mono	d-s	24	86 0 0
84	Mono	d-s	20	79 0 0
(both 368 chassis)				
85	Mono	s-s	24	—
86	Mono	s-s	20	—
(both 169 chassis)				
Sobell				
1040	Col.	s-s	19	—
1057	Mono	d-s	20	—
1058	Mono	d-s	24	—
1060	Col.	s-s	25	—
1063	Mono	d-s	20	—
1064	Mono	d-s	24	—
Ultra				
6800	Mono	s-s	20	66 9 0
6801	Mono	s-s	24	74 14 0
6803	Mono	s-s	17	62 0 0
(all 1500 chassis)				

waveforms in COLOUR receivers PART 6

GORDON J. KING

LAST month we traced the Y signal from the vision detector through the luminance amplifier to the cathodes of the picture tube. We should always have in mind the fact that during colour reception the *beam* from each picture tube gun is modulated with the appropriate *primary-colour* signal, not with the Y signal or colour-difference signal alone. The three cathodes of the tube together receive the Y signal in the so-called colour-difference drive system, so named because each *grid* of the tube separately receives its appropriate *colour-difference* drive. We must concentrate on this aspect before going on to look at the signals in the chroma and colour-difference stages.

Colour-difference Drive

Figure 1 shows the basic colour-difference drive system. As already noted the three cathodes are joined signal-wise to accept the Y signal, while the red, green and blue colour-difference signals are applied separately to the three grids. From the d.c. point of view the cathodes have slightly different potentials to provide the correct grey-scale tracking

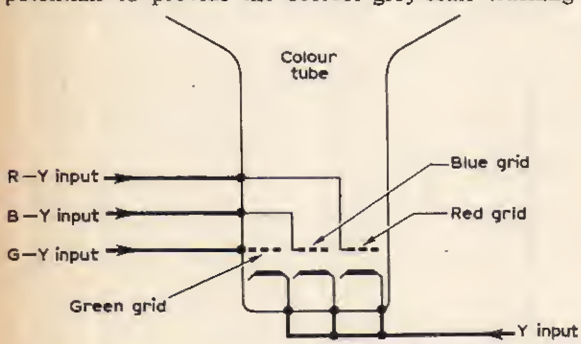


Fig. 1: Colour-difference drive at the picture tube.

in the picture highlights. Since the grids are clamped to a black-level reference, adjustment of the cathode potentials effectively adjusts the grid bias and such adjustments are sometimes called colour-background adjustments. At the other end of the grey scale the adjustments are provided at the first anodes of the guns.

Figure 2 shows separately the red gun at (a), the blue gun at (b) and the green gun at (c) for the purpose of revealing how each gun acts as a primary-colour matrix. It is important to understand this action properly because those sets employing primary-colour drive, as distinct from the colour-difference drive we are now considering, handle the primary-colour matrixing prior to the tube. The principle is the same and we shall be examining the scheme later.

It will be clearest if we consider the matrixing action when the standard colour bars are present. The appearance of the primary-colour signals during such a transmission was illustrated in Fig. 5, Part 1 (July 1969 issue). The waveforms at the guns in Fig. 2 indicate the basic nature of these signals, but we must understand in detail how these signals are derived from the combination of the common Y input at the cathodes and the colour-difference inputs at the grids.

Colour-difference Signals

Figure 3 shows the colour bars at the top and the staircase Y waveform resulting from them as explained last month. It is this signal which is applied to the three cathodes of the tube. Due to demodulation of the V and U signals and the subsequent G−Y matrixing (not to be confused with the primary-colour matrixing!) we obtain the three colour-difference signals—R−Y, G−Y and B−Y—from the colour-difference amplifiers. These are the signals which are fed to the three grids. The block diagram in Fig. 4 clarifies this.

Although we have not yet studied the receiver signals in the chroma channel, the V and U detectors or the colour-difference channels we have at least learnt from Part 1 that the R−Y and B−Y signals are initially created by the Y signal being subtracted separately from the red and blue primary-colour signals. We have also studied the chroma signal at the transmitting end and have seen how this is composed of quadrature-modulated V and U signals in a subchannel. We shall be returning to the V and U signals as they appear in the receiver in a later article; we shall also be seeing how the R−Y, G−Y and B−Y signals are derived from

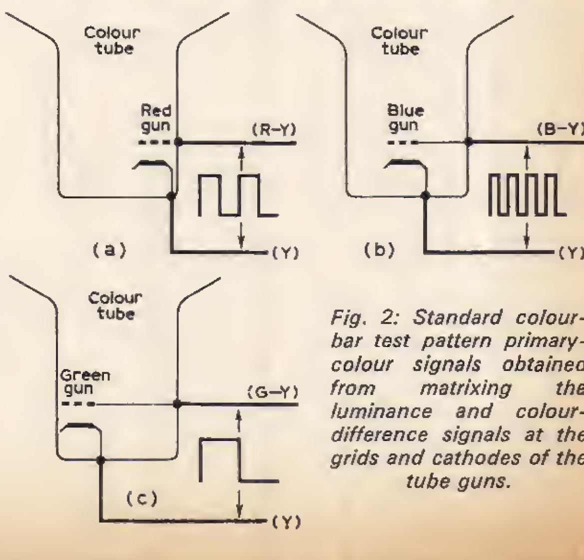


Fig. 2: Standard colour-bar test pattern primary-colour signals obtained from matrixing the luminance and colour-difference signals at the grids and cathodes of the tube guns.

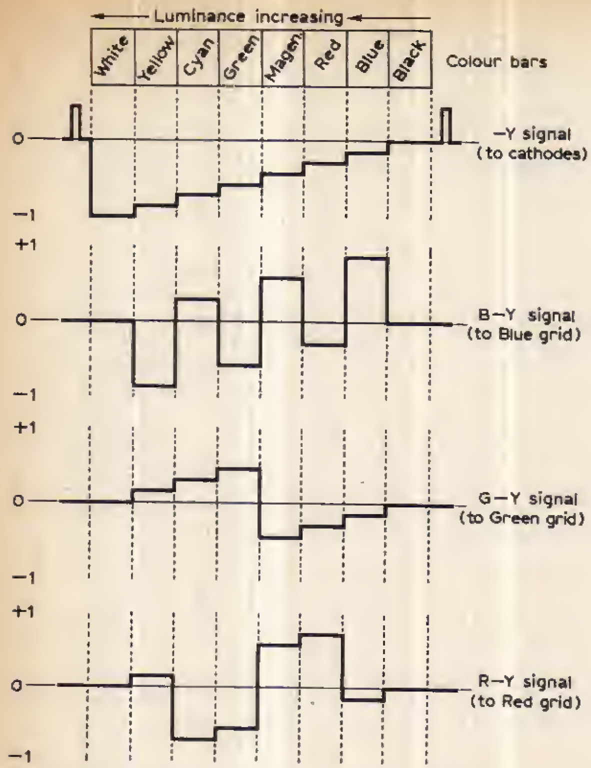


Fig. 3: The Y signal and three colour-difference signals formed by the standard colour bars.

V and U detection and G−Y matrixing. For the moment however let us return to Fig. 3.

From black-level to maximum white the Y signal spans an amplitude from zero corresponding to black-level to −1 corresponding to white. In actual fact the black-level is very slightly down from the start of the sync pulses (one shown each side of the Y signal) on a small step, but to avoid complicating Fig. 3 this parameter is not indicated on the diagram. The Y signal has a negative value towards white because it is applied to the cathodes of the picture tube. Thus with the grids clamped to a black-level reference, white causes the cathodes to go negative relative to the grids, which is the same as the grids going positive relative to the cathodes. This is the normal way of coupling video to a picture tube for cathode drive. It means that the beam current is geared directly to an increase in picture white content—as the white (or luminance) increases, so also does the beam current, resulting in rising illumination at the points on the screen corresponding to white picture elements. This is the basic way of driving a monochrome tube or, indeed, a colour tube on monochrome signals with the grids clamped to a black-level reference and devoid of colouring signals.

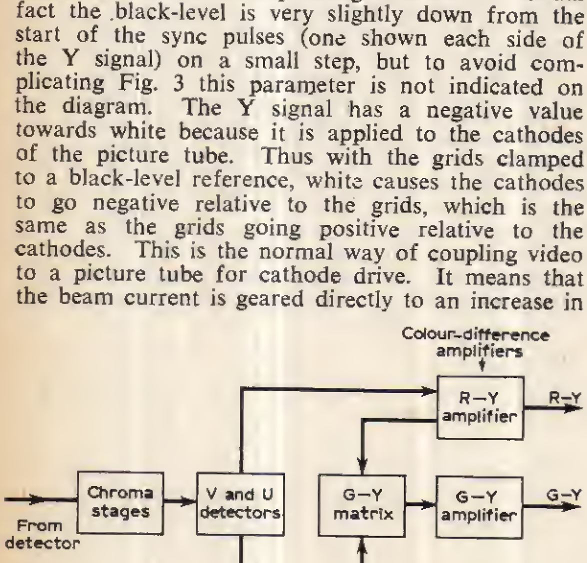


Fig. 4: Basic block diagram of the chroma section that feeds the colour-difference drive stages.

Figure 5 details the primary-colour signals. These are positive-going (at the grids relative to the cathodes) even though the colour-difference signals themselves have both *positive and negative values* (Fig. 3).

Matrixing

The matrixing action of the guns effectively subtracts the −Y signal from the colour-difference signals, leaving the primary-colour signals *across them*. Thus we have (R−Y)−(−Y)=R, (G−Y)−(−Y)=G and (B−Y)−(−Y)=B, which are the red, green and blue primary-colour signals. On each colour bar in Fig. 3 the −Y signal works in conjunction with the colour-difference signals in a manner to yield the appropriate primary-colour signals across the guns, and when examining this action it must be appreciated that the colour-difference signals can assume plus and minus values.

On white the −Y signal alone is operative, so each gun "sees" its primary-colour signal. On yellow the B−Y signal goes negative by the same amount as the Y signal which results in zero blue primary signal, but both the G−Y and R−Y signals go positive by the amount that the Y signal fails to reach its full negative value, resulting in green and red primary-colour signals to give the yellow bar. On cyan the B−Y and G−Y signals go positive by the amount that the Y signal fails to reach its full negative value while the R−Y signal goes negative by the same amount as the Y signal, resulting in primary-colour signals across the blue and green guns and zero signal across the red gun. By similar working it will be seen that the green bar is obtained from a primary-colour signal across the green gun, with zero signals across the other two guns.

We can easily run through all the colour bars like

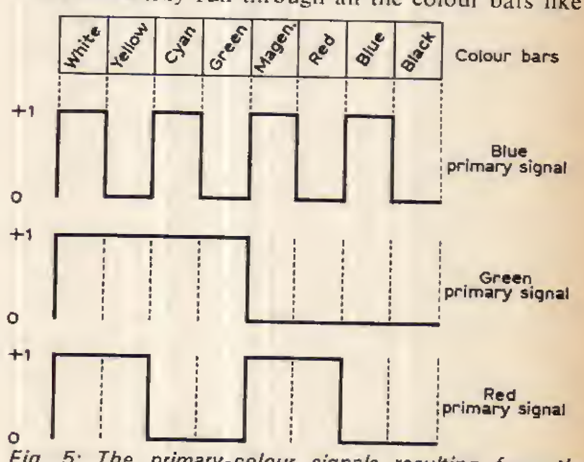


Fig. 5: The primary-colour signals resulting from the standard colour bars. These are derived from the Y component of the colour-difference signals cancelling the Y signal applied to the cathodes, as explained in the text.

this but there is hardly any point in doing so for by referring to Fig. 5 we can glean an overall appraisal of the signal conditions on the eight bars, though it is noteworthy that full-amplitude primary-colour signals are produced because the colour-difference signals in Fig. 3 are assumed to be derived from colours of maximum saturation. On ordinary pictures of course the primary-colour signals would rarely if ever reach maximum amplitude.

Recapitulation

To recap on the colour makeup (see also Part 1), *white* is composed of red, green and blue primaries, *yellow* of red and green, *cyan* of green and blue, *green* of its own primary alone, *magenta* of red and blue, *red* of its own primary alone, *blue* of its own primary alone and black of course results when all three beams are cut off.

When a gun "sees" a primary-colour signal it yields a beam which then illuminates the phosphor dotes of the same colour. On fully saturated red, green and blue primaries the corresponding gun *alone* emits electrons, but this condition is rare in nature since the vast majority of colours are not fully saturated. There is usually slight desaturation, which means that white is added to the primary colour concerned and as we have already seen to get white we need a mixture of red, green and blue light. This means that when a bright colour is being displayed all three beams are active with the appropriate primary-colour beam contributing the majority of the current.

Fault Effects

A corollary resulting from the make-up of the primary-colour signals is the effect that failure of one of the colour-difference signals has on the display. Some readers, students and others who should know better conclude that if a *colour-difference* signal fails the corresponding colours will be missing from the display. This is not true as Fig. 3 can be made to reveal. Suppose that the B−Y channel fails to pass the B−Y signal to the blue grid. The *cathode* of the blue gun will then be under the control of the −Y signal alone: the gun will be biased-on all the time and hence emit electrons causing the blue phosphor dots to glow.

This of course assumes that the blue grid remains properly clamped to a d.c. potential and this is normally what happens in the event of a signal discontinuity. The effect arises because the grid signal is a colour-difference one and because the guns handle the matrixing. Remember that the grid signals carry a Y signal component which effectively "cancels" the −Y signal at the cathodes. If a colour-difference signal is missing therefore the −Y signal at the cathode of that gun will not be cancelled. The gun will thus "see" a signal which is not the proper primary-colour signal but the luminance (or Y) corresponding to the colour and of course will produce a beam on this!

As another example let us suppose that the R−Y signal fails. Then on the blue colour bar there will be no signal to cancel the −Y signal on the red cathode. The negative cathode signal would therefore take the red gun into conduction and produce a red beam and red illumination. This is happening on the *blue* bar when as shown in Fig. 5 the red gun should be quiescent.

So much then for the signals associated with colour-difference drive where the tube guns perform the primary-colour matrixing. Let us now have a look at the primary-colour drive system—often called RGB drive—where the matrixing is performed prior to the tube guns.

Primary-colour Drive

The system in block diagram form is shown in Fig. 6. Here we have separate primary-colour matrices for red, green and blue. Each one receives its corresponding colour-difference signal *plus* the Y signal from the luminance channel. The result is that we get red, green and blue primary-colour signal outputs that can be connected direct to the cathode or grids of the guns as in normal monochrome practice.

With the advent of the single-standard 625-line-only colour set this method of colour tube drive is becoming progressively more popular. It is also found in some dual-standard models such as one Rank-Bush-Murphy series and the all-transistor sets in the British Radio Corporation's range. The application of the red, green and blue signals to a single electrode of each gun offers significant advantages over colour-difference drive, which is one of the reasons why the scheme is adopted by designers of monitor sets which have to display colour pictures of the highest possible standard. Sadly it tends to be somewhat more critical in terms of circuit design and stability than the colour-difference arrangement, which is probably why it has not been employed extensively in the earlier dual-standard sets. With the advent of high-speed silicon switching transistors suitable for video applications and integrated circuits of outstanding stability, however, more makers are exploring the possibilities of using it.

To achieve all the advantages that the system can provide the gain stability—both long and short term—of the colouring stages and the primary-colour matrices must be extremely high, generally better than provided by the colour-difference drive circuits of the other scheme. Moreover the bandwidths of the primary-colour channels must be very closely matched to avoid signals representing one colour

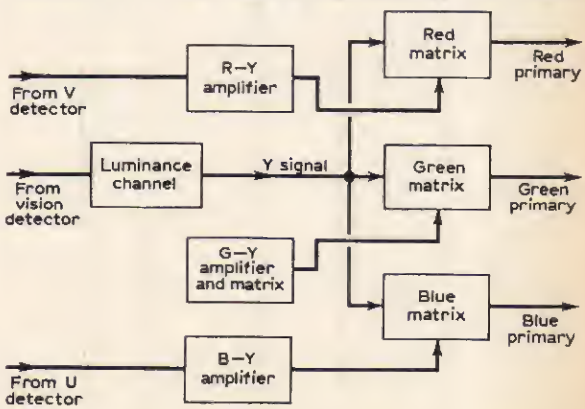


Fig. 6: How the primary-colour signals are obtained by matrixing the Y and colour-difference signals in pre-gun matrices.

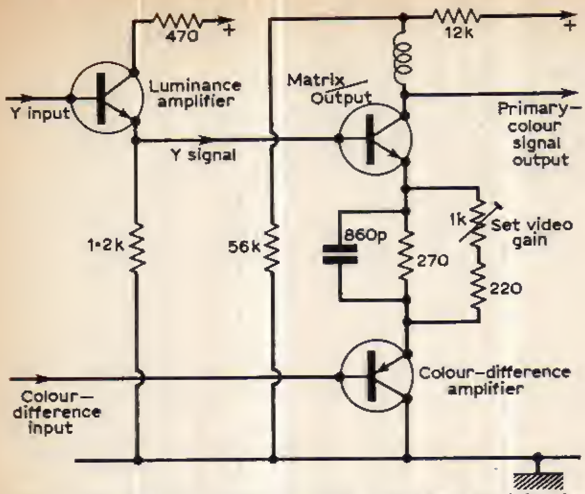


Fig. 7: One of the primary-colour matrices used in the BRC 3000 single-standard chassis.

arriving at the tube before those representing the other colours. If this requirement is not met colour fringeing (horizontal displacement of colours) can become singularly troublesome.

Both requirements—overall stability and bandwidth matching—are satisfied by the use of the most suitable transistors (and/or i.c.s.) and by the way that the devices are used in the circuits. In fact the circuits are designed so that the gain/bandwidth product (figure of merit) is as independent as possible of the semiconductor devices, the essential parameters thus being established by correct choice of passive components. In this manner the circuit is made both gain and frequency stable and it is also possible to replace the semiconductor devices without impairing the circuits' performance. This is neither the time nor the place to explore the design considerations of colour sets but it will be instructive to see the primary-colour matrix used in the latest single-standard chassis (the 3000) of the BRC. This is shown in Fig. 7.

BRC Circuit

The luminance and colour-difference transistors are included to show how the Y and colour-difference signals are fed respectively to the base and the emitter of the matrix/output transistor. There is a colour-difference driver stage for each primary-colour matrix/output transistor but the luminance stage (emitter-follower) feeds all the primary-colour matrices (one for each gun).

The colour-difference and luminance signals are processed in the transistor matrix just as they are in the gun of the picture tube so that the signals at the primary-colour outputs (i.e. the collectors of the matrix/output transistors) are exactly the same in form as those shown in Fig. 5 for the standard colour bars.

The primary-colour signals usually drive the cathodes of the guns in the tube, the grids being returned to a clamping circuit of some kind together with field and line blanking circuits and sometimes auto brightness control. The signals in these parts of the set will be considered in a later article.

TO BE CONTINUED

TEST EQUIPMENT LIMITATIONS

—continued from page 107

be 2·5MHz but for accurate alignment of some colour equipment at least 5MHz is required. (3) Triggering for both line and field waveform observation should be hard and not require constant adjustment with changing signal level. (4) A frequency-compensated probe with shielded cable should be provided. (5) A.C. and d.c. coupling in the vertical amplifier should be available on a switch position.

Points (1) and (2) require little expansion: they are really the purpose of an oscilloscope—to be able to look accurately at the shape of a waveform and measure its amplitude. Point (3) is made because of those oscilloscopes which have poor locking systems and which never seem to trigger on a picture with changing content, or which require almost inhuman effort to trigger steadily on any kind of video signal. D.C. coupling as well as a.c. coupling is emphasised as this prevents waveform bounce and also enables the oscilloscope to measure d.c. voltages with, because of its high input impedance, no loading worries.

These essential features are available in quite modestly priced oscilloscopes. It is true to say that the more an oscilloscope is used the more it is realised how many uses it has. A demonstration was once set up with the author using *only* an oscilloscope to find various unknown faults on a number of television receivers. These were all serviced satisfactorily and a sense of achievement at using one instrument to do the job of three or four was felt. This method is not advocated as always the speediest way of servicing but it is often found that the oscilloscope is the only way out with some types of faults. ■

FILTERING CIRCUITS

—continued from page 125

elaborate and demands close-tolerance components. It is often further complicated by system switching to reverse the detector diode polarity and probably the inclusion in valved receivers on 625 lines of an overload diode to supplement the a.g.c. Figure 5 shows two typical vision detector circuits, (a) using a switched diode as found in STC models and (b) using an unswitched diode with the output feeding a video phase-splitter stage from which signals in the required phase can be tapped from the emitter or collector (Bush-Murphy).

It will be seen that in the STC example a positive-going detector output is directly coupled to the video pentode grid on 405 while on 625 a negative-going output is a.c. coupled by an $0{\cdot}22\mu F$ capacitor. The $2{\cdot}7k\Omega$ resistor in series with L3 constitutes the video load on both systems but this is by no means universal practice and in several other makes the value of the load resistor is reduced on 625 lines to maintain the h.f. response to the higher figure.

Filter capacitors used in vision detector stages always have very precise values—8·2pF and 12pF in the Bush-Murphy example shown—and even a fractional reduction in their value can impair both the h.f. response and the standard of filtering. When instances of background patterning throw doubt on their capacitance they must be replaced by identical components and not other capacitors of equal value, for even differing physical size can alter the intended stray capacitance sufficiently to impair results. ■

ICONOS

UNDERNEATH THE DIPOLE

Today's television gimmick, kaleidoscopic titles in colour for TV features. The kaleidoscope? A toy? A conjuring trick? No! It was originally an optical instrument invented in 1818 by an Englishman, Dr. David Brewster, M.D., the name coming from three Greek words for "a beautiful form to see". The kaleidoscope was exhibited in an optician's shop window before attempts were made to patent it and according to Dr. (later Sir David) Brewster no less than 200,000 of the instruments were sold by several optical manufacturers within three months with no royalties payable to him. Suddenly the kaleidoscope craze—said to be "a sight for sore eyes"—faded away, just another nine-day wonder.

THE KALEIDOSCOPE

Kaleidoscope ideas reappear from time to time in various forms with methods far removed from the original tube containing inclined mirrors. Lately we have frequently been presented with symmetrical moving background patterns to the wording of television titles and "credits" of television plays and other features. These are basically the same as the old kaleidoscope but obtained by clever manipulation of electronic overlays, inlays, "cox boxes" and electronic phase reversals. They are still the same "sight for sore eyes" for many viewers, but causing discomfort, confusion of vision, myopia and eye strain. "Are these clever optical irritants really necessary?" my family ask me, keeping their eyes closed until I give the all clear and the dazzling mosaic has been replaced with normal good-quality colour picture. That is what I have asked several top BBC television engineers at the Shepherd's Bush TV Centre. "Don't blame us" they all answered, "the producers here love it—they think it's marvellous!" One hundred and fifty years ago someone wrote the following stanza on the new optical marvel:

Turn the tube; how quickly they pass—
Crown and stars prove broken glass!
Some bits of glass—a tube of tin!
Such are riches, valued true—
Such the illusions men pursue!

From Brewster to Baird was not too long a stride and today's "bits of glass" are capable of giving the illusion of pictures from the planets as a useful special-effects shot in a TV space-ship drama. But presented as dazzling background—hallucinations to titles—they are merely irritants. They are now even embellishing an American colour television film series of dramas *Premiere* on BBC-2, a very good series when viewers have recovered from the titles. Let us hope this fashionable technical gimmick ends its nine days of popularity as quickly as possible to save eye strain.

GIMMICKS

Gimmicks are fashionable in this age of the personality cult or the groovy dish. I recently saw and heard the latest model of the musical Mellotron, that electronic piano-keyed generator of prerecorded musical rhythms. George Clouston, the genial managing director, gave me a private preview of its potentialities: electronic-wise, rhythmatic-wise and music-wise. What a magnificent gimmick! was my first reaction as an elaborate brass, woodwind and percussion orchestrated march tune ended. "Gimmick! GIMMICK!" he strongly protested. "This is no gimmick—it's a very fine musical instrument, the greatest modern asset for any modern orchestra!" He looked back in anger but turned again to the keyboard and played with delicate virtuosity a soothing lullaby on the "vibes". Mr. Clouston was quite right, it is a musical instrument—and an outstanding one too.

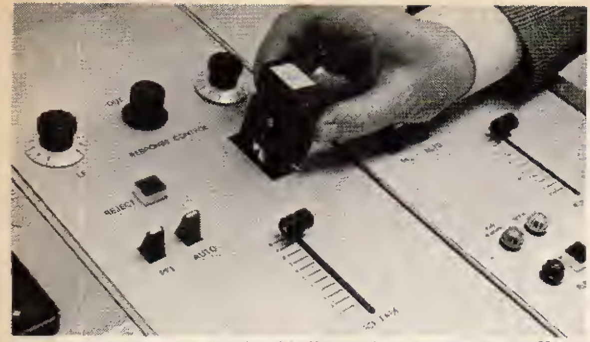
PROGRAMME EFFECTS GENERATOR

On the same occasion I saw and heard the very latest version of the "Programme Effects Generator" (P.E.G.) which was first demonstrated at *Film '69* and is now being acquired by television stations and studios all over the world, though not yet in many film studios. As I have previously mentioned in this column, the programme effects generator is a remarkable example of technological innovation and without doubt will become a "must" in every forward-looking studio—TV or film. It is curious how prejudiced and backward some film studios are, or rather the technicians in them. There are just three or four studios in England that have made technological progress since talking pictures started. Without any doubt the film studios that don't make technical progress will fade away and die. And those who want to make such forward steps are—like the ITV companies—being taxed out of existence.

TOWN PLANNING

The Town Planning Institute recently gave a demonstration of a breakthrough in the visual presentation on film of planning and architectural models. This utilised an optical process invented by a Frenchman, M. Jacques Vingtain, a research worker who has evolved ways and means of photographing inside as well as around objects. The aim of the process is to take the onlooker into the heart of the scale model of the proposed development. The motion-picture camera moves in and around the models with viewpoints that cannot be assessed merely by looking at a fixed model on a table or a perspective drawing or still photograph of either. The commentary sound track associated with such a film is a big asset. This process provides a means of judging the effect of tall buildings and assessing in close up, long shot and perspective the juxtaposition of architectural styles.

What a splendid approach! This kind of thing actually happened before the bombed Coventry Cathedral was rebuilt when a scale model of the



Loading a cassette in the Mellotronics programme effects generator.

interior and exterior was constructed and carefully filmed with a 16mm. film camera tracking about, zooming etc. I saw the film myself as a member of a subcommittee from the British Film Institute. The main committee viewed the film with the architect and others. Modifications were then made in the planning which led to great improvements and eventual saving of cost.

M. Jacques Vingtain's films have shown us the way. Further progress will make pre-filming of large building projects an essential step. Technically, being scale models, the films need high-speed film cameras shooting at 60 to 150 frames per second instead of the standard 24 frames per second. This will be a "must" for the future. Models for special effects in big feature films are always shot at such high speeds to obtain smooth and realistic scenes. Westward's *The Sinking of the S.S. Schiller* was mainly made with models, the best shots being obtained at frame speeds higher than 24 f.p.s. Use of models in this way requires a specialist approach whether film or television techniques are used.

US PROGRESS

British visitors to America are inclined to take a poor view of colour television there; they don't care much for the programmes, the advertising, the panel games, the news and the colour. The colour on the receiving sets in most homes and hotels is dreadful, but visits to the TV stations in New York or Los Angeles have revealed excellent quality colour on the colour monitors or the check receivers. Many programme items are good too, particularly those shot on film, scripted as for film and edited with the precision only possible with film. Recent American TV films *Prescription Murder* and *The Longest Hundred Miles* were excellent examples of film making for television, with plenty of good close-ups punctuating a continuity of story line that was logical and gripping. One concerned a calculated murder worked out (in interviews) by a psychoanalyst. The other was an open-air Western with a Japanese war background in the Phillipines. Both had first-class colour and presentation. The fades, wipes, dissolves and musical backgrounds were used to tell the story, cover the "came the dawn" time changes, and build up the tension

CUTTING CONFUSION

Chaos in film or videotape editing in some of the BBC's own subjects is rather like prose without punctuation, causing confusion and chaos in the minds of viewers, particularly those who have seen a production for the first time with new characters, new styles and new appeals. Producers, directors and editors are familiar with every frame they see on an editing machine and should bear in mind that until viewers know what to expect most of them are against it, prejudiced and impatient.

BBC-2's thirteen episode series *The First Churchills*, a splendid idea of Donald (*Forsyte Saga*) Wilson, gives every indication of achieving a big success in all parts of the world, whether reproduced in colour or black and white. Donald Wilson is a producer and writer with great experience in films and television; he was one of the originators (about twenty years ago) of the Rank Organisation's "Independent Frame" system, which made much use of back-projection of scenery on a screen from films and slides instead of using expensively constructed scenery. This was a splendid concept but before its time.

AN OSCAR FOR THE UK

Earlier this year the Society of Motion Picture and Television Engineers made an "Oscar" award for the first time to Britain for a technological innovation. The citation was to Charles D. Staffell of the Rank Organisation for the development of a successful embodiment of the reflex background projection system for composite cinematography. This means, to you and me, rear- or front-projection of various types for films and/or television. There are few films and television directors and producers who are anxious to make logical use of new technical innovations such as this: those who do study the sophisticated electronic techniques now available and what is more make sure that their scriptwriters are fully aware of them too. Many screen and TV writers might just as well concentrate on sound radio, so ignorant are they of the spectacular visual presentations which can be enhanced by engineers.

COLOUR TV QUALITY

How good can colour television become? The answer in my opinion is as good as the manufacturers are able to make colour receivers at a reasonable price. This will be the limiting factor. The latest colour TV cameras are marvellous examples of just how good electronic, optical, photographic and mechanical technology can, in a combined operation, make them. The governing factors are the capital costs and reliability. This inevitably means a compromise which seems to affect each individual engineering contribution. The "front office" (who control the money) assess the facts tempered with the figures.

Should film features for television be made on 35mm. negative, 16mm. negative or videotape is a constant problem, balancing costs against quality operationally as well as from the points of view of capital outlay. Will a slightly poorer quality TV transmission be revealed as such on the average set? I think it will—and the larger the picture the more its faults will be exposed. The new ranges of u.h.f.-only television receivers—particularly those using integrated circuit "chips"—will be real eye-openers and not nine-day wonder gimmicks.

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 140 must be attached to all Queries, and a stamped and addressed envelope must be enclosed

SOBELL T192

The fault is no picture. The raster is modulated by the sound. All voltages in the vision strip are correct as per service sheet. The vision i.f., detector and video amplifiers have been changed but to no avail. All relevant components in the vision strip have been checked and found to be in order.—T. Whittaker (Lincolnshire).

In these models it is always advisable to check the 10kΩ resistor which is across the valve base of the PCF86 inside the tuner unit. If this is in order check the 1000pF decoupling capacitor from pin 8 of the vision i.f. amplifier to chassis and the chokes and resistors associated with the video amplifier.

PYE SERIES 15

I recently converted this receiver to u.h.f. On testing it worked perfectly for two days with good sound and picture. Since then however after five or ten minutes' working mush has appeared on the picture and this rapidly gets worse until the picture is completely obliterated and the sound also disappears.—D. Simpson (Nottingham).

You possibly have a faulty PC88 in the u.h.f. tuner. Check that its heaters are not becoming shorted out by the wiring. This is easily seen if you remove the cover and watch the set in a darkened room.

THORN 850 CHASSIS

On switching on the picture and raster are OK and full size. After 15-20 minutes there is gradual compression up to 2in. from the bottom only, accompanied by jitter (rapid movement up and down). This jitter cannot be controlled by the vertical lock control since this only rolls the picture downwards. Switching off the receiver for 10-15 seconds will stop the jitter for a minute or so. Sometimes the jitter will cease after two or three hours' use but bottom compression appears—H. Kenworthy (Cheshire).

The usual fault on the Thorn 850 chassis causing field jitter and control only being available in one direction is a changed value R138, the anode resistor of V7B—22kΩ (1W). It usually goes low-resistance, increasing the anode voltage on this side of the oscillator and therefore increasing the frequency, i.e. the field slipping downwards in the normal control position.

If this fails to cure check V7 (ECC804), R144 (2·2MΩ) and C113 (0·03μF).

The field compression is usually cured by overcoming the field hold fault but if it persists after this is done check R150 (360Ω) and C119 (0·01μF).

HMV 1870

The sound keeps deteriorating. I have replaced the a.f. amplifier valve PCL82 several times and each time the set returns to normal working. After a few weeks however things are back where they started.—M. Draper (Woodford).

Check C92 (0·01μF) between pins 9 and 3 of the PCL82, also the 470Ω resistor (R99) pin 2 to chassis.

ALBA T877

My problem is centred around the field output of this receiver. The symptoms are: cramping at the bottom after the set has been operating for about 10 minutes and gradual stretching and compressing of the picture vertically. If the aerial is disconnected or the contrast turned down flashover takes place between pins 6 and 5 of V10. The sound volume seems to vary with the blackness or whiteness of the picture.

I have replaced the PCL85 and several other components but the faults persist.—J. Kidman (London).

The flashover across the pins of the field timebase valve could indicate bad insulation on the valveholder. It should be noted that when the signal is removed—by removing the aerial or retarding the contrast—the field runs free and this can precipitate higher than normal pulses on the output pentode's anode (pin 6). It is normal for the sound intensity to fall with changes in picture black-level owing to the nature of the a.g.c. system employed in this set.

The gradual variation in the field scan is possibly aggravated by changing resistance of the printed circuit board itself between conductors in the field circuit! This has been known to happen due to the accumulation of dust which has ultimately led to discharges, carbonisation and hence insulation fall. Temperature can affect the resistance and in high-impedance parts of the field circuit this can play havoc with linearity. The only real solution to this problem lies in replacing the board.

PYE VT21C

For some time upon switching on the sound comes on for about 20 seconds then goes off for about 30 minutes after which it comes back and is perfect for the rest of the evening's viewing. The picture is rather dark even with the contrast turned fully up.—P. Fitzgerald (Leamington Spa).

The fault you describe could be due to a defective PCL83 sound output valve just behind the volume control or instability of the last sound i.f. stage. In this latter case replacing the 0·001μF screen grid decoupler (inside the detector can) should cure the fault.

EKCO TC313

This receiver works perfectly except for periodic alterations of field form.—D. Davies (Devon).

You may have a noisy vertical linearity control or alternatively a faulty 500μF cathode bias decoupling capacitor on the 30P12.

MURPHY V939U

There is a low "growl" coming through the speaker which continues in the background through all programmes. Sound and vision are otherwise good though there is a tendency for the line hold to vary. Curiously the latter is affected by the position of the 625-line hold adjustment when receiving on 405 lines. After about ten minutes or so the growling effect increases.—W. Rogers (Kent).

Your symptoms suggest faulty decoupling and we advise you to check the main and secondary smoothing. Check also that the diode supplying the heater ballast has not become short-circuit.

GEC BT302

There appears to be a loss of field linearity. The picture opens and closes continuously, losing field linearity in doing so.—H. Gibson (Cheshire).

This symptom results from residual hum in the field timebase and possibly video stages. Check that all the electrolytic smoothers are well up to value. If necessary it may be desirable to improve the h.t. smoothing by additional electrolytics on the h.t. line. The trouble arises now on older sets because of the change to asynchronous working at the transmitters, with the field no longer locked to the mains frequency.

FERGUSON 204T

This set had not been in use for some time and upon switching on the sound came up normally and the usual whistle was present. The fault is a white line across the screen instead of a picture. The height control has no effect.—J. Boyd (Isle of Man).

The ECL80 on the right side of the chassis and the PCF80 on the rear just to the left of the tube, i.e. under the focus assembly, are the valves which should be checked first. Then check the h.t. voltage to pin 6 of the ECL80 if the field output transformer is suspected of being faulty.

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PRACTICAL TELEVISION, DECEMBER 1969

TEST CASE

85

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.

? *The symptom on a GEC Model 448DS—picture height reduced to about 3in.—occurred suddenly. Accompanying symptoms were total loss of field lock and almost total loss of line lock. The field timebase valve was first checked by substitution, but the results with the new valve were exactly the same. Next the cathode bypass electrolytic capacitor was tested and this proved to be in good condition. Tests were then made in the interstage coupling circuit, the field oscillator and amplifier and even the field output transformer and scan coils were tested by substitution but the faults remained.*

Is there any vulnerable component or part of the circuit that was overlooked? See next month's Practical Television *for the solution to this problem and for a further Test Case item.*

SOLUTION TO TEST CASE 84
Page 93 (last month)

Trouble at the top of a picture—as in the Cossor 1972A which was the subject of this Test Case item—is often caused by a fault in the negative feedback linearity network, including the preset linearity control, as distinct from an emission defect of the output stage—such as a low emission valve, faulty cathode bypass, low voltages on the electrodes and so forth—which mostly affects the bottom of the picture.

The linearity components were checked but it will be recalled that the fault remained. Eventually after checking almost all the smaller components in the field timebase the field output transformer was replaced and the problem solved. It is noteworthy that poor insulation can develop in this component and while not revealed by ordinary tests of the resistance of the windings the change in the conditions of the feedback circuit can severely impair the top-of-picture linearity and slow down the field retrace, giving the symptoms described last month.

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