# Practical TELEVISION

MARCH 1968

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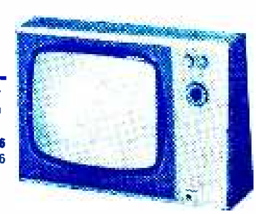

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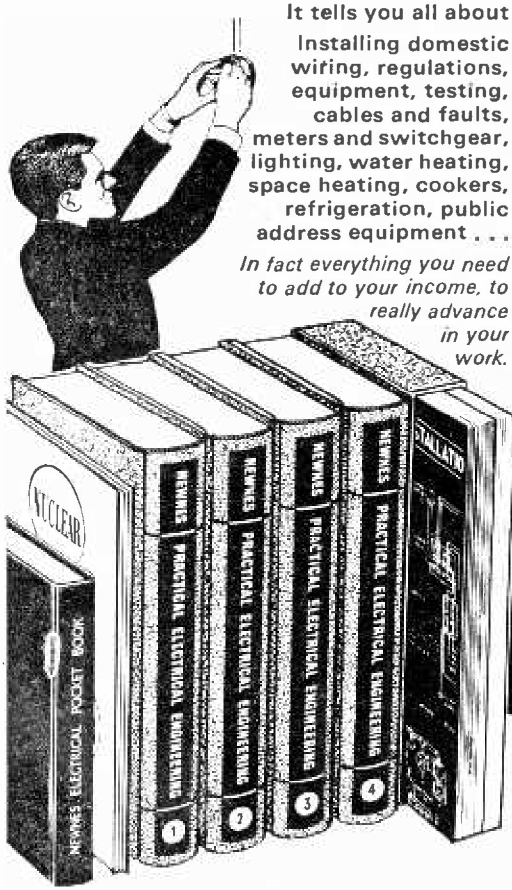


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The first edition of *Aerial Handbook* was published in October 1964 and the 5,000 copies were sold out in just over a year.

This second edition has been delayed until the plans for Colour Television and Multiplex Stereo have matured and could be dealt with from the angles of Transmission and Reception.

The activities of the BBC and ITA are well covered. Relay Systems, Eurovision, World Satellites and Colour Conversion, Post Office Tower etc. also receive attention in non-technical terms.

| *Chapter* | *Contents* | *No. of pages* |
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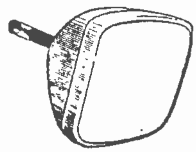

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# Practical Television

MARCH 1968
VOL. 18 No. 6
*issue* 210

## INVITATION

In spring, says the poet, a young man's fancy turns lightly to thoughts of romance. It may also, if he reads P.T. (and even if he is not in the first flush of youth) turn to thoughts of the film show we organise each year in association with Mullard Ltd.

Our poet would probably disapprove of those among us who are prepared to forsake the birds and the bees for a London lecture hall—if only for one evening—at this time of year. But each spring, the hall is packed out with readers of variegated ages.

Another poet, in a more popular medium, once sang that spring will be a little late this year—and by coincidence so is our film show. Part of the proceedings is taken from a Mullard presentation which has been playing to packed houses up and down the country and the demand has been so great that an earlier date was impossible to arrange.

This year's programme is unusually interesting and topical, for we have concocted an evening of film, demonstration, talk and discussion aimed to "take the lid off" colour TV. Even those who have read up the subject, or even had practical experience, have the odd blind spot or aspect which refuses to become really lucid. Well, here is an opportunity to clear up those stubborn details in an informal atmosphere.

As usual, the whole evening's entertainment (we use the word advisedly, for education *can* be fun!) is absolutely free—and this includes the refreshments during the interval.

To obtain your ticket, write to Film Show, Practical Television, Tower House, Southampton Street, London, W.C.2, enclosing a stamped addressed envelope not smaller than 5 x 3⅛ inches and we will do the rest. The venue, as usual, is Caxton Hall, London, S.W.1. and the date is March 29th (kick-off at 7.15 p.m.).

Tickets will be sent out in strict rotation until all accommodation in the hall has been filled. As the advertising people would say—write now to avoid disappointment; every year we have to disappoint those writing in late. We expect a big response this year so make sure of your place if you want to be switched-on (with Colour)!

W. N. STEVENS—*Editor*

## THIS MONTH



THE NEXT ISSUE DATED APRIL WILL BE PUBLISHED ON MARCH 22

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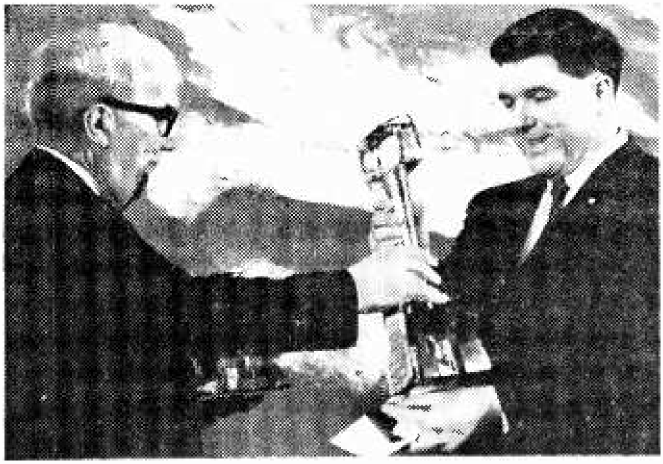
# TELETOPICS

## NEWSFILM OF THE YEAR COMPETITION 1967



*LORD HILL of Luton, Chairman of the BBC Board of Governors, is seen presenting the Rank Organisation Trophy for the British Television Newsfilm of the Year Competition to Mr. P. Beggin of the BBC who becomes this year's British Television News Cameraman of the Year.*

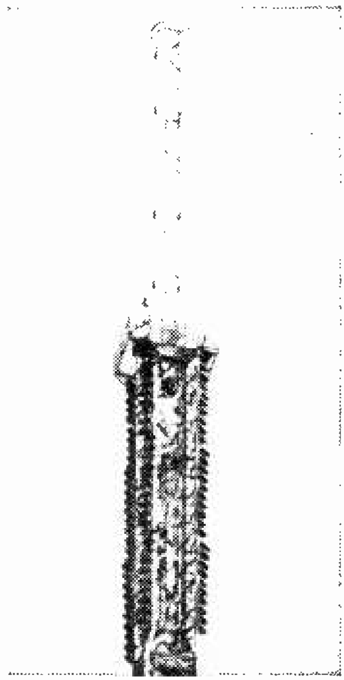
*The picture was taken at the Royal Lancaster Hotel, London, 13 December 1967.*

## Face-lift for Crystal Palace TV tower

*THE BBC's 708ft. high TV tower at Crystal Palace, originally installed in 1956, is to have a slightly new profile.*

*In order to accommodate u.h.f. transmitting aerials which will extend the range of BBC-2 programmes together with the extra aerials required for ultimate ITA participation, BIC Construction Co. Ltd. has recently completed the supply and erection of a 60ft. high cantilever spine which replaces the topmost helical type experimental aerial.*

*Even to erectors accustomed to working hundreds of feet above the ground, the unusually confined working space presented problems concerning the lengths and weight of the steelwork to be installed. These difficulties were successfully overcome by using round steel members varying in length from 12ft. 9in. to 20ft. 3in. to make up the required 3ft. 3in.-sided triangular section spine and upper 27ft. of the tower. The picture below shows the 60ft. cantilever spire in position.*



## LIVERPOOL'S CCTV

PYE TVT Limited of Cambridge announce that they have been awarded a contract for the supply of a closed-circuit television central area traffic control system for the City of Liverpool, whereby channelised intersections controlled by link traffic signals are able to deal with, among other things, the 5,000 vehicles per hour using the Mersey tunnel during peak periods.

Initially there are eight cameras, but provision is made for extension to sixteen, each of which is fitted with pan and tilt mechanism and remotely controlled 10 : 1 zoom lenses. All controls are routed back to a control desk in the central control room.

## Distribution of Jap CCTV equipment

AS a result of negotiations, which have been taking place between Nichimen Company Limited of Tower Block 4, Hillgate House, Ludgate Hill, London E.C.4 and Negretti & Zambra Limited of Stocklake, Aylesbury, Buckinghamshire, agreement has been reached with regard to the distribution of closed circuit television equipment manufactured by the Ikegami Tsushinki Company Limited of Tokyo. Overall marketing, sales promotion and servicing will be undertaken in the United Kingdom by the Negretti & Zambra Group, of which Visual Engineers Limited, is a part, and is already well-known in the miniature closed circuit television field.

## PRACTICAL TELEVISION FILM SHOW—1968

For further details of this film show see the Leader page.

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# NEW ELECTRON GUN

ENGLISH Electric Valve Co. Ltd. has developed a new electron gun for its cathode-ray tubes. Compared with previous designs, this new gun produces an extremely narrow stream of electrons. Hence the name, "Laminar Beam".

The cathode and focusing assembly of this new gun have been designed to produce an electron beam with smaller beam angle and therefore much reduced aberrations. This laminar beam has a uniform electron density (rather than the normal Gaussian, or bellshaped, distribution); it therefore produces a spot which has uniform brightness and a very sharp edge, and the narrowness of the beam at the point of deflection minimises any deflection defocusing. The spot size may also be varied without defocusing.

# SOVIET COLOUR TV

A SYSTEM of closed-circuit colour television for use in industry and other specialised fields is being developed at the Bonch-Bruyevich Institute of Electrical Engineering in Leningrad.

Obvious uses are in hospitals to enable students to follow operations and in steel foundries to observe the colour of molten metal.

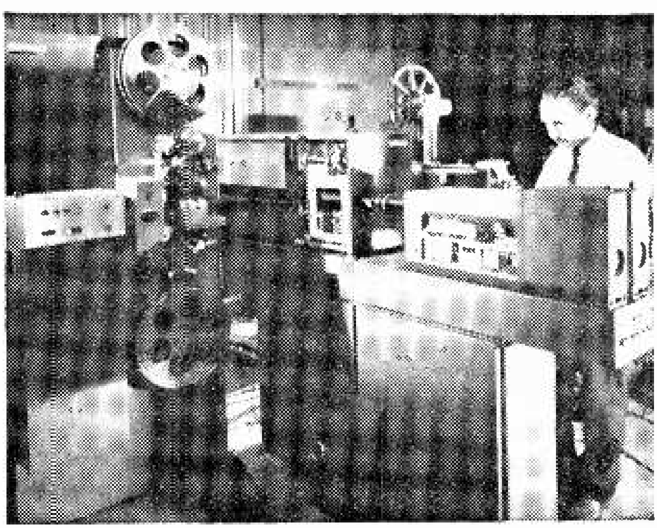
Tests at the Kirov School of Medicine and at the Izhora plant showed that the equipment is easy to install and operate, but there is some difficulty in getting a picture true to the colour of the original.

Work is now going on to achieve simultaneous colour transmission on a narrower frequency band, which is expected to eliminate the present problems of colour variation.

# MARCONI TELECINE SYSTEM

*THE Marconi Company announces the introduction of a new telecine system which sets a new standard of reproduction of television pictures from all types of colour films, black-and-white films, and slides. At the heart of the colour unit, is a version of the Mark VII colour camera which receives images through a revolutionary optical switch, operating faster than the reaction of the human eye, and allowing "on air" cuts between film and slide projectors.*

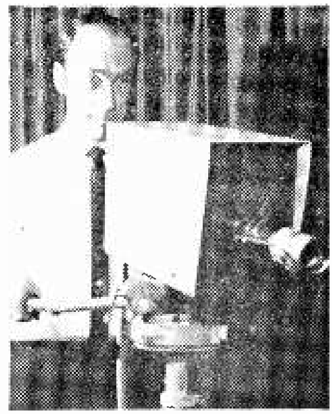
*The photograph shows Mr. D. A. Pay, Group Leader of the Telecine Group, Broadcasting Division, working on the colour television telecine equipment. On the left is the 35mm. projector, on the far left, a 16mm. projector and on the right of the photograph is a dual slide projection unit. The colour camera and optical switching system is shown in the centre.*



## Royal Warrant for DER

DOMESTIC Electric Rentals Ltd. (DER) the television rental company, has been granted the Royal Warrant of appointment as supplier of television receivers to Her Majesty the Queen.

# COLOUR TV FOR HIRE



A COMPLETE closed-circuit colour television system can now be hired, with a cameraman and engineer, for as little as £150 per day. Closed Circuit Television Hire of 93 Greenfield Road, London, E.1, have recently added a Bosch-Fernseh colour camera to their range of equipment available for hire.

CCTV Hire believe the colour equipment will be particularly useful for medical teaching applications, for relaying fashion shows to overflow audiences, for advertising agencies to make pilot colour television commercials and other applications where colour is of fundamental importance. The firm specialises in supplying a wide range of CCTV equipment, from a simple camera system to a fully equipped and manned outside broadcast vehicle, with expert technical advice when required.

The three-vidicon Bosch-Fernseh Type TV-140 colour camera channel originates high-quality RGB signals on 625-line standard. Pre-amplifiers built into the yoke provide adequate screening from external interference and extra-low noise level.

An interesting feature of the CCTV Hire installation is that the RGB signals from the camera are encoded to a composite PAL signal allowing a domestic Decca colour receiver/monitor to be used, for both local and off-air pictures.

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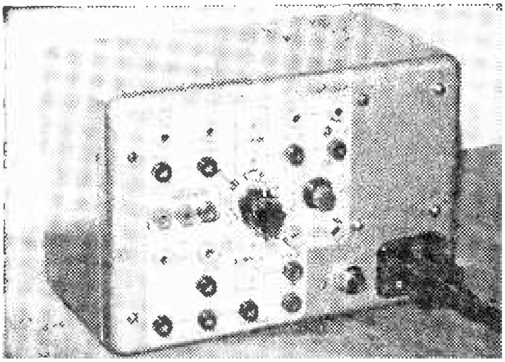

with a clearly arranged front panel in spite of the many outputs, and requires only a quite simple circuit.

The design is based on very careful thought concerning the number and types of supplies which will cover the needs of almost all circuits, so that optimum versatility is achieved with a minimum of components. The aim has been to provide a basic power unit which meets all essential needs, yet does not contain any circuit auxiliaries or performance refinements which are not really essential, i.e. which are required only occasionally for special experiments. However, optional external units are also discussed in Part 2. These can be built and interposed between the basic unit and the experimental circuit, to provide performance refinements for those readers who feel a need for them in their particular experiments. By

# bench POWER UNIT

MARTIN L. MICHAELIS, M.A.

TIMES have changed in the design of television equipment as much as in any other field of electronics. Therefore it is appropriate to develop a new approach to the design of a handy bench power unit for the television experimenter. Nowadays one requires a much more versatile range of outputs than in former days, because transistorised stages have become at least as common as valve-operated ones in television receivers and test gear. Valve-operated equipment calls for conventional h.t., bias and a.c. heater supplies. Transistorised equipment calls for relatively low voltages at fairly high current, and either polarity or both polarities simultaneously may be required.

With the gradual development of transistorised circuits over the past five to ten years, workshop practice has too often drifted towards segregation. Conventional h.t. power units were retained for work on purely valve-operated circuits, whilst separate high-current l.t. power units have appeared for exclusive use with transistorised equipments. This means doubled expense for the newcomer when first equipping his experimental bench. Serious television experimenting is no longer possible if one is to impose a restriction to either valves or transistors, especially since television receiver manufacturers have adopted the practice of hybridisation, i.e. using a judicious mixture of valves and transistors in their recent models.

In the long run it is uneconomical to power transistorised experiments with batteries. Thus it is essential to equip the bench with a suitable mains-derived power supply for all types of circuits. It has often been maintained, by manufacturers and experimenters alike, that a combined power supply unit for transistorised and valve-operated circuits would be unwieldy in size and would need to have a confusingly complicated front panel, so that separate units are preferable. This is no comfort for the reader with limited purse and limited space—and many readers doubtless suffer from both these restrictions. This article is intended for just these readers. The author shows that a combined power unit can be small, lightweight, cheap, fitted keeping the basic unit down to minimum size and weight in this manner, it is small enough to be taken in the toolbag on field work, as well as serving as an extremely versatile bench supply. Its circuit uses semiconductors exclusively, so that it is relatively insensitive to mechanical shock and vibration and thus unlikely to be damaged on field work if reasonable care is exercised.

## CONVENTIONAL OUTPUTS

The conventional outputs comprise h.t., bias and a.c. heater supplies. These are all intended for valve circuits. As can be seen from the complete circuit shown in Fig. 1, the positive h.t. supplies are derived from a conventional 350/250/0/250/350V transformer winding, using silicon diodes as h.t. rectifiers. D1 and D2 serve as full-wave rectifiers for the 350V a.c. taps, with C1 as reservoir capacitor and R1, R2 as discharge resistors to prevent retention of charge on C1 for long periods after the unit has been switched off. The output is fed directly to P15 from C1, as "+500V". The low forward resistance of D1, D2 and the reservoir action of C1 peak-up the 350V r.m.s. a.c. input to this value of 500V. The actual output voltage was +520V on open circuit for the prototype, and still +470V with maximum permissible continuous loading of 50mA. Much poorer regulation would be obtained, i.e. the output voltage would drop much more with increasing current drain, if valve rectifiers, selenium rectifiers or metal (copper oxide) rectifiers were used instead of the specified silicon diodes. Thus only silicon diodes are suitable for this circuit. C1 must not be made greater than 8$\mu$F, since otherwise the rectifiers could be damaged by the large surge pulses on each half-wave of the a.c. input. On the other hand, a value smaller than 8$\mu$F provides poor regulation.

D5 and D6 function as full-wave rectifiers for the 250V a.c. taps on the transformer, with C3 serving as reservoir capacitor to peak-up to a nominal "+350V" output at P16. R3 is the safety discharge resistor for C3. The high wattages specified for these discharge

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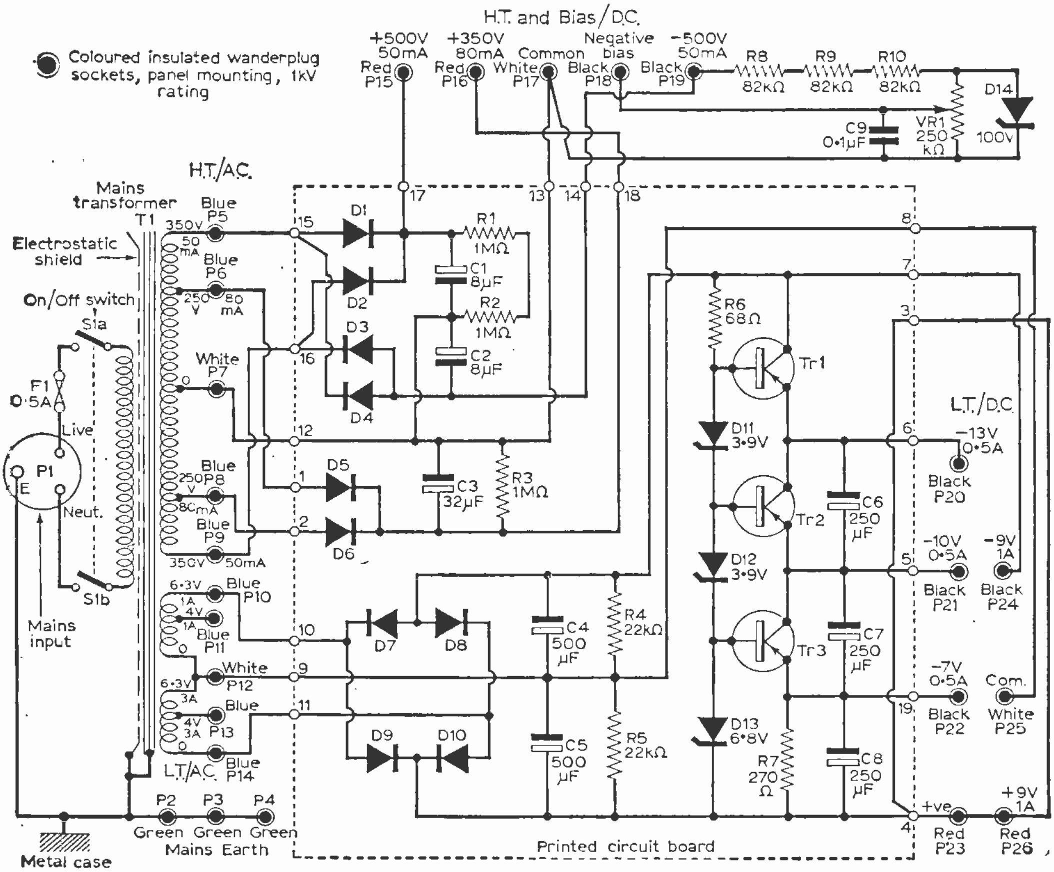

*Fig. 1: Complete circuit of the bench power unit.*

resistors are necessary to ensure adequate physical size to withstand the voltage stress. Since D5 and D6 are operated with lower peak inverse voltage stress, they can withstand greater surge current pulses, and accordingly C3 has a much greater value than C1. This value has again been chosen as an optimum compromise between good regulation and tolerable stress imposed on the rectifiers. The value of C3 should thus not be made different from 32µF. In the prototype the "+350V" output at P16 reads +390V on open circuit and +310V at full load of 80mA. Again, it is important to use silicon rectifiers to obtain this quite good regulation.

## *E.H.T. SUPPLIES*

The negative bias supply is derived from the −500V output which is produced from the 350V transformer taps in the same manner as the +500V output but with the corresponding silicon rectifier diodes D3, D4 and the reservoir capacitor C2 connected with reversed polarities. D1 to D4 thus constitute a conventional bridge rectifier circuit across the entire 350-0-350V a.c. winding, producing an output of about 1kV across C1 and C2 in series, i.e. between P15 and P19. The centre-tap of a transformer winding feeding a bridge rectifier always provides a centre-tap for the rectified d.c. output, and the three resulting d.c. output terminals (here P15, P17 and P19) may be used in any combination up to the full current rating. In other words, the present circuit provides outputs of +500V, −500V and 1kV d.c.

Any of these alone may be loaded up to 50mA, whilst if they are used simultaneously the sum current may be any value up to 50mA. The full 1kV supply is suitable for many oscilloscope cathode-ray tubes, as well as for photomultiplier tubes commonly used in flying-spot scanners and other CCTV equipment (e.g. photomultiplier tube, RCA type 931A). It is permissible to take a nominal +850V (or −850V, according to position of external earth connection) output between the "+350V" and "−500V" terminals P16, P19. This may be loaded up to 50mA maximum, giving a useful supply for small CCTV transmitter power amplifier valves (r.f. distribution systems) or amateur TV transmitter power amplifier valves, or any small amateur transmitter for that matter (e.g. the popular 807, or the smaller types in the QQE double tetrode series).

It is *not* permissible to take an output of supposedly +150V between the "+500V" and "+350V" terminals because this would demand withdrawal of electrons from P16, i.e. reverse current in D5 and D6 which is clearly impossible. However, it does become

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possible if an additional, larger forward current is drawn through D5, D6. The net current through these diodes then remains in the conduction sense. Thus if a small current at nominally +150V is nevertheless required between P15 and P16, a resistor must be connected simultaneously between P16 and P17 such that it passes a *somewhat greater* current here at 350V. To avoid the danger of charging C3 to 500 volts, this practice should be restricted to maximum currents of 2 to 3mA.

## VOLTAGE COMBINATIONS

The general rules to be observed are thus: Any terminal P15, P16, P18 or P19 may be used with respect to the common terminal P17 (white) to provide the corresponding output voltages. If the common white terminal P17 is not used, the output must be taken between one black and one red terminal, *not* between two black or two red terminals. These "like colour" outputs are the only forbidden ones. The allowed outputs may be used simultaneously.

The entire h.t. and bias outputs P15 to P19 are floating as they stand, and an earth connection to define polarity may be made at any point, at one of these terminals or even at an intermediate level on an external bleeder. P2 to P4 are connected internally to the mains earth, to the metal cabinet, to the transformer core and to the electrostatic shield, but to *none* of the actual output terminals or internal circuits. The earth connection can thus be established externally as one pleases. For example, if P19 is linked externally to one of the green earth terminals, voltages of +500V, +850V and +1kV with respect to earth are available at P17, P16 and P15 respectively. On the other hand, if P15 is linked externally to one of the green earth terminals, outputs of −500V and −1kV with respect to earth are available at P17 and P19 respectively. In most experiments the white common terminal P17 will be earthed externally, so that the other h.t. terminals will then provide output voltages and polarities as labelled. The terminals with negative polarities in this sense are black, and those with positive polarities are red.

## EARTHING

Three green earth terminals are provided (P2 to P4) for the following reason. It is evident from Fig. 1 that the h.t. circuits and the l.t. circuits constitute respective complexes which are floating with respect to each other and with respect to ground. Thus we have a free choice of two earth points, one on each complex. Thus an external link (piece of insulated wire with a wanderplug on each end) is taken from one green terminal to the desired earth point on each complex. The third green terminal is then for the "output" earth connection to the chassis or reference rail of the experimental circuit. For most normal circuits the earth connections will be taken to the white common terminals, corresponding to the equivalent internal earthing connections in conventional power packs. These connections are not made internally in this design, to permit the greater versatility of alternative earthing as described.

## NEGATIVE BIAS SUPPLY

The negative bias supply is derived from the −500V output, via the bleeder chain R8, R9, R10, VR1. This chain of resistors also serves to discharge C2 after switch-off. Three resistors are used to distribute the voltage stress. D14 stabilises the voltage across the track of VR1 to 100V. The adoption of a logarithmic potentiometer for VR1 allows good resolution for all bias levels up to 100V, even at levels below 1 volt. In the prototype, 1V appeared at about one-third track, 10V at about two-thirds track and 100V at full track. Bias voltages as low as 250mV can be set with sufficient accuracy for normal purposes. It is hardly necessary to stress that the bias supply possesses high internal impedance, and is thus intended for biasing grids or feeding high-resistance bleeders, *not* for drawing appreciable current. For the former purposes there is no objection to using the bias output with respect to one of the red positive terminals instead of the white common terminal. Thus if the +350V terminal is earthed, a negative bias output variable from −350V to −450V with respect to earth is available at P18. But appreciable current must not be drawn.

## A.C. OUTPUTS

All output terminals carrying an alternating voltage with respect to the associated white common terminals are blue. In effect, the complete set of white and blue terminals represents all secondary connecttions and tappings on the mains transformer, taken straight to the front panel. It is useful to be able to make use of the mains transformer alone in this manner. For example, some experiments will require their own special rectifier and smoothing circuits. Or it may be necessary to check a piece of equipment when its mains transformer has burnt out, to determine whether any further damage has also been incurred or whether the equipment is otherwise intact.

All manner of simple tests also require various a.c. voltages. The l.t. a.c. voltages at P10 to P14 serve as normal heater voltages for valves, for powering small low-voltage soldering irons for working on transistorised circuits, for small lamps, etc. The l.t. a.c. output may be taken between *any* pair of the terminals P10 to P14 without restriction. The output voltage is always the sum of the voltages marked against the embraced sections, and the current rating is the smallest (1A or 3A) one of the marked ratings of the embraced sections. Thus voltages of 2·3, 4·0 and 6·3V r.m.s. are available at 3A, and furthermore 10·3 and 12·6V r.m.s. at 1A. Any or all of these outputs may be used simultaneously, with appropriately shared current rating.

When feeding valve heaters from these terminals, remember that an earth connection *must* be established externally. It is not essential to earth one of the terminals feeding the heaters directly, but the d.c. resistance from there to the actual earth point should never exceed 20kΩ. Otherwise there is a danger of gradual destruction of the heater/cathode insulation through micro-corona induced by stray capacitive and ionic voltages. This danger is most serious when the heaters are left floating, i.e. without any d.c. path to earth, which is a strictly forbidden mode of operating valves. Capacitive and ionic leakage then take over entirely and often lead to very high voltages impressed between heater and cathode, greater than the maximum ratings. This seriously reduces the life of the valves.

## HEATER-CATHODE VOLTAGE

The makers usually specify a maximum permissible voltage which may be applied between the heater and

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the cathode. If such information is lacking, ±50V may safely be assumed. Observe polarity if the makers specify a particular polarity. Many valves will tolerate higher positive cathode voltages with respect to the heater, because this polarity opposes emission current from cathode to heater or heater supports. If the cathode cannot be brought near to the mean heater potential in a particular circuit, aim to make it positive rather than negative with respect to the heater. As far as use of the present power unit is concerned, one of the l.t./a.c. output terminals feeding the heaters may be connected to any point on the experimental circuit whose potential with respect to the valve *cathode* is not greater than the maximum rating. This point or any other point on the circuit may be grounded by linking it to one of the green earth terminals. The d.c. resistance between the heater connection and the green earth terminals must not exceed 20kΩ. Any set of connections satisfying all these conditions is permissible and safe.

## *L.T. SOLDERING IRONS*

When using the l.t./a.c. outputs to feed low-voltage soldering irons it is more important than ever to establish an earth connection from one of the terminals feeding the soldering iron to one of the green earth terminals. Otherwise the floating l.t./a.c. supply may actually be resting at large capacitive voltages with respect to ground (often the full peak mains voltage, or even the peak voltage of the 700V secondary winding, as can be checked with an oscilloscope), so that the purpose of using a l.t. soldering iron for transistorised equipment would be defeated.

The capacitive stray voltages on a floating l.t./a.c. supply possess much too high an internal impedance to give a shock. Nothing, or at most a very weak tingle, would be felt, so that the earth connection is hardly dictated for reasons of human safety. But the capacitive leakage is more than enough to destroy sensitive transistors, especially field-effect transistors. It is recommended that a white and a blue insulated wanderplug should be attached to the respective leads of the soldering iron, and an additional piece of wire carrying a green insulated wanderplug also joined to the white wanderplug. The three wanderplugs must then be inserted into the l.t./a.c. and earth terminals of corresponding colours.

## *L.T./D.C. OUTPUTS*

The bridge rectifier circuit D7 to D10 supplies the entire l.t./d.c. outputs. The two 6·3V heater windings of the mains transformer are used in series to feed 12·6V to the rectifier bridge, producing a peaked-up d.c. output of nominally 18V across the reservoir capacitors C4 and C5 in series, i.e. between P24 and P26. P25, the associated white l.t. common terminal, is connected to the junction of the two 6·3V transformer windings, i.e. to the centre-tap of the windings feeding the bridge rectifier. It is thus also the d.c. output centre-tap.

P24 and P26 provide outputs of −9V and +9V (accordingly black and red) with respect to the white common terminal P25. Either one of these outputs, or both simultaneously, may be used at current drains up to 1A. Alternatively, the white common terminal may be ignored and an 18V output taken between P24 and P26. Since the circuit is floating, we may earth P24 or P26 to obtain a positive or a negative 18V supply with respect to earth, as desired. The 18V output may also be loaded up to 1A, in either polarity.

### COMPONENTS LIST

**Resistors:**

| | |
|---|---|
| R1 | 1MΩ 1W |
| R2 | 1MΩ 1W |
| R3 | 1MΩ 2W |
| R4 | 22kΩ 1W |
| R5 | 22kΩ 1W |
| R6 | 68Ω 2W |
| R7 | 270Ω 1W |
| R8 | 82kΩ 1W |
| R9 | 82kΩ 1W |
| R10 | 82kΩ 1W |

All 10% Carbon

| | |
|---|---|
| VR1 | 250kΩ log |

Carbon pot with pointer knob

**Capacitors:**

| | |
|---|---|
| C1 | 8μF 500/550V electrolytic |
| C2 | 8μF 500/550V electrolytic |
| C3 | 32μF 350/400V electrolytic |
| C4 | 500μF 15/18V electrolytic |
| C5 | 500μF 15/18V electrolytic |
| C6 | 250μF 12/15V electrolytic |
| C7 | 250μF 12/15V electrolytic |
| C8 | 250μF 12/15V electrolytic |
| C9 | 0·1μF 400V miniature foil |

**Semiconductors:**

| | |
|---|---|
| D1–D4 | Silicon h.t. rectifiers, 1kV p.i.v., 0·5A |
| D5, D6 | Silicon h.t. rectifiers, 750V p.i.v., 0·5A |
| D7–D10 | Silicon l.t. rectifiers, 100V p.i.v., 1A |
| D11, D12 | Power zener, 3·9V, 150mA |
| D13 | Power zener, 6·8V, 150mA |
| D14 | Power zener, 100V, 5mA |
| Tr1–Tr3 | Germanium power p-n-p transistors $\beta \geqslant 50$, 3W dissipation |

**Miscellaneous:**

| | |
|---|---|
| T1 | Mains transformer 350/250/0/250/350, 50/80mA; 0/4/6·3V, 1A; 0/4/6·3, 3A (or near equivalent) |
| S1 | Double-pole, panel-mounting toggle switch |
| F1 | 0·5A panel-mounting |
| P1 | Mains input connector |
| P2–P26 | 4 white, 6 black, 4 red, 8 blue, 3 green coloured, insulated wanderplug sockets, panel mounting, 1kV rating |
| | Material for printed circuit and metal cabinet, bolts, etc. |

The regulation of the ±9V and ±18V d.c. outputs is quite good, again by virtue of the low-resistance silicon rectifiers used and the high values of the reservoir capacitors C4 and C5. The regulation is approximately the same as that of an average dry battery of the same nominal voltage. In the prototype, the actual voltages were ±9·5 and ±19·0V on open circuit, dropping to ±6·8 and ±13·6V at maximum permissible load of 1A. The exact nominal voltages of 9V and 18V are obtained at about 200mA drain, which

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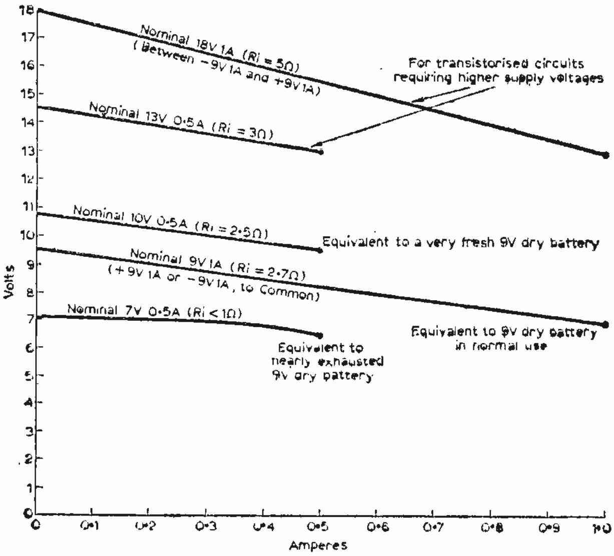


*Fig. 2: Load characteristics of L.T./D.C. outputs. Except for very small currents (bias circuits) of a few mA do not take outputs between the 7/10/13V 0·5A sockets. For high currents these outputs MUST be used with the common positive socket. The —9V/Common/+9V 1A outputs may be used in any combination even at high current.*

| *Output* | *Short-circuit current* | *F1 blows* |
|---|---|---|
| 7V 0·5A | 1·7A | No |
| 9V 1A | 15A | No |
| 10V 0·5A | 2·5A | No |
| 13V 0·5A | 3·5A | No |
| 18V 1A | 15A | Yes |

is at least double the average current drain of items such as portable battery tape recorders and radio receivers.

## *OUTPUTS FOR TRANSISTOR CIRCUITS*

In contrast to valve circuits requiring as a rule only positive h.t. supplies, transistor circuits equally often call for l.t. supplies of either polarity or both polarities simultaneously. If the circuit uses entirely or predominantly p-n-p transistors, a negative collector supply with respect to chassis is usually adopted, and a positive supply correspondingly for n-p-n transistor circuits. However, these rules are not the only possibility, since there is no fundamental objection to earthing the collector returns of p-n-p transistors and then using a positive emitter supply if external connections or other considerations concerning the particular circuit make this desirable. Similarly, a negative emitter supply can be used in place of a positive collector supply for n-p-n (usually silicon) transistor circuits.

After years of considerable variety 9V and 18V are gradually emerging as standard design voltages for transistorised circuits, in the same way that 6·3V is the most common heater voltage for valves. 9V batteries are becoming the standard types for portable transistorised equipment, and simple germanium p-n-p circuits are commonly designed for a single 9V supply. Silicon circuits (n-p-n) may also use a 9V supply, or an 18V supply where higher voltage swings and powers are involved. This may be provided either as a single positive or negative 18V supply, or as a simultaneous positive and negative 9V supply. The latter arrangement is common for pulse circuits, to permit waveforms symmetrical to ground potential with d.c. coupling, and is thus particularly likely to be encountered in experimental television circuits.

These factors show that the −9/0/+9V 1A outputs P24, P25, P26 provided by centre-tapped bridge rectification of a pair of 6·3V r.m.s. a.c. windings furnish us with all polarities and combinations on the "nine-volt standard", and the current rating of 1A is ample even for multistage television equipment, large portable radio sets (2·5 to 6 watt output stages), etc. It is not coincidence but intention that the nine-volt standard supplies can be obtained by rectification of standard 6·3V heater windings. This consideration is one of the factors leading to the gradual dominance of this voltage standard.

A second standard for transistor power supplies which enjoys great popularity makes use of the d.c. voltages produced by rectification of the 5V and 8V outputs of standard miniature bell transformers. This produces d.c. output voltages of about 7V and 10–13V respectively. Thus it is necessary to provide these outputs on the power unit in addition to the nine-volt standard, for developing designs which will use a miniature bell transformer when finished. A maximum rating of 0·5A is here adequate, since a miniature bell transformer cannot supply more on continous duty without serious overheating.

## *7/10/13V OUTPUTS*

It would be uneconomical to provide these outputs from a separate transformer, i.e. from an actual bell transformer, in our power pack. A more elegant solution is to derive these outputs by voltage division of the 18V output. This brings up the question of preserving good voltage regulation, since the division ratio and output voltage of a purely resistive voltage divider are strongly dependent on the current drain. Thus the current through the dividing resistors would have to be very much greater than the maximum intended output current to preserve good regulation. But we have only 1A input current available from the 18V supply, so that we could never obtain the desired 0·5A output with good regulation by this means. A chain of zener diodes provides much better regulation than a chain of resistors as a voltage divider, because the impedance is then given by the differential zener resistances and very low figures are here possible without calling for large currents. The top resistor R6 (Fig. 1) must be chosen so that the open-circuit current through the divider chain is somewhat greater than the maximum load current. To avoid unduly large standing currents in the divider chain, we can use a parallel chain of amplifier transistors. This combination of zener diodes D11 to D13 and transistors Tr1 to Tr3 in Fig. 1 provides us with a voltage

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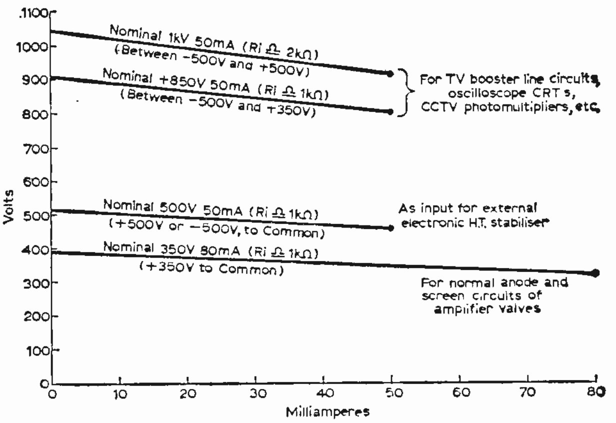
*Fig. 3: Load characteristics of h.t./d.c. outputs. The short-circuit current of all h.t./d.c. outputs is at least 1A and causes F1 to blow immediately. It is NOT possible to take a 150V output between +350V and +500V except at a very low current of 2–3 mA.*




divider possessing at least as good regulation as the input supply driving it. The voltage division ratio is determined by the individual zener voltages and is largely independent of the load current drawn from the respective transistors.

When using these supplies, it is most important always to employ the red common positive terminal as one of the output terminals, in conjunction with any one of the black output terminals for —7, —10 or −13V. Two or all of these three outputs may be loaded simultaneously. The maximum total current rating is 0·5A irrespective of voltage. If an output were to be taken between two black terminals here the load current would have to flow through the base of at least one transistor and through one or more zener diodes. This would endanger these components and lead to very poor regulation, except for very small currents of 1 or 2mA for which such connections are permissible.

We may thus recapitulate and extend our rules as follows: White and blue output terminals (a.c.) may be used in any combination without restriction. White terminals may be used with any black (negative) or red (positive) terminals, or several of these simultaneously. If a white terminal is not used as one side of a d.c. output, then a red and a black terminal must be used to feed each circuit. D.C. outputs from like-coloured terminals (two blacks or two reds) are *forbidden*. The earth connection may be made anywhere, so that all outputs are available with either polarity with respect to earth, without restriction.

## DRY BATTERY SIMULATION

At first sight, it may appear to run against the aim of including nothing but really essential features in the design when introducing the zener diode and transistor voltage divider just to simulate the bell transformer supplies. Would it not be cheaper to use a bell transformer with its rectifiers and capacitors, or to do without these outputs altogether, the 9V and 18V outputs being adequate for basic requirements? Readers who feel that way may certainly omit the zener diode-transistor voltage divider network and associated terminals. However, the price of these components is about the same as the price of a separate bell transformer and a set of rectifiers and capacitors for the same outputs, so that the more elegant arrangement as used is certainly appropriate when included.

To justify its inclusion, we must point out that it fulfils the vital function of allowing equipment tests under conditions simulating new, partially exhausted and nearly fully exhausted 9V dry batteries. This function is not realisable with the 9V/18V supply alone, yet it is considered to be of extreme importance for versatile experimental work. When designing new circuits, we must have a means of testing their behaviour when the batteries for which they are ultimately intended are approaching exhaustion, or are providing overvoltages when brand new. Conventional l.t./d.c. power units meet this requirement with the help of a voltage regulator circuit which uses a zener diode and one or more transistors, and can be varied by hand using a potentiometer scale or panel meter. This involves greater expense and complexity than our fixed voltage divider, which meets the basic requirements just as well.

For normal operation of circuits and equipment intended for a 9V supply, connect as appropriate to the −9/0/+9V output terminals. Equipment with any current drain from near zero to 1A will then be powered correctly and may be operated continuously for any length of time. For checking performance with overvoltages corresponding to very fresh batteries, connect to the 10V output, earthing the appropriate side to obtain the desired polarity. Current drain must be restricted to 0·5A continuous, but 1A is permissible for brief periods (30 seconds maximum). To test the behaviour with batteries approaching exhaustion, connect to the 7V output. This will reveal any failures due to low voltage, but not any tendency to instability due to the high resistance of nearly exhausted batteries. To simulate this feature where relevant (multistage circuits) insert appropriate series resistors externally.

The complete range of l.t./d.c. output voltages (7/9/10/13/18V) also provides a useful selection for the heaters of one or two P-series valves in series, e.g. for working on television tuners outside the set. The detailed load curves (Figs. 2 and 3) should be plotted (according to the actual mains transformer used, they may differ slightly from those for the prototype), and consulted in relation to the heater voltage and current ratings of the valve(s) concerned. One of the available outputs will be close enough (±10% of nominal heater ratings) for most such requirements. The 7V output is also intended for d.c. heating of individual 6·3V valves, either where hum reduction is of importance, or for critical oscillator stages requiring stabilisation of the heater supply. 6·3V heaters with 0·3 to 0·5A current rating may be connected directly to the 7V d.c. output, whilst a small series resistor must be inserted externally for smaller currents. It is seen (Fig. 2) that the 7V d.c. output alone possesses such high regulation that it may be termed stabilised, and it remains effective even in the face of mains voltage fluctuations.

TO BE CONTINUED

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# AN ENTHUSIAST looks at Colour

By H. PETERS

PART 2

THE main problem facing anybody considering investing in a PAL colour set at the moment is that there is no experience on which to base your investment. *Which* reports take time, although it has already commented on the relative merits of buying or renting. Three years from now things will be different but somebody has got to attempt the questions you are bound to be asking. The first one is, of course: "How much?"

A full-specification, 25-in. De-luxe PAL consolette retails at about £300 give or take £25. Rental prospects stand at 27s. 6d. to 40s. per week, which at the time of writing involves a deposit in the region of £75. Licence is an extra £5 per annum, an aerial if your BBC-2 array is inadequate can cost about £10, and if you purchase your receiver, particularly on H.P., you may find yourself obliged to take out a maintenance insurance. This doesn't mean that the trade is expecting trouble with colour so much as that servicing will be expensive initially if anything does go wrong, since the character of colour receivers does not permit the "flow-line" type of rapid TV workshop repair built up by the larger dealers in most towns. Some 19-in. PAL receivers have also been introduced at about £50 less than the larger 25-in. sets.

## What are the design snags?

Probably the design snags would fill a book on their own. Besides the basic circuitry that has had to be developed, such factors as the dual-standard system, the economic situation, purchase tax, and scarcity of rare earths for tube phosphors all add to the problem of producing a set that will have to be able to receive any BBC-2 station and give good results when first switched on even though its design is based on the limited experience gained so far.

## Who is ahead?

Probably nobody. From the limited technical information so far revealed one can only assume that the realisation that PAL is a complicated system rather slowly sunk home in taking the place of the desperate "there must be a better way" attitude. The writer's personal view is that insufficient attention was paid to PAL in the early days. The BBC were "sold" on NTSC, and although some preliminary work was done by ABC TV on the PAL system their chances at the time of being allowed to radiate colour on 405 lines were considered fairly hopeless.

## What do I watch for on demonstration?

Points to watch for when being given a demonstration are first that the conditions approximate to home viewing. Colour sets are rather shy of daylight and high levels of artificial light. Then check that colours—especially flesh tones—are stable over periods of viewing. Compare sets together if possible: you will never remember what the other one looked like if they are yards apart. Check the black-and-white picture reproduction and look for colour fringing. This would merely indicate a badly set-up shadow-mask tube, but it reflects upon the skill of the demonstration staff and their ability to correctly set up receivers. Look for "automatic degaussing" as a feature.

## Am I colour-blind?

Well, are you? Remember that all television is a subjective illusion. There is never a picture on the screen, black-and-white or colour. The illusion relies upon the eye being too sluggish to be able to follow the rate at which the scanning spot moves, merely resolving the "Comet's tail" as it were. Eyes vary and so the image on the screen can appear different from one person to another. This is why grandfather always has the contrast up more than you consider correct. He is different from you. It is possible for an optician to test you for colour-blindness; in fact the writer has it done during normal sight testing and finds it quite painless and very interesting. If you are colour-blind consider carefully if it is worth going any further.

## The specification

The majority of receivers offered for sale initially will be 25-in. De-luxe PAL dual-standard sets. Remembering what we said in Part 1 they will, to start with, be a rich man's pleasure, and so we must expect price variations due mainly to cabinet styling. The enthusiast, however, will be more concerned with the circuitry rather than the cabinet. What then is the difference between "De-luxe" PAL and "simple" PAL? Basically the former incorporates a delay line and the latter does not. The importance of this is worth explaining. As you will have read elsewhere, the basic feature of PAL is that the red colour-difference signal is transmitted in anti-phase ("upside down") every other line. If, therefore, any distortion occurs during transmission or radiation of the signal it will be positive with respect to the red colour-difference signal on one line, and negative on the next. If we can store the "upside down" red line for one whole line period exactly, turn it back upright, then add it to the next red line, the distortion will cancel out. This storage is carried out in the delay line, which is a sealed unit precisely ground to very close limits.

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In simple PAL receivers the delay line is absent and the upside down red line is merely turned upright—not stored and added to the following line. This means that any distortion on one line will be complementary to that on the next. Pure red, for example, may become more orange on one line and more crimson on the next. With a bit of luck the eye will take the average of the two and see pure red, but conditions have got to be right. Certainly a 25-in. tube would show up this effect more than a 19-in. tube and viewers in bad signal areas would notice it more than those receiving a clean signal. So in the beginning the manufacturers are taking no chances and making their sets to the "De-luxe" specification.

The arrival of duplicated services on u.h.f. will bring more economies to the colour set. Making a dual-standard receiver is not only a headache to the designer of the i.f. strip, where compromise results such as are at present deemed passable on monochrome sets simply will not do, but the timebases are more expensive to produce. In dual-standard colour sets there must also be duplication in the convergence circuits (and controls) and whereas in monochrome sets the compromises are confined to the i.f. alignment and horizontal linearity the dual-standard colour set has it compromises made mainly in the convergence circuits. Since perfect convergence is never achieved, one must settle for results which are acceptable on both systems, bearing in mind that early receivers will display black-and-white pictures for more than half the time that they are on.

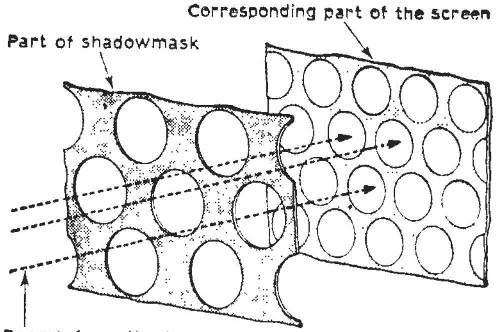


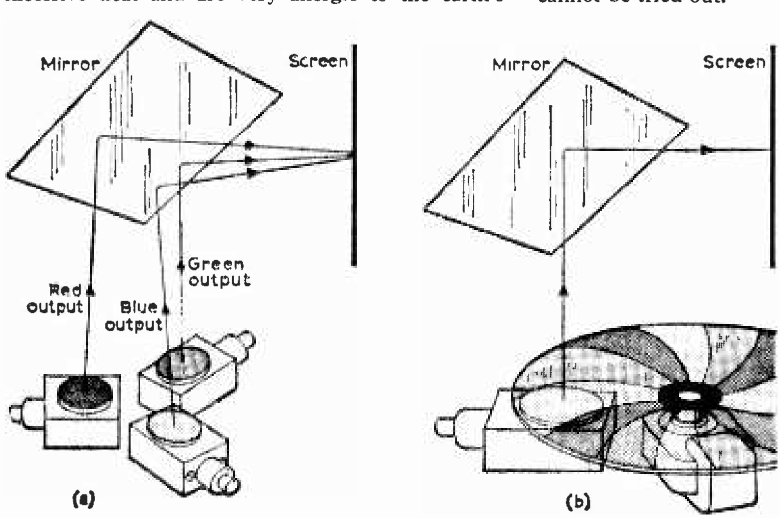

*Fig. 4: Why shadowmask tubes prefer a dark corner. The spaces between the coloured dots on the screen contribute nothing towards illumination while the shadowmask itself has only one hole for each group of three dots on the screen. Thus only a quarter of the beam current is turned into useful light.*

## *The set in the home*

Taking our pipe dream to its logical conclusion, let us suppose we have having our set installed in the living-room. Is there anything we can do to assist the installation team? Yes, plenty. To begin with, it is a heavy, fragile, and expensive item, so the way through should be cleared of all the usual impediments. Then you should take the advice of the engineer as to where to put it. It won't go just anywhere, like the black-and-white set. Colour receivers like a dark corner shielded from the daylight and the main room light (Fig. 4 explains the reason for this); they also hate excessive heat and are very allergic to the earth's magnetism and large metallic objects such as radiators, steel cabinets, and cast-iron fireplaces. Automatic degaussing will combat colour fringing collected on the face of the tube during use, but it will not help if you stand the hi-fi loudspeaker on the top of the set or if your wife switches off the vacuum cleaner just in front of it. Still, having acquired such a luxurious piece of equipment, we are certain you will look after it all right.

## *Some possibilities for the experimenter*

As far as the enthusiast is concerned the snag with colour TV is the shadowmask tube and its scanning assembly. At the moment both are rare and expensive. If only there were other ways to produce coloured pictures! There are, in fact, quite a few, and although the following notes are intended only to *suggest* various lines of approach, there is no reason why any that fire your imagination or suit your spares box cannot be tried out.




### *Three-colour systems*

PAL is a three-colour system, deriving its red, blue and green information from the red colour-difference signal (R—Y), the blue colour-difference signal (B—Y) and the Y luminance or monochrome signal. Tailored as it is to suit the shadowmask tube, the only two

*Fig. 5: Using projection units to provide a three-colour display. The snags are that the three optical units in (a) would be difficult to register while synchronising (b) would be just as hard as three into fifty does not go!*

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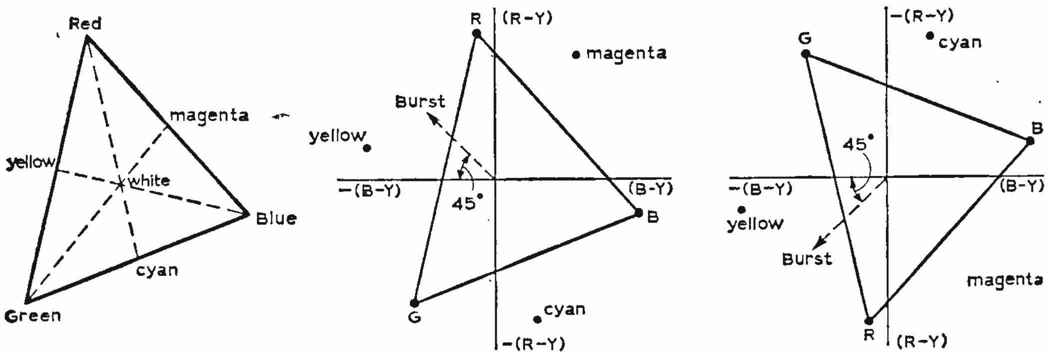


*Fig. 6: Maxwell's colour triangle for lights (painters note: the mixtures don't work with pigments!). (a) Showing how white light comes from mixing a primary colour and its complementary intermediate. (b) Vectors for one line of PAL with the triangle of (a) superimposed. (c) Inverted vectors for the succeeding line in the PAL system.*

alternative means of producing coloured images from it are as shown in Fig. 5, namely (a) three projection systems focused on a common screen, which would be almost impossible to register, or (b) a single monochrome display tube with rotating filters locked to the field timebase. With this second technique synchronising is awkward as three into fifty will not go. Clearly apart from shadowmask tubes three-colour TV systems have many snags.

## Two-colour systems

Some of you may remember a few of the early post-war films and periodicals which relied upon two-colour systems. The results obtained by these systems were nothing like as acceptable as those obtained by three-colour systems, but since the prospects of the enthusiast being able to construct receivers with two-colour displays on a modest outlay are so practical, it does make them worth considering. Before we do, and for the benefit of newcomers to the subject, let us look at colour as a whole.

## Colour mixing

In Fig. 6 we see the well-known colour triangle for additive colours (lights). In each corner are shown the three primary colours red, blue and green. Half-way down each side are the complementaries: magenta, cyan and yellow. Assuming that we get the proportions right: red and blue make magenta; red and green make yellow; blue and green make cyan; red, blue and green make white; red and its complementary cyan make white; blue and its complementary yellow make white; green and its complementary magenta make white.

Lines are drawn on the triangle to illustrate these last four conditions, and as you will notice they all meet in the centre of the triangle at white. Any two colours on a line passing through this centre will indeed make white. The two colours chosen for the films and papers mentioned above were orange and cyan, which you will see lie roughly along a line cutting through white on the triangle. Naturally colours at right angles to this line such as mauve and the grassy shades of green will be badly reproduced, but the eye has been found to respond better to colours on the orange-cyan line than to colours on the purple-green line. Thus if a two-colour system is to be tried, orange and cyan are the two most likely colours to give viewable results.

## Two-colour electronics

A two-colour system is particularly attractive from the electronic point of view. A standard PAL decoder (if at all hazy go back to the April 1967 middle pages of PRACTICAL TV), either simple PAL or $PAL_D$, can be used, omitting the (G—Y) matrix and amplifier. The signal needed to modulate the orange part of the display is very similar to the (R—Y) signal with some negative (B—Y) signal added. The cyan signal similarly is the (B—Y) signal with some negative (R—Y) signal added. This can be seen in the second and third illustrations in Fig. 6 where the colour triangle has been superimposed on the PAL modulation vectors for even and odd lines. Further liberties might be possible to the "pulse minded" amongst you, but before we touch upon them a word of explanation about these two illustrations. Vectors come hard to some people, and the essence of PAL is that the red and blue colour-difference signals (R—Y) and (B—Y) are used to modulate the colour subcarrier with a 90deg. phase difference between them. In this way one of them reaches its maximum whilst the other is passing through zero. Both of the difference signals can modulate the subcarrier either positively or negatively. If you find this confusing let us take the example of a bunch of bananas against a blue tropical sky.

Whilst scanning the sky part of the scene the subcarrier will be modulated by the blue colour-difference signal (B—Y). When we get to the bananas the subscarrier is modulated by a negative blue colour-difference signal —(B—Y) simply because yellow is complementary to blue. If you find negative quantities hard to appreciate simply think of a negative waveform as a positive one turned upside down—as it would be if you passed it through an amplifier. Any particular hue or colour can be represented therefore by a combination of positive and negative red and blue colour-difference signals. Magenta is the vector sum of (R—Y) and (B—Y), yellow is —(B—Y) alone, and so on. Put another way, any particular hue can be represented on our vector diagram as a phase angle.

The snag with PAL is firstly that on alternate lines

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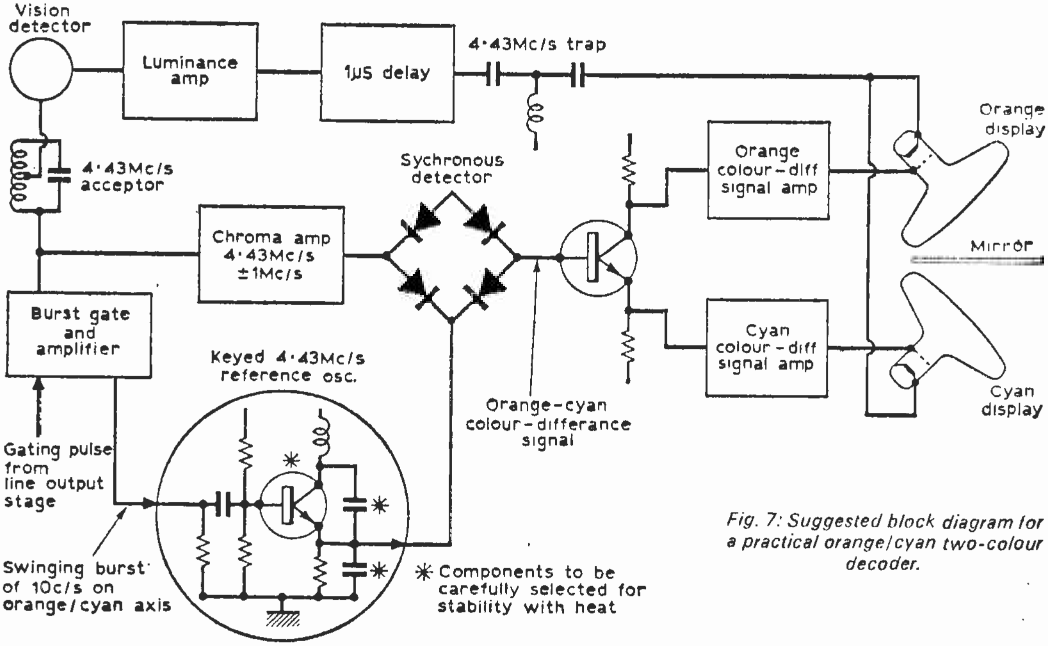


*Fig. 7: Suggested block diagram for a practical orange/cyan two-colour decoder.*

the red difference-signal is inverted to enable distortion to be cancelled out, as we saw earlier, and secondly that since the colour subcarrier is suppressed at its source (the transmitter) it has to be reinserted at the receiver by an oscillator working precisely in phase and frequency with the subcarrier oscillator at the transmitter. The receiver oscillator is synchronised by a burst of 10 cycles of subcarrier radiated during the line flyback period. More complications are introduced here. The set as yet cannot tell which way up the red difference-signals should be, and so the burst is swung 45deg. either side of —(B—Y) on alternate lines to produce the identification signal as well.

This feature provides the enthusiast with two useful signals: (a) an "ident" signal at half-line frequency (7·8kc/s) which can be used to switch a display tube from the orange to the cyan signal, and (b) a reference signal which is exactly on the orange/cyan axis on every line of the transmitted scene. You will immediately see possibilities here. A simple decoder should be a practical proposition, omitting all the PAL "sticky bits" such as the delay line, bistable, phase detector, and crystal oscillator.

A block diagram for you to fill in by experiment is shown in Fig. 7. The key move is to lock a fairly stable reference oscillator to the burst at the beginning of each line. It only has to be stable enough to last the line out, as on the next one it will be triggered again 90deg. out of phase. Since it is always in phase with the burst it will detect the chroma signal on the orange-cyan line in a simple synchronous detector. The resultant signal can be fed directly to the orange display, and after inversion to the cyan display.

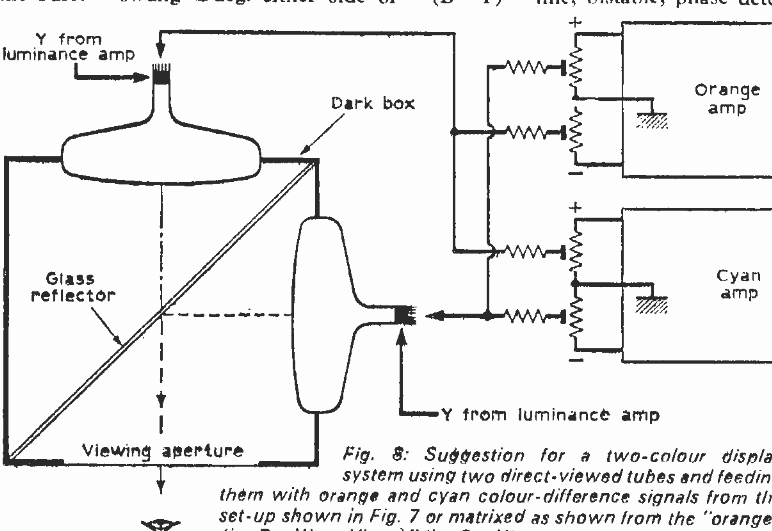


*Fig. 8: Suggestion for a two-colour display system using two direct-viewed tubes and feeding them with orange and cyan colour-difference signals from the set-up shown in Fig. 7 or matrixed as shown from the "orange" (i.e. R—Y) and "cyan" (i.e. B—Y) outputs of a standard decoder.*

—*continued on page 263*

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# INSIDE tv TODAY

## PART 6 M. D. BENEDICT

DURING the 1950s it became apparent that the expanding television networks of the world needed a system of recording that allowed programmes to be quickly replayed. For example, ABC TV had to cover two ITA areas (North and Midland) at the weekends. Only rehearsals could take place during the week and all live programmes had to be crammed into two days of the weekend, leaving the studios hardly used for the other five days. In America, too, the various time zones led to programmes being repeated three or four times so that the programme could be broadcast at a certain time of the evening. Many companies were in the field to develop a recording machine capable of handling both sound and vision. All faced a similar problem.

To record video information on to magnetic tape two things are required. First, a high tape speed to allow the large bandwidth to be reproduced—audio tape recorders operating at 7½in./sec. do not handle much more than 20kc/s, whilst a 625-line picture requires a 5½Mc/s bandwidth. Secondly as the output from a playback head is proportional to the rate of change of magnetic flux on the tape, the output increases with higher frequencies. In audio work frequencies of 40c/s—20kc/s are about all that are required and these nine octaves can be achieved quite satisfactorily by direct recording methods with equalisation of the frequency response on playback and record. For television work the range is 50c/s—5½Mc/s, a swing of 16 octaves, and this cannot be directly achieved. Equalisation as applied to audio tape recorders does not help as so much low-frequency boost would be required that the low-frequency part of the signal would be swamped by excessive noise. To overcome this second problem it is necessary to use a modulation system of some sort in recording, with corresponding demodulation on playback.

Early video tape recorders designed for broadcast use, as well as some later simple video recorders for home use, used a straightforward type of high-speed tape transport. Ordinary ¼in. tape similar to triple-play audio tape was pulled past the heads at a speed of around 120in./sec., about the speed at which many sound tape recorders rewind. Special heads were used to reduce high-frequency losses. In addition to this high tape speed a modulation system is used. For example, the BBC's VERA (Vision Electronic Recording Apparatus) separated off the low frequencies (less than 100kc/s) and modulated them on to a carrier, and recorded that and the high-frequency parts separately. Other systems on similar lines were developed in America by R.C.A. and others; even colour versions were developed. All these systems suffered from a basic disadvantage that a vast amount of tape was needed, and the tremendous speed of the tape and the transport mechanism made such high-speed video tape recorders rather dangerous. Head wear was also a considerable problem.

Just about the time that the limitations of VERA and similar devices were being realised, the Ampex Corporation in America announced a completely new system of recording which is still in use today. Ampex, in common with several others, realised that although it was necessary to have a high speed relative to the tape, it was possible to move the head as well as the tape. In the system Ampex decided on, four heads were used. These are fitted on the edge of a rotating disc, across the circumference of which is pulled the 2in. wide tape. This arrangement, shown in Fig. 7, is the standard four-head system used by many manufacturers the world over.

In this country Ampex and R.C.A. are the main manufacturers of four-head machines. Many differences occur in the design of these machines but the basic principles of operation are identical. Each function of the machine may be performed by completely differing circuits but the end result is the same. Naturally the video tapes can be replayed by any type of machine.

In all machines the heads rotate in the "head drum" at 250 revolutions per second. During the same time the tape has been pulled along about 15in. resulting in each head making a track across the tape from edge to edge. As a result, tracks are laid down as shown in Fig. 8. Following the rotating heads are two sets of stationary erase and record/replay heads, mounted on both edges of the tape. Programme sound is recorded on one edge and cues and instruction on another narrow audio track on the other edge. Yet another head, mounted near the rotating video-record heads, records a sinusoidal signal derived from the position of the head drum. In this way an indication of the phase of the record head is recorded on the tape. This is most important when replaying the tape.

Continuity of signal off the tape is ensured by fixing the diameter of the head drum and the tape width so that the tape is curved around the head drum over an arc of 114deg. Thus during 24deg. of head rotation two heads are replaying information and the switch from one head to the next can be made at a convenient time during this period. In fact it is arranged to occur during a line blanking period so that switching transients can be suppressed.

Tape transport is more or less standard using take-up spools of up to 14in. diameter carrying 95 minutes of tape. Tension arms are used to steady the tape and this in conjunction with power applied to the feed spool motor provides back tension on the tape. Friction is reduced by using an air bearing type guide which is a fixed pillar in which small holes are bored from the bearing surface to the hollow centre. Air is blown through these from the centre of the pillar and as it leaves the holes it cushions the tape and reduces friction.

Air bearings are also used in the rotating head. A motor drives the head drum and a disc with a notch in it so that the disc and an adjacent coil form a variable-reluctance device which indicates the phase

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of the head drum. This is called the tone wheel. Early machines used a lamp and photocell system with black-and-white segments painted on the head drum. All these rotating parts are carried in air bearings which also reduce friction and give an improved performance as regards stability of reproduced picture.

Also air operated is the tape guide. A groove in the centre of this is connected to a vacuum pump. Tape near this is sucked against the guide and takes up the curved shape required.

A spooling potentiometer which supplies infinitely variable power from the take-up motor and the feed motor allows the tape to be wound smoothly in each direction at any speed up to the maximum. This facility is found on most professional quality audio tape recorders and allows the operator to find an exact spot on the tape with great accuracy, assisted by a tape timer calibrated in minutes and seconds. This is driven from a roller around which the tape passes. In general, with the exception of the video-head assembly, the tape transport is similar to an enlarged professional audio tape recorder.

When recording, the video signal enters the video tape recorder and is modulated to produce an f.m. signal in which the signal level of the bottom of the sync pulses (zero modulation) is 4·28Mc/s., black level (30% modulation) 5·0Mc/s and peak white (100%) is represented by the frequency of 6·5Mc/s. Unfortunately owing to the large swing in frequency at a low value of carrier frequency considerable distortion of the sidebands occurs. Patterning, not unlike r.f. patterning, tends to occur, becoming very severe with colour signals, as these contain a considerable amount of high-frequency information in the form of the subcarrier and chroma signals. A "high-band" standard of 7·16Mc/s for sync tips, 7·8Mc/s for black level and 9·3 Mc/s for peak white has been adopted in an effort to reduce these troubles. A considerable improvement in patterning is achieved, but this technique demands more of the heads and tape to be able to cope with the much higher frequency (up to 16Mc/s for some sidebands). Frequency modulation is achieved by controlling a v.h.f. reactance circuit which is heterodyned against a fixed frequency oscillator to give a lower frequency, with wide deviation.

From the modulator the f.m. signal is amplified by a power stage and fed to all the heads by slip rings or rotating transformers in the newer types of head. These are mounted on the side of the head drum.

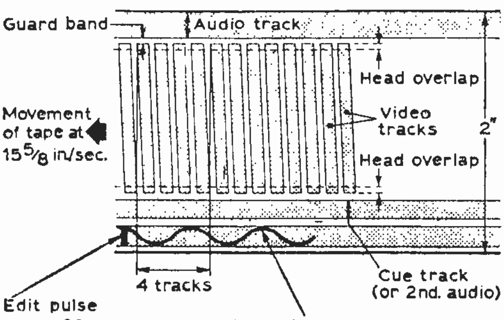


*Fig. 8: Arrangement of tracks with a standard four-head video tape recorder.*

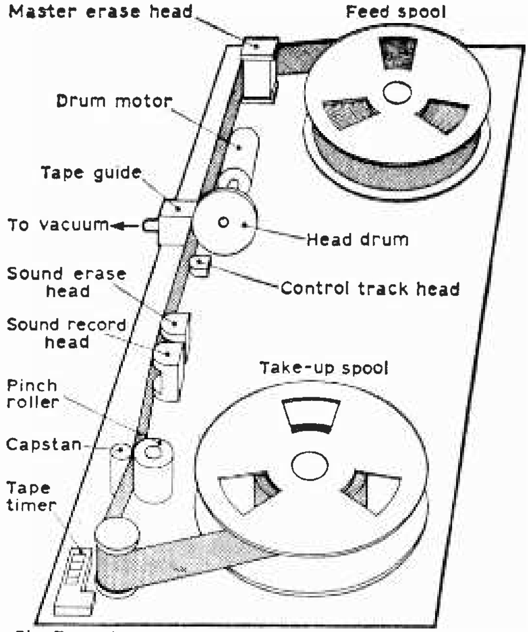


*Fig. 7: Basic deck layout of the Ampex 1000 video tape recorder.*

## Motor control

While recording, the head drum and the capstan motors are controlled accurately so that a standard recording is achieved. A 250c/s signal generated from a ×5 multiplier circuit driven by the field sync pulses and the 250c/s signal from the head drum are compared in phase and the resulting error signal controls the speed of the head drum. As well as the correct speed, correct phasing is achieved by making sure that the field sync pulses are recorded by the first head. The capstan motor is driven by a 62·5c/s signal derived from the 250c/s control signal by dividing it by four. This ensures that the tracks are laid down evenly.

Control during replay is far more complex. It is necessary to refer the replayed control signal to an external signal. This may be the mains frequency or it may be the field frequency of the studio's sync pulse generator. All but the earliest or the simplest machines can control the replay to such an accuracy that the replay is synchronous, i.e. exactly in step with studio pulses. Here advanced servo techniques are used and the reference is sync pulses from the studio.

During reproduction it is necessary for the heads to follow the exact tracks that they laid down during record. The control track record head acts as a replay head and the output from this gives the required phase of the head drum. Comparison of this signal with the signal from the head drum photoelectric cell or tone wheel would indicate the error in tracking over the recorded tracks. An error signal derived in this way controls the speed of the capstan motor and adjusts it until the recorded tracks are aligned exactly.

Of the various methods of replay control the simplest is where the head drum speed is controlled by only a tone wheel or photoelectric cell and a reference

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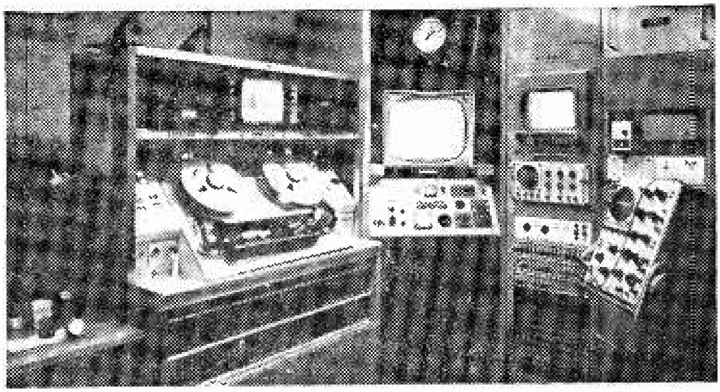

*An R.C.A. TR22 video tape recorder with BBC equipment bays for monitoring at various points. Sound and vision faders, a stabilising amplifier, vidicon caption camera for identification and telephone control panels are all included. BBC photo.*

50c/s signal (the mains or studio field sync pulses). Although the reproduced signal is running at the correct frequency there is no guarantee that it is in the correct phase and when cutting to it a considerable field disturbance may take place.

With the "vertical" or "switchlock" technique, however, the field sync pulses from the replayed signal are compared with incoming reference sync pulses (mains or the local studio sync pulses). To do this the capstan error signal is derived by comparing the field pulses and special "edit" pulses which are added to the control track waveform when recording. These correspond to the field sync pulses as recorded on the tape. When the capstan error signal has allowed the tape position to bring the edit and field pulses in approximate sync the tape is moved against the head drum and a signal reproduced. Control of the capstan is then by control track and photoelectric cell or tone wheel outputs as before and the head wheel is controlled by the comparison between the reference sync pulses and reproduced field sync pulses. R.C.A. machines use a different technique but achieve a similar result.

Fully synchronous working can be achieved by modern machines and a large part of the stability required for this operation is achieved by very tight electro-mechanical servo control of the head drum and capstan. "Automatic" and "Pixlock" modes, as they are called, are not switched in until field synchronisation is achieved. Very high-gain servos control the head drum by a comparison between the timings of incoming reference line syncs and the reproduced line sync pulses. Remarkable stability is required; any disturbance in syncs causes a considerable break-up to occur and even when operating satisfactorily the stability is not entirely satisfactory so an all electronic technique is used in addition by both Ampex and R.C.A., which utilises the principle of a variable delay line.

A coax cable has both series inductance and parallel capacitance between the inner and outer conductors; it also introduces a very slight delay. This delay can be increased by increasing the inductance and the capacitance. Artificial delay lines with the desired inductors in series and capacitors in parallel across the line give the same effect. By using variable capacitance diodes in the place of the capacitance the delay can be varied by altering the bias of the diodes, and hence their capacitance, and this varies the delay of the time. Such a delay line can be fed by correction waveforms so that it corrects for any instability that remains between the signal off the tape and the studio sync pulses. In addition geometric errors in the picture caused by head misalignment can be corrected. Correction is achieved by comparing the signal off the tape and the reference studio pulses, deriving a signal to delay the signal off the tape by the required amount to bring it into exact synchronism. Such units are called Amtec or A.T.C.

Each head mounted in the head drum should be exactly 90deg. apart but even the slightest error in assembly can show up. As the tape is held by the vacuum guide against the head drum with a fair pressure the tape is stretched very slightly. Exactly the same stretch should be applied during playback. Similarly the height of the head with reference to the edge of the tape is important. Effects of this misalignment cannot be seen on a tape replayed on the same machine as all of these errors cancel out. But if a tape is replayed on a different machine errors will be apparent unless both machines are standardised. Delay lines for each head on both record and playback correct for the heads not being 90deg. separated, and mechanical adjustment of the head guide height corrects for one type of error and a motor-driven control (which may be servo operated) gives an adjustment of the tape stretch or head "tip projection" as it is called.

These errors appear as a series of bands of ten lines being offset slightly from the rest of the picture (heads not 90deg apart) or the picture being broken up like a venetian blind (guide height and tip projection). All these errors can be eliminated by the delay line technique provided that they are not too great. Hence Amtec and A.T.C. allow tapes to be replayed on different machines although as a matter of principle all machines are aligned to a standard tape produced by the manufacturers. Each video tape recorder is aligned on the recorded programme without the use of Amtec or A.T.C. before a programme or insert to a programme is replayed for transmission.

## Use of video recordings

Video tape recordings are used for two sorts of items; complete programmes recorded for transmission at a later date and parts of a programme prerecorded at an earlier date. Inserts to a complete programme are often used for sports, news and current affairs. Highlights of events are recorded as they happen and can be shown at a later round-up. News and current affairs use video tape to record items when news personalities are available in the studio and when films shot in one of the regions are recorded in London for replay into a programme at a later time. Difficult sequences, in particular fight sequences, are prerecorded, as are those which require a lot of cleaning up afterwards. In fact, if any

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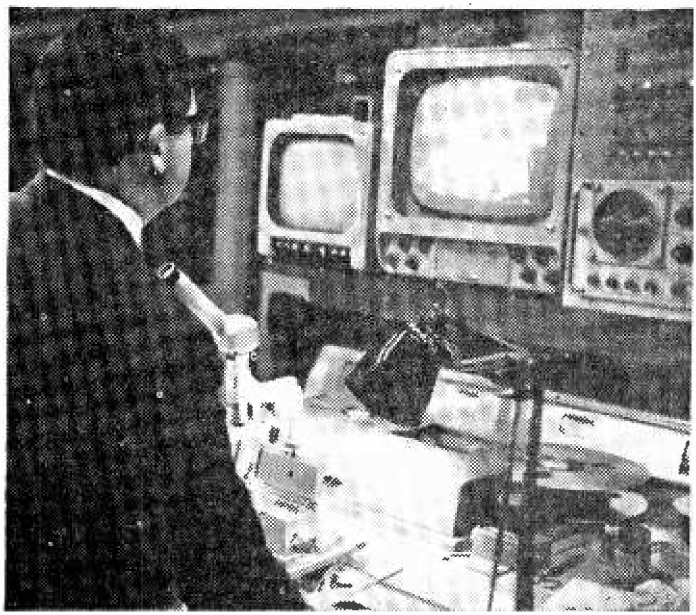
difficulties are foreseen, prerecording inserts are often used, allowing more time and studio space to be used to get the sequence right.

When the operator has recorded the complete programme or the insert for a programme he has to "cue" it up. All complete programmes and most inserts are recorded with a close up of a clock running for one minute or thirty seconds. The programme is started as the seconds-hand reaches zero so that on replay there is an indication of how long is available before programmes start. This guides both the operator and presentation staff, announcers, etc. As a guide to these people the name of the programme, episode number, etc., are chalked on to a board adjacent to the clock face. With a clock on the recording the video tape operator stops the tape at the ten-second mark and then marks the back of the tape with a felt-tipped pen to show exactly where his starting point is. Similarly when part of a complete recording is required the operator winds back ten seconds from the required starting point and marks the tape. After checking that the "run up" is exactly ten seconds the tape is rewound to the mark when it is ready for technical line-up before transmission.



*Editing video tape. The jig with built-in microscope is on the front of the video tape recorder—an Ampex 1000. ATV photo.*

Complete programmes are recorded often on one continuous take, as though the programmes were going on the air, but sometimes with breaks in recording. These are physically edited out of the tape to give a continuous programme.

## Editing

Editing video tape is a rather delicate operation and a highly sophisticated technique using a microscope for accuracy is required. To edit video tape the part of the tape under consideration is run through the machine, which is stopped at the required cutting point. A mark on the back of the tape is made with a felt-tipped marker before rewinding the tape and replaying it again. As the mark passes the head the operator checks that it is the correct cutting point both for sound and vision. At this point a conflict may arise. COMMAG film editing and video tape editing both suffer from the fact that sound and vision are recorded at a slightly different point on the tape so that although the sound track may be satisfactory this would result in difficulties with the pictures. Video tape is worse in this respect as often a cutting point coincides with a change in camera on the recorded sequence which must be eliminated entirely. In fact, on some occasions sound has to be taken off tape and "relayed" after the edit.

When the exact cutting point has been established, the operator cuts the tape with scissors and lays the cut tape in a special editing block. Editing fluid, which is a suspension of fine particles of iron, is applied to the surface of the tape making visible the magnetic tracks and control track signals. Using the control track as a guide the tape is moved to an exact position under the edge of a guillotine where the tape is clamped before cutting.

After selection of the next editing point the tape to be joined is similarly cut at the same point with reference to the control track. Both ends of cut tape are then spliced with very thin adhesive tape on the back of the video tape. Use of a microscope and fine adjustment of the tape position on the jig by geared rollers allows a nearly exact synchronism to be achieved between the two parts of the tape, so that a good edit causes no disturbance on replay.

Sound problems can be overcome by lifting off the sound, i.e. recording it on a sound recorder and re-recording the sound on to the second part of the tape without erasing the video.

A recent development is electronic editing which allows a machine so equipped to replay and be switched instantly to record. Hence a sequence can be added to the end of a sequence already recorded. Two basic modes of operation are possible. One allows a sequence to be added into the middle of a recording so that different shots can be inserted. Sound can be re-recorded or left undisturbed during this process. Alternatively a sequence can be added on to the end of the recording. In both cases the video tape recorder is run up in lock with the incoming signal. When stable, the signal is adjusted so that the incoming signal ready to be recorded and the replayed signal are in phase. On pressing the record button the erase is switched on. After a suitable delay to allow the erased part of the tape to reach the record head (about ½ sec.) the video head is switched to record and continues to lay down the tracks in exact synchronisation with the signal just reproduced off the tape, so achieving a smooth cut. Both modes use the control track to effect the synchronism but in the mode "adding on a sequence" the recorder lays down a signal in the control track.

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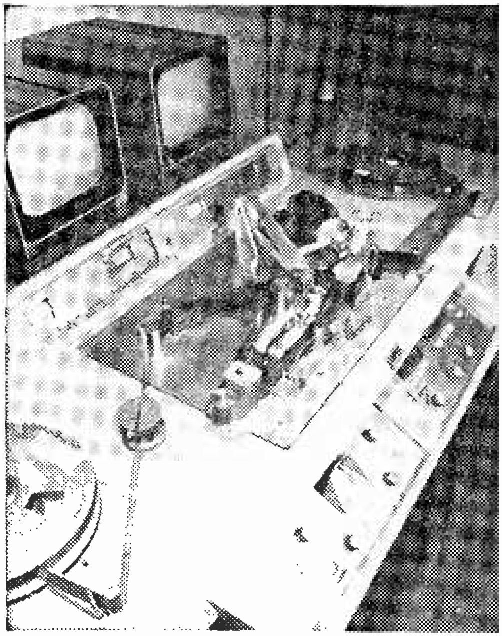

*BBC slow-motion video tape recorder. Tape follows an unusual path round an arm which is vibrated by the electric motor fitted on the top plate. This gives the correct tape motion for replaying one field at a time. BBC photo.*

Advanced electronic editing can be used for the most complex editing as the position of the electronic edit can be recorded on the special cue track so that its exact position can be adjusted field by field. In fact, using one camera, direct animation techniques akin to stop motion cine photography can be achieved. In the same way the simplest studio equipment can be used to record very complex items as the recording can be stopped and restarted at will, allowing cameras to change position, and both sets and lights to be repositioned.

Besides these highly complex and rather bulky video tape recorders there exist a considerable number of portable machines. All but the Ampex 3000 use a helical scan principle, the 3000 being a record only miniature version of the four-head machine, complete with its own camera and pulse generator.

Helical scan video tape recording principles have been discussed in PRACTICAL TV by H. W. Hellyer and little need be added except that only the best quality video tape recorders of this sort find their way on the air. Machines by Ampex, Sony and Mactronix have been used in this country but the simpler types can be found in use in closed-circuit installations, such as educational television. All simple machines suffer from complete loss of picture information at one point—this is the point where the head runs off one edge of the tape and on to the next. Video information is removed by the sound erase head before the sound track is laid down. Normally this information occurs at the top of the picture but on the best quality helical scan machines it is made to occur during field blanking. On replay a special processing amplifier regenerates this part of the signal so that a clean signal will result. Cheaper video tape recorders, as used in educational television and in industry, do not use such a processing amplifier as it is not necessary for producing stable pictures.

Helical-scan machines can give excellent results but owing to the much simpler techniques used they are still inferior to four-head machines. They are not entirely compatible with regard to replaying on a different machine as the tape guides which determine the path of the tape around the rotating head assembly must be exactly similar to the recording video tape recorder. If this is not the case then the head will not follow the same tracks on record and replay. Another disadvantage is that the simple helical scan does not lend itself to a remote control of head and capstan, so that locking the replaying signal to the studio sync pulses is very hard to achieve. One system seems to have overcome most of these faults by using a conically shaped head assembly and two capstan motors. Along with this greater stability, it is claimed that such a technique will allow colour television signals to be recorded without undue difficulty.

Modern four-head machines can replay colour although a great deal of development has been required to bring colour video tape recorders up to the standard where colour signals can be re-recorded up to three times without noticeable loss of quality.

Another facility sometimes to be found is slow-motion video tape recording. Helical-scan machines record a complete field in one continuous track so that when the head geometry is altered slightly and the tape speed reduced (or even stopped) then the head can be made to reproduce one field four or five times before moving on to the next track with the next field recorded on it. Four-head, slow-motion video tape recorders have also been made. For the 1964 Olympic Games the Japanese produced a machine using a special head drum with each head offset with respect to the first head. A much simpler machine, but without the excellent performance of the Japanese machine, has been built by the BBC. In this machine the tape path was modified to give a section of tape that could be vibrated backwards and forwards past the head. This movement, combined with the slowed movement of the tape through the machine, allowed the tape to be moved past the head at normal speed, stopping and restarting after a suitable pause. As only one field is replayed at a time a special rotating magnetic disc system was used to store the signal and read out the signal four times before the next field is replayed off the tape. Hence a slow motion ratio of 4 to 1 is achieved, along with frozen field from the magnetic disc if required.

Also available is a simple magnetic disc recorder on which about 30 seconds of picture are recorded on a spiral track similar to that of a gramophone record. On reproduction a "freeze" button is operated and the next field is recorded on the reverse side of the disc and then is reproduced for as long as required. Such machines are very simple and compact so that they are often used to replay goals just scored and other highlights of sporting events. Colour versions have been announced

Video tape and its techniques have come very far from the first Ampex recorder in 1955; it is one of the fastest expanding branches of television engineering although one of the newest.

**TO BE CONTINUED**

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# Servicing TELEVISION Receivers

**No. 143 - ALBA T990 SERIES**
*—continued*

*by L. Lawry-Johns*

## *Valve voltages*

The readings in the following table were measured under no-signal conditions and at maximum gain, with 230V a.c. mains input, using a 20,000Ω/V meter.

| Valve | $V_a$ | $V_{g2}$ | $V_k$ |
|---|---|---|---|
| V1 | 154 | 53 | 0·3 |
| V2 | 150 | 164 | 2 |
| V3 | 142 | 170 | 2·6 |
| V4B | 42 | — | — |
| V5A | 50 | — | — |
| V5B | 215 | 187 | 17·3 |
| V6* | 22 | 14 | — |
| V6† | 168 | 93 | 2 |
| V7A | 93 | — | — |
| V7B | 228 | 188 | 5 |
| V8A | 168 | — | 4·3 |
| V8B | 116 | 163 | 4·3 |
| V10 | — | 177 | — |

* Readings on 625. † Readings on 405.

## *Fault conditions*

The most likely trouble spot is the PL500 valve which is prone to lose emission, causing lack of width, or go soft, causing a no picture, no e.h.t. condition. Where the PL500 is not responsible for the lack of full width condition, check the R94 1·5kΩ screen dropper, V8, the PCF802 line oscillator valve and its 33kΩ (pin 6) load resistor R89 which can change value. In stubborn cases check the width circuit resistors.

## *Severe interference*

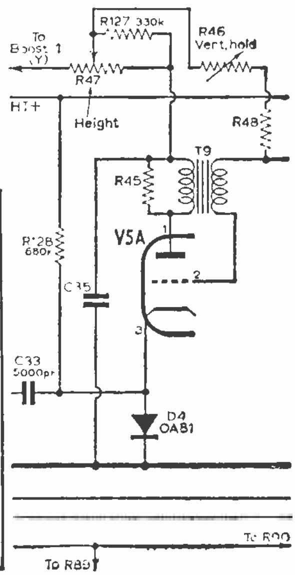
Severe interference giving rise to irregular vertical flashing and white dots is most often caused by breakdown of the insulation between the line deflection coils and the line linearity closed-loop sleeve. This is of course on the tube neck, partially under the coils. The clamp should be slackened and the sleeve pulled out a little way to verify whether this is the source of discharge. Sometimes it is only necessary to move the sleeve slightly in order to stop the discharge but a new sleeve may be fitted as a more permanent cure.

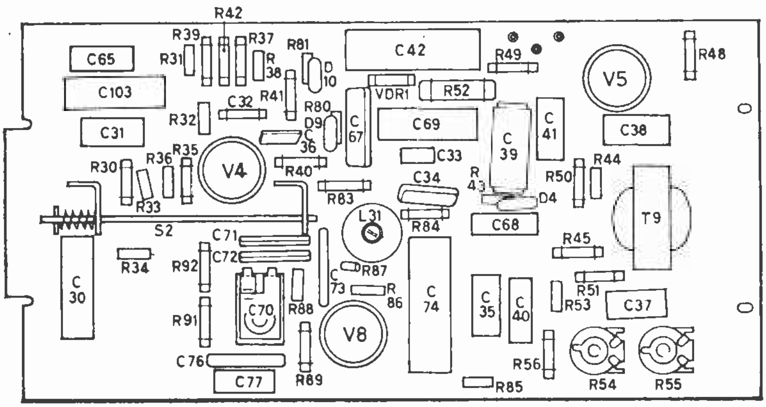
## *No picture*

If the line whistle is normal on 405 but there is no e.h.t., verify its presence at the top cap of

*Fig. 4 (right): Modifications to the field oscillator.*

*Fig. 5 (below): Layout of the timebase printed board.*

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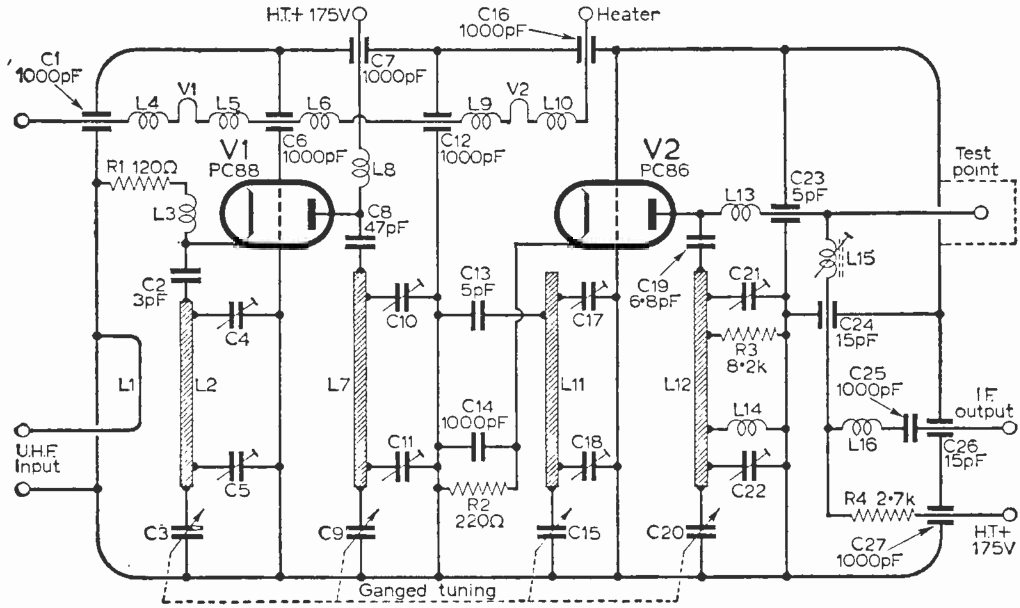


*Fig. 6: Circuit diagram of the u.h.f. tuner unit.*

the DY86. Although it is well insulated, there will still be a blue glow to the tip of a screwdriver. If the high voltage is present here but the DY86 does not light up, check the DY86 and the continuity of the choke (L35) between pins 7 and 9. The valve has a low heater voltage and there is only one turn on the transformer yoke. Needless to say an EY86 cannot work in this position. In the event of there being no or very little voltage at the top cap of the DY86, with the line whistle being absent or very weak, note the effect of removing the top cap of the PY88. If this brings the stage to life, replace C84 (0·25$\mu$F) which will be shorted. If removal of the PY88 top cap does not make any difference check the PL500, the 8$\mu$F capacitor C83 and the PY88, having first checked the DY86 for shorts by removing its top cap. If the PY88 and the PL500 appear overheated check the PCF802 line oscillator and associated components, and also the OA81 flywheel line sync discriminator diodes D9 and D10 if necessary. A rough check is to measure their back-to-front resistance by applying one prod of the meter to their junction and the other to either side in turn, noting the readings, and then repeating with the test prods reversed.

The pentode section of V8 is the actual line oscillator, with the feedback via a tuned circuit between its screen and control grids. The triode section controls the frequency of oscillation in accordance with the bias applied to its grid from the flywheel sync discriminator circuit.

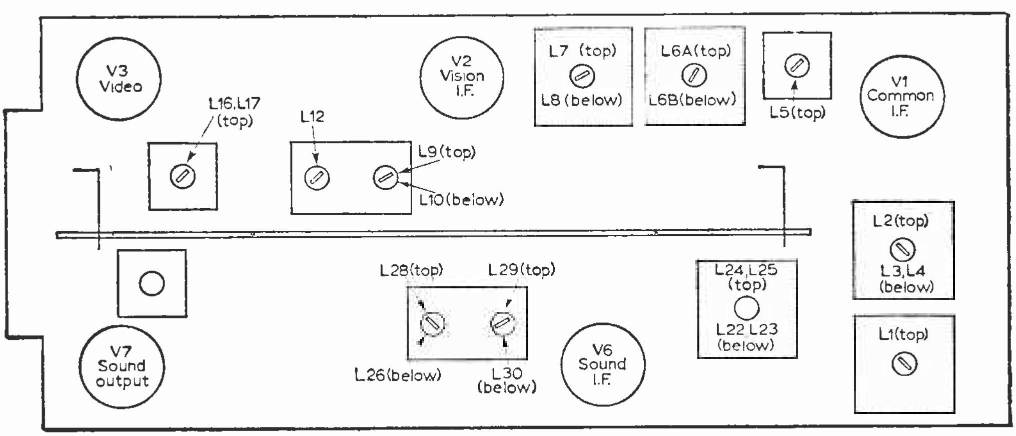


*Fig. 7: Valve and coil positions on the receiver printed panel.*

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### *The field timebase*

We have not had a lot of trouble in this part of the circuit so can only dwell upon possibilities. Complete collapse produces a single white line across the centre. Check V5 and V4, h.t. to pins 6 and 7. If h.t. is not available at either check the PCL85, R49, R111 and R52. If h.t. is at 7 but not at 6 check at R111 end of transformer T10 and if present here suspect T10 of an open-circuit primary. If however the output stage is functioning attention should be directed to the 2MΩ height control R47, thence to the T9 end of R44 (original circuit later modified, see Figs. 3 and 4) as C35 (0·05μF) could be shorted to chassis.

If there is a gap top and bottom of the picture, i.e. insufficient height, check C87 0·05μF which can short to the h.t. line (from the boost line).

If there is a white band across bottom accompanied by field roll, with the hold control at the end of its travel, check C37 0·05μF for leakage then C38 0·02μF. If the control is at the end without bottom cramping check R48 1·2MΩ.

If the bottom part of the picture is compressed without any foldover check C39 100μF and C40 0·01μF.

### *Very weak reception*

This applies to sound and vision including u.h.f. As the PCC189 in the v.h.f. tuner is not used for u.h.f. this need not be suspected. The same cannot be said for the PCF801 as the mixer section is used as an i.f. amplifier on u.h.f. This is not to mean that V1 EF183 could not be at fault. Indeed it could, but the fault the writer has in mind is more elusive than a faulty valve and a good deal more time consuming. On several occasions we have traced this type of fault to the v.h.f. tuner unit and have found little or no voltage at pin 7 of the PCF801 because the 18kΩ screen feed resistor R211 (22kΩ on some tuners) becomes partially or wholly open-circuit. It may read several hundred thousand ohms or complete infinity. Replacement is not easy but is not too difficult once the turret or rotor is removed.

### *Video streaking*

This is particularly noticeable on captions where black streaks into white etc. Attention should be directed to the video amplifier components, particularly the 4·9kΩ anode load R25 and R26 (10kΩ). Also check C27 32μF and C25 100μF. These latter components can also cause weak sync where the holds become critical.

### *No results*

Valves not lighting. Check F1 2A fuse, supply to dropper sections R118, R117 and R116. If all give full indication check through the valve heaters starting with V10. If the valves are glowing normally, check R119, R120, R121 and output of MR1 (BY100) at R115, R112 and R113.

### *V.H.F. tuner*

Sometimes a fault which can be confusing occurs in the v.h.f. tuner, affecting ITV and BBC-1. The symptoms are inability to properly tune in the required channel, and, after it has been tuned with the oscillator core it will not be obtained the next time the switch is operated. When these symptoms show up the primary suspect should be the fine tuner core which should slide inside a sleeve. The plastic can snap or the metal sleeve become loose on the plastic former the remedy being obvious in either case. ■

# AN ENTHUSIAST LOOKS AT COLOUR

—continued from page 255

### *Two-colour display systems*

A single cathode-ray tube, projection or direct viewed, could be utilised in conjunction with a rotating disc of coloured filters placed between it and the viewer. A synchronous 50c/s motor drive can be obtained by amplifying the field timebase output via a pair of thyratrons, thyristors, output valves, or transistors as you prefer. The mechanism should be made to pass alternate orange and cyan filters down the screen at the same rate as the field scan. The "flicker rate" will be 25 per second, not quite as objectionable as the 16 per second that would be required for three-colour scanning along these lines, and with this system a bistable circuit would be needed switching the video signal on alternate fields from the orange chroma detector to the one for cyan. Although the colour filters will synchronise to the field timebase automatically there is a 50 : 50 chance that they will produce the right colour rendering at any particular switch-on. This can be readily corrected by momentarily suppressing the field sync pulses to the bistable switch.

An alternative means of display is to employ two identical direct view cathode-ray tubes arranged at right angles with filters and reflectors as shown in Fig. 8. This is the most practical form available to the widest number of enthusiasts. Two identical sets can be used, with the line scan coils reversed on one since it will produce a mirror image. Registration and brightness regulation should be carried out on a monochrome transmission for the best black-and-white reproduction.

Apart from the timebases it is not essential to duplicate the receiver section. One r.f., i.f. strip and one decoder should suffice. An alternative method of display using two projection tube assemblies (if you still have them) may possibly produce registration difficulties unless they can be mounted very close together. In all cases better linearity and registration is always possible if you settle for small pictures.

To those of you who were looking for detailed circuits of how this can be done we can only say that colour TV is unfortunately too young. The writer can, however, add as a footnote that although untried, a two-colour system should enable the keen to produce some sort of colour from their spares boxes. A few experiments were carried out on a PAL$_D$ receiver to this end. Each gun in turn was muted during a colour-film transmission. Results were intolerable with no green, watchable with no red, and quite presentable with no blue. In this latter test the pictures had a yellow cast similar to results obtained by taking indoor pictures on an outdoor colour film. So clearly if a two-colour system is at all practical it must indeed be demodulated somewhere along the orange-cyan line. ■

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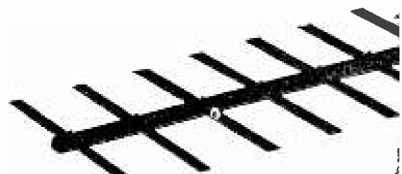
# OBTAINING SIGNAL



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GORDON J. KIN

A LARGE proportion of the reports of poor television reception dealt with by the Query Service of this m ;azine, by the BBC and ITV, the Post Office, television dealers and other independent television consultants stems wholly or in part from inadequate aerial signal. Enthusiasts often spend a lot of time searching the receiver circuits for a fault that does not exist, when in the majority of cases the reception could be considerably improved by supplying the set with a few extra decibels of aerial signal.

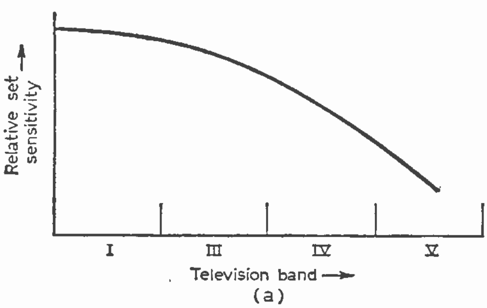
Low signal strength affects BBC-1 and ITV as well as BBC-2 and colour, but u.h.f. reception generally suffers more than v.h.f. This is because most sets require a stronger signal on BBC-2 and colour to give the same quality of pictures as obtained on BBC-1 and ITV. In other words, sets are less sensitive on the u.h.f. channels than on the v.h.f. ones, and this shows as a gradual fall in sensitivity from Channel 1 in Band I (the most sensitive channel of all sets) to Channel 68 in Band V, as shown in Fig. 1(a). To offset this sensitivity decline the aerial signal should ascend with increase in channel number, as shown in Fig. 1(b), but this rarely happens. Instead, the problem is often worsened by the aerial signal being less on the u.h.f. channels than on the v.h.f. ones, as shown in Fig. 1(c).

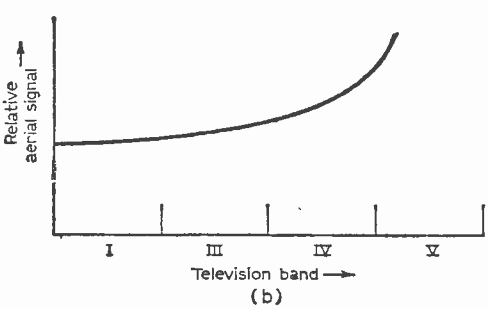
## Beyond the line of sight

There are various reasons for this, but a major one is that the u.h.f. signals reduce in strength more rapidly than v.h.f. ones beyond the theoretical line-of-sight distance between the transmitting and receiving aerials, as defined in Fig. 2. Another reason is that u.h.f. signals fail to possess the same penetrating ability of the lower frequency ones, which means that while a v.h.f. signal might produce a satisfactory signal field strength on the far side of a large obstruction a u.h.f. signal could be completely isolated by the same obstruction.

U.H.F. signals travel almost in the straight lines of light rays, and can be likened to the rays of light emanating from the top of a lighthouse. Discounting the influence of large buildings, hills and other earthly obstructions, therefore, the signal induced into an aerial increases in direct proportion to its height above the earth, as shown in Fig. 3(a). Sadly, this relationship does not always occur in practice owing to the influence of earthly obstructions, and there are times when the signal picked up by the aerial actually falls as its height is increased, as shown in Fig. 3(b). However, the tendency is always for the signal pick-up to increase on average with increase in aerial height, as the dotted line on the graph reveals.

Sets call for a stronger signal on the higher



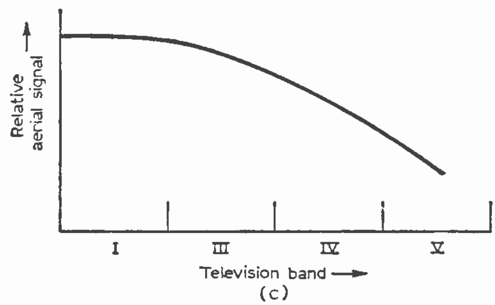




*Fig. 1: (a) Fall in receiver sensitivity with increase in channel number. (b) Required increase in aerial signal with channel number increase to maintain the same signal-to-noise performance. (c) General effect of signal fall-off with increase in channel number.*

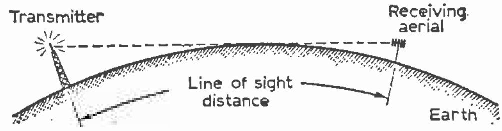



*Fig. 2: Line-of-sight distance.*

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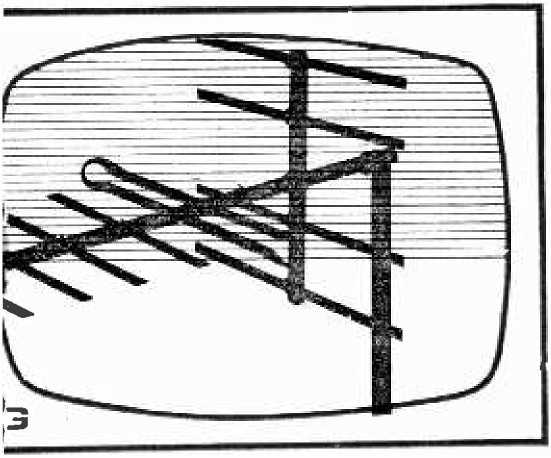
# THE BEST



channel numbers because the noise signals generated by their tuners increase as the channel number increases, as shown in Fig. 4 Picture quality is ultimately governed by the signal-to-noise ratio, which is the ratio given by the aerial signal and the noise signal. Noise signal shows up on the picture as grain or "snow-storm" effect and for this not to be discernible to any degree the aerial signal must always be 200 times stronger than the noise signal. This represents a signal-noise ratio of 46dB, the practical minimum for high-quality reception.

To maintain such a signal-noise ratio, therefore, either the noise signal produced by the tuner has to be reduced or the strength of the aerial signal increased. Noise signal created by a tuner is a factor of its design, and during the last three or four years this has been significantly reduced by the use of low-noise valves and, more recently, low-noise silicon transistors. One can be sure, therefore, that a modern set in proper working order is producing the very smallest noise signal possible with the present state of the art.

## Colour noise

Tuner noise is a little more troublesome on colour pictures than on monochrome ones. This is because of the extra colour (chroma) information carried by the transmission. Sidebands of the colour signal interleave with the monochrome information, and if there is noise on the former it adds to the general overall noise effects in a subjective manner. Tests made by various authorities to find out just how much the colour picture is degraded by noise indicate that between 50 and 100 per cent more signal is required by a colour set to yield a subjective signal-noise performance comparable to a black-and-white picture obtained under similar conditions.

This is very important right now, for it means that if a BBC-2 picture has just about adequate monochrome signal-noise performance the same signal applied on colour will show rather a disturbing noise. The only way that this problem can be satisfactorily solved is to ensure that the u.h.f. aerial is delivering about twice as much signal as required to give the minimum signal-noise performance on a monochrome transmission. The colour picture will then be noise free.

It is unfortunately not possible here to illustrate colour noise, but some idea of how noise affects a colour transmission received in monochrome is shown in Fig. 5. At (a) the signal strength gives the desirable minimum 46dB (200-to-1) signal-noise ratio, while the picture at (b) shows how grain predominates the background when the strength of the aerial signal is only a third of that required for the desirable minimum signal-noise ratio. The ratio is cut to about 70-to-1, which is close to 37dB. Since such a poor signal-noise ratio cannot normally be improved by reducing the tuner's noise signal, the only practical solution lies in increasing the strength of the aerial signal itself.

Increasing it by three times, of course, restores the picture quality to that shown at (a). Further increase is accommodated by the set's a.g.c. (automatic gain control) systems without overloading,

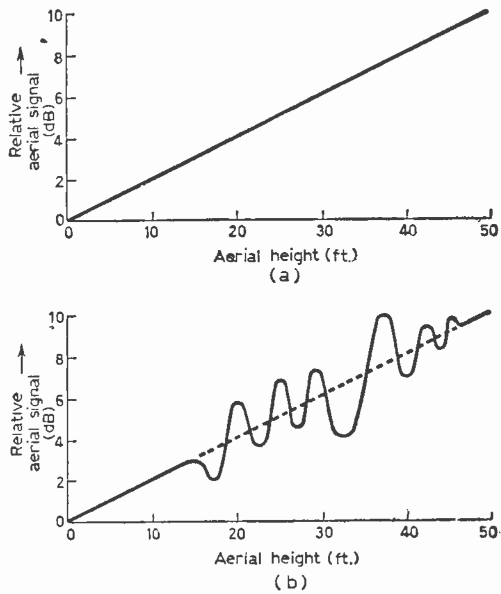



*Fig. 3: Aerial signal versus aerial height (a) in open space and (b) in screened areas where standing waves are troublesome.*

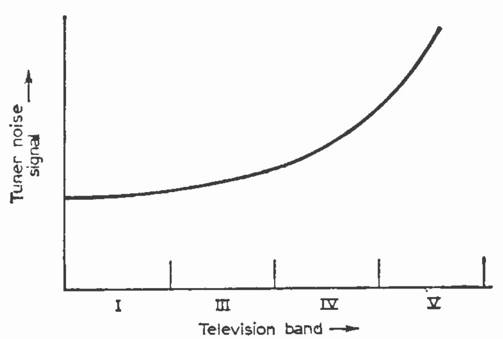



*Fig. 4: Increase in tuner noise with increase in channel number.*

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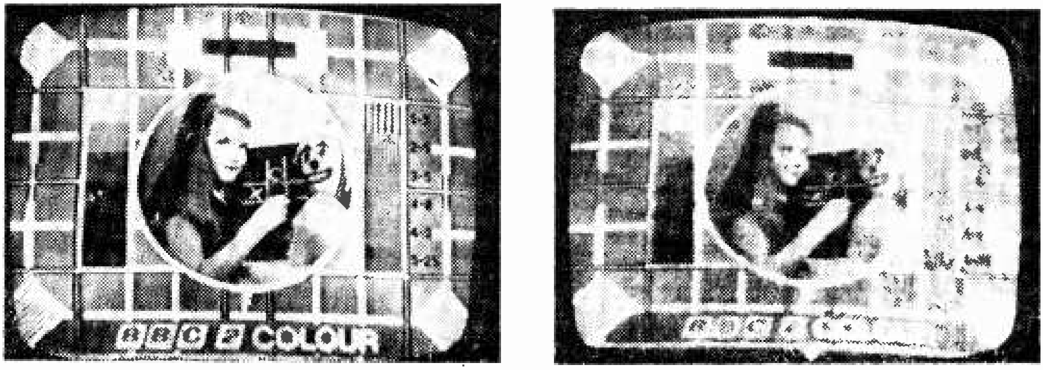


(a) (b)

*Fig. 5: Signal/noise performance at (a) about 46dB and (b) about 37dB signal-to-noise ratio.*

and to some extent the picture becomes even less grainy with improved definition. The aim, then, should always be to abstract as much signal energy as possible from the passing radio waves—and this calls for a suitable aerial system, correctly erected and adjusted.

## Low signal symptoms

Other symptoms of inadequate aerial signal include hiss on sound, which is the audio representation of the picture grain, critical line and vertical hold controls, the picture tending to "roll" in the presence of even minimal interference, abnormally high sound and vision interference and unbalance between sound and vision on the fine tuning control. This last symptom is often put down to a fault in the set because when the fine tuning control is adjusted for a fair picture the sound is very low or appears off-tune. Conversely, the adjustment corresponding to the best sound gives a poor picture. In extreme cases of low v.h.f. signal strength it is often discovered that the contrast control fails to work properly. This is because the potential for controlling the gain of the set is derived from the a.g.c. bias, which itself is obtained from the signal. When the signal is weak, therefore, there is little or no bias from which the control can work, and the gain of the set remains at maximum at all settings.

The strength of the signal fed to the set's aerial socket depends on the intensity of the signal field in proximity to the aerial and on the aerial's gain and orientation. In most areas devoid of local screening within about 30 miles of a main transmitter the signal field is relatively high in the v.h.f. bands at least, and relatively simple Band I and Band III aerials abstract sufficient signal energy to provide a reasonable signal-noise performance.

## Aerials required

For Band I reception a simple dipole or "H" aerial is generally adequate, but about five elements or so might be required for comparable Band III reception. On the u.h.f. bands, however, the aerial requirement is nowhere near as clear cut. A very rough guide is that for co-sited transmitters receiving aerials having about the same amount of metal in them are required for the various channels in all bands to give comparable aerial signals.

This means that if Band I requires two elements, Band III will require five or six elements, Band IV ten or so elements and Band V even more, depending on the channel number. This is because television aerials are tuned devices, and the higher the channel number, the shorter the tuned length of each element.

Height and screening are two factors which come into play more with increase in channel number. The diagrams in Fig. 3 show the influence of height, but it is not possible to be so definite with regard to screening. Even the screening effect of a brick wall or the roof of a house can severely affect the signal field round the aerial, especially on the u.h.f. bands in wet or damp weather. This is why it is generally undesirable to fix the u.h.f. aerial indoors. If this is absolutely essential, however, the attic or roof-space is far better than a ground-floor room in which the television set is used. The extra height of the roof-space puts the aerial in a greater signal field away from living-room proximity effects and variations, but even so when it is wet the signal will drop to at least half that available with the aerial outside the house at a similar height. On no account should a roof-space u.h.f. aerial be employed if it has to point through a row of houses, for example, towards the transmitter.

By far the best idea is always to arrange for the u.h.f. aerial to be outside the house, on the chimney stack or some other lofty site, even if this means putting the v.h.f. aerials into the roof-space. V.H.F. signals, particularly those in Band I, are less attenuated by wet walls and roofs than u.h.f. ones.

Areas more distant than about 30 miles from a main station require aerials of even greater complexity, especially on the u.h.f. channels, but again very much depends on the height of the site above sea level (or local screening level). The maxim is always to use a more elaborate aerial if there is any doubt about the signal conditions, rather than one of insufficient gain or number of elements.

In areas with heavy local screening standing-wave signals are generated in space, and since the strength of these vary with height and lateral distance substantial rises and falls in the signal strength induced in the aerial are not uncommon

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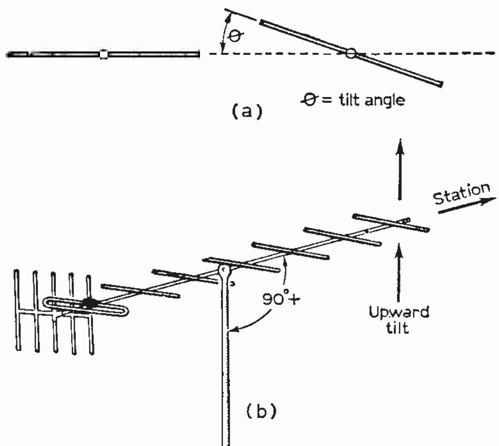


*Fig. 6: Tilting the aerial (a) to line up with the plane of polarisation and (b) to increase effective aerial height.*

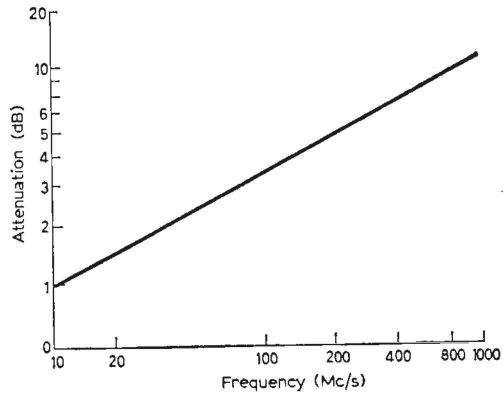


*Fig. 7: Attenuation increase with increase in signal frequency*

as the position of the aerial is changed (Fig. 3(b)).

Long propagation distances and screening effects can sometimes alter the plane of polarisation of the signals at the aerial. This is more noticeable on the u.h.f. channels, and it has been known for the signal at the set to rise by almost 40% by tilting the aerial to match the changed polarisation. Polarisation tilt should not be confused with overall aerial tilt, which is sometimes adopted to give the aerial greater effective height. Fig. 6 shows the two kinds of tilt, polarisation tilt at (a) and tilt for increasing the effective height at (b).

The latter, too, can assist in increasing the signal induced into the aerial, particularly when there is rising ground between the u.h.f. station and the receiving aerial. Special boom-mast coupling brackets are available for giving this kind of tilt, while polarisation tilt is easily applied by releasing the boom clamp sufficiently to turn it through the required number of degrees, after which it must be tightened, of course. Maximum polarisation tilt rarely exceeds 15 deg. for optimum results (often less than this), while a tilt of 25 to 30 deg. can be applied to increase the effective height, depending on the local conditions.

The majority of viewers are within v.h.f. signal fields sufficient to give at least the minimum desirable signal-noise ratio on BBC-1 and ITV programmes, but this certainly does not apply to BBC-2 reception, and the rest of this article will apply mainly to u.h.f. problems.

Where possible always mount the aerial out of doors as clear as possible from other aerials or metal items, such as pipes, guttering, metal roofs and so forth. In screened areas and at distances in excess of 30 miles from the transmitter try altering the position of the aerial for the best possible reception (to clear snow-storm effects, for instance). Always orientate the aerial for maximum signal, remembering that multi-element u.h.f. aerials are extremely directional and that off-beam siting of 10 deg. or less can halve the available signal pick-up. In notoriously poor reception areas try the effect of tilt (Fig. 6).

Always use a separate length of coaxial feeder from the u.h.f. aerial to the set's u.h.f. socket. It is possible to combine the u.h.f. signals to the feeder connected to the v.h.f. aerial, but the signals have to be split again at the set for application to the v.h.f. and u.h.f. aerial sockets. This scheme not only attenuates the u.h.f. signal, via the filters used for combining and splitting, but can also introduce mismatching, further reducing the effective signal transfer to the set. However, in high signal strength areas this technique can be adopted if required.

Always use special extra low-loss coaxial from the u.h.f. aerial, for the aerial signal can be attenuated by as much as 40% by passing through medium-loss or poor-quality coaxial cable. The graph in Fig. 7 gives some idea of how coaxial cable attenuation rises with increase in signal frequency.

Always make certain that the coaxial plug is connected properly at the end of the feeder. Fig. 8 shows the correct fitting method and reveals a common fault, that of a badly soldered inner conductor to the inner connector. Sadly, many radio dealers simply press the end of the inner connector with a pair of pliers to save soldering. While this may not affect v.h.f. reception unduly, it certainly can cut the signal by 50% or more on u.h.f. This is very important.

Never connect coaxial cable together to extend a u.h.f. feeder. This can produce impedance discontinuity with a severe fall in signal at the set. Similar trouble can result from sharp bends in the feeder; always apply a gradual radius of bend when passing the feeder from the roof to the wall and through windows etc.

*—continued on page 279*

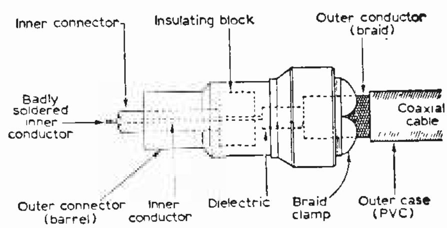


*Fig. 8: Correct way of connecting a coaxial plug. Avoid badly soldered inner conductor to plug inner connection, especially at u.h.f.*

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# UNDERNEATH THE DIPOLE

THE title of this column *Underneath the Dipole* was adopted a good many years ago, when television transmissions were restarted by the BBC after the war, in June 1946. In that year there happened to be a popular music hall ditty "Underneath the Arches", which was sung by Flanagan and Allen, the star comics of the Crazy Gang. It was Bud Flanagan who sang "Underneath the Dipole" in a typically crazy moment. At that time, being underneath a dipole seemed to carry with it a "one-upmanship" in electronics, the privilege of being in at the very start—or restart—of British television. The BBC restored the pre-war transmitter and studios at the Alexander Palace on June 7th 1946. This was a date when television aerials were rare, because the total number of television sets in operation before the war was only about 38,000 and most of these were useless in 1946.

## Electrolytic blow-ups

The pre-war TV sets with the 405-line standard, using d.c. restoration circuits and many of them with mirror viewing and all with excellent sound were splendid—if they had only been thoroughly checked before being switched on! The trouble was that not having been in use for years the electrolytic capacitors broke-down, blowing up the transformers, chokes and sometimes the whole sets, with the emergence of acrid blue smoke. Those were the days—days when it would have paid to have paused a few months or even a year or so to agree upon a world standard superior to the 405-line, interlaced high-definition miracle of 1936.

## 14,560–Repeat–14,560

It now seems fantastic that there were only 14,560 TV licences in 1947, when combined sound and television licences were just issued! How easily it would have been to "buy off" the 14,560 licensees at £75 each as compensation and to have aimed at 625 lines, negative modulation and a standard of operation suitable for all nations which had a 50c/s mains supply! The original transmission frequencies now used by BBC-1 from London are still the best in the world—but we are now saddled with u.h.f. and its aerial troubles for colour.

All of these nostalgic musings arise from the birth of the original title of this *Underneath the Dipole* agreed by the late F. J. Camm who was then the Editor. There may be portable TV sets in this day and age, but when looking at a television set underneath the Adelphi Arches, Strand, it would still be necessary to have a well-sited dipole. In the rainy Manchester area, the aerial should also include an ITV array resembling the Granada umbrella-like trade mark!

## TV standards for film production

The television industry and the film industry are highly technical fields which have been troubled from time to time by policy decisions made by non-technicians. The film-production industry has learned its lesson and in this respect is growing closer to television production. The advantages of television monitor aids for the motion picture camera are at last being appreciated by some of the film makers, particularly those producing films specifically for television, such as *The Avengers* series. This has naturally led to the use of video tape for artistes' tests, scene checking, etc., apart from its value for photographic trick shots cueing.

## TV and live theatre

Television studios were hurriedly improvised set-ups from the very start, in 1936. As time passed they were improvised from film studios, theatres, cinemas, agricultural halls. This applied in America as well as in England. The first elaborate purpose-built television studios in Britain were, I believe, those of Granada Television, Manchester. This was where the first Mole Richardson slotted lighting grid was introduced, from which were suspended Strand Electric 2kW spot- and floodlights. This type of lighting has been introduced into a few of the modern live theatres, to which have been added very up-to-date remote control dimmer consoles. These are splendid when they are properly operated with the lighting units properly sited.

What sometimes happens, however, is that the lighting is mainly overhead and hard, resulting in hard dark shadows. These shadows are not softened by traditional footlights, which are now considered out of date by the modern arty-crafty lighting directors. This is why good-looking actors and actresses look so aged and, in some cases, downright ugly. "Filler light" to soften the hard shadows under the eyebrows and under the chin does the trick; soft front and side lighting plus hard "kicker" light (angled from the back) will take years off the faces of the victims, especially if wide-angle lenses are avoided on close shots, whether for films or for television.

In many modern live theatre auditoria, dozens of splendid lamps are suspended around the bare walls until they resemble a marine store or an ironmongers rather than an elegant theatre, pleasant to look at and comfortable to sit in.

## Video tape in film studios

The Film Production Association is now in the process of arriving at a standard for video tape to enable recordings to be readily played off on VTR machines in studios other than the originating studio. Film tests of actors for films have been made

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for years and years and are very expensive to carry out. However, such film tests are readily exchanged between the casting directors of film studios. Broadcast quality video tape is an expensive venture for capital and operational costs and this method has not been pursued. However, the helical-scan, video-tape systems, described by H. W. Hellyer in recent issues of PRACTICAL TV, have made this a practical possibility. The Film Production Association is considering the adoption of a standard of tape width, tape speed and all the other specifications which will enable a compatible system to be agreed between the studios, with acceptable picture quality at a reasonable cost.

The universities, schools and other educational establishments have rushed into television without very much technical assessment being made of what can be done. The use of video tape is desirable for interchange, but the use of broadcast quality standard equipment is too expensive for most establishments. Instead of deciding on a lower standard of the helical type, such as is now being agreed in the Film Production Association, each individually have gone in several different directions for several different standards. This has therefore restricted the interchange of tutorial lectures that is so desirable. Standardisation of broadcast quality of video tape and one lower quality helical standard would be more sensible: two standards only should be the ultimate aim. In this day and age, technicians should be brought into the committees which decide upon policies which require technical advice and agreement.

## Executives! executives! executives!

Top executives in the television industry have a heavy load of responsibility to carry, administrative, financial, technical and artistic. This modern complex of show business was brilliantly summed up by Nat Cohen, a top figure in the film business and on the race course, including the Grand National. This is what he said:

"Executives are a fortunate lot, for, as everyone knows, an executive has nothing to do; that is except:

"To decide what has to be done; to tell somebody to do it; to listen to reasons why it should not be done, why it should be done by somebody else, or why it should be done in a different way; and to prepare arguments in rebuttal that shall be convincing and conclusive. To follow up to see if the thing has been done. To discover that it has not been done; to inquire why it has not been done, to listen to excuses from the person who did not do it; and to think up arguments to overcome the excuses.

"To follow up a second time to see if the thing has been done. To discover that it has been done incorrectly; to point out how it shall be done; to conclude that as long as it has been done it might as well be left as it is; to wonder if it is not time to get rid of the person who cannot do a thing correctly; to reflect that in all probability any successor will be just as bad or worse.

"To consider how much more simply and better the thing would have been done had he done it himself in the first place; to reflect satisfactorily that if he had done it himself he would have been able to do it right in twenty minutes and that as things turned out he himself has spent two days trying to find out why it is that it has taken somebody else three weeks to do it wrong and to realise that such an idea would have a very demoralising effect on the organisation because it would strike at the very fountain of the belief of all employees that the executive has nothing to do."

## BBC's magical mystery

There was a proud Lancashire boast that "What Manchester thinks today, London thinks tomorrow". There was also another old Lancashire saying "Where there's muck, there's brass". Of course, as the late Dr. Joad would have said on the wireless years ago, "It all depends what you mean by muck." In show business it is referred to as rubbish. The BBC demonstrated that there is money in rubbish when they paid £10,000 for two television broadcasts of the Beatles' *Magical Mystery Tour*, their Boxing Day débâcle which received the biggest critical blast ever inflicted on "pop" performers of world-wide popularity. I don't disagree with the newspaper critics, who obviously enjoyed hurling verbal custard pies in the manner fashionable at the end of 1967, the British year o down-beat down-beat. But let's think again.

## Unfair to Beatles

Have the critics been quite fair to this pop group? Have they not, themselves, been guilty of elevating rather ordinary "pop" entertainment to the upper strata of a new art form? What about the critics' pompous reactions to certain plays at the Royal Court Theatre; to the shoddy "X" films at many cinemas; to the smutty paperbacks with even grubbier covers. And what about the *avant-garde* psychodelic exhibits at the Tate Gallery, with wirework or hole-in-the-stone sculpture and painted portraits of gentlemen with triple eyes and no chins. And what about the discordant quarter-tone syncopations, posing as modern music, which hurt the ears and make the teeth grate! Are these *any better* in their own particular fields than the film effort of the Beatles?

And why—unlike the amateurish film enterprise of Beatle Paul McCartney—has some of the Arts Council stuff been aided by you and I—taxpayers—in the form of grants? At least the Beatles make a big profit for their group and provide an enormous taxable proportion of the ultimate revenue, plus dollars and ducats from exports. This is something that the Arts Council will be unlikely to achieve! "Well done, the Beatles!" is what Iconos says, even if their Magical Mystery is poor stuff! We must hand it to them that they are professionals in their own field of making tunes that are catchy.

Iconos

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# DX-TV

A MONTHLY FEATURE FOR DX ENTHUSIASTS

by Charles Rafarel

"WHAT a turn up for the book" this time with a very unexpected change in the type of propagation in comparison with the period we reported last month.

The tropospherics for most of the current period have largely gone again, although on 21/1/68 there was evidence of improvement. The real interest, however, has been the reappearance of quite considerable Sp.E. activity normally rare in January.

These openings have been almost daily since the beginning of the month and have produced some quite long duration signals or alternatively short bursts throughout the day, and this has been a very pleasant surprise! As usual, here are details of the best days for reception and there was even some activity on dates not mentioned but short duration programme signals precluded precise identification of the stations. Period from 24/12/67 to 21/1/68 Sp.E. reception.

24/12/67 Sweden E2 (short duration meteor shower).
27/1/67 Czech. R1.
2/1/68 Czech. R1.
3/1/68 Czech. R1, Austria E2a.
4/1/68 Czech. R1, Hungary R1, Austria E2a.
5/1/68 Czech. R1, Hungary R1, Austria E2a.
6/1/68 USSR R1.
8/1/68 Czech. R1, Austria E2a.
9/1/68 Hungary R1.
10/1/68 Czech. R1.
12/1/68 USSR R1.
13/1/68 Czech. R1, Austria E2a.
18/1/68 USSR R1.
21/1/68 USSR R1.

One further point worth noting was the reception of Russian space communication messages on 23/12/67 on the 35/40Mc/s band; these must have been tests only this time.

High winds and unsettled weather conditions earlier in the month put paid to the tropospheric signals, but I am pleased to note that they are now building-up again, and on 20/1/68 Ruiselede E2 has put in its first appearance for a very long time. I hope we shall have some Trop. news to report next month.

## NEWS

We have the following news items for you from R. Bunney. First some details of new stations

**W. Germany:** Osnabrück Ch.39, 250kW Hor. (Colour). **E. Germany:** Dresden E5 power and polarisation unknown. **Spain:** Santiago (2nd Prog.) 3kW Vert. Alicante Ch.32 (2nd Prog.) 100kW Hor. Seville Ch.52 (2nd Prog.) 100kW Hor.

And here are some amendments, for Spanish stations: Izana C/I E3 350kW Hor. but mast height reduced; that may not help us! Zaragossa-La-Muela E3 up to 35kW Hor. Barcelona-Tibidabo E4 up to 150kW Hor. Guadalcanal E4 up to 120kW Hor. Madrid Chamartin Ch.21 up to 100kW Hor. Bilbao-Archunda Ch.22 up to 60kW Hor. Madrid-Navacerrada Ch.24 down to 870kW Hor. Barcelona-Tibidabo Ch.31 up to 300kW Hor. San Sebastian-Jaizquibel Ch.48 up to 100kW Hor.

The most interesting would seem to be the 2nd Prog. from Santiago on E2, and as far as I know there is a new 1st Prog. transmitter at Gomontiero-Asturias (E3 70kW Hor.) in North-Western Spain—just right for us!

Norway, Modifications: Stiegen E2 up to 60kW Hor. Hemnes E2 up to 60kW Hor.

Switzerland, Additional: Rigi-Lucerne, Ch.32 Experimental.

Jordan, Amman E3 100kW Hor. Daily programme 1600 to 2100 GMT. The source of this information is as yet unconfirmed (remember the Amman caption some time ago?) so we had better be careful over identification!

## TOWARDS F2 DX?

American reports from Stan Panc of Utica N.Y. show reception of B1 BBC sound only on 22 October, 26 November, 15, 24 and 25 December 1967, so there may have been pictures by now! The latest sun-spot counts are as follows:

1968. January 110, February 113, March 115, April 117, May 117, June 116, but rising to 123 for November next. Not very startling, but could be high enough for F2 DX here all right.

## READERS' REPORTS

We have a log from D. Bowers, of Saltash, held over from last month, which indicates that mid-November Sp.E. was quite active in his area, although relatively quiet elsewhere in the country. Between 13/11/67 and 17/11/67 he had Holland E4, W. Germany E4, Norway E4, Italy IB, and Sweden E4, so skip distances must have been right.

Reports of the excellent November Trop. opening are continuing to arrive. S. Hoskins of York reports CDX/TV (colour) from Lopik Ch.27 so he is now our second CDXer, and our congratulations to him, in particular because of the distance involved from York to Lopik.

"Steam" black-and-white DX/TV! brings us a report from I. Rowe of St. Helens, and he is a long way from the Continent too, so our congratulations on W. Germany, Bremen Ch.42 Aachen Ch.58, Holland, Lopik Ch.27 Smilde Ch.47, and Markelo Ch.54; also in Band III France Niort F7 as well.

R. J. Bentley of Huddersfield reports Holland

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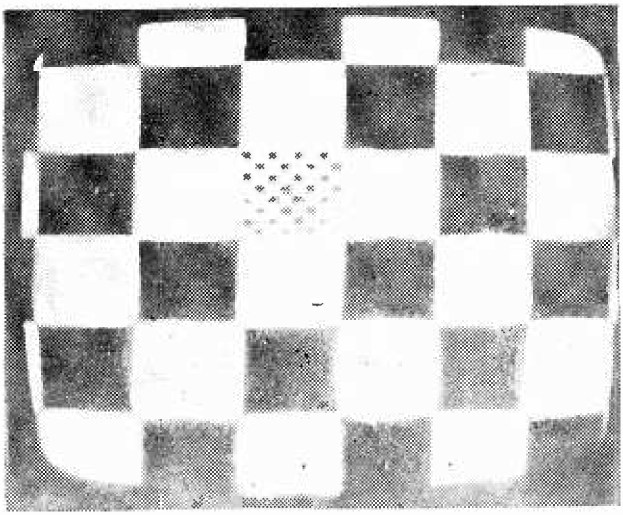
## DATA PANEL-25 WEST GERMANY SAARLÄNDISCHER KUNFUNK. S.R.



This Test Card is used by Göttelborner—Höhe. Ch.E2. 100kW. Vertical polarisation.
This very distinctive card is only used by Saar TV. Due to the short skip it is difficult but not impossible to receive in the South of England, but in the North and West of British Isles it should be a reasonable Sp.E. signal.
This photo was taken by Mr. G. F. Van de Wijngaart of Mierlo, Holland as a tropospheric signal and we thank him for the chance of including this "rare" card in the Data Sheets.

Goes Ch.31, and Roermond Ch.32, France Lille Ch.21 and Caen Ch.25. He also mentions that he saw CDX/TV on someone's set from Wuppertal Ch.22, so there is really a third CDX/TV report from a person whose identity we do not, as yet, know!

Top marks this month must however go to J. Boswell, of Hornsey N.8, for his u.h.f. log for November 1967. His total was 48 u.h.f. stations and there is hardly a single channel on which he did not get a signal. Among the rare ones that he notes are Sweden, Horby Ch.43, France Mezières Ch.23, W. Germany Eiderstadt Ch. 31, Bungsburg Ch.50, and Ostfriesland Ch.43 (I do not as yet even know where this one is located: perhaps he would enlighten us!)

## LETTERS TO THE EDITOR

### *FUN WITH THE HELICAL*

SIR,—May I tell you of my experience with the Helical U.H.F. Aerial described by Mr. Benson in the November issue of PTV. For several months I have been renting a 19in. TV set capable of receiving BBC-2, but have not bothered to have a suitable aerial erected. This is not a particularly good reception area and I have been told that a fairly complicated aerial would be required.

I decided to "have a go" at making the helical aerial, but was determined that only those materials that were already to hand would be used (apart from the co-ax feeder that I had to rush out and buy). A search of the garage failed to produce any ½in. tubing although there were plenty of scraps of wood.

The former for the helix and the reflector were soon made and liberally coated with synthetic varnish. The reflector was fashioned from tin-plate, and the helix was made from ⅛in. thick galvanised iron wire, wound to an approximate shape on an old paint drum that happened to be about the right diameter. The matching transformer was made from some ¼in. diameter aluminium rod.

With the eager help of my young son the aerial was taken into the house the next day and put on a table pointing roughly in the direction of the transmitter at Crystal Palace. We connected up, switched on, and waited hopefully. To our delight the BBC-2 test card appeared! We moved the aerial around and soon discovered that it worked better outside the house, and better still when I clambered up on the garage roof. The aerial was then coated with varnish again and strengthened to cope with the wind. In order to get it erected quickly it was firmly fixed to the top of a 26-foot wooden extension ladder which was then fixed vertically to the side of the house to raise the aerial above roof level. The helix has only six turns since I didn't have enough wire for more. Total cost was £1, for the co-ax cable. Reception is quite good and no doubt will be improved when I make a more permanent one and site it more carefully.

Thank you Mr. Benson, and PRACTICAL TELEVISION for giving us some fun in making it and a great deal of satisfaction.—J. G. NIPE (Byfleet, Surrey).

*The Editor does not necessarily agree with the opinions expressed by his correspondents.*

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# MICROPHONY IN CAMERA TUBES

K.T. WILSON

Of all the maladjustments of a TV set, slipping timebases excluded, sound-on-vision is the most obvious and most annoying. The eye becomes accustomed to 1Mc/s resolution, non-linearity, ghosting, lack of black level and all the other usual dreary faults which go uncorrected on 95% of the nation's TV sets, but the spectacle of moving bars on the picture does seem to rouse even the most passive viewer to action of some sort.

Because of this, most viewers appreciate the use of the fine tuner and adjust it accordingly, but there are times when the picture presents all the symptoms of sound-on-vision even when the receiver is perfectly adjusted. This is quite baffling and leads to complaints that sound-on-vision is occurring at the repeater station or even in the modulation stage of the transmitter.

In fact the effect is due to microphony in the camera tube itself, and the fact that it is so visible and so annoying has made it a major problem for the manufacturers of TV camera tubes in the past. It is only at the present time that many years of research are paying off in the form of tubes which exhibit little or no microphony.

Anyone who has constructed audio amplifiers must be familiar with microphony in valves. If the internal structure of a valve is free to vibrate, then its amplification factor varies as it is shaken, and this appears as a variation of voltage at the anode. If the valve is in an early stage of the amplifier this voltage variation is amplified in each subsequent stage and converted into sound (as a "howl") by the loudspeaker; and, if the microphony is serious, the sound from the loudspeaker may excite the valve further so that a continuous howl is set up.

Very much the same thing occurs in the TV camera except that the electrical voltage variation is not translated into sound by a loudspeaker but into vision variations by the c.r.t. In addition, the amplification which is built into one type of TV camera tube is very much greater than that found in an audio amplifier so that microphonic effects are that much more important.

## VIDICON MICROPHONY

From what parts of camera tubes does microphony originate? Figure 1 shows diagrammatically a portion of the vidicon camera tube, which uses the principle of photoconductivity for its operation. When the tube face is dark, the electron beam scanning the surface of the target forms a connection between the cathode and target just as if the electrons were passing along a piece of wire, and the voltage on the gun side of the target layer is the same as the voltage at the cathode of the electron gun; this voltage is usually earth. Although the other side of the target is at +10V, practically no current passes through the target because the material has a very high resistance when it is in the dark.

When the target is exposed to light, however, the target becomes conductive where light strikes it, the voltage on the gun side changes, and the scanning beam has to pass current to the target to bring the voltage back to earth potential. The amount of current which is passed depends on the voltage which in turn depends on the pattern of light and shade (the picture) on the target and it is this current which is used as the video signal.

It is, however, necessary to provide some sort of anode for electrons to land on when they are not required at the target. For this reason, a mesh of extremely fine wire is placed a few thousandths of an inch from the target and held at a more positive voltage; this also has the effect of greatly improving the resolution of the tube at the edges if the voltage of the mesh can be varied independently. Unfortunately, it is the introduction of this electrode which makes microphony possible, because the combination of mesh, target and the empty space between creates a capacitor. Now when a capacitor is formed by two parallel conducting plates with air or a vacuum between them, the capacitance depends on the area of the plates and on the distance between them, increasing as area increases, and also increasing as distance *decreases*.

If our mesh vibrates for any reason, the capacitance between the target and mesh must also vary, and the value of this capacitance at any instant regulates the current which flows to the target. Reference to Fig. 2 will clarify this. If we have a fixed voltage available, then the total current which flows momentarily through a resistance in series with a capacitor increases as the capacitance of the capacitor increases, and, conversely, we can draw a much more impressive spark from a 1μF capacitor than from an 0·001μF one. In the same way, the electron current which flows to the target of the vidicon depends on the capacitance between target and mesh at the instant of

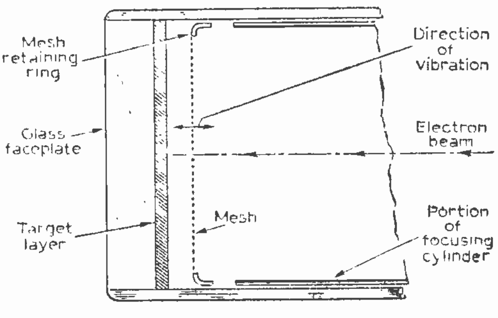


*Fig. 1: Microphonic portion of vidicon tube.*

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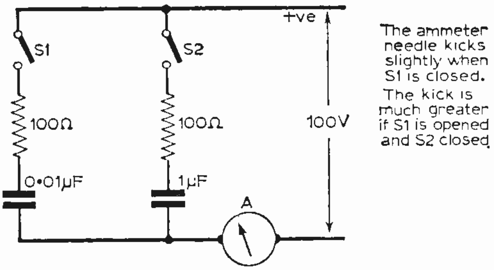


*Fig. 2: Effect of capacitance on charging current.*

scanning, and, if this capacitance is varying, the current must also vary. If the variation is at a frequency between the field and line frequencies, the effect is of a pattern of light and dark bars which move up and down the picture unless the frequency happens to be exactly a multiple of the field frequency.

Vibration of the mesh may be due to camera vibration (when being panned or tracked or when changing lenses or zooming) or it may be due to the impact of sound waves on the camera tube in a noisy studio; in each case, the bar-pattern appears if the tube is microphonic.

No complete cure has been found for microphony in vidicons. Fortunately, only a small percentage of tubes have serious microphony, and, in addition, vidicons are usually used for outside broadcasts where the effects of sound are less serious than they are in echoing studios. The worst tubes are rejected by manufacturers in an ingenious test which consists of connecting up target and mesh as a capacitor microphone and feeding into a high-gain amplifier which in turn feeds a loudspeaker at a fixed distance from the vidicon. At some value of amplifier gain, positive feedback starts a "howl", and the value of gain is noted on the tube test sheet. Tubes which require less than a determined value of gain in this test are rejected.

## IMAGE ORTHICON MICROPHONY

The target portion of the image orthicon, the camera tube most frequently used for high-quality pictures, is shown in Fig. 3. I have already written extensively on the operation of the image orthicon (PRACTICAL TV, July 1967), and shall only recall the details briefly. Here again, the signal appears as voltage variations on an insulator, in this case glass, separated by a very small distance (0·001in.) from a metal mesh. In the image orthicon, however, the signal at the target is used to modulate the returning electron beam, and this modulation is amplified by 100,000 in the photomultiplier section. Microphony in the image orthicon is therefore extremely serious; it occurs more easily and image orthicons are used more frequently. What is even worse is that the image orthicon shows two quite distinct types of microphony.

The first type of microphony has been christened "shock microphony" and arises from the same causes as the microphony which we have seen in the vidicon. The area of the target and the mesh is much greater in the image orthicon than in the vidicon, however, and the capacitance change when the spacing alters because of this is much greater. In addition to this both the target and the mesh of the image orthicon are liable to vibrate, since each is a thin sheet of material held in a ring frame, unlike the case of the vidicon where the mesh can vibrate but the target cannot because it is fixed to the face of the tube.

The image orthicon is thus more prone to microphony than is the vidicon, and the last straw came around 1961 when most of the television companies decided that they required a larger range of shades of grey in their pictures. This is easily done with the image orthicon by raising the voltage applied to the target, but, in a very short time, complaints of microphony began to be heard. At first the operator did not connect this with raising the target voltage, and it was only when the manufacturers of camera tubes started an intensive research project into camera tube microphony that this effect was discovered. One remedy would have been simple, to lower the target voltage at which image orthicons were worked, but this was unacceptable on artistic grounds (in this country, at any rate). The only alternative was to discover some method of treating the target assembly so that microphony was lessened.

## CURING SHOCK MICROPHONY

At first, it was thought that the construction of the target and mesh might affect microphony, and tubes were made with targets and meshes slack or tight or with one slack and the other tight. Although several methods were found of making microphony *worse*, it did not seem to be possible to improve the tube in this way, and this line of inquiry was dropped.

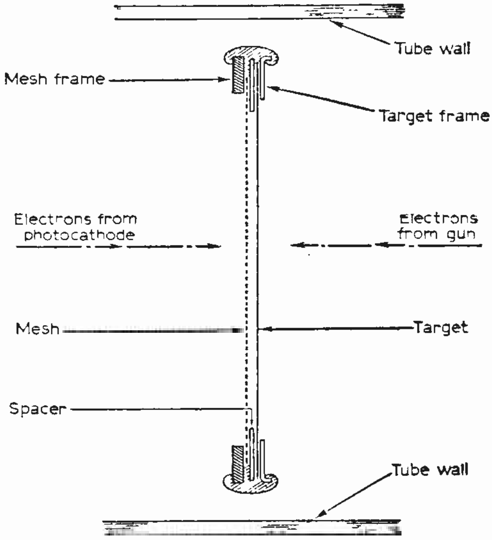


*Fig. 3: Vibrating components of image orthicon.*

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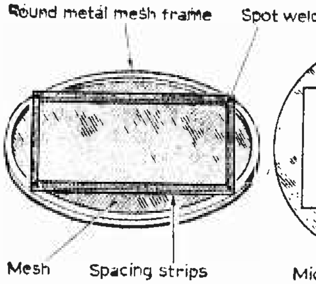


*Fig. 4: Target spacing strips.*

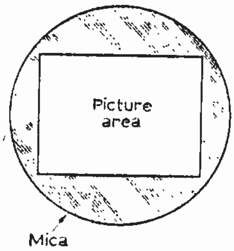


*Fig. 5: Mica spacer.*

The next attempt was much more fruitful. The mesh and the target are normally held apart by means of spacers, which, at that time, consisted of ⅛in. wide strips of nickel-chromium alloy of 0·001in. thickness. These strips were pulled tight across the mesh and welded to the mesh frame before the target was clipped on (see Fig. 4). Reducing the tension on the strips reduced the tendency to microphony, and leaving them loose reduced microphony considerably. The springiness of the material, however, caused them to bow and increase the spacing of the target to the mesh to an unacceptable degree.

The next step was to try the effect of soft copper and soft nickel strips. The reduction in microphony was startling, but spacing problems still existed. The best solution was found to lie with mica spacers cut to fit between target and mesh, and this method of controlling microphony was introduced by EMI in 1964. The shape of the mica is shown in Fig. 5. The thickness is usually about 0·0005in. and great care must be taken to ensure that there are no projections from the surface of the mica which will alter the spacing or even shatter the glass target.

## ELECTRICAL MICROPHONY

During the time in which all this work was going on, evidence was gathering of a further form of microphony which had also appeared as a result of running image orthicons at higher target voltages. Several reports claimed that tubes gave microphonic bars on pictures even when cameras were running untouched in empty studios. At first this was thought to be shock microphony which had run on for a long time after the original shock, just as a pendulum swings for hours after being set into motion. Experiments soon proved, however, that something new was happening, and that an image orthicon could produce an effect exactly like microphony even when it was totally insulated from the effects of shock or sound.

Since the electrical signal of this "microphony" seemed to originate by itself it was called *electrical microphony*, a term which was much more accurate that was realised at the time. Electrical microphony was found to become more severe as the target voltage was increased and as the illumination of a scene decreased. This explained why the effect had suddenly become troublesome; previously producers had worked at lower target voltages and with stronger set lighting, but, with productions becoming more adventurous, artistic demands had led to higher target voltages and less light.

The research work on this problem was much less straightforward. At least with shock microphony the cause was known and research could proceed to its prevention. With electrical microphony the cause was not understood, and much groundwork had first to be done into the forces acting at the target in the absence of mechanical vibration.

## FORCES IN THE TARGET

By the laws of electrostatics, there is a force between any two charged particles which depends on the charges on the particles and also inversely on the square of the distance between them. Mathematically, it is expressed as $F = (q_1 \times q_2)/r^2$ where $F$ is force, $q_1$ and $q_2$ are the charges and $r$ the distance between them.

In the image orthicon this means that the target is being attracted to the mesh at the instant when the beam lands on it (the mesh remains at a positive voltage while the target is discharged to earth potential by the beam) and this force of attraction decreases as the target charges up again by the action of electrons from the photocathode. Since electrostatic force depends on light level (since this determines the charging of the target by electrons from the photocathode) and on target voltage, it seems a plausible cause for electrical microphony. Hopes were dashed, however, when measurements on targets and calculations on the maximum possible electrostatic force showed that the electrostatic forces could not possibly produce enough deflection of the taut glass membranes of the target or mesh to cause the observed effect. Nor did it act on all the target at any one time. Some other force had to be found to account for the effect.

## EFFECT OF MAGNETOSTRICTION

There were two clues to the nature of this force. One was that the metal alloy used for the target frame happened to be an alloy exhibiting the property of magnetostriction (change of dimensions in a magnetic field), the material having been chosen mainly for its ability to seal to the glass of the target. Magnetostriction, incidentally, is the effect which causes the whistle from line output transformers, the laminations of which shrink and expand as the magnetic field varies. The second was that tubes using targets of magnesium oxide had never shown electrical microphony, and their target frames were made of another material.

Magnetostriction seemed to be the clue to the trouble. If the target frame shrunk at the same time as a steady electrostatic force was applied to the target, then the surface of the target would move. If both these forces were turned on and off, then the movements of the target might build up in the way that a child can build up the oscillations of a swing. This type of increase in the amplitude of an oscillation is called "parametric", because the capacitance of the target (the parameter, or quantity, varied) varies with the forces applied to it and also changes the forces which vary it.

It would have been possible to construct

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elaborate measuring apparatus to check this effect, but it seemed unnecessary. The magnetic fields were certainly present, the electrostatic forces were known. The quickest way to check was to start making image orthicons with targets of some material whose magnetostrictive effects were negligible. Finding such a substance was not easy, because it had also to seal to the glass of the target.

The newly-available metal titanium filled the bill, and tubes using titanium target frames were carefully tested for electrical microphony. None was found, and EMI started to supply tubes free of electrical microphony early in 1965.

## PRESENT POSITION

As far as high-quality studio broadcasts from the major programme contractors in the UK are concerned, microphony in camera tubes is no longer a source of trouble. Other countries seem to be less fussy, and viewers of programmes live or taped from other countries may see this type of fault frequently. It can be distinguished from sound-on-vision because it does not change frequency with the sound. The two forms of microphony can also be distinguished; shock microphony occurring after a noise or during camera movement, and electrical microphony causing bars to run up or down the picture for no apparent reason, and often in shaded pictures. Amateur TV is also likely to be troubled by microphony in vidicons since vidicons rejected because of this fault may end up being sold for amateur purposes.

This story is an illustration of the way in which artistic decisions in television can have far-reaching technical consequences. It also shows the continual efforts which are made by manufacturers to keep the British television system consistently ahead in picture quality. ■


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# VIDEO TAPE RECORDING

## PART 6

H.W.HELLYER

HAVING last month looked at the record circuitry of the Sony helical scan recorder we shall this month turn to the playback circuits. Replay is a much more complicated business, electronically, than recording. The signal from the two playback heads, collected by the wiper/slip-ring arrangement previously described (see Part 4), is very small and has a frequency characteristic which depends on the tape and the heads themselves. This small signal first has to be amplified, under the very best conditions to prevent noise increase, before any "tailoring" can be done. For this purpose, separate two-stage preamplifiers are provided for the signal from each head, the outputs being combined at a level that can then be handled with less fear of distortion due to frequency-conscious networks. The outputs from these preamplifiers are fed to the following stage via a control which provides a means of balancing the outputs from the two heads and of making some allowance for slight discrepancies due to wear. This arrangement, with the two preamplifier circuits, is shown in Fig. 19a. It will be noted that the first stage uses a pnp transistor while the second has an npn transistor

To obtain the correct impedance match the replay head signal is fed to the preamplifier by a transformer. The presence of the comparatively large (0·1μF) capacitor from one side of the secondary to the positive line ties this side of the winding to chassis, via smoothing, decoupling, etc. Thus the first transistor operates as a simple common-emitter amplifier with the output signal applied to the base of the succeeding stage by the 0·01μF coupling capacitor. The second stage of each pair is an emitter-follower, with the output fed, via another 0·01μF capacitor, to the balancing control. Taken off from this 500-ohm preset, the signal is next applied to a two-stage amplifier as a complete carrier. The carrier is matched to the following limiting stages by taking the output from the emitter-follower section of this two-stage "block", again via a preset control, which forms the main playback output level control for the head signal (not to be confused with the main video-level control).

At this point, marked TP9, an oscilloscope will show the combined head outputs as a positive and negative waveform, something like that of Fig. 19b, where the outputs from the two heads show as successive "envelopes". The amplitude should be adjusted to more than 0·4V, and in practice something like 0·6V gives best results. But of equal importance is the balancing of the two outputs. There should be as little difference between the two successive envelopes as possible. In practice, the makers give the surprising tolerance of 6dB, but a much closer parity should be aimed at and can generally be

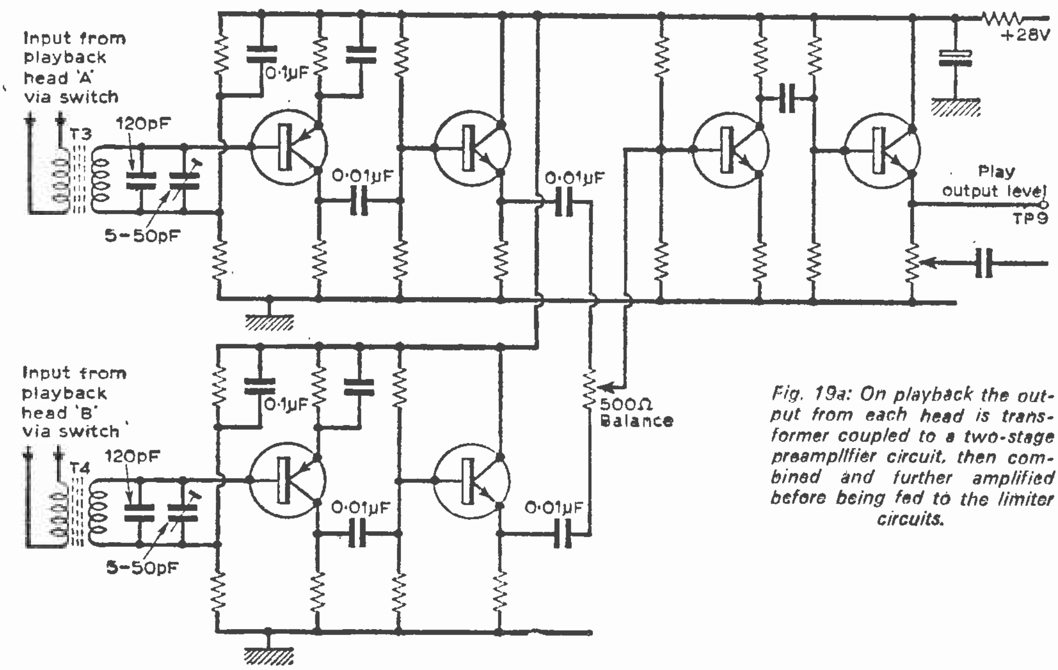


*Fig. 19a: On playback the output from each head is transformer coupled to a two-stage preamplifier circuit, then combined and further amplified before being fed to the limiter circuits.*

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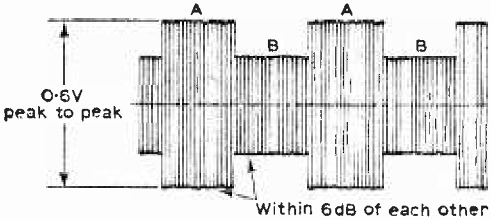



*Fig. 19b: The outputs from the preamplifiers appear at TP9 as successive "blocks" which should be within 6dB of each other for correct playback conditions, with a minimum peak-to-peak voltage of 0·4V.*

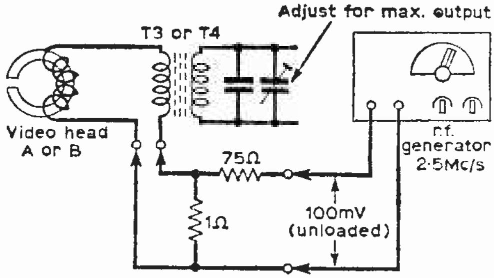



*Fig. 19c: Tuning head transformer circuits requires an r.f. generator tuned to 2·5Mc/s with a matching pad in the head return lead.*

obtained by careful adjustment of the two controls shown in Fig. 19a.

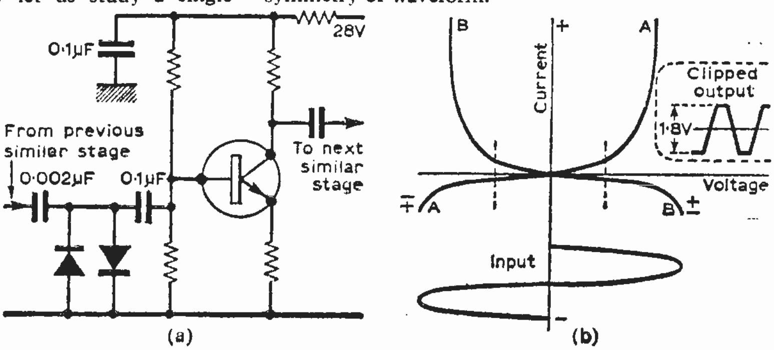
The eagle-eyed will have noted that I have passed and apparently ignored two other controls, the two preset capacitors that tune the secondaries of the head matching transformers in parallel with 120pF fixed capacitors. Their function is to give maximum signal boost at the higher frequency end of the response curve, where, of course, head and tape losses are most likely to be apparent. They are tuned for maximum output at 2·5Mc/s, again reading this at TP9, and are adjusted after the circuit has been set up for gain and balance. An r.f. generator is coupled—see Fig. 19c—to give an output of 100mV across the attenuator shown (which provides the matching for the normal 75-ohm output of most instruments).

At this point it may be well as to pause and consider just what sort of signal we are handling. Remember that this is the carrier signal, and it is frequency modulated. In other words, it is absolutely essential to reduce variations in the amplitude of the signal to a minimum. These are principally noise signals, but if the loading conditions are wrong amplitude variations can be caused by the amplifying stages themselves. Hence the need to balance and adjust the signals at the preamplifiers before applying the carrier to the limiter section, to reduce the chance of saturation which causes the signal-to-noise ratio to be impaired.

There is no need to illustrate the limiter section in full: it consists of five common-emitter stages in cascade, with base voltages tied by shunting parallel but reversed diodes which provide the limiting. This technique, familiar to computer circuit students and associated branches of electronics, may not be quite obvious in its action, so to discuss the limiting circuits more fully let us study a single stage (Fig 20a). The two diodes are connected across the base-emitter circuit, the standing bias being fixed by a conventional potential divider, and a relatively large (to the 1·7Mc/s f.m. carrier) blocking capacitor is included. In effect the diodes shunt the output from the preceding stage, with a capacitor coupling the signal to them and once again acting to block the effective shunt from the collector-emitter circuit.

Although it looks as if the signal will be permanently shunted, i.e., whether the signal is positive- or negative-going there will always be one conduction path, we must remember the fundamental diode characteristic. The characteristic curves of a typical silicon diode pair connected as shown are illustrated in Fig 20b, on a pair of axes that denote at their junction zero current and voltage. After a relatively small forward bias current conduction rises and the shunting action takes place. But there is always a finite value of forward current, however small, and the applied voltage reaches an amount determined by the characteristic impedance of the particular diode and the time constants of the associated circuits. In Fig. 20b the curves of the two diodes are shown superimposed to demonstrate that there is a region of "neutral" positive and negative voltage where only small leakage currents are present. Thus an applied voltage that swings beyond these limits will be clipped symmetrically as shown provided that the diodes are carefully chosen to match. In fact, the 1·8V peak-to-peak waveform (1·7Mc/s) illustrated is that taken from a test point in the final stage of the limiter, and the lower connections of the two diodes preceding this stage are taken not to chassis but to a balancing preset which can be adjusted to obtain symmetry of waveform.

*Fig. 20: (a) Single limiter stage, showing a diode pair used to perform the clipping action. There are in all five limiter/amplifier stages. (b) Superimposed diode characteristics, showing the effect of combined forward- and reverse-biased diodes, giving a zone of "neutral" voltage before the clipping action commences.*

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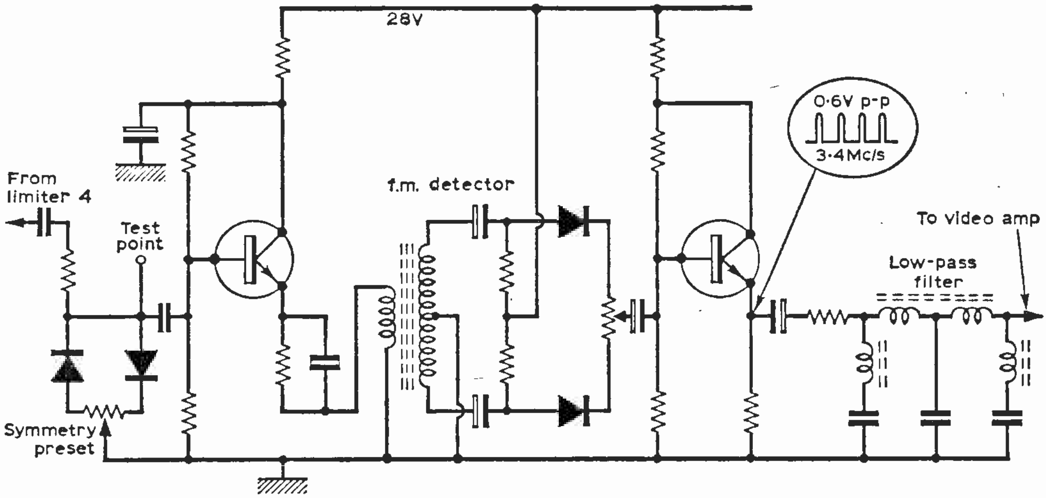


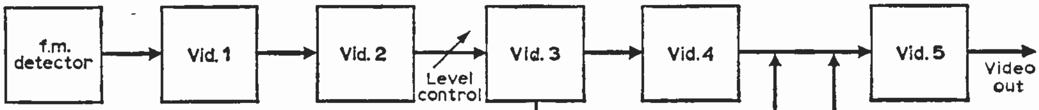

*Fig. 21: Final limiter stage and f.m. detector. The detector output is fed to the video amplifier section via an emitter-follower and low-pass filter.*

Although this final stage of the limiter is in a different part of the circuit, Fig. 21 shows it as it occurs logically in the train of events, that is as the matching input stage of the f.m. detector. This stage is coupled by a differential transformer. When a virtual square wave is fed to a circuit such as this and the components across the secondary are chosen with care for the correct time constant, the output becomes a series of spiky pulses of opposite polarity which are detected by the two diodes. The circuit falls into balance and a pulse is produced each time the voltage crosses the zero reference voltage line. The combined pulse output is at 3·4Mc/s and this is taken from the balancing control to an emitter-follower which couples the signal to a low-pass filter.

The low-pass filter is quite complicated in its action but we need only note that it blocks the higher frequencies, rejecting the unwanted double carrier frequency and integrating the video information which is then passed to a common-emitter video amplifier stage that serves both as a buffer amplifier and to allow some de-emphasis to the signal. We must remember that when the carrier was at a low level the higher frequencies were boosted to obviate losses. Boost was also applied during recording, as we noted last month. We thus have to bring the response curve back to what it should be, that is a video signal that as nearly as possible approximates that initially recorded. So in the output circuit of this stage and of the next video amplifier small capacitors shunting some of the higher frequencies are included to provide correction.

There are five stages of video amplification and between the third and fifth there is what seems, to this observer, the most interesting section of the machine. This is a noise-cancelling circuit of quite novel design. (Someone is sure to demonstrate my ignorance by writing in to tell me that Baird used it to control his spinning mirrors or Blumlein patented it during the thirties!) The block diagram (Fig. 22) shows the general arrangement, with the video signal taking two paths, straight through to the main video output stage and via the noise-cancelling circuit to a pulse mixer. The feed to the noise canceller is from the emitter of the third video amplifier stage. Noise is contained in the high-frequency band of the video signal, which is, of course, a signal of varying amplitude from d.c. to virtually 3Mc/s on the 405-line standard. A network in the emitter circuit where the sample signal is tapped off acts as a high-pass filter and the following amplifier handles the high frequency component of the video signal plus any noise on it. A preset is included to regulate the amount of cancellation signal that is taken off, and the setting of this control is extremely important.

Another pair of diodes is employed at the output



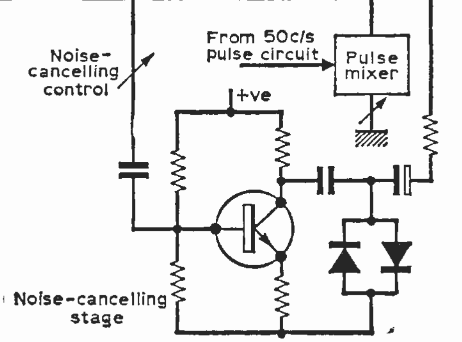




*Fig. 22: Block diagram of the video amplifier section, showing pulse mixer position and skeleton circuit of the noise-cancellation circuit.*

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of the first cancellation amplifier, as shown in Fig. 22. These act as an amplitude limiter and ensure that it is mainly the noise component of the signal that is fed to the base of the video amplifier—which seems a curious thing to do! However if we remember that this chopped-off upper part of the video signal, with its noise, has gone through one stage since its take-off point, whereas the main video signal has gone through a further two-stage process, we see that the two signals will be in antiphase. Hence the term "noise-cancelling". Observed on a good oscilloscope and with the take-off preset varied it can readily be seen that this is precisely what the circuit does. The antiphase signals at the noise end of the spectrum cancel out; the "grass" at the top of the waveform reduces and vanishes.

In practice we have to set up these circuits with regard to the overall recording and replay conditions. Last month we dealt with the symmetry of the modulating waveform and stressed that it is necessary to adjust the two symmetry controls with regard to the playback signal. We must also remember that the noise-cancellation circuit is a form of clipper and it is necessary to reduce the take-off to minimum, i.e. letting the signal go through to the video output "warts and all" for observation, if we want to adjust the symmetry controls for best balance of the modulating waveform. This is where video tape recording servicing becomes, like colour television work, a trifle more difficult and time consuming than the usual run of tasks. The action of the controls is interdependent to a much more subtle degree than in general television servicing. However, it is nice to be able to see what one is doing—and with VTR jobs one can certainly view the bad effect of indiscriminate twiddling immediately!

A clamping circuit is included between the third and fourth video amplifier stages. This samples the sync tip and clamps the video signal for correct sync insertion. Remember that our video and sync signals can arrive by quite different routes under different conditions—we don't get things ready made as with broadcast TV.

Between the fourth and fifth video amplifier stages a pulse mixer is fitted; this takes the clamped video pulse and also an amplified vertical sync pulse (50c/s), applying the mixed signal to the base of the video output stage. The level of applied vertical pulse is regulated by yet another preset. The reason for this extra flip to the signal and sync waveform is really to allow for the overlap action of the two-head replay system, which must inevitably allow some noise to break through at the preamplifier mixing stages we spoke about earlier and illustrated in Fig. 19. This will occur during the field blanking period and can affect the locking of the field circuits in the monitor unless it is cleaned up. This pulse-mixing method is one way of achieving a clean field lock, and the preset adjustment can be very useful under certain adverse conditions.

At this point we have reached the main video output stage, where the signal is matched to a 75-ohm line and taken to the 8-pin plug which feeds the monitor. This signal is also fed to the metering circuit through a two-stage amplifier and a rectifier circuit which is conventional enough for us to omit it. Next month we shall follow the operation through the synchronising stages, which have some unusual and interesting features.

**TO BE CONTINUED**

# OBTAINING THE BEST SIGNAL

—*continued from page 267*

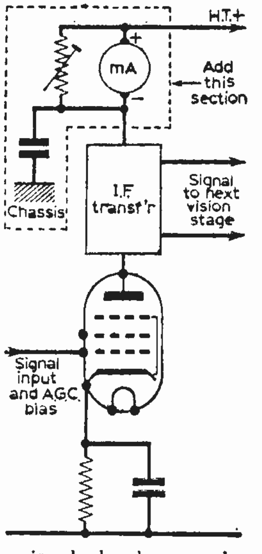


*Fig. 9: Using a milliammeter to detect changes in signal strength. An f.s.d. of 1mA is required.*

It now remains to see how any change in receiver signal due to altering the aerial system can be detected. The best way, of course, is to measure the signal on a signal-strength meter while aerial adjustments are being made, but very few readers will be in possession of such an instrument, especially for the u.h.f. bands.

The set itself can be used, but since vision a.g.c. tends to hold the level of signal at the picture tube constant over a wide range of signal levels at the aerial socket, detecting changes on the picture is not very easy. The brightness of the picture tends to hold constant, but there is a change in background grain as the signal changes, and it is on this that attention must be concentrated (not picture brightness).

There is a better way which involves putting an attenuator in series with the aerial lead at the set so that the line is barely locked. This puts the a.g.c. into its "delayed" region. Now, if the line hold control is adjusted so that the picture just starts breaking up, any slight increase in signal will put the picture back into lock. It can then be unlocked again, and so on, as aerial adjustments increase the set signal.

Alternatively, a milliammeter can be connected in series with the anode circuit of the i.f. amplifier valve under a.g.c., as shown in Fig. 9. The preset resistor across the meter can be adjusted to give full-scale deflection under zero signal conditions (aerial removed), and then the presence of signal will cause the deflection to reduce by an amount according to the signal strength. This, of course, is because the a.g.c. increases the valve's grid bias, thereby causing its anode current to fall as the input signal rises. The idea is suitable for single- and dual-standard sets, and also for those using i.f. transistors. However, with transistorised strips, care should be taken to avoid short-circuits and to make sure that the meter polarity matches the type of transistor used. NPN transistors should have the meter connected the same way round as for valves, but in the collector circuit, of course. The meter must be reversed for pnp transistors.

Note also, however, that forward a.g.c. is generally used to control transistor i.f. stages, and with this system the current passed by the controlled stage *increases* to reduce gain (a series resistor being incorporated so that the voltage at the collector falls with increase in collector current). ■

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| 1T4 | 2/9 | 12AT7 | 3/9 | DF33 | 7/9 | EF41 | 9/6 | PCF86 | 9/9 | U49 | 13/6 |
| 3A5 | 8/6 | 12AU6 | 4/9 | DF91 | 2/9 | EF80 | 4/9 | PCF800 | 11/6 | U52 | 4/6 |
| 3S4 | 4/9 | 12AU7 | 4/9 | DF96 | 6/- | EF85 | 5/6 | PCF801 | 7/9 | U78 | 3/6 |
| 3V4 | 5/9 | 12AX7 | 4/9 | DH77 | 4/- | EF86 | 6/3 | PCF802 | 9/6 | U191 | 11/- |
| 5U4G | 4/6 | 12K8GT | 7/6 | DH81 | 12/6 | EF91 | 3/6 | PCF805 | 9/- | U301 | 13/6 |
| 5V4G | 8/- | 20F2 | 10/6 | DK32 | 7/9 | EF97 | 7/6 | PCF806 | 11/6 | U801 | 18/- |
| 5Y3GT | 5/- | 20L1 | 17/3 | DK91 | 5/6 | EF183 | 6/6 | PCF808 | 12/6 | UABC80 | 6/3 |
| 5Z4G | 7/6 | 20P1 | 9/- | DK92 | 9/3 | EF184 | 6/6 | PCL82 | 7/3 | UAF42 | 7/9 |
| 6/30L2 | 11/9 | 20P3 | 14/9 | DK96 | 7/- | EH90 | 6/6 | PCL83 | 9/- | UB41 | 6/6 |
| 6AL5 | 2/3 | 20P4 | 17/- | DL33 | 6/9 | EL33 | 8/9 | PCL84 | 7/6 | UBC41 | 7/9 |
| 6AM6 | 3/6 | 25U4GT | 11/6 | DL35 | 5/- | EL34 | 9/6 | PCL85 | 8/3 | UBF80 | 6/- |
| 6AQ5 | 4/9 | 30C1 | 6/9 | DL92 | 4/9 | EL41 | 9/6 | PCL86 | 8/6 | UBF89 | 6/9 |
| 6AT6 | 4/- | 30C15 | 11/6 | DL94 | 5/9 | EL84 | 4/9 | PENA4 | 6/9 | UBL21 | 9/- |
| 6AU6 | 5/6 | 30C17 | 12/6 | DL96 | 6/6 | EL90 | 5/- | PEN36C | 15/- | UC92 | 5/- |
| 6BA6 | 4/6 | 30C18 | 9/- | DY86 | 5/9 | EL95 | 5/- | PFL200 | 13/- | UCC84 | 7/9 |
| 6BE6 | 4/3 | 30F5 | 12/- | DY87 | 5/9 | EM34 | 13/9 | PL36 | 9/6 | UCC85 | 6/6 |
| 6BG6G | 15/- | 30FL1 | 12/6 | EABC80 | 6/6 | EM80 | 5/9 | PL81 | 6/9 | UCF80 | 8/3 |
| 6BJ6 | 6/9 | 30FL14 | 12/6 | EAF42 | 8/6 | EM81 | 6/9 | PL82 | 6/6 | UCH42 | 9/9 |
| 6C86 | 6/6 | 30L1 | 5/9 | EB91 | 2/3 | EM84 | 6/3 | PL83 | 7/- | UCH81 | 6/6 |
| 6F1 | 7/9 | 30L15 | 14/- | EBC33 | 7/- | EM87 | 7/6 | PL84 | 6/3 | UCL82 | 7/6 |
| 6F13 | 3/6 | 30L17 | 13/- | EBC41 | 8/- | EY51 | 7/- | PL500 | 13/- | UCL83 | 9/3 |
| 6F14 | 9/- | 30P4 | 12/- | EBF80 | 6/- | EY86 | 6/3 | PL504 | 13/6 | UF41 | 10/6 |
| 6F23 | 12/6 | 30P12 | 11/- | EBF89 | 5/9 | EZ40 | 7/6 | PL820 | 15/- | UF80 | 7/- |
| 6K7G | 1/6 | 30P19 | 12/- | ECC81 | 3/9 | EZ41 | 7/6 | PX25 | 10/6 | UF89 | 6/3 |
| 6K8G | 4/3 | 30PL1 | 12/6 | ECC82 | 4/9 | EZ80 | 4/6 | PY32 | 9/6 | UL41 | 8/9 |
| 6K8GT | 7/6 | 30PL13 | 14/6 | ECC83 | 7/- | EZ81 | 4/9 | PY33 | 9/6 | UL44 | 20/- |
| 6L18 | 6/- | 30PL14 | 14/6 | ECC84 | 5/6 | KT61 | 8/9 | PY80 | 5/3 | UL84 | 6/6 |
| 6V6G | 3/6 | 35L6GT | 8/- | ECC85 | 4/9 | KT81 | 15/- | PY81 | 5/3 | UY41 | 7/- |
| 6V6GT | 6/6 | 35W4 | 4/6 | ECF80 | 7/- | N78 | 14/9 | PY82 | 5/- | UY85 | 5/9 |
| 6X4 | 3/6 | 35Z4GT | 4/6 | ECF82 | 6/9 | PC86 | 9/6 | PY83 | 5/9 | VP4B | 10/6 |
| 6X5GT | 5/9 | 6063 | 12/6 | ECF86 | 9/- | PC88 | 9/6 | PY88 | 7/3 | VP1321 | 21/- |
| 7B6 | 10/9 | AZ31 | 9/- | ECH35 | 6/- | | | PY800 | 6/9 | Z77 | 3/6 |

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| EB91 | 9d. | KT36 | 5/- | U191 | 5/- | 20P1 | 5/- |
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| ECC81 | 3/- | PCF80 | 2/- | U282 | 5/- | 5U4G | 4/- |
| ECC82 | 3/- | PCL82 | 4/- | U301 | 5/- | 6B8 | 1/8 |
| ECC83 | 4/- | PCL83 | 5/- | U329 | 5/- | 6K7 | 1/9 |
| ECL80 | 1/6 | PL36 | 5/- | U251 | 5/- | 6K25 | 5/- |
| EF50 | 1/- | PL81 | 4/- | U801 | 8/6 | 6P25 | 5/- |
| EF80 | 1/6 | PY33 | 5/- | 10C2 | 5/- | 6U4 | 5/- |
| EF91 | 9d. | PY81 | 1/6 | 10P13 | 2/6 | 6V6 | 1/9 |
| EL36 | 5/- | PY82 | 1/6 | 185BT | 8/6 | 6P28 | 5/- |
| EY51 | 2/6 | PZ30 | 5/- | 20D1 | 3/- | | |

EF50, 10/- doz. Post Paid.

**Indicator C.R.T. Type 7921.** Complete with 5in. Tube Type 2292. Front marked in figures, also many spares, less valves, clean condition. 10/- plus 10/- carriage.

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**Bush 14in. T.V. Set.** Type TV53. £5, carriage 15/-. Ideal for 625 line picture conversion. Complete with good tube. Tested working, all BBC1 and ITV channels. Cabinet fair.

**Jap Personal Earpieces.** Small or large, plug 1/11 post paid. Silicon rectifiers 500mA, 800 P.I.V., no duds, 2/6 post paid.

**Top Grade Mylar Tapes.** 7in. Standard 11/6. L.P. 14/-. D.P. 19/6. 5in. Standard 7/9. L.P. 10/-. Post on any Tape 1/6 extra.

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**Reclaimed TV Tubes** with six months' guarantee. 17in. types: AW43/88, AW43/80. 40/- each. AMW43/69, 30/-. 14in. types: 17/-. 12in. types 10/-. All tubes 10/- carriage


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# TRADE NEWS • TRADE NEWS • TRADE NEWS

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### *TV AERIAL CODINGS*

THE Radio and Electronic Component Manufacturer's Federation have agreed to the following coding and grouping of u.h.f. television aerials. This will help in cases where the aerials for the different groups bear similar appearances and thus offer some confusion.

Channels 21—34, group A, colour code red; Channels 39—51, group B, colour code yellow; Channels 50—66, group C, colour code green; Channels 49—68, group D, colour code blue; Channels 39—68, group E, colour code brown.

### *MOBILE TV STUDIO*

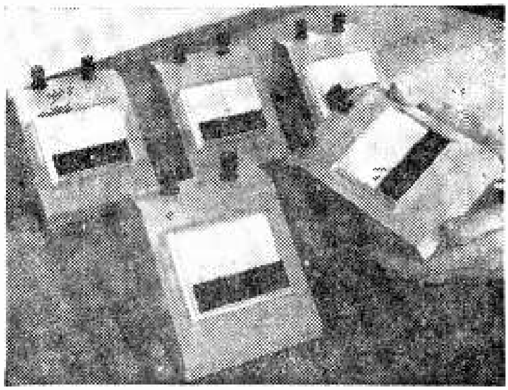
THE Marconi Company has developed a complete mobile television unit intended primarily for educational use. It is capable of providing both live and taped programmes and is self-contained in a 30cwt. Ford van complete with its own video tape recorder and three cameras.

The van forms a versatile studio control room on wheels with two 23inch monitors, vision and sound mixers, and test gear: sync pulse generators, provision for pulse and vision distribution and a control desk.

The van holds all equipment and still has room to accommodate 5 personnel, the low staff complement is achieved by using the Marconi V322B cameras which are extremely simple to use thus eliminating the need for extra "specialist" personnel. Further details from Electro-optical Systems Division, The Marconi Company Ltd., Christopher Martin Road, Basildon, Essex.

### *SIFAM'S NEW RANGE*

A NEW range of portable bench instruments, housed in 'ABS' plastic cases, to meet the special requirements of schools, colleges, universities etc., has been introduced by Sifam Electrical Instrument Co. Ltd., Woodland Road, Torquay, Devon.



The complete set, known as the Sifam 'Student' range, comprises seven instruments with scale ranges as recommended for Nuffield Physics Courses: 0—1A, 0—5A, 0—5V, 0—15V, 0—1A and 0—5A dual range, 0—5V and 0—15V dual range and a 3—0—3mA galvanometer.

Two terminals are fitted (three on the dual-range instruments) suitable for wire, spade, and 4mm. diameter plug connections. Accuracy of the instruments is to B.S. 89:1954 industrial grade; sensitivity is 100mV (ammeters) or 1,000Ω per volt ±2 per cent (voltmeters).

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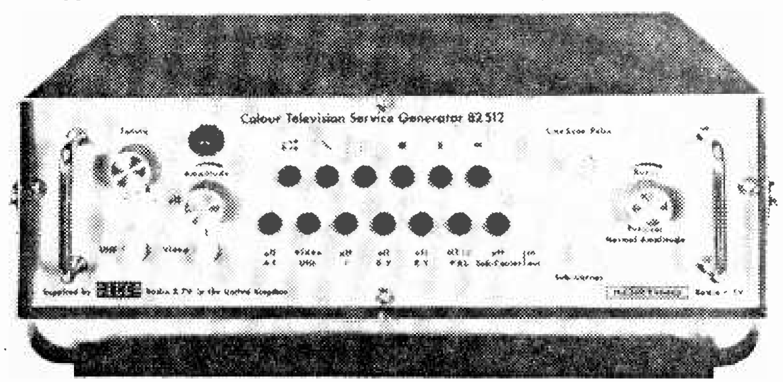
### *KORTING COLOUR TV SERVICE GENERATOR*

DECCA have announced that they have been appointed sole UK agent for the Korting Colour Television Service Generator. It must be pointed out that Decca are Korting distributors only for products of this type. All domestic equipment of Korting manufacture will continue to be supplied by Europa Electronics Ltd.

The generator will provide all required test signals for the alignment and repair of colour receivers, claim the suppliers. Push button controls provide Dots; Cross hatch; Colour bars exactly as per BBC, and a choice of both PAL and NTSC colours; parallel or vertical lines and a 1,000c/s note. A further button allows the polarity of all these signals to be reversed. The unit is continuously tunable over Bands IV and V. There is a variable Burst Amplitude control useful for ensuring that the decoder locks at a reasonable level. The suppliers claim that the cross hatch, in particular, is extremely stable, while the 1,000c/s tone proves invaluable for checking receivers when an aerial is not available on the workbench and also for a check on the audio stages. The luminance signal can be switched off for adjustment of receiver purity and the grey scale can be checked without the chrominance.




The generator is available ex-stock from the agents, Decca Radio and Television (M.I.P.), Ingate Place, Queenstown Road, London, S.W.8. (Telephone 735-6677).

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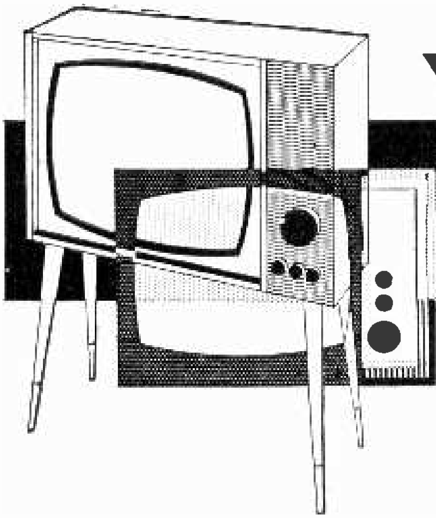

# Your Problems Solved

*Whilst we are always pleased to assist readers with their technical difficulties, we regret that we are unable to supply diagrams or provide instructions for modifying surplus 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 284 must be attached to all Queries, and a stamped and addressed envelope must be enclosed.*

### *FERRANTI 1002*

**The two resistors in the width control smoked and burned out, I altered the 2-pin plug from minimum to one before maximum and the picture came on, but there was an arcing from what I took to be the soldered joint of the choke near the width control. I later changed the width control to maximum and the result was no picture or sound and the surge resistors of the PY32 glowed red. There appears to be a short between rectifier and width control. Could you state the value of these burned-out resistors?—G. Blake (Co. Durham).**

If you examine the coil near the resistors, you will find the core is earthed to chassis. The coil has probably shorted to the core. The simple answer is to disconnect the earthing lead.

The width control resistors are 82Ω each. The resistor across the coil is 3·9kΩ and the PY32 surge resistors are 35Ω each.

### *McMICHAEL M94HFC*

**The quality of the sound when turned down quite low is very good. If the volume is increased however, it becomes very distorted.—P. Willett (Holt, Norfolk).**

If the distortion occurs when the contrast is advanced, rather than the volume control, check the 3·9MΩ load resistor (R88) of the sound noise limiter and associated 0·01μF capacitor.

If it is the volume control which has the decided effect, check the PCL84 and associated components.

### *MARCONIPHONE VC69DA*

**At first, the picture and the sound are perfect, but after about 5 minutes, the picture begins to jerk about and then, after turning the vertical and horizontal holds, it then becomes steady once again.—W. Slegworth (Shipley, Yorkshire).**

You should check V10 (Z152) sync separator and its associated components. Similarly, check V11 (Z152) and V15 (LN152) if necessary.

### *STELLA 2113*

**I have erected a BBC-2 aerial and I am receiving a good picture on this station but I am unable to receive any sound at all.**

**The sound and picture are perfect on BBC-1 and ITV.—M. Brown (Great Yarmouth, Norfolk).**

The fault is usually in the L211 and L213 coil can, one of the coils being open circuit, possibly due to a poorly soldered joint.

The clue to this trouble is in the h.t. supply to pin 7 of V202 (EF80). If this 150V (approx.) fails, when switched to 625, suspect the coils.

### *BUSH TV95*

**The picture has a margin of approximately 2in. all round it. After switching off the set for the day and then switching it on the next day, a broad white band appeared across the screen.—L. Seaborn (Loughborough, Leicestershire).**

We would suggest you change the h.t. rectifier which has probably deteriorated.

The broad band that you mention could be caused by a faulty video amplifier valve.

### *STELLA 2049A*

**The fault on this receiver is confined to the BBC-2 picture. When first switched on and switch to BBC-2, the picture is very good, but during the next 30 minutes, the brightness of the picture increases, with flyback lines showing.**

**Eventually, the picture is too bright to view even with the brilliance control at minimum. If the set is left on, the picture eventually unlocks and rolls upwards.**

**Both BBC-1 and ITA are good except for a bright ragged line to the left of the BBC-1 picture.—D. O'Sullivan (Hillingdon, Middlesex).**

Replace the PFL200 video amplifier valve. Change C249 to 0·15μF (at present 22kpF) and R258 to 150kΩ (at present 1MΩ).

These video components are to the left of the PFL200.

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## FERGUSON 306T

**There appears to be trouble in the line output stage. There is no raster.**

**Soon after switching on, I can get a good spark from the top cap of the EY86 but no spark from the connection to the tube—this only just lights the neon tester.**

**The EY86 lights up but has a blue glow. After about 20 seconds, there is no spark from the EY86 top cap and also the blue glow and the light-up of this valve disappear.**

**Further, a strong line whistle continues all the time and the line output stage gets and smells very hot but there is no sign of smoke or fire anywhere.—W. Lewis (Pontypool, Monmouthshire).**

Note the effect of removing the top cap of the EY86 on the line timebase whistle etc.

If there is no marked difference, change the EY86. If there is no difference, check the operating conditions of the PL81.

## BUSH TV138R

**The line will not lock when first switched on but after about 20-30 minutes it becomes possible to lock the picture. The line hold control is not locking at one end but approximately in the centre. However, slight movement either way loses the sync completely.**

**I have replaced the valves PCF80 and PL36 but this has made no difference.**

**Also, since new, the sound level on this receiver has not been very high, even set at maximum. This can be improved by adjustment of the fine tuner but sound-on-vision ensues.—J. Ashdown (London S.E.17).**

Check the 400$\mu$F capacitor in the cathode circuit of the video amplifier PFL200. Also check the capacitor decoupling pin 3 of the sync separator section.

If in order, check the sync coupling components to the discriminator circuit. Check the PCL82 sound output valve and the i.f. alignment if necessary.

## MARCONIPHONE VT163

**There is sound on both radio and TV channels but there is no vision and no raster and no 10·125kc/s line whistle to be heard.**

**Also, could you please state how the slow motion v.h.f. radio knob comes off?—G. Young (Darlington, Co. Durham).**

To remove the chassis from the cabinet, prise at the centre cover of the knob and unscrew the recessed screw in the centre hole.

For the no-picture fault, check the PL81 valve next to the PY81. Check the line oscillator and coupling components if necessary.

## BUSH TV128

**After about 1 minute after switching on, the set loses sync on both field and line. The picture can be corrected by adjusting field and line controls but slips again after a few seconds.**

**The picture has a "milky" appearance and the contrast control has little or no effect on this. The brightness control is set at minimum.**

**I suspect trouble in the video circuit—possibly the video output—all the valves have been checked.—J. Davison (Morpeth, Northumberland).**

You should replace the 10kΩ anode load resistor of the video amplifier PCF80. This is situated at the top of the left side chassis.

## SOBELL TS17

**The sound is normal but there is no picture—only a white line when the horizontal hold control is adjusted. I have had all the valves checked and none were found to be defective.—T. Boat (Swansea, S. Wales).**

We presume the white line is across the centre of the screen. Check the h.t. voltage to pin 6 of the field output ECL80. If this is absent, replace the field output transformer.

## DECCA DMCD17

**A considerable amount of time elapses before the picture appears on the screen and even more time is required for the picture to actually fill the screen. —D. Kennedy (Stranraer).**

Check the PL81 and PY81 valves in the centre and the 4·4kΩ resistor to pin 8 of the PL81 valve base.

Check the heating time of the valves and change the thermistor if necessary (CZ1 or VA1005).

## FERGUSON 145T

**Sound and picture are good at first, but after about half-an-hour's viewing the picture breaks up into a mass of horizontal lines.**

**Could you also state if a 246T line output transformer can be used in this receiver.—W. Hunter (Middlesex).**

On the left side of the chassis there are two EF80 valves. Check these, one at a time by replacing with a NEW EF80.

A 246T transformer can be used in the 145T if necessary.

## MURPHY V350

**Can you state the type of tuner fitted in this receiver and whether I could obtain the same with biscuits and coil for BBC-1 Channel 4 Midlands, as I have a broken coil.—N. Raeburn (Coventry, Warwickshire).**

The V350 has a special tuner manufactured by Murphy Ltd. Biscuits for it are obtainable from your Murphy dealer and are comparatively easy to fit without dismantling.

## PYE V220

**There are black lines on either side of the screen that cannot be eliminated by use of the horizontal hold control.**

**I changed the PL81 valve and the set went perfectly for the first hour or so, then the lines started to close the sides of the picture in again. —O. Jenkins (Newport, Monmouthshire).**

The lack of width could be due to low h.t. or more likely to change in value of the screen grid feed resistor on the PL81 line output valve. This is a large carbon type fitted behind the valveholder, and should be replaced by a 2·7kΩ 5W wirewound for preference.

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### SOBELL 1005DST

**The picture on this set is closed in about two inches either side. This fault appears on all channels. I have changed the PL500, DY87 and PY800 valves but this has made no difference. Other than this, the picture is of good quality.—W. Goodge (Bromley, Kent).**

The screen feed resistor to pins 6 and 7 of the PL500 should have a value of 2·2kΩ (R122.) Check this and the PCF802, the width control preset and associated resistors and VDR.

### MURPHY 216

**This set has a Channel 3 unit fitted. I get good Channel 1 pictures but there is a terrible noise on the sound.**

**It is possible to eliminate this noise on Channel 3 by using the fine tuner on the channel switch, but this is very critical.**

**All the valves have been changed one at a time but this has made no difference.—C. Fenner (Dorking, Surrey).**

The symptoms you describe suggest an unstable sound i.f. stage. This can usually be isolated by taking a good 0·0003$\mu$F decoupling capacitor and bridging it across each of the decoupling capacitors in turn. Replace any where difference is noted.

### FERGUSON 3618

**The fault on this receiver is a distorted raster, bulging at the left and indented to the right side of the screen. I have replaced V7 (line osc.), V9 (line output), V8 (efficiency diode). Checked electrolytics C88, C97, C86 (line section) and h.t. voltage and ripple. All seem to be in order.—S. Barton (Stevenage, Hertfordshire).**

If you are satisfied that there are no faults with the electrolytics, we would suggest that you check the panel for leakage from a heater line track to some part of the line oscillator.

### BUSH TV135

**The fault in this set appears to be instability in the line circuit. On switching-on the set, it is completely out of alignment and when an attempt is made to adjust it, it locks unstably, displaced about 2in. to the left. After about quarter of an hour, it becomes stable in the correct position.—F. Sp-iggs (Patchway, Bristol).**

The fault appears to be associated with the discriminator diodes. If these diodes are definitely not at fault, check their associated components.

**QUERIES COUPON**

This coupon is available until MARCH 22nd, 1968 and must accompany all Queries sent in accordance with the notice on page 282.

PRACTICAL TELEVISION, MARCH, 1968

# TEST CASE -64

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

? *A 405-line-only set suddenly developed a background of weaving vertical lines. Examination on Test Card D showed that the definition was also a little below its normal standard, and the 2·0Mc/s bars were the maximum that could be reproduced at full definition.*

*The symptom was at first thought to be caused by a form of external interference, but this was disproved as the trouble occurred on all channels and at different locations. Internal feedback was then investigated, but to no avail, and the vision channel alignment was checked normal. The screening round the vision detector was carefully examined, but nothing appeared wrong here. The sync separator stage was working okay, and all components were normal, proved by substitution.*

*What could have been responsible for this curious symptom? The answer will be given in next month's* PRACTICAL TELEVISION, *along with another item in the Test Case series.*

## SOLUTION TO TEST CASE 63

## Page 237 (last month)

Many receivers now incorporate a thermistor in series with the field scanning coils to combat change in height with increase in temperature of the coils. The resistance of the coils rises with temperature, while the thermistor resistance falls, and one balances out the other, thereby keeping the height constant.

As this thermistor is often located in the scanning coils themselves it is often overlooked when diagnosing in the field circuits. This was, in fact, causing the trouble in the Pye 510. The component had developed high-resistance connections and was thus seriously limiting the scanning current in the coils. More current was developed by advancing the height control, but the amplifier then ran into non-linearity, causing the bottom compression. A clue was given by the excessive field drive at the amplifier control grid, as revealed on the oscilloscope (i.e., height control full on).

Replacing this component completely restored normal working, but both the height and linearity controls had to be reset on Test Card D for the best geometric form.

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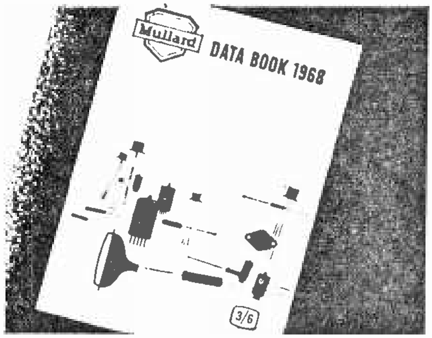
# Now available Mullard 1968 Data Book




136 pages of data, including for the first time, colour-coded sections for quick reference—covering comparables and equivalents and all current Mullard semiconductors, valves, tubes and components for Radio, TV, Audio and HiFi applications.

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| 1S5 | 6/9 | ECC81 | 3/9 | PCL85 | 8/3 |
| 1T4 | 2/9 | ECC82 | 4/3 | PCL86 | 8/- |
| 3S4 | 4/3 | ECC83 | 4/3 | PFL200 | 12/6 |
| 3V4 | 5/6 | ECC85 | 4/9 | PL36 | 9/- |
| 5Z4G | 7/ | ECH35 | 5/9 | PL81 | 6/9 |
| 6AQ5 | 4/6 | ECH42 | 9/6 | PL82 | 5/9 |
| 6F1 | 6/3 | ECH81 | 5/3 | PL83 | 6/6 |
| 6L18 | 6/- | ECL80 | 6/9 | PL84 | 6/- |
| 10F1 | 9/6 | ECL82 | 6/3 | PL500 | 12/6 |
| 10P13 | 10/3 | ECL86 | 7/9 | PY32 | 8/6 |
| 12K8GT | 7/- | EF39 | 3/6 | PY33 | 8/6 |
| 20F2 | 9/- | EF80 | 4/9 | PY81 | 5/- |
| 20P1 | 7/6 | EF85 | 5/- | PY82 | 4/9 |
| 30FL1 | 12/3 | EF86 | 6/ | PY83 | 5/3 |
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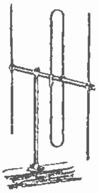

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