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Practical TELEVISION

OCTOBER 1968

2'6

START OF NEW SERIES

COLOUR receiver installation and servicing

ALSO

colour broadcasting

BOOKS BY G.A.BRIGGS

BOOKS BY G.A.BRIGGS

Practical Television

OCTOBER 1968
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Impact

THERE can be little doubt that many TV programmes have a profound impact on the viewing public, and ITV advertisers will readily testify to the efficacy of their commercial spots.

Because of the potential influence of TV, many loose theories have been propounded, e.g. programmes showing violence lead to an increase in actual violence; predominance of the sex theme encourages promiscuity; programmes noted for verbal vulgarities result in more bad language; crimes and exploits shown on TV are used as a basis for real crimes; etc.

These accusations may well hold some truth, yet the conclusions are arrived at on a purely theoretical assumption unsupported by real substantiating evidence. There is obviously an urgent need to investigate these problems on a wide scale. Moreover, a complicating factor has now been established.

Research carried out by Dr. William Belson, director of the Survey Research Centre at the London School of Economics, shows that not only is the impact assessment of some programmes "wildly wrong" but unexpected side-effects are produced and some programmes achieve the opposite effects to those intended!

Dr. Belson quoted the programme *Bon Voyage*. Intended to help those contemplating a visit to France, it actually aroused apprehension among some viewers and decreased their interest in visiting that country.

He also found that serious discussion programmes can rebound. For instance, a programme on the economic situation, based on a debate between representatives of management and labour, instead of creating a better understanding and tolerance served only to harden the existing viewpoints of the two factions. It seems that viewers with partisan opinions store up points made by their particular champions to use as debating points, thus narrowing their outlook even further.

From this limited research, gaps in our knowledge of the nature of TV impact are ominously revealed. Surely the time is long overdue for a deep searching probe by an independent body into the influences, real or imagined, that TV is exerting on the mass viewing public.

W. N. STEVENS—*Editor*

THIS MONTH

THE NEXT ISSUE DATED NOVEMBER WILL BE PUBLISHED ON OCTOBER 18

TELETOPICS

SEEING IN THE DARK

SEEING in the dark without the aid of a source of infra-red radiation to illuminate the object or scene being observed is now possible using this image intensifier tube announced by Mullard.

Originally produced in close collaboration with government research establishments for military purposes, the tube has now been de-classified and made available for civil use. Possible applications include navigation, aerial reconnaisance, space and underwater exploration, astronomy, nature studies of nocturnal animals and aiding police, prison authorities and private security organisations in night surveillance. The tube also makes possible the use of closed circuit television in conditions of very low ambient lighting.

It is shown here being demonstrated by Miss Daphne Lamport, B.Sc., A.R.C.S., Project Leader of the group at Mullard Research Laboratories responsible for the early development work on the tube. Further engineering development work has been undertaken at the company's Mitcham plant where the tubes will be produced.

LIBYAN TELEVISION CONTRACT

EMI ELECTRONICS has been awarded an order worth £500,000 by the Italian engineering firm Radionica SpA for four outside broadcast vehicles and studio equipment for the Libyan State Television Service. The vehicles, each of which will be equipped with four EMI image orthicon monochrome cameras, are to be used at Tripoli and Benghazi to inaugurate phase I of the plan for equipping Libya with a television service.

Silicon semicon catalogue

WESTINGHOUSE announce the new edition of the Westinghouse Semiconductor short form catalogue providing abridged data on the following ranges of their silicon semiconductor devices.

Silicon diodes (including avalanche types). Current ratings 500mA up to 830A. Voltage rating up to 3kV.

Thyristors (converter and inverter types). Current ratings 500mA up to 500A. Voltage ratings up to 2kV, and information on driver and controller units for thyristor circuits.

The publication is fully illustrated and contains complete dimensional drawings of all semiconductors.

Copies are available on request to Westinghouse Brake and Signal Co. Ltd., 82 York Way, King's Cross, London, N.1.

ROYAL TV SOCIETY SEMINAR

A SPECIAL Royal Television Society seminar entitled 'Television in Educational Technology—what is its role?' is being held in London at the Institution of Electrical Engineers, Savoy Place, W.C.2 on Friday, October 11th 1968 at 3 p.m. The seminar will include the following speakers: Guthrie Moir (Rediffusion Television Ltd.), Professor J. Black (UGC Committee on Educational Technology), J. C. Wykes (ILEA), G. Sattin (Eothen Films), Dr. R. C. G. Williams (ICETT), Dr. Gerald Vaughan (Guy's Hospital), E. Stones (Birmingham University).

Admission is free to both members and non-members of the Royal Television Society. Applications for tickets should be made to The Secretary, The Royal Television Society, 166 Shaftesbury Avenue, London, W.C.2. Tel: 01-836 3330/3788.

TV LICENCES

TELEVISION licence figures for the second quarter of 1968 show the June total as 127,014 more than the total on March 31, 1968, and nearly three-quarters of a million more than the total at the end of June last year.

Colour television licences which were introduced on January 1 continue to rise steadily at the rate of 5,000 a month and now total over 35,000.

MULLARD AT BRITISH WEEK IN STOCKHOLM

MULLARD LTD. will be staging a symposium and exhibition at a British Week in Stockholm (30th September-4th October) sponsored jointly by the British National Export Council and the Board of Trade.

A delegation of company specialists including ten leading experts from the Mullard Research Laboratories, Redhill, and the Central Application Engineering Laboratory, Mitcham, will present papers on a wide range of subjects at a symposium and exhibition being held throughout the British Week. In addition members of the delegation will visit leading Swedish users of electronic components, including government establishments.

At the exhibition many of the latest developments in components for use in telecommunications and radar, instrumentation and control, computers and other industrial applications will be featured. These include new integrated circuits, solid-state and thermionic microwave devices (including a recently announced range of electronically tuned Gunn oscillators), infra-red devices, passive night-viewing image intensifiers, ultra-high vacuum pumps, gauges and taps, magnetic materials and computer stores.

Wymer leaves Mullard

THE Council of Engineering Institutions is setting up a Public Relations Unit as from 1st October, 1968.

Peter Wymer, B.Sc., C.Eng., will be relinquishing his present position as Head of Public Relations for Mullard Ltd. to head this new Unit. Mr. Wymer is a Chartered Engineer, being a member of the Institution of Electronic and Radio Engineers, and a member of the Institute of Public Relations.

As Information Adviser to the C.E.I. he will be responsible to the Chairman and Secretary of the Council for all aspects of public relations. He will also provide an advisory service to the member Institutions of the C.E.I. on these matters.

COLOUR TELEVISION FOR HUNGARY

HUNGARY'S television company is to start regular transmissions in colour next year using the SECAM system.

Dr. Sárközy, one of Hungary's top TV men, said in an interview that experimental transmissions in colour can start next year. A colour transmitter is already being built by the Electro-Mechanical company of Budapest.

"It will be a good deal smaller than the existing black and white transmitter—operating at 2 kilowatts maximum, compared with 30kW, and with sound transmitted at 0·4kW compared with 10kW.

"The experimental programmes will go out on Channels 4 and 5, and can be picked up in black and white on the latest TV receivers from the Orion factory."

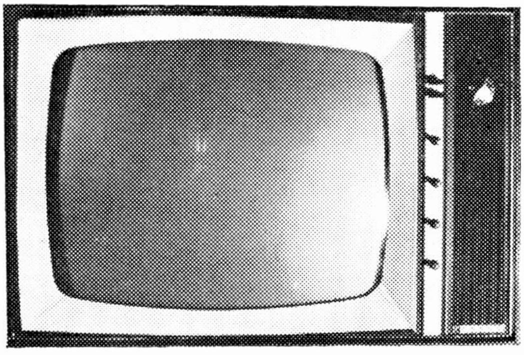
New Camera Coil Technique

EMI have developed a range of high performance scanning coils for camera tubes using flexible printed circuit techniques. The method ensures very close manufacturing tolerances giving greater consistency of performance than conventional wire-wound coils and is particularly useful for 3- and 4-tube colour cameras and high performance monochrome systems.

The coils are available for 1¼in. lead-oxide vidicon, 1in. and ½in. vidicon tubes. They have been designed to give excellent geometry, resolution and orthogonality with minimum line fly-back pick-up. This very low pick-up is of particular importance in the chrominance channels of colour cameras used in low light levels.

Coils for the lead-oxide vidicon are available in a complete scan focus and alignment assembly as a direct replacement of the wire-wound units in current use.

SOVIET COLOUR AT EARLS COURT



This Rubin 401 colour television receiver was on show at the USSR Exhibition held at Earls Court recently. It has a screen size of 24in. and can receive 12 channels. Moscow had its first regular colour TV service last year and the full service started on October 1.

The SECAM system is employed and the Soviets admit that this system has its shortcomings with the image being less sharp than the US NTSC system, but think that it is more than compensated for by its reliability.

The main difference with SECAM is that the signals corresponding to red and blue are not sent out simultaneously but in succession against a continuously transmitted black-and-white image.

The Rubin 401, the Soviets say, costs only about twice the price of a first-class black-and-white set.

INSTALLING and SERVICING COLOUR RECEIVERS

PART 1

P. G. ALFRED

THE progress of colour TV in this country depends to a large extent upon the quality of service available to the customer. A few careless installations, a few badly handled service calls, and word soon begins to spread that colour TV is no good. If this kind of situation ever became established it would take a very long time to undo the damage, in spite of the fact that we all know that colour TV is capable of providing superb entertainment. Clearly the service engineer has a considerable responsibility both to his customers and to his profession, and it is no mean task. What are the problems that face him?

In this series of articles we are going to take a look at the whole process of installing a colour receiver and of servicing it afterwards if any faults occur. All sorts of issues are involved and in order to have an opportunity of meeting a fair cross-section of them we are going to consider the operation from the point of view of a fair-sized service workshop attached to a rental and retailing business. In this way we shall be able to meet problems of safety, organisation, receiver adjustment techniques, and detailed fault-finding procedures.

All the operations that we are going to discuss involve handling colour receivers. In some cases it is just a matter of adjusting preset controls; in others it is necessary to work on printed boards and other assemblies whilst the receiver is switched on and working. Unless sensible precautions are taken sooner or later someone is going to get hurt, and it might be you. So we offer no apologies for appearing to digress at this early stage in order to talk about safety. This is the right time to start being careful.

Safety is an attitude of mind—a part of your basic technique. It is simply a way of working that minimises the danger to yourself and to others, bearing in mind that you will be handling electrical apparatus on countless occasions over a period of years. It needs a conscious effort from time to time to assess how you are doing various operations, and what habits ought to be changed. You have to keep an eye on yourself, but there is no question of being scared for your own skin, or of being a hypochondriac! It is plain common-sense.

The main hazards fall into two groups: electrical and mechanical. Do you always use a screwdriver in such a way that if it slips the blade never gashes your fingers, or causes you to skin your knuckles on that sharp metal bracket? How often have you pinched your hand in a pair of pliers? Do you ever burn yourself by holding a piece of bare wire whilst you are soldering it? Why suffer these minor irritations which impede your working when they can be avoided so easily by a more professional approach?

Soldering irons are so often hung on the edge of a bench where a colleague can lean on it when he cames to have a chat. It many only burn his new jacket, but he will have some pretty terse things to say about people who don't hang their soldering irons out of harm's way! Trailing leads, cupboard doors left open, small stuff lying about the floor, all cause accidents from time to time and result in inefficient working.

On the electrical side there are several basic do's and don'ts. Always have your apparatus correctly connected to the mains so that the chassis is earthy and not at full mains potential. *Never* hold the chassis whilst poking about with a test prod or screwdriver. Sooner or later you will get a nasty shock, drop the lot and have extensive damage to repair. Always try to work with one hand whilst the other is held well clear, preferably in your pocket where it cannot instinctively grab the chassis if it starts to move.

If you are working near any earthed metal objects note where they are and try to keep well away. Radiators and water pipes are obvious hazards, but there are others. It is all too easy to hang on to a conveniently placed pipe whilst you bend down to prod in a dark corner of the cabinet.

Have you ever felt the sharp tingle in your feet when standing in wet shoes on damp concrete whilst inadvertently touching a fairly innocuous h.t. line? It might not be quite so innocuous if you happened to touch live mains instead.

A colour receiver has numerous danger points. Here are a few. E.H.T. (25kV), focus potentials (5kV), boost voltages (1,000V or so), 300V h.t. lines of low source impedance, live mains feeding switch solenoids, and large line pulses on deflection coils, linearity controls, and many line transformer connections. Even a field ouput valve may have 1,000V pulses on its anode.

A special point concerns X-ray radiation. All receivers produced in this country are safe to view and to work upon under all conditions providing you do not remove any line output transformer screening cans or shield. *Do not work with the shielding removed and the set switched on.* This is a handicap when carrying out routine fault-finding but with experience and the use of logical checking procedures the difficulties will soon be overcome.

Installation

The process of installing a colour receiver in a customer's home does not begin when it is carried in through his front door but when it is unpacked in the service workshop. In a perfect world it would simply be lifted out of its carton on to

Table 1: Checking monochrome performance

Operation	*Check*
Switch to a 625-line colour signal; kill the colour; tune carefully for best picture quality; adjust brightness, volume and contrast.	Sound, quality and volume; focus; is definition good to 4·0 Mc/s; rings, smears, and overshoots; ease of tuning, and a.f.c. action if fitted.
Allowing for any misconvergence, is the i.f. response normal for this model of receiver, and does it tune correctly?	
Adjust line and field hold controls to the middle of their hold range.	Picture centring; picture size; linearity; raster shape.
Switch to a 405-line signal; tune for best picture; adjust line hold control (if fitted).	Sound, quality and volume; focus; definition; rings, smears and overshoots; ease of tuning; picture centring; picture size; linearity; raster shape.
Switch to weak, noisy, 405-line signal; tune for best picture.	Adequate drive; picture noise; line and field sync; sound, quality and volume; spurious interference patterns.
Switch to weak, noisy, 625-line signal; tune for best picture.	Adequate drive; picture noise; line and field sync; sound, quality and volume; spurious interference patterns.

the lounge carpet, moved into place, and switched on. Alas, however, our world is not perfect, and the fallibility of human nature is reflected in the products it produces, especially when it is a complex piece of domestic equipment such as a colour receiver which cannot be manufactured regardless of cost. So to guard against the minor faults which are liable to occur all receivers should be checked over in the workshop before installation.

The amount of checking carried out will depend upon the policy and past experience of the individual workshop, but let us take the most comprehensive case even if it is seldom necessary to be quite so thorough. The first thing to do is to remove the backplate and check the mains tapping adjustment, if any, and ensure that it is set to the local mains voltage. The next step is to inspect the receiver carefully all over for any "sillies" such as leads tending to short, loose screws holding various assemblies, components bent over towards hot wirewound resistors, and so on. This only takes a minute or two, but it may avoid unnecessary trouble later and in any case it helps to familiarise the engineer with the exact layout of the receiver. Now plug in, switch on, and give it a few minutes to warm up. Meanwhile the carton can be put away and the record card filled in with the serial number, model number, date, any faults repaired, and any other relevant information.

Assessing Monochrome Performance

An important point to bear in mind is that it is impossible to get a good colour picture unless the monochrome picture is of good quality also. This is because the colour picture is transmitted with a monochrome component and a colour-difference component, and the receiver adds these together to give the full colour picture. In all colour TV servicing it is a basic principle that there is no point in doing anything to the colour circuits until the monochrome picture is correct.

Every engineer will have his own private drill for checking out a receiver, but Table 1 gives a sample. Note that all servicing operations apart from routine adjustments should be left until after all the relevant items have been checked because this leads to more efficient working, and adding together several small clues may well lead to a ready diagnosis of an obscure fault.

We have now established whether the monochrome parts of the receiver which are more or less common to an ordinary black-and-white one are functioning correctly in terms of i.f. response, synchronisation and scanning display. If there are any faults correct them now before going on to assess the colour performance.

Assessing Colour Performance

In order to get a good monochrome picture on a colour receiver it is essential to have correct purity, convergence, and grey-scale tracking; but we include these under the heading "colour" because these aspects of the performance are peculiar to colour receivers and have no parallel in ordinary monochrome ones. When assessing the colour performance it is important to have a fair-sized working area in near total darkness—the darker the better—and it is worthwhile taking some trouble to achieve it. Colour, whether white or any other hue, will be distorted or swamped by the presence of ordinary ambient lighting. Continue checking as in Table 2.

We now have a pretty fair idea of the colour performance of the receiver and whether any

Table 2: Checking colour performance

Operation	*Check*
Turn off lights; unplug i.f. input to i.f. strip *or* short-circuit luminance detector output *or* adopt any other convenient means of obtaining a noise-free blank raster; turn up brightness control to maximum; turn contrast control to minimum.	Check purity. Are there any areas of spurious colour on the blank raster? It should be perfectly even in colour all over. If in doubt check beam landings with a magnifying glass. Check grey-scale "white": it should be illuminant C.
Reduce brightness.	Check dark greys for neutral colour.
Restore receiver to normal condition; plug in dual-standard crosshatch generator; switch to 625; tune for sharpest pattern.	Inspect convergence: errors in the centre of the picture are *static* errors; all others after static errors have been removed are *dynamic*.
Switch to 405.	Inspect 405-line convergence.
Plug in 625 colour pattern; tune carefully; kill colour.	Inspect grey-scale tracking again. Adjust if obviously necessary.
Unkill colour.	Inspect the colour picture and, by experience, assess the colour quality allowing for any patches of impurity and any convergence errors. Are there any major colour defects? Are venetian blinds obtrusive?
Change systems 405/625 several times.	Check for correct ident.

Venetian blinds are symptomatic of decoding errors and if they are too obtrusive the decoder alignment should be checked.

faults are present and any adjustments to purity, convergence and grey-scale tracking are needed. If so, attend to them now. Give the colour and monochrome performance a final check, as Table 3.

If the colour picture is unsatisfactory because of poor colour rendering adjust the colour-difference drives as described in a later section. Recheck the colour performance which should now be satisfactory. Run the receiver on soak test for several hours and check quickly the purity and convergence again. Adjust the tuner for local off-air channels. Replace the backplate, disconnect aerial and mains leads to prevent them being accidentally kicked, and protect the cabinet from normal workshop wear and tear. Note any work done and any performance characteristics on the record card.

The receiver is now ready for installation in a customer's home, and the presale inspection procedure that has been carried out should ensure that this can be done quickly and efficiently and with little likelihood of further service calls being needed for some considerable time. Both the service department and the customer will feel the benefit.

The detailed checking procedure that we have just been discussing makes rather a formidable list when it is put down on paper. However things are not as bad as they seem, as the experienced reader will have spotted. It is all a matter of method and practice. For instance, one careful glance from a trained eye is all that is needed to check a monochrome picture completely in a few seconds, and a colour picture can be treated in the same way. The important thing is to go about it systematically so that after a while the process becomes automatic and you do not have to think laboriously about every picture characteristic in turn. Otherwise there are bound to be times when

Table 3: Final performance check

Operation	*Check*
Tune in 625 colour signal	Check pastel colours—particularly skin tones. Are they correct? Check colour picture generally—has it a red, green, or blue bias i.e., skys too blue or trees too green etc.?
Tune in 405 signal	Is a good monochrome picture obtained?

you forget something important and in any case the operation takes far longer to carry out. Every engineer should have his own private check list which suits his way of working and should stick to it until it becomes as automatic as the morning shave.

The other point to bear in mind is that this is a *checking* process. Do not waste time making adjustments unless a significant improvement can be made. The receiver has been carefully adjusted at the factory and, human errors apart, it should need very little attention.

At this stage it is perhaps in order to issue a word of warning to the uninitiated. *If you are not experienced in adjusting purity, convergence, and grey-scale tracking do not adjust a customer's receiver: you will probably make it worse!* Leave well alone and find a workshop receiver to practise on, making full use of the appropriate workshop manual. The same comment applies also to certain other adjustments such as colour-difference drive voltages, boost voltages, beam-current limiters, etc. This is not a scathing attack on your ability as an engineer but simply a matter of facing up to the fact that these techniques require skills born of knowledge and experience.

Colour Adjustments

There are three sets of adjustments which are completely fundamental to the process of obtaining a good monochrome picture on a colour receiver. These are *purity, convergence* and *grey-scale tracking*, and they are always carried out in that order. To complete the process and get a good colour picture it is essential also that the *colour-difference drives* are in the correct proportions relative to each other. When these four adjustments are correct a good colour picture should be obtained, and the PAL system will take care of most operational errors caused by propagation defects and normal receiver tolerances. Indeed the differences between the colour characteristics of individual programmes are likely to be appreciably greater than the residual errors in the receiver. Let us consider each of these adjustments in turn—but first a word about workshop facilities.

You cannot work comfortably and efficiently unless you clear the decks and get yourself organised. The first requirement, above all others except a safe working technique, is near total darkness. It is not possible to check purity and grey-scale tracking properly in normal ambient lighting—usually either too cold or too yellow in any case—and you are handicapped when doing convergence. So get yourself plenty of darkness.

Next, clear some of that junk off the bench and make sure you have enough space to work in comfortably without having to contort yourself into backbreaking postures. Many jobs are tiring simply because you stand slightly bent or slightly off-balance for long periods. Usually this is quite unnecessary and is simply a matter of unconscious bad habit. Reorganise your working space, think about it from time to time as you go through the day, and you will probably feel a lot less tired when you go home in the evening to face the garden.

Now make sure that you have a good sized mirror, a degaussing coil, a dual-standard crosshatch generator, a colour pattern (preferably colour bars) on tap, and enough coaxial aerial leads. Your mains supply should, of course, be isolated.

How you arrange the receiver will depend upon whether it is a table model or a full-blown console, and upon workshop facilities. Undoubtedly one of the best ways of handling a receiver is to put it on a light trolley fitted with the best castors that money can buy. This saves an enormous amount of lifting, and avoids having to call someone to lend a hand. Workshop managers please note!

One final point. Is the axis of the tube lined up East-West? If so then on average the earth's magnetic field will have the least effect on purity after the receiver has been adjusted and moved to a different location with a different compass bearing.

Adjusting Purity

First check that the timebase scanning conditions such as centring, amplitude and linearity are correct, as listed earlier. Next plug in a 625-line crosshatch pattern and make sure that the *static* convergence is also approximately correct, i.e. the convergence at the *centre* of the screen: the red, green and blue beams should be correctly superimposed to give a white crosshatch pattern in the centre of the screen. There should not be any serious *dynamic* errors in the *corners* either. The reason for checking this first is that the magnetic fields for purity and convergence are close together in the tube neck and tend to interact slightly. Any adjustment of the purity magnet's field will affect the convergence, and so purity is always done first. Similarly changes to the convergence field will have a small effect on purity.

When adjusting purity it is essential to have a noise-free blank raster at a reasonable brightness level. Never try to adjust it on a picture or a noisy raster—you simply cannot do it sufficiently accurately. Turn the contrast control to minimum, the brightness control to near maximum, and switch to a blank 625-line channel. If the raster is noisy look for instructions in the manual or disconnect the i.f. input to the i.f. panel or adopt any other appropriate means. If the raster is not bright enough turn up the three tube first anode grey-scale controls, because it is very important to achieve near perfect purity, and in any case the first anode controls are easy to readjust afterwards.

Take a quick look at the white raster. Is the purity nearly all right, or is it bad? If it is bad you will have to start from scratch: if it is only slightly out it can probably be reset by means of the purity magnets alone. In either case start off by degaussing the shadowmask and c.r.t. safety band with a portable degaussing coil (see Fig. 1). Move it in circles all over the screen area and all round the front edge of the cabinet to a depth of about six inches towards the rear of the receiver, paying special attention to the corners of the screen. Move away about six feet before switching off.

If the purity is now nearly all right (viewed in near total darkness), stand behind the receiver and rotate both purity magnets together, watching the white raster in a large mirror placed several feet away from the front of the screen. Try turning the tabs of the magnets together about a quarter of a turn in both directions and find the best position. Then turn both magnets in opposite directions about a quarter of an inch or so and see if any position gives an improvement. Repeat both operations several times. In a good many cases a slight adjustment will restore good purity, but do not spend too much time in a vain search. It is quicker in difficult cases to start from scratch and do the job properly. Note that by "good purity" we mean a white raster that has no more than a single small barely perceptible discoloured patch. Any appreciable discoloration is not good enough, because it is often possible to get a perfectly pure screen.

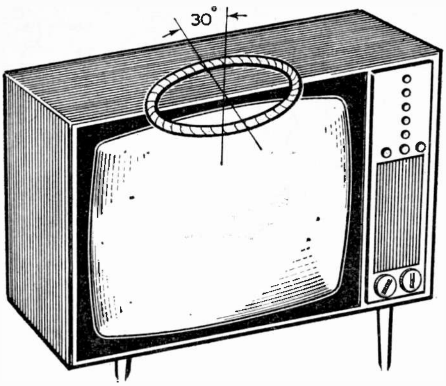


Fig. 1: Degaussing the c.r.t. safety band: manual degaussing coil is held at 30° to the cabinet and moved all around the front edge.

To do the job properly switch off the blue and green guns and plug in a 625-line crosshatch pattern. Rotate the purity magnets until they are fully cancelled: i.e. rotation of both together produces the minimum picture movement. Remove the crosshatch pattern and restore the blank raster. Now slacken off the clamping screws on the deflection coil housing so that the coils themselves can be moved forwards and backwards along the neck of the tube.

Then slide the coils to the limit of their travel either towards the screen of the tube or towards the end of the neck. Both techniques will give the same result, but it is probably better to push the coils hard up against the cone of the tube. Then adjust the purity magnets to obtain a circular patch of pure red in the centre of the screen. Now slide the coils back until the red circle nearly fills the screen, or it starts to break up. Readjust the magnets for the largest possible area of pure red, centrally disposed on the screen, and then move the coils back a bit more. Repeat these two operations until a perfectly pure red raster is obtained. In cases of difficulty make sure that you have not moved the coils too far back, past the optimum position, and that the purity magnets have not been rotated too far in opposite directions resulting in an unnecessarily strong magnetic field. The magnets usually need rotating only a few degrees apart.

Having obtained a perfectly pure red raster switch off the red gun and switch on the blue. Is the blue field pure? Look for a hint of red near the edges giving a magenta hue. If there is, readjust the purity. Now switch off blue and switch on the green gun. You will seldom see any impurity, but check just the same. Switch on all three guns and examine the white raster.

The white raster will usually show slight signs of impurity—a small discoloured patch near the edge of the screen. If you are lucky you will have to look quite carefully to see it, looking away from time to time to rest the eyes. You may tell yourself that it is too slight to be significant, but don't be fooled. It will probably show anyway, especially on a sky scene, but if it gets a little worse it will show up more than you thought possible. So adjust the purity magnets again (on the white raster still) and see if you can make it even better: you probably can. Do not forget to tighten the deflection coil screws.

To get really good purity is not always easy: in fact it may be more difficult than carrying out convergence or grey-scale tracking. However, it is the basis of a good picture and deserves both your conscientious care and the space that we have spent discussing it.

Just to summarise things, here is the check list for purity:

(1) Degauss the shadowmask and c.r.t. safety band.
(2) Obtain noise-free blank raster at good brightness level.
(3) Cancel purity magnets.
(4) Slacken deflection coil clamping screws.
(5) Slide coils up against the cone of the c.r.t.
(6) Switch off G and B and adjust purity magnets for circular red patch at screen centre.
(7) Slide coils back until the red area nearly fills the screen.
(8) Adjust magnets for largest symmetrical red area.
(9) Repeat (7) and (8) until a pure red field is obtained over the whole screen.
(10) Examine green and blue fields in turn and adjust purity magnets if necessary.
(11) Switch on all three guns and examine white raster. Adjust magnets if any impurity is visible.
(12) If good purity cannot be obtained repeat (5)-(11).
(13) Tighten deflection coil clamping screws.

NEXT MONTH: CONVERGENCE ADJUSTMENTS

Book Reviews

TV TUBE SYMPTOMS AND TROUBLES

By Robert G. Middleton. Published by Foulsham-Sams. 96 pages, 8½ x 5½in. Price 16s.

ANY practising television engineer can verify the author's prime argument: faulty tubes, i.e. valves in British parlance, are responsible for 80 per cent of TV receiver troubles. This fact has led to a modern generation of young field technicians whom we disparagingly call "tube-jerkers". With a caddy full of bottles they flit from house to house and what they cannot cure by almost indiscriminate valve-changing they return to the workshop to dump in the lap of a better-qualified engineer.

All very fine but the average reader of PRACTICAL TV does not possess a well-stocked tube-caddy, and would anyway eschew this haphazard approach to fault-finding.

Mr. Middleton's book thus serves a real need. It is not the first of its kind by any means. The principle behind such a book is that we must be sure before spending money on replacement valves exactly where the fault lies. With a television receiver we have a ready-made diagnostic tool built in. We can observe the picture and make our decisions in the knowledge of what symptoms are produced by various faults. A plenitude of photographs, a few words of explanatory text, a simple discussion of primary tests, and we may save ourselves the modest cost of such a volume over and again. Nine times out of ten the fault source can be pin-pointed.

Unfortunately if you are anything like me it is the tenth time that matters. One then needs to be able to make circuit tests and know which component to blame, or to prove the guilt "beyond reasonable doubt" of the valve you suspect.

I favour the "prove-it" approach, leaving tube-swopping to those aforementioned cowboys. But for anyone lacking experience and willing to spend sixteen shillings plus a few hours easy browsing this book is well worth consideration.

Mr. Middleton begins with the TV receiver generally, illustrating fault conditions photographically. He then proceeds to a symptom and fault cause chart that occupies ten pages and covers most of the faults we are likely to come across plus many we would hope never to meet. The second section deals with the display resulting from each symptom, and a basic discussion of the reasons. The book ends with a couple of pages of sound section faults.

In this second edition of a proven popular work the author has included references to hybrid circuitry and u.h.f. sections. His wide experience ensures that what he writes is based on personal knowledge. He is one of the few full-time electronics writers in the USA and is well known for books and articles on the whole subject. He paradoxically proves here that there really is no substitute for experience: not even a well-stuffed tube caddy and a copy of his latest book!—*H.W.H.*

PROGRESS IN TELEVISION

Edited by A. William Bluem, Ph.D. and Roger Manvell, Ph.D. Published by Focal Press Ltd. 328 pages. Price 42s.

REGULAR public television started in Britain in 1936, four years before the USA. Technically great progress has been made since then and the international exchange of programme items has been achieved by standards conversion and/or *Telstar* and *Early Bird*. It is still a relatively new medium of communication for ideas, policies, and the ways and means of putting to use these technical achievements, and it is by the exchange of non-technical (but productive) ideas between USA and UK such as those set out in this book that further progress can be achieved on the "creative" side.

Selections have been made by Mr. Bluem (USA) and Mr. Roger Manvell (UK) respectively from essays and discussions published over two or three years in *The Television Quarterly* (USA) and the *Journal of the Society of Film and Television Arts*, of which they are editors and contributors.

The different approaches, editorial styles of presentation and even spellings have been retained throughout. This has underlined the vitality of all that is best in British and American television programming.

Progress in Television is a lively anthology covering the broad field of the writers, the producers, the designers, lighting men, cameramen, technicians, newsmen, politicians, etc.

Each contribution is annotated with details of original publication dates and tempered with valuable footnotes and controversial facts and counter-facts.

One main fact emerges clearly: film and television are growing closer together year by year. The further development of both media calls for safeguards. Only if a reasonable proportion of people such as the authors in this book, artistic and technical professionals all, take part in the policy deliberations (and the inevitable politically flavoured committees) which will shape the future of television will this objective be sensibly attained.

Bluem and Manvell have presented a well-balanced survey which is a most valuable reference book for technicians and non-technicians in television and, it must be added, films.—*B.H.*

G. F. CLARKE'S BUSH CONVERSION · FOR · SOUND

THE range of Bush models that can be converted according to this article includes the following: TV53, TV56, T57, M59, TUG58, TUG59, TV62, TV63, TV66, T67, TUG68, TUG69 and M69. These receivers use the type A71, A83, A95 or A98 receiver unit and whilst the channel selector may appear to be of the turret type it will be found that the mechanism is very different from that used on turret tuners. The channel selector and tuning control consists of a click-stop mechanism and cam which adjusts the separately ganged core assemblies, L4, L7, L9 and L13 (see Fig. 1) being the coils for Band I and L2, L6, L8 and L12 those for Band III. The tuning control moves the entire selector assembly thus giving variation over each channel position. Band change from I to III is achieved at the appropriate place by an auxiliary cam. As a great deal of interest was shown in the author's adaptation of a series of Ekco receivers published in PRACTICAL TV in December 1964 it was felt that practical details of the conversion of the above models would also prove of interest.

After simple modification the receiver gives complete coverage from 41Mc/s to 68Mc/s and from 174Mc/s to 216Mc/s without change to the coils. With changes in the coils the amateur 70Mc/s and 145Mc/s bands may be covered. It may be that some readers may wish to do additional work on this unit and include an f.m./a.m. detector or to modify for single sideband reception. It is suggested that the unit be converted to a Band I-III sound receiver before any of the coil changes or additional circuitry is added.

If the simple conversion only is required then the final circuit may have a series heater chain when a heater transformer giving 72·8V or 53·8V at 0·3A is required. To include additional valves a 6·3V parallel heater circuit should be used and some change of valve types made. The line up for the two conversions is as follows:

	Series heaters	*Parallel heaters*
Cascade r.f. amplifier	PCC84	ECC84*
Mixer and oscillator	PCF80	ECF80*
1st i.f. amplifier	EF80	EF80
2nd i.f. amplifier	FF80	EF80
3rd i.f. amplifier	EF80	EF80
Detector and noise limiter	EB91	EB91
1st a.f. and output	PCL83	ECL83*
Rectifier	PY82 or BY100* silicon diode	EZ80* or BY100*

The asterisks denote items that must be purchased while the PCL83 and PY82 can be removed from the timebase chassis.

The receiver is released from the cabinet after removal of the fine and coarse tuning knobs by the two screws holding down the rear. Removal of the interconnecting plug and the screws holding the aerial sockets will allow the receiver

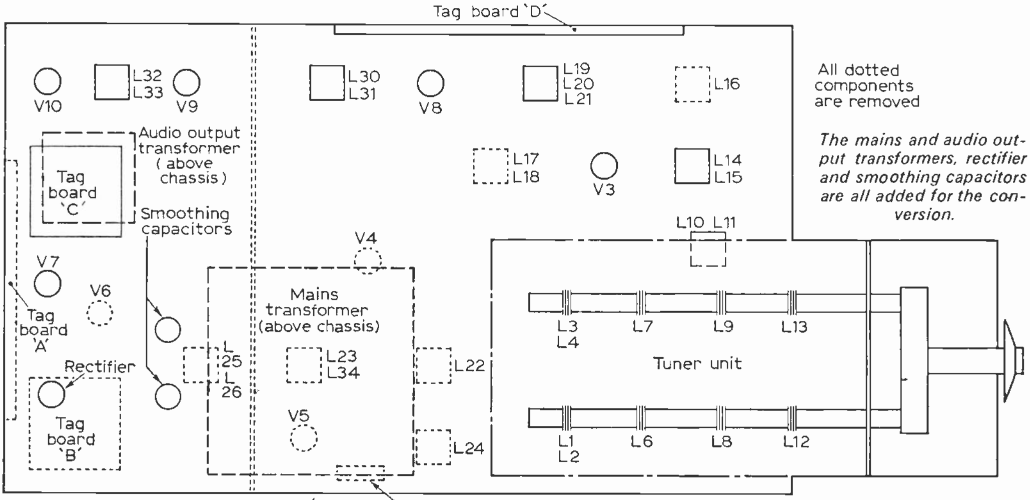
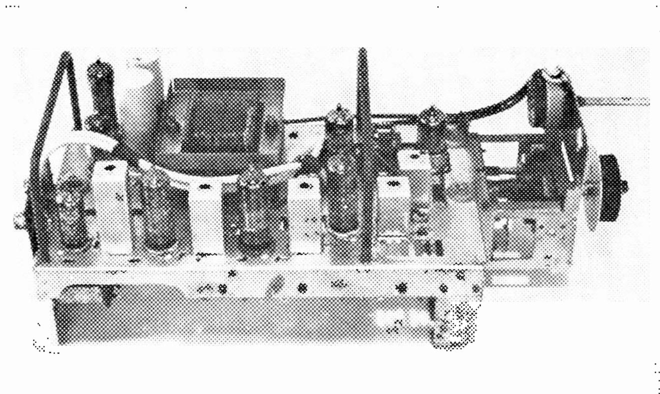


Fig. 1: Under chassis view of the receiver unit used in this series of Bush models.

chassis to be withdrawn. At this stage it is suggested that the receiver be given a good brush down to remove accumulated dust. Place the chassis on the bench upside down with the tuner unit to the right. In all the "clearing" operations which follow the wires to tagboards, valveholders, etc., should be cut as near to these components as possible.

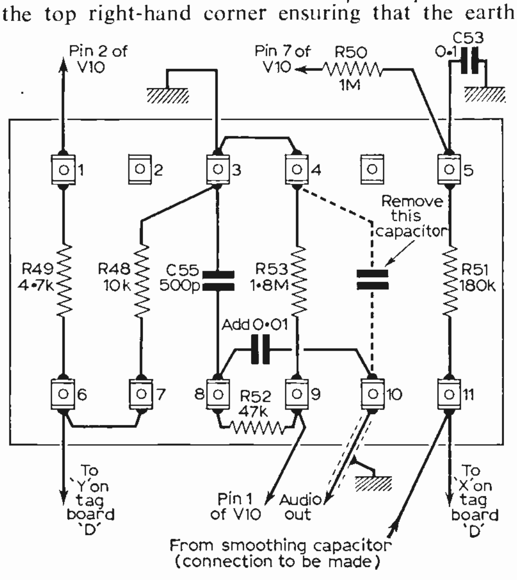
Two screws hold both tagboard A and B (Fig. 1). These should be removed and the boards cut free. Clear the components around V6, V7 and L25/L26 and then remove V6 base and the i.f. can. Valvebase V7 is left in position as this will become the a.f. amplifier and output stage in the finished receiver. V5 components and base as well as L23, L22 and L24 and the local/distant socket can next be removed. The wire from the tuner coming through a grommet at the rear of the tuner should, for the moment, be allowed to stay free.



The completed conversion.

The components around V4 and the valvebase itself can now be removed. The heater connection on pin 4, V4 should be pushed away to the right until it is required at a later stage in the conversion. The screen connection pin 8, V4 will be found to run along the top side of the chassis as viewed to tagboard D where it may be disconnected. L17/L18 should now be removed. The wire from pin 7, V3 should be connected to L19. It will be found that the easiest method is to unsolder L17 from pin 7 V3 and bring the wire that runs from L19 to L17, after unsoldering at L17, across to V3.

Cut the wire from pin 6 of L14/L15 that connects to L16 and then remove L16 and the 1000pF decoupling capacitor. Pin 6 should then be strapped to the nearest earth point. Remove the 100kΩ resistor and the 0·01μF capacitor in the top right-hand corner ensuring that the earth connection on the L11 to L14 link is replaced.



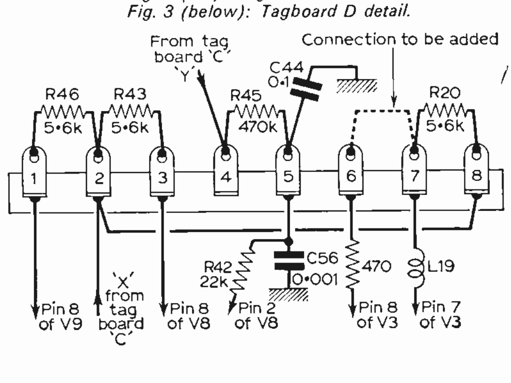
Turn the chassis over and remove the two potentiometers from their position above the band selector and also remove the lengths of wire running along the chassis. The four nuts holding the cover of the tuner should now be removed and after turning the chassis upside down again the cover removed. The wire leaving the tuner through the rear should be soldered to any convenient earth point inside the tuner and the cover replaced and bolted up. The wires running through the large grommet and ending in the interconnecting plug should be cut free at tagboard D and removed.

At this stage it is worthwhile removing all the valves and giving the above chassis a good clean to remove dust and grease using methylated spirits. It will be found that the chassis is anodized steel and will come up to a brilliant finish.

To commence the reconstruction, the aerial sockets should be unsoldered and after cutting the socket-mounting plate to size this should be bolted to the rear of the chassis. The cables should be cut to a suitable length and clipped to the top of the chassis. One input is the existing 41Mc/s to 68Mc/s range and the other for 174Mc/s to 216Mc/s. If two separate aerial inputs are not required these may be paralleled in the tuner unit leaving only one aerial coaxial cable and socket at the rear of the chassis.

At this stage a decision has to be made as to

Fig. 2 (left): Tagboard C detail.
Fig. 3 (below): Tagboard D detail.



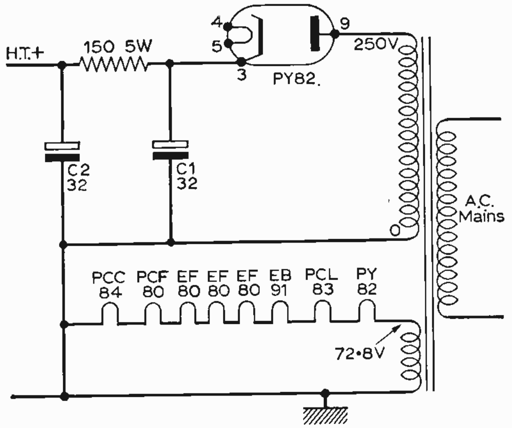


Fig. 4: Series circuit using PY82 and PCL83 valves removed from the timebase chassis.

the type of power supply and heater circuit to be used. Figs. 4 and 5 give the simplest type of heater chain and rectifier. There is little to choose between the two but it is felt that the novice should select either of these as further work is required for the 6·3V parallel version. It must be admitted that no further valves can be added to the series chain having once decided on the heater circuit.

The mains transformer may be purchased from any of the advertisers in this magazine or may be partially rewound from a 250-0-250 volt transformer from the spares box. If the latter course is adopted the following method should be used. Firstly check that the transformer has the secondary and heater windings on the outside of the primary winding. The transformer should then be connected to the mains and the voltage of the low-voltage heater windings taken. The heater windings will be either 4V and 4V for an old transformer or 5V and 6·3V for a transformer of more recent manufacture. As the transformer is off load voltages somewhat higher than these will be indicated. Having decided which of the above types is the one being used the laminations should be carefully removed. The heater windings should

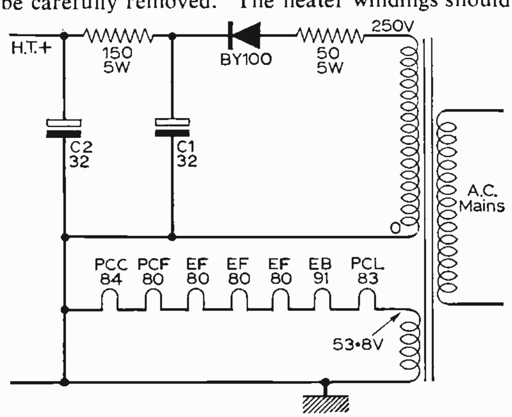


Fig. 5: Series circuit using a BY100 and a PCL83 removed from the timebase chassis.

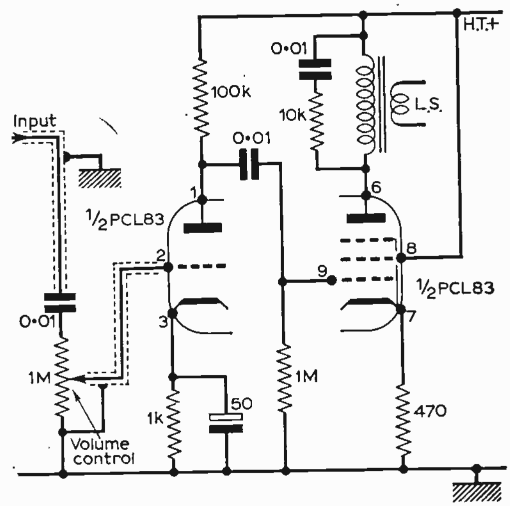


Fig. 6: Circuit diagram of the audio stages.

be unwound taking careful note of the number of turns. All the h.t. secondary winding down to the centre tap should then be unwound. A layer of tape must then be wound on to insulate the secondary from the new heater winding. The new heater winding may then be wound on to the original primary and secondary windings, the number of turns being derived from the formula:

$$\frac{\textit{Number of turns}}{V} = \text{turns per volt}$$

(V being either 4, 5 or 6·3V as measured).
Turns per volt × required voltage=number of turns required.

This winding should be of 26s.w.g. enamelled wire and have approximately 5% more turns than calculated to compensate for voltage drop in the windings. The winding should be as neat as possible and the two ends sleeved. A final layer of tape should be added and the laminations replaced.

The reconstruction work may now commence. A hole should be cut in the chassis at the rear of the tuner unit to take the transformer. If a valve rectifier type PY82 or EZ80 is to be used a hole should be cut in the chassis at a point where one of the lugs of tagboard B remains. One of the valve holders removed earlier should be cleaned up and mounted in this position. Two further holes may be cut in the chassis between the transformer and the two valves at the rear to take two 32 μF threaded boss electrolytic capacitors. If the transformer is so large that no space is available the smoothing capacitors may be mounted elsewhere under the chassis.

For those intending to use a parallel circuit as they are more experienced constructors it is sufficient to say that a twisted heater pair should be run from the mains transformer to V7 base to V10, V9, V8 and V3 and then above chassis to the filter unit where, after its removal, the connections to pins 4 and 5 of V1 and V2 can be found. The EZ80 rectifier will of course have its own heater supply.

The heater rewiring for the series circuit is very

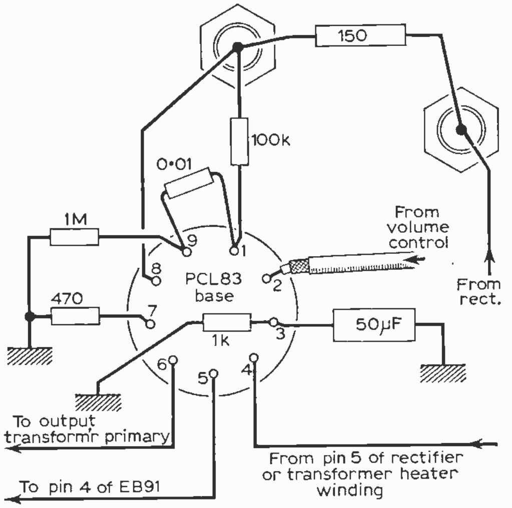


Fig. 7: Wiring of the audio section and h.t. filter.

straightforward and should present no difficulty. If a PY82 is to be used one end of the heater secondary is connected to pin 4 of the valvebase —pin 5 being connected by a short length of wire to pin 4 of V7 (if a BY100 is used the heater secondary will be connected to this latter pin). Pin 5 of V7 is connected to the wire which runs under tagboard C to pin 4 of V10. The other end of the heater secondary is run alongside the tuner unit through a grommet and soldered to the filter unit on top of the tuner. A length of red wire running through the grommet and soldered to this point will have to be removed.

The h.t. secondary can now be wired up. One end of this is soldered to a convenient earth point and the other end soldered to pin 9 of the PY82 base. If a BY100 is being used then a 50Ω, 5W resistor and the rectifier must be mounted on a short tagboard and the transformer connection made to the resistor. Pin 3 of the PY82 (or the cathode of the BY100) should now be connected to one of the 32μF capacitors and a 150Ω, 5W resistor soldered between this capacitor and the second 32μF capacitor.

The audio output transformer, removed from the timebase unit, should now be bolted to the rear of the chassis above tagboard C. The 1MΩ volume control may be mounted above the tuner knob on the existing bracket or a new bracket made up and mounted to the left of the control knob. The small capacitor between tags 4 and 10 on tagboard C should now be removed and an 0·01μF capacitor connected between tags 8 and 10. A screened and earthed lead should next be run from tag 10 to the volume control. The output stage should now be wired up as in Figs. 6 and 7, the slider of the volume control being wired in screened wire back to pin 2 of the PCL83.

A connection from the h.t. supply at C2 should be made to tag 11 on tagboard C, this point supplying h.t. to the i.f. stages. A further connection from C2 should be run around the chassis

—*continued on page 36*

PART THREE

X-RAY RADIATION

MARTIN L. MICHAELIS M.A.

WHEN measuring X-rays we are nearly always interested in obtaining a numerical value which is a direct expression of the biological hazard. The actual rate of arrival of photons, or expressions such as V/m when the rates are large enough for wave considerations, are of little direct interest. since the same intensities in this sense are more dangerous the greater the quantum energy, i.e. the higher the frequency and the shorter the wavelength. The biological hazard of an electromagnetic radiation (or of any particle radiation for that matter) is expressed in terms of its ionising power, i.e. in terms of the total number of ion pairs produced by the given radiation dose per unit amount of the ionised medium.

The basic international unit is called the *roentgen* (r). named after the discoverer of X-rays.

1 roentgen (1r) = $2{\cdot}08 \times 10^9$ ion pairs in one cm^3. of air at normal temperature and pressure.
= 1 electrostatic unit of charge liberated in one cm^3. of air at normal temperature and pressure.
= 11·33 microwatt-seconds of energy deposited in one litre of water as ionisation.
= approximately 90 ergs/gram deposited in air or water as ionisation energy.

Strictly speaking the roentgen is restricted to electromagnetic radiation.

For any particle radiation. including X-ray photons, the international unit is the "rad" (*r*adiation *a*bsorption *d*ose).

1 rad = 100 erg/gram absorbed as ionisation energy. For practical purposes we may take the roentgen and the rad as being approximately equal, since the human body consists approximately of water.

For more accurate biological assessments we use a unit called the "rem" (*r*ad *e*quivalent *m*an). This is defined as 1 rad of X-rays with 225keV quantum energy, being the mean quantum energy of medical X-rays. To a first approximation the definition of the roentgen. and thus of the rad for X-rays, is such that it is *independent* of the quantum energy.

Thus the roentgen, rad and rem are identical for our purposes, to a sufficiently close approximation. We may therefore confine ourselves to the basic roentgen unit and ignore the other two. Furthermore, we may calibrate our X-ray meter (see May and June issues of Practical TV) with *any* conveniently available source of X-rays irrespective of its quantum energy in relation to the 25keV maximum quantum energy of X-rays from colour TV receivers. The calibration will then hold with sufficient accuracy for our 25keV X-rays and even softer ones, *provided* we employ a detector whose entrance window does not absorb 25keV X-rays to a significantly greater extent than the quantum energy of the X-ray source used for calibration.

The Mullard MX147 Geiger-Müller counter tube used in our meter satisfies these conditions to sufficient accuracy for our purposes, and is the cheapest detector device available with good sensitivity to 25keV X-rays. The most convenient calibration source for amateur purposes is a small bottle or sealed glass tube containing 2·5 micro-Curie of the radioactive isotope Cobalt-60. This emits very hard X-rays, more properly called gamma rays, with quantum energies around 1250keV. These are produced by charge displacements inside the tiny nucleus of the Cobalt-60 atoms. The minute size of the nucleus compared to the atom as a whole accounts for the still shorter wavelength and higher quantum energy of the Cobalt-60 gamma rays. Gamma rays with this quantum energy can penetrate small volumes of solution (2-5cm^3.) and the glass container unhindered, so that no correction factor is here necessary.

The Mullard MX147 tube possesses a 2-3mg/cm^2. mica entrance window with an area of 63·5mm^2. This window alone will permit 25keV X-rays to enter virtually unhindered. whilst the much harder Cobalt-60 gamma rays will also enter through the side walls. The calibration sample must thus be positioned exactly on the tube axis in front of the mica window at a distance greater than the tube dimensions, so that its radiation is made to enter only through the window on purely geometric considerations. The calibration sample may be purchased without special permit from the Radiochemical Centre, Amersham, Bucks.

2·5 micro-Curies of Cobalt-60 (1 Curie = $2{\cdot}2 \times 10^{12}$ disintegrating atoms per minute) produce a dose rate of 336 micro-roentgen/hour (336μr/h) at 10cm. range between the centre-point of the sample and the detector window. The dose rate changes according to the inverse square law for other ranges, i.e. it is four times greater at 5cm. range, for example, and it changes in direct proportion for any fixed range for other amounts of Cobalt-60.

If a standard sample of Cobalt-60 is not available use may be made of the mean response published in the valve data of the tube manufacturer. This states that the MX147 produces a counting rate of 25 photons (25 electrical output pulses) per second for a dose rate of 1000μr/h. The author's tube actually produced only 17 output pulses per second with the standard Cobalt-60 source spaced so as to give 1000μr/h at the detector window. This lower figure may be due in part to the shielding of the metal cabinet, and in part due to parameter tolerance of the particular tube. It is suggested that the author's figure should be used when a Cobalt-60 source is unavailable for fresh calibration of an X-ray meter built by any reader according to the constructional details given in previous issues.

The roentgen is a total dose unit irrespective of the time taken to administer this dose. Intensity meters must be calibrated in terms of dose rates, i.e. roentgens per hour (r/h). This unit is inconveniently large, so that we must calibrate our X-ray meter in terms of micro-roentgens per hour (μr/h).

The Copenhagen conference of 1953 stipulated for professional workers a maximum dosage of 0·3 roentgen in any one week for total body exposure, or 1·5 roentgen in any one week for the hands alone. The maximum permissible dosages for the general public were specified as ten times smaller. The second Copenhagen conference of 1956 qualified the above limits by setting a professional limit of 5 roentgen in any one year for total body exposure and 10 rem for total body exposure of any member of the general public for his lifetime, or any period of 30 years. Dosages in isolated weeks may still reach values as specified by the first conference as long as the average does not exceed the long-term limits imposed by the second conference.

A member of the general public will thus tolerate a continuous dose rate of 7000μr/week throughout his lifetime without significant impairment of health. About one tenth of this dosage is provided by inevitable cosmic radiation, so that taking account of the higher professional doses permitted anyway, dose rates up to some fifty times the cosmic background are not unduly dangerous.

If we express these figures in terms of maximum conceivable viewing hours in front of a television receiver we see that the dose rate should not exceed 100μr/h at any point external to the closed receiver cabinet, whilst dose rates of 1000μr/h should never be exceeded under any conceivable conditions of servicing work on the opened receiver, as measured at the hands and body of the service engineer.

It is therefore convenient to provide our X-ray ambient radiation meter with three ranges. The lowest range reads 100μr/h full-scale deflection, and is intended for checking closed receivers under normal operating conditions. These are safe as long as the meter pointer never moves beyond full scale for any point close to the cabinet. The reading will always be about quarter scale, since the cosmic radiation background amounts to about 25μr/h. A *definite* reading is thus always obtained, and it is easy to judge whether this is significantly greater than the cosmic background by switching the TV receiver off and watching whether the pointer reading drops.

The highest range reads 1000μr/h full-scale deflection and is intended for checking opened TV receivers during servicing. The pointer should not move beyond full scale at any position where the service enginer must place his hands or body during servicing work, in particular if working on the switched-on e.h.t. section of a colour receiver in the opened state. The middle range of 500μr/h is provided for general convenience.

The calibration value of 17 photons per second for 1000μr/h obtained with the author's prototype happens to make the μr/h calibration identical with a pulses/minute calibration. This is very useful for general use of this radiation meter for studying radioactive samples, e.g. from atomic bomb test fallout in rainfall or with school demonstration samples. Such measurements are normally expressed in terms of counts per minute (c.p.m.). The meter described is eminently suitable for all such experiments too and an output socket is provided for connecting digital counters, headphones or other more versatile equipment for such experiments.

Actual Readings

We will conclude by discussing some actual readings of X-ray dose rates from TV receivers. Various short news items in technical journals have reported dose rates of up to 400μr/h at the rear of the bulb of monochrome picture tubes running at high intensity (16kV, 100μA). The author has *not* been able to confirm this with a number of monochrome receivers examined in the service shop with the X-ray meter previously described. No significant X-ray radiation was detectable anywhere around properly functioning monochrome (or colour) picture tubes. The only conditions which sometimes led to dose rates of up to several hundred μr/h at point-blank range with respect to the e.h.t. rectifier (not the picture tube) of a monochrome receiver were deliberate e.h.t. shorts. The e.h.t. voltage is then dropped across the rectifier causing it to generate X-rays in the same way as the shunt triode of a colour receiver. However, e.h.t. shorts in a monochrome receiver can seldom persist for long before the line output transformer is destroyed so that the accompanying X-rays are relatively harmless especially as they emerge if at all from the back of the closed cabinet.

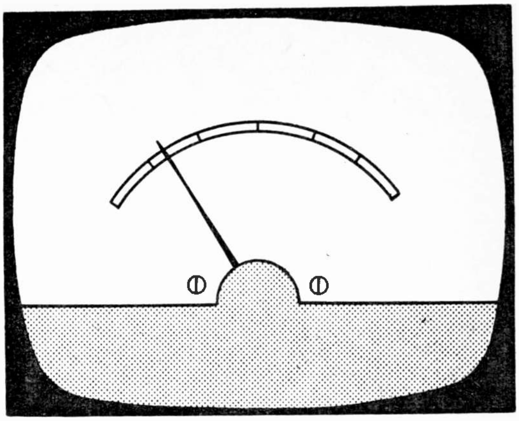
The same reports in the press speak of 2 to 5μr/h on the screen of colour or monochrome receivers at maximum brightness. This is barely detectable above the 25μr/h inevitable cosmic radiation background, but could be approximately confirmed by the author's measurements. This level of radiation is not significant.

Another press report stated that the dose rate should be less than 500μr/h on all exterior surface

continued on page 22

TELEVISION RECEIVER TESTING

Part 5 by Gordon J. King



SYNC TESTING

THE composite video signal after leaving the video amplifier is applied both to the cathode of the picture tube and to the sync separator valve. The picture tube translates the video impulses to almost instantaneous changes in scan spot brightness, and because the scan spot on the picture tube screen is in exact synchronism with the end of the electron beam impinging upon the target of the camera tube the brightness changes of the scan spot are integrated by the eyes of the viewer and appear as a monochrome picture. A colour picture is created in precisely the same manner, but the colour picture tube also has the attribute of producing on its screen changes in hue as well as brightness.

The sync separator valve on the other hand is arranged electronically so that it delivers an output from the composite video signal only during the periods corresponding to the line and field sync pulses. It does not—or should not—let through any signal information corresponding to the picture. The sync separator, therefore, can be regarded as a kind of electronic gate which opens when the sync pulses occur and closes during the periods of picture signal.

The term "composite" video signal refers to the signal as a whole, including picture information, line and field sync pulses and blanking pulses, while for the purposes of this article *picture information* and *video signal* references relate to pure picture signal minus the sync and blanking signals.

The picture tube is fed with the composite video signal but since it is biased by the brightness control to respond only to picture information the sync pulses (in theory at least) pull the tube into even greater back-bias, thereby ensuring that the scan spot during those periods is blacked out. This action is related to the black-level performance of the set—that is, how well the black level of the picture information is "locked" to beam current cut-off. Sadly for a diversity of reasons modern sets have a performance somewhat lacking in this respect, but the tube is still pulled hard into beam current cut-off during the sync periods by blanking or "reverse biasing" pulses fed to the grid (sometimes cathode) from the line and field (not always the former) timetable. Nevertheless the relatively poor black-level performance—brought about by semi-a.c. coupling in the video circuits, by not-too-good e.h.t. regulation and by mean-level vision a.g.c.—is responsible for the overall brightness of the picture rising above what is natural, for example, when the televised scene changes from light to dark key levels. Some recent sets, however, are equipped with quasi-black-level restoring circuits—such as those of the Rank-Bush-Murphy series—which combat to some degree the effects of inherently poor black-level clamping.

As is pretty well known, a line sync pulse occurs for each line of picture signal, while a series of about eight (405-line system) field sync pulses occurs for each field scan. At this stage it must be recalled that one field occurs every fiftieth of a second, that two fields interlace line-wise to make one frame and that one frame is equal to one complete picture which thus occurs every twenty-fifth of a second

From this, then, it follows that each field must be composed of half the number of lines of a complete picture or frame, and that some artifice for "timing" two fields must be used to secure accurate interlacing so that the scan lines of one field will fall exactly in the centre of the spaces between the lines of the partnering field. This interlacing business ensures that the complete picture or frame has the full number of lines. If the interlacing is poor, it is possible for the lines of one field to fall on top of the corresponding lines of the partnering field—instead of in the spaces between the lines. The net effect of this would be virtually a 50% reduction in vertical definition ot the picture. The picture would also appear to be line predominant.

The timing for the interlacing is provided by the positioning of the field sync pulse train relative to the lines of picture information, and this is carefully geared-up at the transmitter. In effect, there are half lines of picture information on each field, and the way that these are related make interlacing possible.

In passing, it should be noted that not all the lines of a picture carry picture information. A number of them on each field are down to black level, while others occur during the train of field sync pulses. It is not proposed in this article to delve deeply into the theory of TV signals which is adequately covered in various reference books.

We can rest assured that at the transmitter signals are being produced that in conjunction with a set in proper working order will provide (1) solid line sync, (2) solid field sync and (3) good interlacing. The set must therefore be designed and adjusted to yield these conditions. We shall now look at these separately and in detail so far as testing is concerned.

Before we get down to hard reasoning, however, let us get clear that the sync separator delivers at its anode and/or screen grid (or collector in the case of a transistor) both line and field sync pulses, and it is rather important for the happy working of the line and field timebase generators that only the appropriate sync pulses are fed to them.

This is achieved by the use of filter-type feed circuits interposed between the output of the sync separator and the sync inputs of the generators. The filter in the line generator feed passes only the line sync pulses and that in the field generator feed passes only an integration of the field sync pulses (remember there is a series of these). The filters do rather more in practice than just discriminate one set of pulses against the other set, for they are designed to shape the pulses so that the generators are "fired" in a definite manner exactly at the right time on each line and field, and consistently from line to line and from field to field. Random firing of say the line generator gives a nasty ragged effect to all vertical parts of the picture, while inaccurate firing of the field generator plays havoc with the interlacing.

The circuit to the line generator is called a *differentiator* and that to the field generator an *integrator*. The former while attenuating field pulses also changes the flat line sync pulses into spikey pulses, while the latter "adds" or integrates (hence its name) the field pulse series so as to form one large-amplitude pulse of correct shape to fire the field generator. The overall picture in elementary form is shown in Fig. 1.

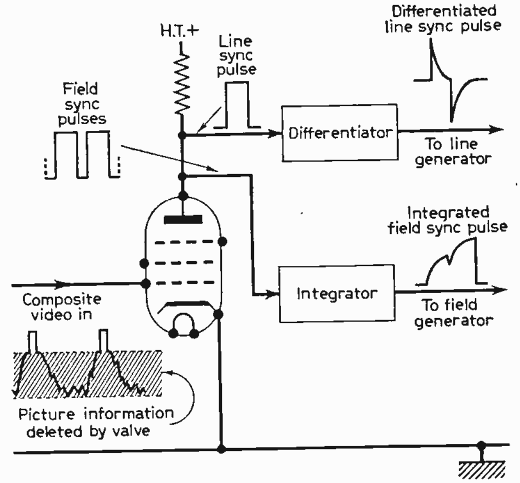


Fig. 1: Simplified sync separator stage showing feeds to the line and field timebase generators with waveforms.

Line Sync Testing

It is of course impossible to explore all the various circuits adopted for sync separators and filtering but the basic principles are common to all sets and once they are understood it is fairly easy to go to a circuit and identify the sync separating and pulse filtering and shaping circuits.

Let us suppose that the picture is perfectly okay as judged by a test card, that it is locking solidly on the field (vertically), but that it has a very touchy line lock, calling for critical adjustment to the line hold control to prevent it from breaking up horizontally. This is the symptom of poor line lock, and it almost certainly means that something is amiss in the coupling through the differentiator to the line generator.

Before we become too definite about this though it is essential to make sure that the line generator is trying to lock well within the range of the line hold control. If the lock occurs best with the control hard against one of its end stops then the trouble would more likely be in the line generator timing circuits and the first move should then be to correct the circuit until the best lock occurs towards the centre of the control's range. Testing along these lines will be considered in later parts.

Let us assume therefore that the correct line speed occurs well within the range of the hold control. We can be reasonably sure that the sync separator is doing its job properly because the field locking is all right, so we would commence our testing in the circuit between the output of the sync separator and the input of the line generator.

The simplest differentiator consists merely of a low-value capacitor connected between the sync separator valve anode and the sync input of the line generator, as shown in Fig. 2. The differentiating action takes place through this capacitor in relation to the effective sync input resistance of the generator, giving a circuit like that in Fig. 3 which produces the differentiated pulse from a rectangular pulse (line sync pulse) input. Assuming, then, that the sync separator is delivering line pulses, lack of line hold could be caused by (1) trouble in the coupling capacitor (the 33pF capacitor in Fig. 2) or (2) trouble in the generator

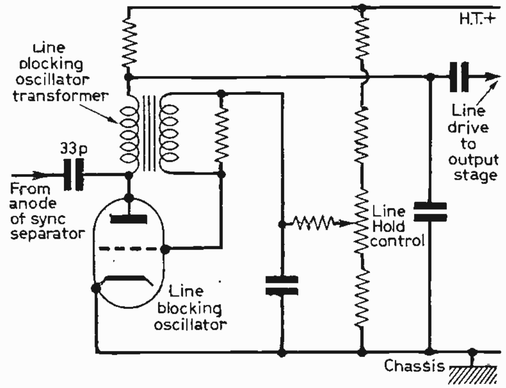


Fig. 2: Typical line blocking oscillator with sync pulses applied via a low-value capacitor to the anode circuit.

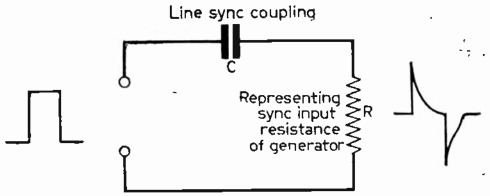


Fig. 3: Basic differentiator circuit.

itself, even though the generator is running normally otherwise.

The first test would thus be of the 33pF capacitor, and this is best done simply by replacing it. If the trouble persists the generator could be at fault. In blocking-oscillator generators, as for example Fig. 2, slightly impaired insulation from the windings of the blocking-oscillator transformer to chassis (core) or between windings can modify the *R* value in Fig. 3 and thus mess up the line sync performance. This trouble is not as uncommon as it might seem, and it can often be brought to light by applying pressure to the windings of the transformer with the flat part of the blade of a screwdriver. If this action modifies the line lock efficiency the transformer should be replaced.

Improved line lock can sometimes be achieved by increasing the *C* value in Fig. 3 (the 33pF capacitor in Fig. 2) and the author has known instances where doubling the value has immensely improved the locking. However it must be appreciated that the *RC* time-constant is arranged to suit the time period of the line sync pulses, and since *C* is relatively low value a positive and negative differentiation occurs during the *intervals* between the series of field pulses. These are responsible for keeping the line generator in sync during the time that the field pulses are occurring.

The effective *R* of the differentiator can also change due to a line oscillator valve fault so another test should be that of the valve itself. This applies in particular in circuits using the multivibrator type of oscillator. Change in value of an anode or grid resistor or an electrical leak in a capacitor in such an oscillator circuit can also upset the nature of the sync pulses and sometimes reduce their amplitude.

Field Sync Testing

The basic components of the integrator in the field sync feed are again a resistor (*R*) and capacitor (*C*), but this time arranged in a different manner as shown in Fig. 4. Field pulses are of longer duration than their line counterparts, so the *RC* time-constant has to be longer in the integrator. Moreover the plan is for each field pulse of the series to add an increment of charge to the capacitor, building up to a fairly

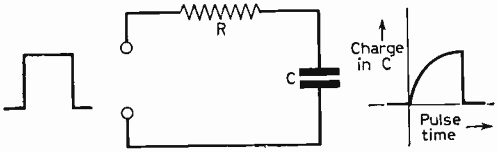


Fig. 4: Basic integrator

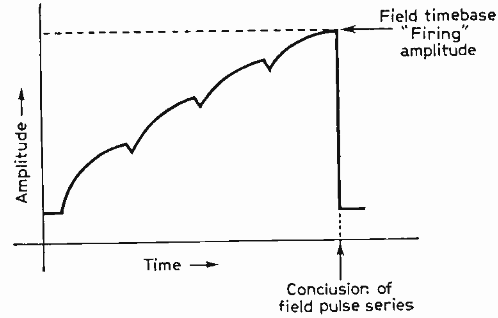


Fig. 5: The pulse used to fire the field generator is built up by integration of the series of field sync pulses transmitted.

large charge at the end of the series as shown in Fig. 5.

This produces a high-amplitude pulse which, except in very early sets, is shaped and further filtered to rid it of traces of line pulses. The fact that *C* in the integrator is of a higher value than that in the differentiator means that line pulses (and their equivalent produced during the intervals of the field pulses) add very little to the charge in the capacitor, but they are still present to a small degree which is why additional filtering is desirable. Good interlacing relies on the very accurate and consistent firing of the field generator, and the presence of spurious line pulses, even though of small amplitude relatively, can upset the consistency of firing and thus impair the interlacing.

Fig. 6 shows a multivibrator field generator, pentode sync separator and interlace filter stage consisting of diode D1 and associated components. This sync separator circuit is chosen since it shows how the field sync pulses are occasionally extracted from the screen grid of the pentode valve while the line sync pulses are taken from the anode circuit, as in Fig. 1.

R1 and C1 in the screen grid circuit are basically representative of *R* and *C* in Fig. 4. At this point (i.e. the cathode of D1) both line and field pulses occur, but C1 considerably attenuates the former and a waveform similar to that shown in Fig. 7 would be expected (excluding the waveforms from the generators themselves). The compressed waves are the line sync pulses while the powerful-looking wave effect in the middle is due to the integration of the series of field pulses.

This is not a very good waveform to feed into the field generator for consistent, good interlace firing, and it is cleaned up by the action of D1 and the associated components in Fig. 6. The diode is normally biased towards cut-off by R1, R2, R3 and R4 from the h.t. line so that the weakened line pulses fail to get through its circuit. However, when the larger amplitude integrated field pulse occurs, the bias is effectively removed and so only the field pulse gets through the diode which charges C2 in the time-constant circuit comprising R2, R3, R4 and C2. The result of this is a much more useful field pulse as shown in Fig. 8. This pulse is of very consistent timing and amplitude and completely free of spurious

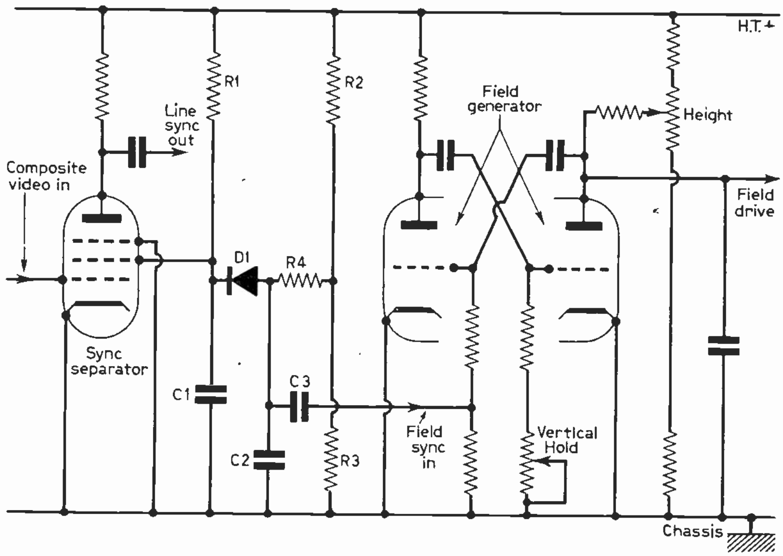


Fig. 6: Typical multivibrator field generator synchronised by feeding in sync pulses from the screen of the sync separator via the interlace diode D1.

line pulses, thereby ensuring a very good interlace performance.

Now the symptom of bad vertical hold with good line hold and good picture as appraised by a test card would almost certainly indicate trouble between the sync separator and field generator sync input, and a very common cause is open- or short-circuit of the diode D1 itself. The very first test therefore should be that of the diode, and the best plan is to replace it and note any improvement. Small metal rectifiers are generally used in this circuit and some of the early versions were not all that reliable. Good current replacements are the Westinghouse types WX6 and 39K2. This diode should also be checked if the vertical lock is weak and if the picture tends to trigger on the slightest interference to give the symptom shown in Fig. 9. But as with the line timebase the generator itself could be out of circuit adjustment if the vertical hold control needs to be up hard against one of its stops for the best lock.

If the diode is all right attention should be directed to the associated resistors and capacitors. It is not particularly uncommon for several resistors and/or capacitors to change value in this circuit, so replacement of one might not give a complete cure.

The professional way of checking in the sync circuits is by means of an oscilloscope, feeding the sync signals into the Y amplifier and setting the scope's timebase to suit the line or field frequency. In this way the sync pulses themselves—before and after filtering—can be seen and tracked from the start to the finish of the circuit. When adopting this method of testing, however, it is as well to mute the line and field timebases to avoid the scope displaying these instead of the real sync pulses from the signal! When the line timebase is muted it is essential (a) to disconnect the screen grid h.t. feed to the line output valve and (b) to load the h.t. circuit with a heavy wattage, wire-wound resistor, burning up about 100mA, to simulate the load normally taken by the line output stage. It is necessary to disconnect the screen feed to prevent the line output valve from overloading when line drive is removed by muting the generator.

Poor interlace performance can also be caused by trouble in the filter diode or its associated circuits and these components should be tested when this symptom is present. Another common cause of the trouble, assuming normal interlacing when the set was first put into service, is feedback of line pulses from the line output stage into the field timebase circuits. This can happen when the shielding round the line output stage is insecurely fitted after a servicing operation or, indeed, if it is left off completely. Misplaced wiring in the field and line timebases is another fairly common cause of the symptom, as also is some weakness in the field generator valve.

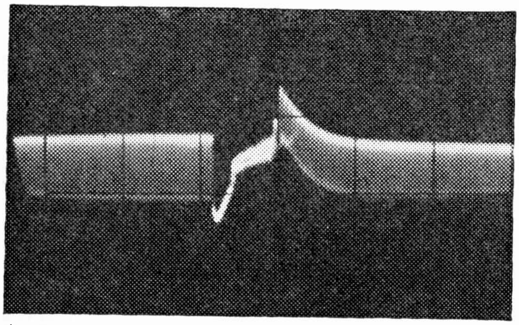


Fig. 7: Oscilloscope display showing the integration of the field sync pulses to give a single large-amplitude pulse.

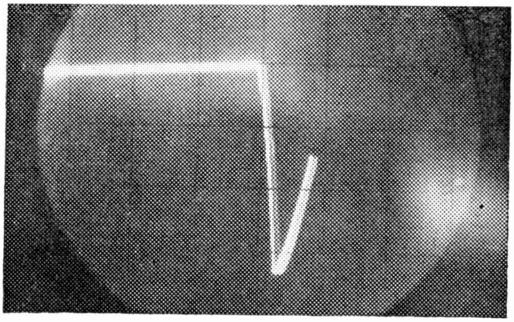


Fig. 8: The composite field pulse after integration and filtering to obtain a sharper pulse for better triggering.

Fig. 9: Typical symptom of weak field lock.

A good way of testing for line timebase pulse leakage is to mute the field generator (by disconnecting the feedback coupling) and check for line pulses in the field circuits with a scope having high Y gain and set on its sweep to line frequency. The Y connection to the scope should be screened to avoid direct pick up from the line output transformer, line output valve, booster diode etc. and only the probe end of the lead should be exposed for coupling to the various circuits.

Excessive line signal in the field circuits is almost certain to upset the interlacing badly and steps should be taken to locate its source and to stop its entry. Remember that a wire in the field circuits badly misplaced so that it trails close to the line circuits commonly causes the trouble.

Finally mention should be made of the possibility of poor vertical and horizontal hold due to distortion of the composite video signal either in the video amplifier or as the result of insufficient bandwidth in the vision i.f. channel. The latter, of course, will be cured by realignment, but the former will possibly call for component tests in the video amplifier, including the valve and the resistor-capacitor combination coupling the video amplifier output to the sync separator input. Trouble here can also encourage the symptoms of pulling on whites and line tearing, the first showing as cogging on Test Cards C and D and the second as bands of picture pulling away from the field horizontally.

Apart from misalignment both of these symptoms can result from a defective capacitor in the anode and/or cathode circuit of the video amplifier valve. Where it is common to the picture tube feed and the sync separator feed a Test Card will reveal poor definition, but this will not always be the case when the fault lies at the input or output of the sync separator valve or transistor for then the actual picture information is likely to be clear of distortion.

Tests in flywheel-controlled line sync circuits have not been covered in this article because they are somewhat specialised: it is proposed to cover them however in a later part in this series.

The theme of Part 6 will be testing in the timebase and e.h.t. circuits.

TO BE CONTINUED

X-RAY RADIATION

—continued from page 17

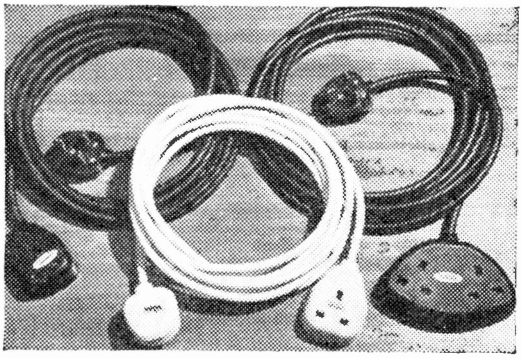
points of a colour TV receiver, including screen and rear panel. If this is supposed to be the total integrated dose rate coming out of the receiver in all directions taken together it is probably a realistic figure, but if it is intended to be a specification of the ambient level in the normal sense it seems to be disproportionately large and quite out of keeping with the author's actual measurements performed on a typical colour receiver. The maximum ambient level close to any point on the test receiver was definitely less than 5μr/h.

Substantial dose rates which could easily be made to exceed the tolerance limits were unobtainable from monochrome receivers, and were obtainable in the test colour receiver only from the opened e.h.t. compartment. The shielding plate carried a very clear warning of the radiation hazard when the plate is removed whilst the receiver is running. The tolerance limit of 1000μr/h (full-scale deflection on the highest range of our X-ray meter) was obtained at a distance of 15cm. from the unshielded shunt stabiliser triode, dropping to 600μr/h when the picture brightness was advanced from dark to normal, and dropping further to 400μr/h at maximum possible picture brightness. With the e.h.t. shield in position no significant level of X-ray radiation was detectable above the cosmic background even with the detector hard up against the shield.

Since the test receiver, from a reputable manufacturer, achieved these excellent radiation shielding figures without any expensive complications the author sees no reason whatsoever why any other manufacturer should market receivers not similarly protected. Thus a further recent press report of 100μr/h on the screen surface at 1cm. distance sounds absurd. Either some reporter got his decimal points mixed up or the manufacturer concerned deserves a rocket! But possibly this report was referring to the recent incident in the United States where a batch of colour receivers emitting undue levels of X-rays was actually marketed and then withdrawn again. The author has been unable to obtain definite information concerning the cause of the radiation from these receivers, but it seems to have been due to the picture tube. The shadowmask may have been made of an unduly heavy metal, or the glass may have contained a heavy metal as impurity. ■

USEFUL MAINS LEADS

A 15ft. mains extension lead set has been introduced by the Force Ten Co. of Fairlands, Surrey. The extension unit comprises a heavy-duty cable with a 13A fused rubber plug and socket. It is available with black cable for 18s. 6d. or white at 25s. 6d. A two-way socket version may be obtained at 28s.



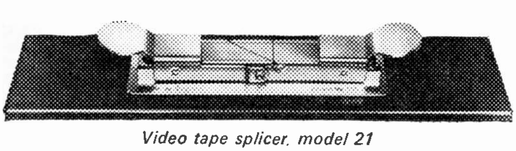
The three types of mains extension leads

SPLICE YOUR VIDEO TAPE

Multicore Solders Ltd., of Hemel Hempstead, Herts. have released a ½in. video tape splicer, type 21.

The design of this splicer is based on Bib's ¼in. tape splicer. Diagonal or butt joints may be made, two swinging clamps gripping the tape firmly in the channel of the splicer block. The splicer is chrome-finished and mounted on a plastic-covered non-slip base. The actual splicing unit can be removed from the base by the removal of two screws so that it may, if required, be fitted directly to the tape deck. A razor cutter may be stored under the base of the splicer block.

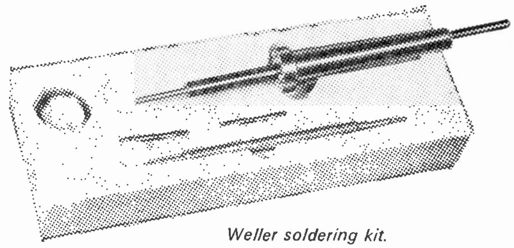
Coming complete with six razor cutters, a reel of special splicing tape, a Bib Head Maintenance Kit size E and instruction leaflets, the price of the ½in. splicer is £9 10s.



Video tape splicer, model 21

SOLDERING KIT FROM WELLER

Weller Electric Ltd. have produced a complete soldering kit which contains a Marksman 25W soldering pencil, two spare tips, a soldering aid-heat shunt, scraper and wire grip and a coil of 60/40 solder. Price is £2 1s. 6d.



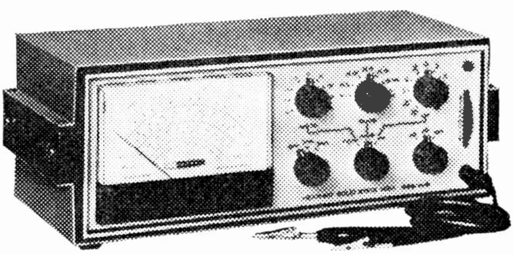
Weller soldering kit.

TWO MORE FROM HEATHKIT

Daystrom Ltd. of Gloucester announce two new units for the test bench. The first is a Solid-State Volt/Ohm Meter, model IM-16. It uses solid-state circuitry and operates from internal batteries or from 120/240V 50-60c/s d.c.

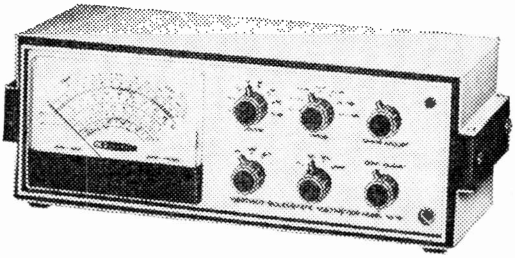
Seven ohmmeter ranges are featured: x1 (with 10Ω at the centre scale), x10, x100, x1k, x10k, x100k and x1MΩ.

Eight a.c. and d.c. ranges from 0·5V to 1500V full scale are employed with accuracy of ±5% of full scale for a.c. and ±3% of full scale for d.c. The input impedance is 11MΩ on the d.c. ranges



V-O-M type IM-25.

Voltmeter type IM-16.



and 1MΩ on the a.c. ranges. Price in kit form is £28 8s.

The second unit is a Solid-State High Impedance Volt/Ohm/Milliammeter, model IM-25. This has nine a.c. and d.c. ranges from 150mV to 1500V with accuracy of ±5% for a.c. and ±3% for d.c. Eleven current ranges from 15μA to 1·5μA and seven resistance ranges (10Ω centre scale) x1, x10, x100, x1k, x10k, x100k and x1MΩ are provided. A.C. response is to 100kc/s (±2dB). Price in kit form is £48 10s.

INSIDE tv TODAY

PART 12

COLOUR B

M. D. BENEDICT

AFTER several months of very successful BBC colour television with Independent companies installing colour equipment in readiness for colour on ITV, colour television has at last left the experimental stage that started in this country as long ago as 1954. In those days the American NTSC system represented the first practical fully compatible system of colour transmission though many other systems had been proposed, both in this country and abroad.

Colour television dates back to 1928 when Baird demonstrated a colour television system using a field sequential technique with a version of his normal scanning disc arrangement. Even in those days it was appreciated that the colour picture could be synthesised from three basic colours—red, blue and green. A simultaneous scanning system was developed in America soon afterwards, similar in other respects to the Baird system.

With the development of monochrome television towards the high definition system colour television development was shelved until about 1940 when Columbia Broadcasting System (CBS) developed a field sequential technique. It used a rotating filter wheel containing six segments, two of each primary colour (red, green and blue). Such a wheel was placed in front of a black-and-white camera and a similar wheel in front of the receiver. The wheels were synchronised to each other and to the vertical scanning rate of the camera so that a complete field was scanned whilst a given colour was in front of the lens. A field of each colour was transmitted in sequence and the three colour images appeared superimposed due to the persistence of vision of the human eye.

The deficiencies of such simple colour systems soon became apparent. In order to broadcast this system within the 6Mc/s channel bandwidth allowed, the scanning standards were altered to give a 120c/s field rate and 343 lines per picture. This non-standard signal meant that only specially modified receivers were satisfactory with black-and-white and colour pictures suffered from a lot of flicker.

After the war CBS decided to try out a more advanced standard which required a 12Mc/s bandwidth. RCA proposed a different system in which the green signal was assumed to be equivalent to the black-and-white signal and the red and blue signals were separately transmitted on a subcarrier but with a lower definition than was normal. Ordinary scanning standards were used (525 lines, 60c/s) and normal receivers displayed the green signal only. Thus ordinary black-and-white receivers needed no modifications in order to receive colour transmissions although naturally displaying them in monochrome.

However, the Federal Communications Commission, who control broadcasting in the United States, decided to opt for a 6Mc/s bandwidth, field sequential system. CBS adapted their field sequential system to fit this by using 405 lines, a 144c/s field rate and a "crispening" technique to improve horizontal definition. This system was transmitted in 1951 in New York but not without controversy. RCA had developed their ideas of using different bandwidths for various colours and this development was proposed as a rival to the CBS system but was turned down.

RCA's system took the three colour signals and filtered off the high frequencies (2-4Mc/s). The low-frequency colour signals were applied to a switch which switched red, green or blue signals sequentially at a very high rate. The high-frequency components were combined and transmitted together so that the complete signal was a low-frequency component of sequential colour signals laying down "dots" of information for colour with a high-frequency component corresponding to black-and-white detail. The eye does not notice small details in colour changes, only small details of brightness changes, so that this was not a handicap. The system was both compatible (i.e. ordinary monochrome receivers work satisfactorily on colour transmissions) and reverse compatible (i.e. colour receivers reproduced black-and-white transmissions satisfactorily). The RCA system was in fact only a short step from the NTSC system and the FCC was heavily criticised for not realising the potential of the RCA system.

Although the FCC had made up their minds on the system many people disagreed and the National Television System Committee (NTSC) was set up to coordinate various firms' efforts to find a better system than the CBS field-sequential system and then to alter the FCC decision. RCA and other industrial organisations provided a considerable research effort in which it soon

ROADCASTING

became realised that since the eye does not see small details of colour changes the RCA system demonstrated a very useful technique in conserving bandwidth. It was then apparent that it would be necessary to transmit a black-and-white signal and add colour information of limited bandwidth. The black-and-white, or luminance, signal was obtained by mixing the correct proportion of full-bandwidth red, green and blue signals while the colour information, called chrominance, was found to require a bandwidth of only 1·3Mc/s and 0·5Mc/s (only two colours need be transmitted as the third can be obtained from the black-and-white information). These figures refer to the American standards.

To achieve the aim of reverse compatibility it was necessary that white, grey and black signals (i.e. those without colour) should reduce the colour information to zero. Hence when a colour set received no colour or chrominance signal it would reproduce a monochrome picture. This was done by mixing the colour signals in such a manner that *colour-difference* signals were obtained, i.e. red−luminance and blue−luminance. When only greys and whites are present the red, blue and luminance (called Y) outputs are equal so that both R−Y and B−Y are zero, i.e. no colour information is present.

NTSC settled on a system of quadrature modulation to transmit both chrominance signals as the technique allows two separate signals to be carried on the same carrier. This was placed within the video bandwidth at a frequency of 3·579545Mc/s, so a complete fully-compatible system was obtained within the normal bandwidth. After field tests it was apparent that the system was a winner and the FCC was forced to rescind its original decision. NTSC transmissions were started in January, 1954.

The BBC kept in close touch with the American scene and realising the NTSC potential it was decided to adopt the NTSC system which was, of course, designed for 525 lines to the British 405-line standard. This required changes in subcarrier frequency and bandwidths, yet the British 405-line NTSC system proved even more successful than the original American system in several respects.

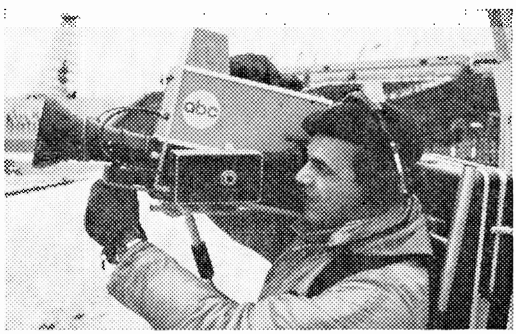
Colour cameras and coding equipment were built and installed in the studio now used for BBC-2 colour news transmissions and in 1954 test transmissions were started, broadcasting after close down. Many experiments followed showing that by about 1958 colour television was a practical system ready for introduction on BBC and ITV.

However at this time many manufacturers felt that colour would not sell well enough to compensate for the amount of development required by firms who had not followed colour developments in this country. They put up the alternative suggestion that a 625-line u.h.f. service should be introduced. This divided the radio industry into two groups—those for colour on 405 lines and those for 625-line monochrome and colour on this standard at a later date. Technically the 625-line systems would be better than the 405 standard provided that the coverage on u.h.f. could be as good as the v.h.f. coverage. Most engineers could see that the coverage was the critical factor but field tests only showed that it was harder to get a satisfactory coverage. Just how hard was a matter of opinion and the opinions were largely influenced by the politics of the situation and a vociferous pressure group backed by the Pye group.

In the end it was left to the Pilkington Committee to make a decision. In its report published in 1962 Pilkington endorsed the idea of a third channel and postponed a decision on colour except to say that it should be on the new channel to be run by the BBC. In spite of strong opposition from the ITA who demanded a 405 colour service, the BBC started their service in April 1964, a day after the Television Centre was put off the air by a failure of mains due to a fire at Battersea Power Station!

As there was enough bandwidth on the u.h.f. frequencies it was planned that BBC-1 and ITA should move to 625 and then start colour services. After the start of BBC-2 the decision on colour television became considerably more complex when SECAM and PAL became serious rivals to the NTSC.

SECAM, a variation of the basic NTSC idea, was developed in France and by about 1960, the time of the Pilkington Committee, it was being examined in this country by GEC and ABC TV who saw in this system a chance to catch up with the BBC's lead in colour work. SECAM used a different method of transmitting the colour infor-



An Ampex "Scrambler" used at the Winter Olympics at Grenoble. The cameraman views an electronic viewfinder based on a 1 in. c.r.t.

mation. This was done because quadrature modulation suffers badly from phase distortion in some amplifiers unless they are carefully designed, resulting in changes of colour with changes in brightness. In the SECAM system R-Y is transmitted on one line and B-Y on the next line, both being frequency modulated before combination with the luminance signal. At the receiver, the colour signals are separated and fed to a delay line as well as direct to a demodulator which uses one signal, say R-Y, direct with the other, B-Y, delayed from the previous line via the delay line. On the next line it is the B-Y signal that is used direct and the R-Y that is delayed. Both R-Y and B-Y information is thus available for the demodulator.

Unfortunately the f.m. technique used meant that the subcarrier was always present even when no colours were present, unlike the NTSC quadrature modulation technique where the carrier is suppressed when the colour-difference signals are modulated. Hence on SECAM the subcarrier is somewhat more visible. In addition with NTSC the subcarrier is made to be an exact multiple of line frequency so that the dot pattern it produces on the displayed picture is less obvious as adjacent dots to a large extent cancel out. With frequency modulation there is no fixed carrier frequency so that this technique is impossible to apply.

The German PAL modification of the NTSC system has proved to be one of the best as it overcomes the major disadvantage of NTSC, susceptibility to phase distortion occurring in amplifiers, video-tape recorders and long links, without losing other advantages of the system. In this system the phase of one of the chrominance signals is reversed on alternate lines before being modulated on to the subcarrier. At the receiver the phase is switched back in step with the switch in the coder so that demodulation takes place in the normal NTSC manner. However, if any phase distortion has taken place between the coder in the studio and the decoder in the set this distortion on alternate lines will be opposite and can be cancelled out electronically in the receiver by using a delay line to store the previous line signals for addition (de luxe PAL) or by allowing the errors in adjacent lines to cancel optically (simple PAL).

Although the decision to start a colour service in the UK was delayed for political reasons it did allow the SECAM and PAL systems to be evaluated. In addition the delay allowed technical developments, in particular the introduction of the Plumbicon camera tube, to be used as well as the development of fully-transistorised ancillary studio equipment giving better stability than valve equipment. So when the BBC started its full colour service on 2nd December 1967 it was in the fortunate position of having a large choice of new equipment. In February 1967 it was agreed that ITV would duplicate their 405 service on 625 lines u.h.f. in late 1969 and colour transmissions would start then or soon afterwards. BBC-1 will also go 625 at about the same date.

Colour Cameras

The most important part of the system is of course the colour camera. Early colour cameras used three image-orthicon tubes but the bulk and weight of these tubes and their yokes make such cameras very heavy and unwieldy. Although these are still made in America and Japan the Plumbicon-tubed cameras are being developed by, or are available from, most manufacturers.

In all colour TV cameras the light enters from the lens in the normal way but is then split into the three primary-colour components. A special type of coated prism reflects certain wavelengths and passes others. Two of these "dichroic" surfaces separate off two of the required colours leaving the third primary colour image to pass direct to its corresponding camera tube. Filters are used to adjust the colour balance in a precise manner determined by theoretical considerations. After passing through these filters the light passes to the respective tubes so that three separate outputs are obtained.

In some newer cameras the light is split four ways, between the colour tubes and a monochrome one. It may seem rather pointless to obtain red, green, blue and monochrome pictures when it is simple to obtain the monochrome one by simply combining the red, green and blue pictures as is in fact done in three-tube cameras where the correct proportions of the three primary colours (59% green, 30% red and 11% blue) are combined to give a black-and-white or luminance signal. (This is the picture displayed on black-and-white receivers or monitors connected to the output of the coding equipment.)

In the case of four-tube or separate-luminance cameras, however, the luminance image is derived direct from the fourth tube and is claimed to be of higher quality than that obtained in three-tube cameras. When lining up a three-tube camera the images for each colour must be exactly superimposed (registered) or colour fringing will occur where the images do not exactly coincide. Naturally the geometry of each tube and its scanning yoke must be very good and matched to the other tubes and their yokes in order to achieve this. The four-tube camera provides a luminance signal without any errors in registration and as the outputs of the red, green and blue tubes are later restricted in definition the effects of any misregistration are not as noticeable. For the best quality black-and-white pictures the registration of the three-tube camera must be of the highest order otherwise the definition deteriorates. Naturally this is not so important for separate-luminance cameras. The penalty for

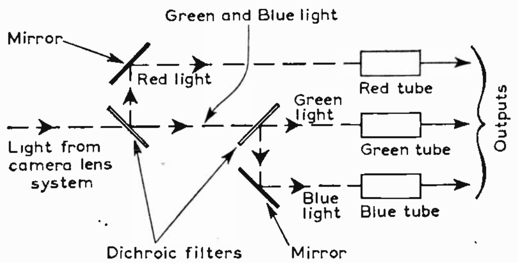
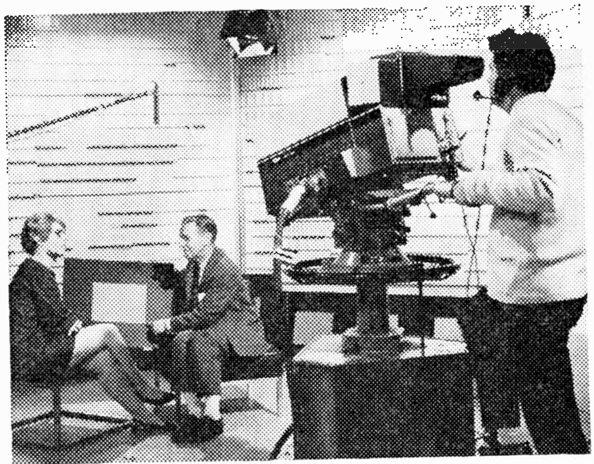


Fig. 9: How a system of mirrors and light filters separates the three primary-colour components of the light from the scene being televised in a three-tube camera.

this extra performance is a decrease in sensitivity as the light has to be split between the separate luminance or fourth tube and the three colour tubes.

Philips, who make the leading three-tube cameras, have come up with the answer to this problem, however. When they first produced a successful lead-oxide or Plumbicon camera tube they were very quick to realise its potential for colour television. An early colour camera of remarkably small size was tested by the BBC and proved a very good basis for the colour television camera now marketed in this country by Peto Scott. The present range of Peto Scott cameras are all three-tube cameras (though signal processing offers some of the advantages of a four-tube cameras). No luminance tube means extra light levels of 15ft.-candles (a poor reading light is brighter than this) though normal levels are around 150ft.-candles (just higher than that of a studio equipped with monochrome image-orthicon cameras).



The EMI 2001 *camera in action on Late Night Round-Up.*

If the high-frequency component of the luminance signal is taken from the green tube rather than all three tubes the effects of slight misregistration will be less. Green comprises over half the luminance signal and taking the fine detail from the green channel rather than a separate monochrome channel does not alter the picture very much.

Like most other manufacturers Philips produced a device for correcting aperture distortion. This is caused by the finite size of the scanning beam and results in loss of high-frequency details in the horizontal and vertical direction. Correction is simple in the horizontal sense as a form of variable high-frequency boost is applied; all camera channels apply this as standard, whether monochrome or colour. Vertical aperture correction is much more complex and the technique is fairly new. It can be used with any signal and can be placed anywhere in the transmission chain. The video signals are fed through a delay line which delays the signal by exactly one line. This delayed signal is then compared with the incoming direct video signal corresponding to the same point on the following line. It is also compared with the signal from the previous line which is obtained from a second delay line. Changes between these three signals are detected and exaggerated before being added to the original signal. This has the effect of sharpening all horizontal edges, i.e. correcting for picture distortion in a vertical sense. Both monochrome and colour pictures derive a great deal of extra sharpness and sparkle from such a unit but in addition Philips use their device to process the green signal for both horizontal and vertical correction before adding it back to each colour channel as high-frequency detail. This detail is not dependent on the registration of the tubes thus reducing the effects of misregistration just as with a four-tube camera but without the light losses of such cameras.

Philips Plumbicon cameras were the first colour cameras available with these tubes and their lighter weight and ruggedness as well as their ability to work in very low light levels makes them very popular for o.b. use; the BBC and ATV, as well as many stations in the USA, use units equipped with these cameras. As with all colour cameras available in this country a servo-controlled zoom lens integrated into the camera is used. These cameras are simple to use and easy to line up compared to some other types of camera. Philips, through Peto Scott, are now producing a newer type of channel which incorporates detailed improvements over their original camera.

In addition to this Philips have produced as an experiment a hand-held colour camera which is based on their normal high-quality industrial colour channel. Little more than the three tubes is carried at the camera head, most of the equipment being mounted in a back pack with a monitor hanging from a belt, facing upwards, to act as a viewfinder. After use by the BBC several improvements to this camera have been devised, and would be incorporated in a production version.

Marconi produced the first four-tube camera for quantity production, the Marconi Mark VII. Several companies have used four tubes in experimental tests even to the extent of using 4½in. image-orthicon tubes! However with the advent of the Plumbicon tube a four-tube layout became a practical proposition.

ABC TV ordered these cameras off the drawing board and as soon as they were announced BBC ordered 17 for the colour studios at the Television Centre. Thin-film circuits featuring resistors deposited direct on to glass were a new technique incorporated, along with other high-stability components, in an effort to increase stability to a point where no operational controls are necessary except for the normal lift, iris and gain controls found on all cameras. A high-quality luminance signal is assured by using a high focusing potential on the luminance tube, three times that of the chrominance tubes.

Like all other colour cameras in use in this country the Marconi Mark VII is fitted with an integrated servo-controlled zoom lens but since a relay lens system is used lenses of the larger image-orthicon tube size are used. A relay lens forms the image farther away from the main lens, allowing a longer light path before being focused on the various tube faces. Like most other colour cameras neutral-density filters and colour-correction filters are incorporated. As an emergency facility should the light fail on an outside broadcast all light can be directed straight to the luminance tube to give a sensitive black-and-white only output.

Marconis have reverted to a tilting viewfinder allowing the tube to be viewed directly with the camera at various heights and positions. Like the other colour cameras a high brightness display c.r.t. is used in the viewfinder allowing comfortable viewing in the bright studio lighting. Normally this would be about 200-300ft.-lamberts but it is claimed that pictures can be used down to levels of 30ft.-lamberts.

Use of a relay lens system allows all the tubes to be nearly parallel to each other so that the effect of the earth's magnetic field on registration is the same for all the tubes.

Because of the large size and weight of the cameras ($18\frac{1}{2} \times 11 \times 26$in. without the zoom lens) it has been necessary to alter many of the mountings used in the studio. In particular the camera crane platforms need extending to allow the cameraman enough room behind the camera. One particularly special use is for the Austrian version of "The Golden Shot" where the Marconi cameras are the only cameras proof against the recoil effect of the crossbow; other cameras tested tended to lose registration.

In order to correct for lack of balance between cameras and imbalance in the studio scene Marconi produced a "paint pot" control operated like a joystick. This varies the gain of each colour channel by movements of the joystick around a "colour triangle". Hence movement towards the red apex of the colour triangle reduces the green and blue as well as increasing the red gain. Unlike the present technique of adjusting the preset controls any alterations with the "paint pot" can be easily restored to normal. It can be used to correct for some effects of difficult lighting. Also available with the Mark VII camera is a vertical aperture corrector which gives the same sharpening effect to the picture as the Philips equipment, although this is not used to provide the "contours out of the green tube" technique used by Philips.

Last in the colour camera stakes in this country was EMI with a four lead-oxide vidicon channel called the Type 2001; "lead-oxide vidicon" because the term Plumbicon is a Philips trade name. Somewhat similar and lighter than the Marconi, this camera has no external lenses as its zoom lens is completely integrated into the camera. As with an earlier three-tube vidicon channel direct optics are used, the integrated lens being designed to give sufficient light path length. Both weight and space are saved and light losses minimised by this technique. Servo amplifiers for the zoom lens are built in and all the normal controls are fitted to the back of the camera but may be detached if required.

In fact two types of zoom lenses are provided, one for outside broadcasts and the other for studio use, the difference being the ranges covered by these 10-1 zoom lenses. Since the lens does not project to any great extent the cameras are easier to carry and when in position they are easy to balance for the cameraman.

The four tubes are mounted in a capstan arrangement radiating from the colour splitting prism assembly. This allows a reduced light path length but means that careful screening of the yokes is necessary to prevent external magnetic fields affecting the registration. Naturally great care has gone into the stability of all the circuits and in practice this works well. Power supplies are particularly stable and incorporate overload protection and a sensing circuit to compensate for losses in long camera cables. All video amplifiers are heavily stabilised by negative feedback and many advanced techniques are used.

Errors in colour analysis with four-tube systems do occur with straightforward matrixes and when gamma correction takes place. Plumbicon tubes have a linear output (i.e., gamma = 1) and so the signal must be corrected to a gamma of about 0·4 for transmission. Gamma correction upsets the maths on which the coding of the colour signals depends, and although such errors are small they may be significant with certain scenes. EMI use an unusually complex coding system which helps to eliminate this and other errors.

EMI's 2001 camera is proving a great success, particularly with the BBC where it is replacing some of the Marconi Mark VII cameras. Engineers who tested the various types of camera recall when EMI sent a camera for trials. Unlike the other companies no engineers accompanied the demonstration camera, only an instruction manual. When removed from its packing case and connected to its c.c.u. and power supply it was found to need very little alignment and produced first-class colour pictures! This is probably a tribute to its ruggedness and no doubt it will be very popular for outside broadcasts as it is very sensitive for a four-tube camera (100-150 ft.-candles normally).

Another camera which no doubt will prove very popular is a hand-held camera produced by Ampex who normally do not manufacture cameras for broadcast use. Not only does it have only two tubes, but it is linked to the mobile control room by a two-way radio link which locks the output of the camera to the mobile control room pulses, even to the phase of the subcarrier. Most of the coding and processing equipment is carried on a back pack, as is the transmitter/receiver unit, this being replaced by a lightweight cable link if the flexibility of the radio camera is not required.

No details of the two-tube system have been released but a very successful Japanese two-tube colour camera used one tube for luminance and the second for providing both sets of colour information required. On the face of the chrominance tube was placed a special filter consisting of two strips of two different colour filters. The video signal from this channel consisted of alternate colour information and suitable circuits coded this with information from the luminance tube. Naturally this relied on the reduced amount of information required from a chrominance tube, otherwise the filter would be very difficult to manufacture.

TO BE CONTINUED

THE PRACTICAL TV VALVE TESTER

PART 2

MARTIN L. MICHAELIS, M.A.

TELEVISION receivers generally use valves with heaters designed for a fixed current, commonly 0·3A in the P-series. This allows all valves to be run in series with each other and a suitable dropper across the mains. The different heater powers are obtained with corresponding voltage ratings. The most common heater voltage for valves operated in parallel off a transformer winding is 6·3V ±5%, so that these valves can also be operated on a 6V supply. Other heater voltages for transformer-operated valves and battery valves are nowadays rare. P-series valves normally do not use heater voltages greater than 30V. Some older television receivers are still in use with series chain valves for lower heater currents, requiring heater voltages up to 90V. If it is felt that a need may arise for testing such valves an additional 60V, 0·15A centre-tapped winding should be provided on one of the mains transformers.

The most convenient source for operating any P-series valve heater as well as normal 6·3V and 12·6V types comprises a pair of separate 15V transformer windings rated at 1A continuous, 1·5A intermittent duty, and each tapped at 10V and 12V. All required voltages are available either directly or by means of appropriate series addition or series opposition connection of these windings or parts of them. It is an easy matter to rewind the secondary side of a 30W heater transformer to provide these two tapped windings. They should be wound bifilar, i.e. two wires should be wound in neat layers simultaneously, so that alternate turns on each layer belong to the respective windings. This ensures absolute symmetry and also permits parallel connection for higher currents where appropriate. Count the turns of the old winding when stripping it off to determine the turns per volt figure for the new windings.

6·3V heaters are run at 6V by linking the 12V tap of one winding to the 15V tap of the other and taking the remaining 12V and 15V taps to the heater pins. 25V for a PL36 would be obtained by connecting one whole 15V winding in series with 10V of the other. 9V for a PCC85 would be obtained by connecting the 12V section of one winding in series *opposition* with the 3V section between the 12V and 15V taps of the other winding. To avoid confusion the wander-plug sockets on the front panel should be placed in consecutive order of increasing voltage so that series addition results when the leads to the heater pins embrace the crosslink between the windings whilst series subtraction (opposition) results when the crosslink embraces the two connections to the heater pins.

The voltage controls can be calibrated directly since all d.c. supplies are fully stabilised. Thus voltmeter ranges are not required but may be added in the conventional manner if desired, or a multimeter can be connected externally in parallel with the load.

The built-in meter provides only current readings. It is evident from the circuit (Fig. 1) that this meter is in series with the low h.t. output (h.t.+1) in settings 1 and 2 of the meter switch S2 whilst in the third setting of S2 it is in series with the high h.t. output (h.t.+2). Appropriate shunts are switched across the meter in each setting and the other h.t. supply is always connected straight through to its output socket. Thus current readings may be taken successively for screen and anode by moving the meter switch accordingly without disturbing the test circuit. The two settings for h.t.+1 provide 10mA and 40mA f.s.d. ranges respectively. The latter covers all values up to the maximum permissible current for this output whilst the former range provides greater resolution for reading very small currents. The third switch setting gives a single 100mA f.s.d. range for the h.t.+2 output. A large meter should be used so that small currents can still be read reasonably accurately on this range. If only a small meter is available further switch positions may be added to give low current ranges for the h.t.+2 output too.

It is *very important* to employ a switch type with break-before-make action for S2 since serious short-circuits are possible if contacts belonging to different settings are bridged by the wipers. A suitable available switch will probably possess two wafers each containing three single-pole three-way sections. One of these six sections is superfluous since the circuit requires only five sections. Unless it is used to switch the multiplier series resistors if voltmeter ranges are added a sixth section should be connected in parallel with section E. This is not essential, but it reduces the possible danger of erratic readings in case the switch section E deteriorates. The latter is in series with the meter branch M1, R37 which is switched across the shunts R35 and R36 so that any appreciable contact resistance at E will affect the current sharing ratio between the meter and the shunt. This error is imperceptibly small with a healthy switch in this circuit because the value of R37 is vastly greater than normal switch contact resistances. However, this form of circuit would be rather unreliable if R37 is omitted and the shunts R35, R36 are given correspondingly smaller values.

The series resistor R37 is necessary for a further important reason. If a short-circuit is

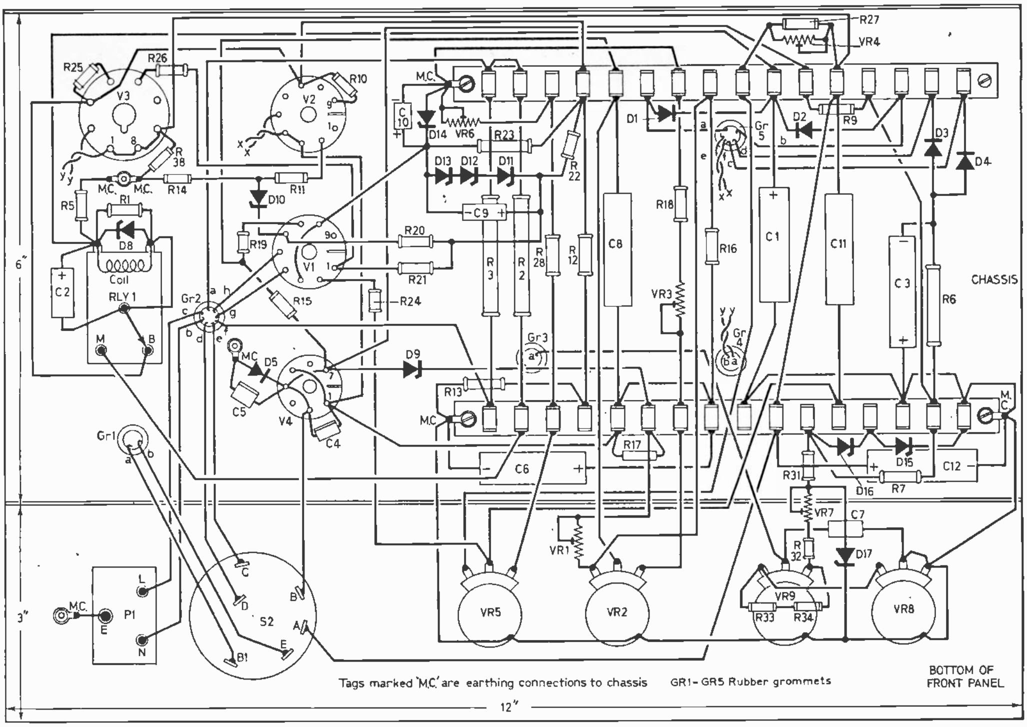


Fig. 2: Below chassis wiring diagram. The connections to S2 will be shown in greater detail in Part 3.

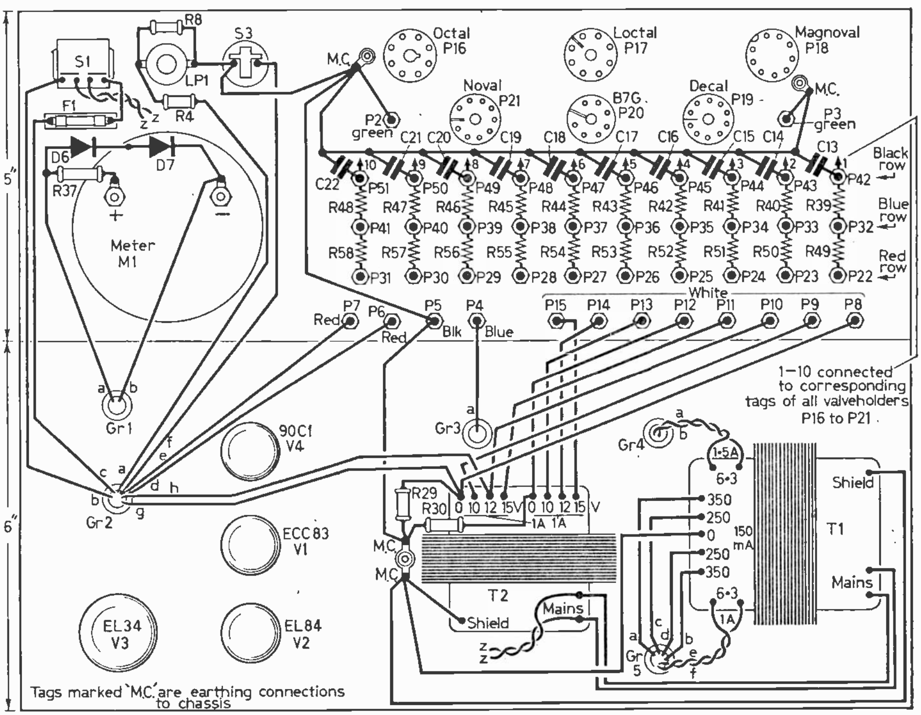


Fig. 3: Above chassis wiring diagram.

caused by a faulty valve being tested or by some other external overload the pointer of an unprotected meter would slam over hard beyond full-scale deflection leading to early damage to the meter especially on the lower current ranges. This hazard is completely avoided by connecting two ordinary silicon rectifier diodes D6 and D7 across the meter in the conducting sense. As soon as the threshold voltage for these diodes is exceeded by the voltage drop across the meter the diodes conduct and divert all further current from the meter. The value of R37 has been chosen to make the voltage drop across itself and the meter equal to the threshold of the two silicon diodes at about 1·5 times full-scale deflection of the meter. This avoids non-linearity near full-scale deflection and gives a safety margin with respect to the drop of the silicon threshold voltage with increasing temperature but still provides adequate protection.

On a full short-circuit the overload trip RLY1 operates faster than inertia allows the meter pointer to reach a final reading so that the meter merely gives a harmless kick and then drops back to zero. In view of the need for a meter protection circuit it is inappropriate to save the cost of a meter by using an existing multimeter externally for taking current readings: this multimeter could be destroyed in such an arrangement if the valve on test has an internal short. On the other hand it is quite safe if desired to use a multimeter externally as an output voltmeter.

The meter protection circuit introduces resistance into the h.t. outputs and this is tantamount to a slightly poorer voltage stabilisation factor. This impairment amounts to about 0.5V drop at full-scale deflection. As this is not more than 25% of the maximum drop due to the residual impedance of the stabilised circuits, it is negligible within the normal tolerance range for this unit. This also means that the change in output voltage and current for any given load is negligible when the meter is switched into and out of the circuit so that the arrangement is satisfactory in every way.

In its normally de-energised state relay RLY1 feeds the rectified h.t. voltage from the reservoir capacitor to the stabiliser circuit, via its own coil and a resting contact. If the current in any branch or the sum current exceeds about 150mA the relay will energise and break all h.t. outputs immediately. Capacitor C2 across the relay coil sustains current through the coil for a sufficient time to allow the contact to move over from the break to the make positions. The relay then latches permanently via its make contact and resistors R2 and R3. A neon pilot lamp LP1 on the front panel indicates this state. All h.t. outputs are now dead because the raw d.c. feeds to the stabiliser valve anodes are broken at the break contact of the relay. After clearing the short-circuit the h.t. outputs can be restored by pressing button S3 briefly. This breaks the latching circuit of the relay so that the latter drops off and reconnects the stabiliser circuit.

Diode protection is required for the relay. During a short-circuit surge a large fraction of the high reservoir voltage of nearly 500V d.c. would be impressed across an unprotected relay coil. This treatment could seriously modify the magnetic and electrical parameters of the relay. It is important never to operate a relay much above its nominal voltage, preferably only just above its snap-in voltage, if it is to retain long-term stability of response at a definite current. A relay with 24V nominal rating is used here. Zener diode D8 prevents the voltage across the coil from rising above 22V. A good power zener diode is necessary because it must carry large short-circuit surge currents which approach 1A in some settings. D8 also permits use of a low-voltage electrolytic for C2.

RELAY SUBSTITUTES

If the specified relay is unobtainable any other type may be used provided the snap-in voltage and current values do not exceed those of the specified type and that the contacts are capable of carrying *and breaking* up to 500V 1A d.c. on resistive load. For any such substitute relay first measure the snap-in current with a meter and variable resistor. Next add a series resistor of adequate current rating to make the snap-in voltage 16V across coil and series resistor. Then shunt this series connection with a resistor R1 calculated and selected so that the snap-in values for the entire combination become 16V 150mA.

D8 remains unchanged but C2 will have to be checked. If the circuit already hunts instead of switching off promptly on a total short-circuit deliberately applied to the output C2 is too small for the substitute relay. On the other hand if switch-off is prompt and reliable check that it is still reliable with at most one hunt cycle when the value of C2 is temporarily halved. After a satisfactory coarse value for C2 has been found in this manner gradually increase the output current (use a suitable high-wattage fixed resistor and turn up the voltage control) over a period of about two seconds. Make sure that definite switch-off takes place at about 150mA even under these circumstances without hunting. If necessary increase the value of C2 until this condition is satisfied or bend the relay contacts judiciously.

THE STABILISER CIRCUIT

The principles of the stabiliser circuit are best understood with reference to Fig. 4. Fig. 4(a) shows the conventional choke-capacitor smoothing circuit for an h.t. supply. The reservoir capacitor C1a is continually charged to the raw d.c. voltage from the rectifier. The resulting voltage across C1a has a high ripple because the rectifier injects new charge only in brief pulses around each peak of the a.c. waveform whilst charge is being drained off continuously. The choke L1a possesses a high impedance and the capacitor C2a a low impedance to this a.c. ripple component so that with suitable component values the ripple is dropped almost entirely across the choke and the output voltage across C2a is essentially smooth d.c. Whilst this circuit gives a ripple-free d.c. output it cannot give a constant output voltage irrespective of the output load current because the steady voltage drop across the d.c. resistance of the choke, rectifier and transformer depends upon the load current. These variable losses can be compensated by replacing

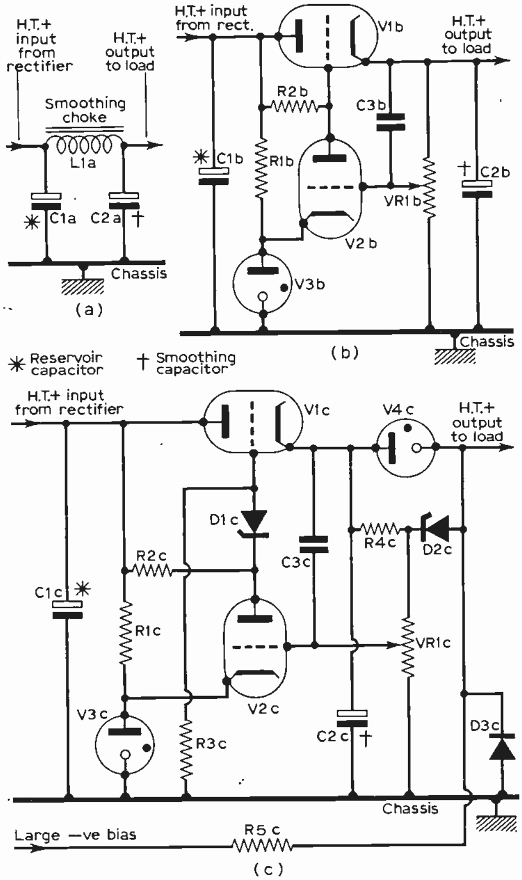


Fig. 4: Basic principles of voltage regulation. (a) Conventional Π-filter h.t. smoothing circuit. (b) H.T. stabiliser smoothing circuit for variable medium to high output voltages. (c) H.T. stabiliser circuit for variable low to medium output voltages. Components with same functions carry the same numbers in these circuits; suffixes a-c distinguish them in the various circuits (a), (b) and (c).

the choke with an automatically variable impedance consisting of a network of three valves, three resistors and a capacitor as shown in Fig. 4(b).

If there is any ripple voltage across C2b this is fed via C3b to the grid of V2b which in turn feeds an amplified *phase inverted* replica to the control grid of V1b which functions as a high-inductance choke whose reactance is determined by the gain of V2b and the slope of V1b.

If the d.c. voltage across C2b tries to change a fraction of this change is immediately felt at V2b grid via VR1b. Since the cathode of V2b is clamped at constant voltage by the reference neon V3b the anode current of V2b and thus the grid voltage of V1b must shift. The phasing corresponds to negative feedback so that the tendency is to cancel the initial change of output voltage. It is immaterial whether the initial change was due to a change of input voltage (mains fluctuation) or a change of output load. The d.c. resistance of V1b is automatically altered so that the output voltage remains constant at a value which makes the voltage at VR1b slider approximately equal to the running voltage of the neon tube V3b irrespective of the output load current. V1b thus not only functions as a high-inductance choke but also as an automatically variable resistor in series with this choke. The output voltage across C2b is thus essentially constant and almost free from ripple.

The output voltage can be set to any value within a certain range by moving the slider of VR1b. The ratio of the output voltage to the running voltage of the neon V3b is approximately equal to the ratio of the full track resistance of VR1b to the resistance of the section between the slider and chassis.

There is an upper as well as a lower limit to the range of output voltages which this circuit can provide. The grid of V1b must be negative with respect to its cathode so that the anode of V2b is always at a potential somewhat less than the output voltage across C2b. But the cathode of V2b is held at the running voltage of the neon V3b. Consequently the output voltage must be considerably greater than the running voltage of the neon, normally at least twice as great, since the h.t. voltage across V2b is at most equal to the difference and if this is too small V2b is unable to fulfil its error-amplifying function. The smoothing function and the voltage stabilisation then both fail. Normal neons have running voltages of about 90V so that this circuit is unsuitable for providing output voltages less than about 180V.

Wherever possible modern circuits use zener diodes instead of neon tubes. This permits an unrestricted choice of zener voltage and obviates problems caused by the difference between the striking and running voltages of a neon tube. In principle we could use a low-voltage zener diode in place of V3b in order to obtain lower minimum output voltages. But we still require at least 50V between the cathode and anode of V2b for proper error amplification. Furthermore the zener voltage at V2b cathode must still be large compared to the grid base of V2b since the latter is the error control range. If the zener voltage is reduced until it is comparable to the error control range (grid base) the control swing will be a large fraction of the reference voltage so that voltage stabilisation is lost. Thus even with a suitable zener diode in place of V3b the circuit is unable to provide well stabilised voltages less than about 100V.

Fig. 4(c) shows the modifications which will make it possible in principle to obtain stablised voltages right down to zero. A neon tube V4c is connected in series with the output so that it subtracts its own running voltage from the actual stabilised output voltage in the same manner as the zener cables discussed in Part 1.

The stabilised output voltage can have a minimum value of 100V as we have just seen, which is about equal to the running voltage of a neon tube, so that theoretically the remaining voltage beyond the neon tube can now be taken right down to zero. In practice this is still not quite realisable. The residual load-dependent voltage change is retained in full and even aggravated by the differential resistance of the neon tube V4c. Thus an output setting of 0V at one load current may drift to some positive or negative value at other load currents. In other words the zero point would be unstable.

The output voltage must not go negative so that D3c is essential and thus the minimum stabilised voltage at V1c cathode must be the striking voltage, not the running voltage, of V4c. As soon as V4c has struck the difference appears at the output. It has a value of about 20V which is now the minimim output voltage reliably obtainable in practice. A zener diode in place of the neon tube V4c would avoid the voltage discrepancy between striking and running but the current rating of common 100V zener diodes is far too low. Thus the function of V4c is an example of where a neon tube is still superior to a zener diode. All other reference voltage functions in our circuit have been taken over by zener diodes. In general neon tubes are superior when high voltages and high currents are involved: the rated power dissipation of a neon tube is superior and its temperature coefficient is smaller under these conditions.

STABILISER LOOP DESIGN

The stabiliser loop is the circuit loop from the point of sensing the output voltage via V2c and V1c back to the output voltage sensing point. Impedances outside this loop on the output side cannot be compensated with the stabiliser and thus impair the performance. The differential resistance of a neon tube is large compared to that of the main stabiliser so that it is most desirable to include the neon tube V4c in the stabiliser loop. To do this the sensing feed to VR1c must be taken from the cathode of V4c and not from the cathode of V1c. But this would immediately defeat the purpose of V4c since the cathode voltage of the neon must then be at least about equal to the running voltage of V3c and we have simply raised the minimum possible voltage at V1c cathode.

To overcome this difficulty we must connect a zener diode D2c and high-value resistor R4c in series across the neon V4c. The zener voltage of D2c is conveniently about two-thirds of the running voltage of the neon. The current in this shunt path across the neon is small and constant irrespective of the output load, so that the voltage at the junction point of the zener diode and the resistor is always a *fixed* amount higher than the output voltage at the cathode of the neon tube. We can now take the sensing feed for V2c from this junction point. Only a third of the running voltage of the neon V4c is then added back to the minimum voltage at V1c cathode, yet the neon is entirely within the stabiliser loop.

The further zener diode D1c reduces the minimum voltage at V1c again by the remaining third of the running voltage of V4c, because it makes V2c anode rest higher than V1c grid by an amount equal to its zener voltage. The minimum usable operating voltage of V2c then corresponds to a lower voltage at V1c cathode. R3c is a high-value resistor to maintain sufficient minimum current through D1c for proper zener operation even when V2c is nearly cut off.

R5c is taken to a large negative voltage and ensures that a minimum current flows through the neon V4c on open-circuit output to prevent sawtooth oscillation. It is necessary to use a high value for R5c taken to a large negative voltage, not a low-value resistor taken to chassis, because otherwise the internal current drain would increase to an unnecessarily large value and restrict the output current range at the higher voltage settings. It is no problem to find a suitable negative point to which R5c can be returned because a stabilised negative bias supply must be incorporated in the valve tester in any case.

D3c is a safety diode which normally rests cut off because all intended output voltages are positive. The function of D3c is to prevent the appearance of large negative voltages at the output via R5c before the neon tube V4c has struck after switching the unit on.

We must now consider the factors restricting the maximum available output voltages with the circuits shown in Figs. 4(b) and (c). In Fig. 4(b) this maximum voltage is less than the raw d.c. voltage across the reservoir capacitor C1b at full load current by an amount equal to the voltage drop across V1b at zero bias and full load current. Thus it is theoretically possible to obtain any desired maximum output voltage by designing the transformer and rectifier to produce a sufficiently large raw d.c. voltage across the reservoir capacitor C1b. However this is subject to practical limitations because the maximum voltage ratings of valves V2b and V1b would soon be exceeded and the rated maximum power dissipation in V1b would be exceeded for low output voltages at high currents, i.e. the bottom end of the voltage control range would become restricted for this reason. Under otherwise identical conditions a circuit according to Fig. 4(c) gives a lower maximum output voltage than Fig. 4(b), the difference being the running voltage of neon tube V4c. The ability of circuit Fig. 4(c) to control down to zero output voltage is thus bought at the price of a correspondingly reduced maximum output voltage.

With a single circuit using common components it is evidently hardly possible to cover the entire voltage range from zero up to high values. The alternative of operating two circuits of type Fig. 4(b) back-to-back is uneconomical because it will not provide the required two independent outputs yet already uses two basic circuits. There would also be power wastage because two such circuits can be backed against each other only if the one driven with inverse current is preloaded internally so that the net current remains positive. The final solution we have adopted for our design is to use one circuit of each type according to Fig. 4(b) and Fig. 4(c) driven from a common transformer, rectifier and reservoir capacitor via the overload trip relay RLY1. This common feed is essential since a valve can suffer damage if the anode voltage is switched off and the screen supply left connected. The complete practical circuit based on Figs. 4(b) and (c) was given in Fig. 1, Part 1.

TO BE CONTINUED

MULLARD SHADOWMASK TUBE PRODUCTION

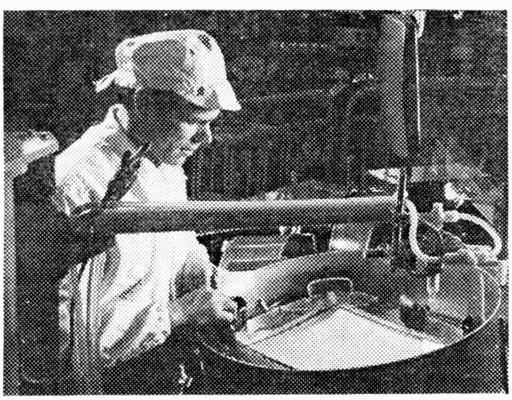
by DAVID CAMERON

THE shadowmask colour TV tube is the most expensive single item in a colour receiver, its production involving many intricate processes requiring considerable skill, ingenuity and precision. We were fortunate recently to be invited to look round the largest television picture tube factory in the UK, and the most modern in Europe, and as a result can provide a run down of what is involved in mass producing what is basically a custom built article.

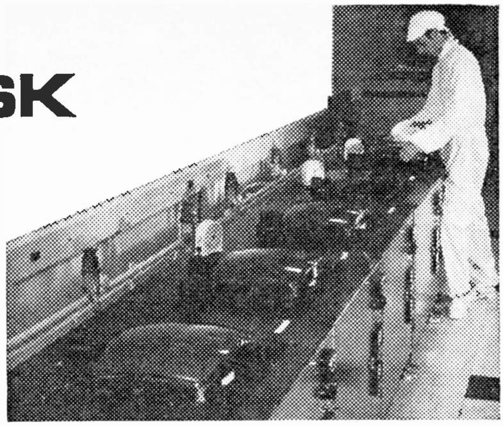
Simonstone, a small village between Preston and Burnley, was undeveloped until 1954 when Mullard Limited selected it as the site for their new colour TV tube plant. By the middle of 1955 pilot production was under way and since then the site has expanded to 44 acres. The plant is now producing up to 2,500 shadowmask tubes each week and this is expected to reach 3,000 by the end of this year, an annual production of 150,000 tubes. It is considered to be one of the most highly mechanised plants in the UK and much of the equipment has been designed and constructed by Mullard themselves. Nearly 2,000 people are employed, working on a 3-shift 24-hour system.

A striking feature of the plant is the conveyor system which is more than two miles long. Apart from the obvious use in transporting items in various stages of completion it is also employed, by timing, for purposes such as slow cooling, drying and as a "store". In fact some operations are performed with the tubes *on* the conveyor.

The complex includes its own glass factory, the second largest in the country, and plans are announced for the building of a second unit. It would be appropriate to begin at this stage of manufacture.



An operator loads a tube faceplate on to one of the flow mills where the phosphors are dispensed.



Our photo above shows faceplates in position on the lighthouse stations where each layer of colour phosphor is exposed to ultra-violet light to harden the phosphor dots.

Special quality glass is needed for picture tubes. It must be strong enough to withstand atmospheric pressure and a force of several tons when the tube is evacuated. The faceplate must be free from distortion and blemishes and must be able to withstand high-velocity electron bombardment without discoloration. And, of course, it must be capable of withstanding high voltages without electrical breakdown.

The glass is manufactured from sand, cullet (broken glass), soda ash, potassium carbonate and other additives depending on whether it is required for faceplates or cones. To change the type of glass being produced takes ten days. The raw materials are stored in giant bins and some ingredients are used in ratios of ounces to the ton. All handling and mixing is automated and the exact stage of the processing and the stage of each unit can be checked on a large illuminated panel something like those used in modern railway signal boxes.

The final mix is passed to a giant furnace of the regenerative tank type, oil-fired, and operating at 1,550°C. The life of this furnace is around 3½ years after which it has to be closed down and rebuilt. It handles 100 tons of glass a day.

The molten glass is fed to two automatic presses used alternately, "cooled" to 1,000°C. The correct amount for a faceplate is automatically dispensed, nipped off, and dropped into a pre-heated mould then pressed to shape. A quick cooling stage to set the glass then follows and the blemish which occurs where the glass was nipped off is eliminated by flame polishing. A 1½-hour annealing process relieves internal stresses in the faceplates which then pass through controlled decreasing temperature zones until they reach temperatures at which they can be handled.

Visual inspections for cracks, bubbles, etc are the next processes and each faceplate is checked on jigs for edge dimensions at 16 different points and screen curvature at 40 different points. Having passed this inspection the faceplates are fitted with three metal studs for the accurate locating of the shadowmask. The two final stages are polishing (there are 70 machines for this process) and grinding the edges optically flat. The faceplates are then ready for assembly.

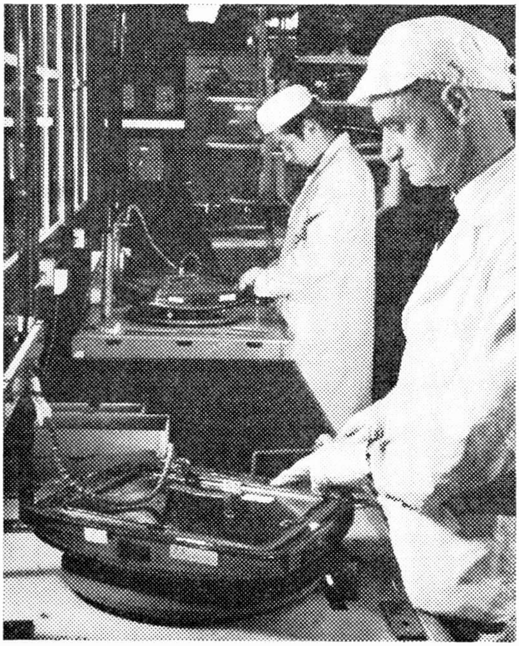
THE SHADOWMASK

A typical shadowmask is 0·006in. thick and has 440,000 holes at a density of about 1,500 to the square inch. These holes vary in size according to their position on the mask down to 220 microns diameter—and are tapered. The holes are etched in acid baths after exposure between two photographic negatives but extreme care in handling and cleanliness is vital because a spot of dust could easily become an unwanted "hole".

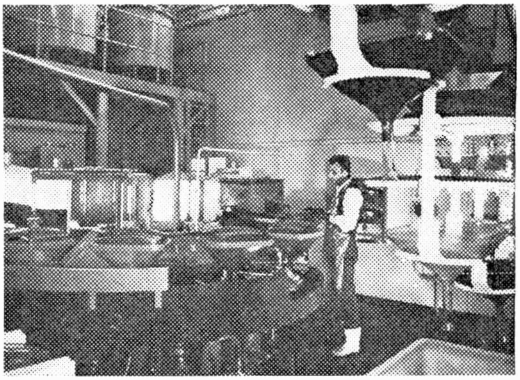
The shadowmask must be capable of withstanding temperature increases without deformation. The holes occupy only a quarter of the mask area so that only a quarter of the electrons projected from the guns pass through to the screen, thus the need for a higher e.h.t. than with monochrome tubes to obtain adequate raster illumination. Due to the absorption of the electrons which impinge upon it the mask dissipates some 20W.

FLOW-COAT ROOM

Faceplates from stock are washed in hydrofluoric acid, rinsed and dried, after which a layer of potassium silicate is laid on the screen to form a barrier between the phosphor and the glass. The faceplates then pass to the flow-coat room, strictly temperature and humidity controlled. Here the red, green and blue phosphors are laid



The assembly station for mounting the shadowmask to the faceplate. The operators are spot-welding steel strips round the edge of the shadowmask. These prevent any stray electrons reaching the screen round the edges of the shadowmask.



An automatic screen-washing machine in action.

on the screen in the triad formation. A preheated faceplate is loaded on to an automatic flow mill and as the phosphor is dispensed the faceplate spins and tilts at varying speeds to ensure an even distribution over the screen area. The phosphor is suspended in a mixture of polyvinyl alcohol, distilled water and ammonium dichromate, and it acts as a photo-resist.

After the green phosphor has been laid in this way the faceplate is passed to a piece of equipment known in the factory as a "Lighthouse". At this point the shadowmask is introduced to the faceplate and acts as a template for fixing the position of the green dots. Ultraviolet light concentrated through a quartz resonator is applied by the lighthouse and this hardens the dots of green phosphor in line with the green electron gun. The shadowmask is removed after this exposure and the faceplate is passed to another flow mill to wash away the unexposed green phosphor to leave the required pattern of green dots on the screen. From the moment the shadowmask is fitted to its faceplate the two components remain as complementary items. The blue and red phosphors are then laid in a similar manner.

One of several difficulties in this process is that the lighthouse optical system has to take into account that the electron beam in an operative tube appears to arrive at the screen from slightly different angles according to the angle of beam deflection at any given instant.

TUBE ASSEMBLY

The faceplates are next lacquered and dried, then cleaned by hand and painted with a patch of graphite for later electrical connection with a spring to the shadowmask. At this stage the cones are also graphite coated.

The aluminising process then takes place. A slug of aluminium is heated in vacuum and vaporises to deposit a fine film over the inner surface of the faceplate, the thickness being automatically checked by a capacitive probe. After the lacquer is baked off the faceplate is ready for permanent mating to its shadowmask.

A series of thin steel plates is spot welded round the mask periphery to prevent stray electrons escaping round the edges and activating the phosphors. The two springs to make electrical contact with the graphite coating on the interior of the cone are also spot welded on.

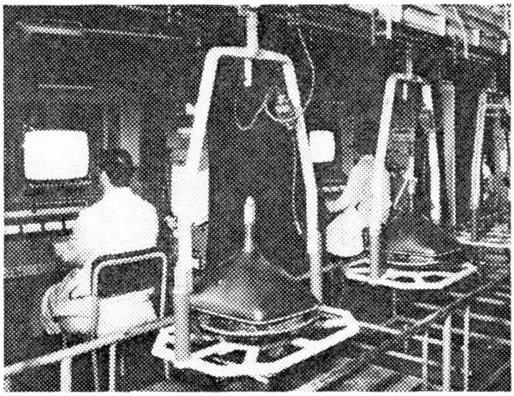
The cone, after a baking process at 450°C, is mounted on a jig and the faceplate accurately positioned with powdered glass between the two surfaces. After one hour the powdered glass slowly melts and fuses the two pieces together. After a full inspection the assembly is ready to receive the electron guns.

THE GUNS

The electron guns are assembled in a clean-air zone under "untouched by hand" conditions. About 40 girls are currently engaged on the three-gun assemblies and all are obliged to wear nylon overalls and gloves. Nearly 30 stages of assembly are involved and the final accuracy depends on precision assembly jigs and the skill of the operators. Spot welding plays a large part. This department uses specially designed test equipment, the automatic tester in the final assembly rooms checking more than 60 parameters for continuity and short-circuit in addition to measuring heater resistance.

The completed guns are maintained in a "hot box" to reduce the risk of thermal shock during the sealing-in process. The bulbs are automatically vibrated over a frequency range of 600-1,100c/s (which takes in the bulb resonant frequency) to shake out any residual foreign matter. The tube necks are then manually cleaned with alcohol. Gun assembly follows standard practice but the sealing process requires considerably more accuracy due to the alignment of the three-gun assembly.

Electrical and visual final inspection of the colour guns.



General view of the final test booths where every Mullard ColourScreen tube is given a full performance test. In the foreground can be seen part of the extensive conveyor system.

For the evacuation process 90 self-contained pumping stations are used, the process taking about three hours. This also follows conventional monochrome practice. It includes a series of checks and processes to further activate the tube and probe for rejects. Although the normal operating e.h.t. is around 25kV the shadowmask tubes must withstand a test voltage of 44kV. Also, 65kV is applied to the anode to break down any sharp points in the internal structure which could result in flashovers.

After gettering the tubes are mounted on an ageing conveyor in which each tube is electrically connected and current drawn from the cathodes for 1½ hours; the emission is stabilised and two more 65kV tests made. For their final test the tubes are checked for blemishes in each colour and in monochrome, for convergence, linearity, cathode quality, overvoltage and so forth. This process has been speeded up by the installation of five special colour test booths and such refinements as digital read-out for colour purity checks. A complete test now takes less than ten minutes.

After fitting a reinforcement guard, a final wash and a coating of graphite on the outside of the cone the tubes are ready for the stores. ■

BUSH SOUND CONVERSION

—continued from page 15

to the 470Ω resistor on the filter unit on top of the tuner, a length of wire remaining from the "clearing" process being removed. To complete the h.t. wiring tag 6 of tagboard D should be joined by a short length of wire to tag 7.

For the benefit of those readers intending to modify the coils the following information is given. To tune to 48-75Mc/s one turn should be removed from L13. To tune to 75-100Mc/s C69, of value between 17 and 22pF and which will be found under L13, should be reduced to 5·6pF and three turns taken off L9, four turns off L7 and two turns off L4. It will be found that a certain amount of detection takes place of the f.m. Band II transmissions allowing the coils to be spread to peak up the tuned circuits.

Servicing TELEVISION Receivers

No. 150 K-B RV20 SERIES

by L. Lawry-Johns

THIS article is intended to fill in the gap between the QV20/1 and QV30/1 series dealt with in the April-May 1964 issues and the VC1-VC2 series in the October-November 1966 issues. Whilst there are of course strong family resemblances between these three groups of models each have their own characteristics and servicing differences. The RV20 series embraces the RV20 Princess (17in.), the RV60 Prince (21in.), the SV20 Princess de luxe (19in.), the RV30 Imperial (twin speakers and tambour doors version of the RV20) and the SV30 (similar with 19in. tube). Also covered are the RV70 Consort (23in.), the RV80 Sovereign with pressmatic tuning and automatic contrast control, and the earlier RV10 Crown which was more akin to the QV30/1 series. The main feature is a long single chassis to suit the short-necked tubes and slimmer cabinet, a feature which was carried on in all later models except that these later designs had the tube separate from the chassis and mounted on the cabinet.

Chassis variations

A number of differences in detail exist between the various models in this series. The main ones are as follows. On some models R42 is 1·8k; in receivers fitted with a Fireball tuner unit C31 is 45 or 37 pF, R31 1·2k and R37 3·9k, whilst with some tuner units C30 is omitted; some models use a PL36 in position V7 (pin numbers differ to those on our circuit); on Model RV10 R151 and L66 are omitted, the line scan coils are connected in parallel, C62 consists of two 40pF capacitors in parallel and a plug-and-socket focus arrangement replaces R131, R150, R130; in some models C62 is 20pF while in earlier ones it is 60pF; in Model RV80 V3 is an EF183 with R42 3·3k, R39 180Ω, R40 22Ω, R38 33k and R41 22k. Other differences will be illustrated next month.

Chassis removal

Remove front control knobs. Remove loudspeaker plug from output transformer (RV80 only, also remove auto-contrast control plug and pilot lamp from socket). Remove chassis fixing screws at rear of chassis (RV80, also remove two screws at top corners of tube). Slide out chassis complete with tube.

Common faults

As the RV20 series were produced in 1960-61 by now they will almost certainly be showing two main fault symptoms. The first is a low-emission tube which gives the classic symptoms of a dark picture with silky whites, turning negative as the brilliance or contrast is advanced. The 17in. models used a C17AF tube which can be replaced by an AW43-89; the 21in. models used a C21AF which can be replaced by an AW53-88. A metal shield over the tube base may be removed if the replacement tube is a trifle too long. The small difference in heater voltage may be ignored. The C17AF had a 4V heater whilst the AW43-89 has the more usual 6·3V. The 19in. and 23in. tubes can be replaced from the Mullard range but in some cases the back cover may have to be stood off slightly with spacers.

The second very common fault which comes with age is deterioration of the metal rectifier. A silicon diode such as the BY100 can be used in series with a 15Ω wire-wound resistor across the existing rectifier if the insulation of this has not failed. The h.t. voltage across C103 (output of rectifier) should not exceed 240V otherwise some valve or other component failure may occur. Deterioration in the metal rectifier causing the h.t. voltage to fall shows as lack of width and a certain amount of reduction of height, particularly at the bottom.

The previously mentioned tube and rectifier faults are usually the result of age but there are several faults which can and do occur from time to time which have little or nothing to do with age. As examples we would mention the following.

EHT rectifier

This is an R20 or U26. Several things can happen to this. It can develop an open-circuit heater. This results in a complete loss of picture and raster but leaves the line timebase working and whistling normally. A screwdriver blade will give a blue glow when touched to the rubber top-cap cover of the valve although the heater is out. Replacement will provide a cure unless there is a fault in the heater winding or at the base connections.

It can also short internally causing a heavy load on the timebase generally, damping down the line whistle and causing the PL81 to over-

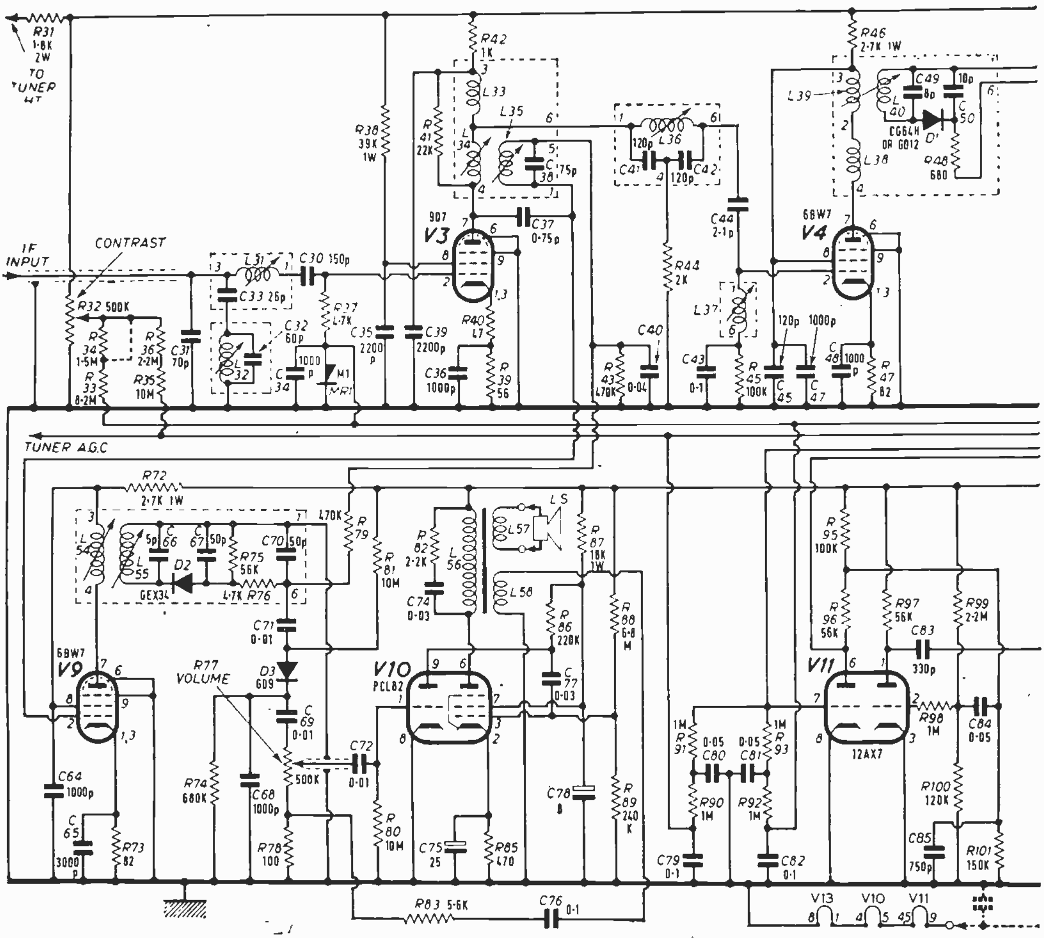


Fig. 1: Circuit diagram of the

Valve	Va	Vg2	Vk
V3	222	106–189	0·4–1·2
V4	195	192	1·2
V5B	65–164	—	122–188
V6P	122–188	152	4·2
V6T	145	—	0
V7	—	173	0
V9	185	215	0·45–1·25
V10T	65	—	0
V10P	210	139	17
V11A	112	—	0
V11B	115	—	0
V12T	59–196	—	0
V12P	—	190	16

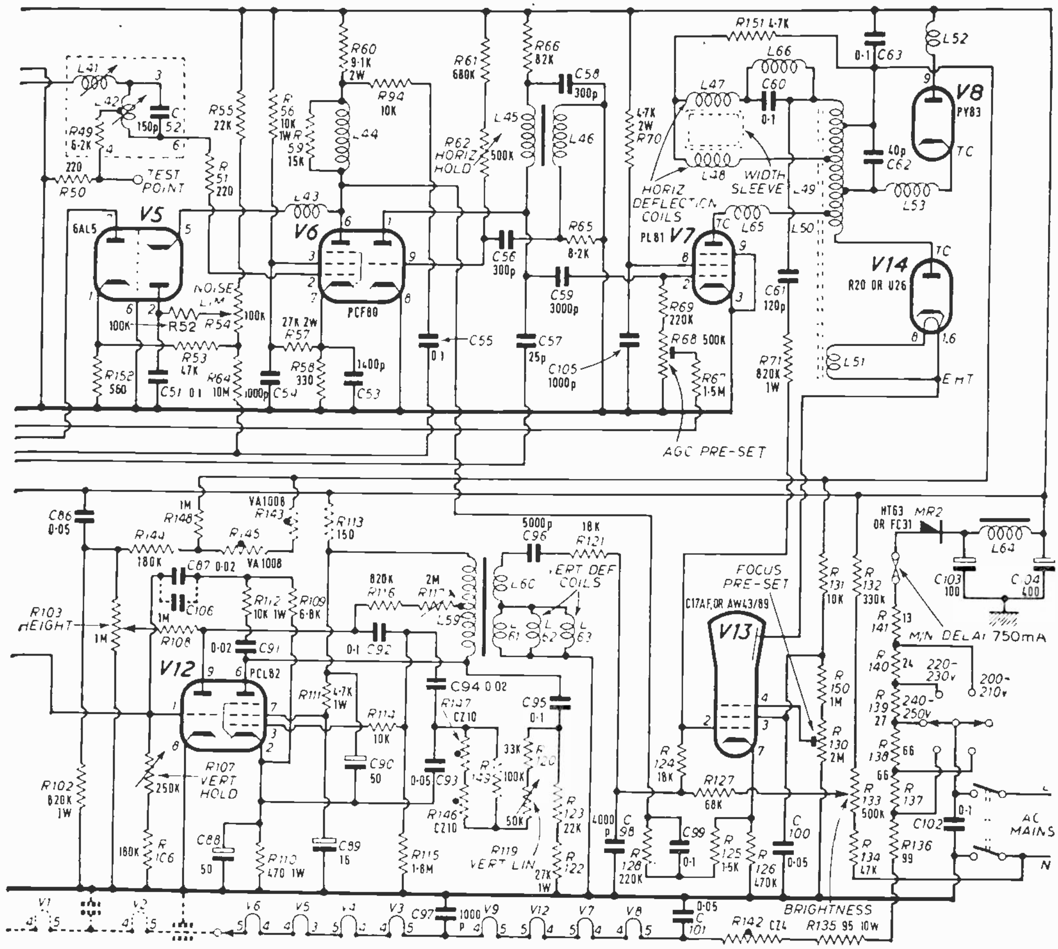
Smoothed h.t. 230V; unsmoothed h.t. 237V; e.h.t. 15kV; boost supply (junction C62, C63) 710V. C.R.T. cathode 120–133V, grid 14–130V, first anode 680V.

heat (some models use a PL36 line output valve). Perhaps most frequently however the valve loses emission causing the picture to expand and lose focus on bright scenes, or when the brilliance is advanced to balloon and disappear altogether.

Line output stage

The PL81 (or PL36) itself can give the symptoms of lack of width and poor e.h.t. regulation (as just described). It can also develop internal shorts causing the screen-feed resistor to overheat and change value. Even though the valve is replaced the symptom of inadequate width will quickly show itself due to the defective resistor causing the new valve to pass excessive current.

The PY83 suffers from two main defects. The first is internal arcing between electrodes causing heavy interference on the screen with an irregular white line intermittently flashing down the centre. The second defect is loss of emission causing anything from lack of width to complete loss of picture. It also has a habit of developing an



main chassis, K-B RV20 series.

open-circuited heater. This, of course, causes all valve heaters to fail since the series circuit is broken. A PY81 or PY800 can be used for replacement.

Line oscillator

V6 PCF80 is used as the video amplier (pentode section) and line oscillator (triode). Replace this valve if the horizontal hold is at the end of its travel. If this doesn't produce the required effect check R61 (680kΩ). Complete failure of the valve will cause the PL81 to overheat with of course a " no picture " condition.

Boost reservoir capacitor

C63 0·1μF 750V can become faulty on two counts. It can become open-circuit causing loss of picture and e.h.t. or it can short with the same effect except that in this case removal of the PY83 top cap will restore a degree of timebase working which immediately identifies the fault since with the PY83 circuit broken there is no other path to h.t. save through the shorted capacitor.

Width sleeve

This is the closed-loop sleeve on the tube neck under the deflection coils. Quite often the insulation will break down at a particular point. The arcing from the line coils to the copper foil will cause heavy interference on the screen. Quite often however it is not necessary to replace the sleeve since slight withdrawal from the coils will remove the point of discharge and stop it.

Weak sync

If the picture is difficult to hold, particularly in a vertical sense, check V11 12AX7 (ECC83). If necessary check associated components. VII functions as the sync separator and field sync amplifier.

TO BE CONTINUED

UNDER NEATH THE DIPOLE

THE television tempest is here: it is rolling at the time of writing these notes. No character in Shakespeare's plays stirred up the cauldron so fiercely as the top executives of the ITA, ACTT and the BBC. Macbeth's three witches gloated over the hissing bubbles rising from their "spell" potion; television tycoons and technicians contemplated their mess of potage with dismay. The fact is that troubles have been brewing for about two years or more; even as far back as when the Pilkington Committee's report on television was published and the ITA had certain frequencies (previously allocated to them and not used at that time) reallocated to the BBC. But this transfer of transmission frequencies was only one of the policy mistakes stirred up by anti-ITV members of that committee. There were toils, troubles and unrest in both broadcasting organisations from top to bottom. Heads rolled unnecessarily (as well as necessarily).

The BBC was at one time a kind of imperialist empire of its own with the late Lord Clarendon, Chairman of Governors, as a monarch without executive power and Mr. (or Sir John or Lord) Reith as his Prime Minister. Now it has appeared to many people on the side lines as having become a kind of built-in republic, with Lord Hill as President and Sir Hugh Greene as his Chief-of-Staff-to-be-retired. With such goings on no wonder the staff are twitching coyly. The BBC staff now consider that they are unshockable and produce television plays which *are* shockable. *The Year of the Sex Olympics* on BBC-2 was a sheer waste of excellent colour technical equipment and studio space. Who was responsible for this, Lord Hill, Sir Hugh Greene, or someone else who escalated the trend? We can be certain that it wasn't Charles J. Curran, the new Director-General, whose promotion from within Broadcasting House calls for congratulations.

Earlier this year the ITV companies, complacent in the anticipation of the renewal of their area licences for commercial television, had shocks too. TWW, the very well run Wales and West company, took over some years ago the activities and responsibilities of the ill-fated WWN-TV Cardiff studios with no less than *ten* transmitters in North Wales. All have a large sound quota of the Welsh language. TWW kept these stations in action in addition to their own and, some people say, saved the face of ITA in Wales because of the old show business legend "The show must go on!" Harlech TV wrested the franchise from TWW with their brilliantly written licence application to the ITA backed up by an equally brilliant galaxy of stars. Harlech's opening did not fulfil its promise, due to an under-rehearsed premiere, poor material and professional actors behaving like amateurs.

Yorkshire Television valiantly faced up to staff troubles in Leeds with their opening—new staff, new premises and a lot of cooks around the broth. Nevertheless, they did well. Thames TV, uneasily commuting between Wembley Studios and Teddington Studios, worked miracles in improvisation, showing quite clearly that a television studios' telecine and other operations can be carried out by four or five persons instead of two hundred. I have actually seen one such station operate for 2½ hours with only two persons keeping it going, with local news, incoming network material, film and of course the commercials which provide the money which pays the wages (less tax). There have certainly been "front office follies" but the underground trouble-makers have been steadily at work ever since the reshuffle of TV managements in reshuffled TV areas.

That there will be more reshuffles soon is the opinion of many technicians within the television industry. This will possibly happen when ITV companies turn over on 625 lines to new u.h.f. channels in readiness for colour. ITV studios will change over to 625 lines with converters for changing down to 405 lines on the old original ITV transmitters. Some areas will be supplied with reasonably good u.h.f. signals from a few powerful new transmitters on high masts plus a few smaller transmitters in "black-spot" reception districts. Those areas which are mountainous, hilly or full of large old gasholders, chimney stacks and pylons may need relay transmitters.

Pop Goes the Seaweed!

And what about the Hebrides and the wild coastal areas on the west of Scotland, where there is no acceptable BBC or ITV coverage on any of the present bands? The seaweed of that magnificent coast was once the drama for another production hold-up in filming. There was a quarrel as to whether the extra seaweed required for a scene in a studio should be "handled" by a landscape or a property man! After an expensive hold-up the matter was settled that if wet the gardener should do the job and if dry the prop man should do it. A ceremonial walk then had to be made. If the seaweed popped when walked on, it was wet. If it crackled it was dry. The appropriate man then put the appropriate seaweed into the appropriate sack instead of getting the sack himself!

In the meantime the rash of high masts, chimney stacks and flag poles for supporting aerial ironmongery on a big scale, with u.h.f. aerials for colour, is spreading. Soon will come the demand for "motorised" aerial-array twisters, which could be important in places that can pick-up several reasonably strong u.h.f. stations in one fell sweep. There may also be a demand for neat aerial earthing switching devices for protection against the unlikely event of a lightning strike and for the peace of mind such protection gives.

Iconos

DX-TV

A MONTHLY FEATURE
FOR DX ENTHUSIASTS

by Charles Rafarel

I CERTAINLY wish I had been wrong with last month's prediction of a short SpE season this spring and summer, but alas I was not. This relates to my own area, the South of England, but from reports the prevailing poor conditions have applied to most of the country. Although DX in the North and West has been a little more encouraging, this is no great joy I fear to most of us! Here it has been the dullest July-August for eight years of SpE DX with many completely blank days: I have never known of anything like it.

The period reported below is somewhat shorter than usual but one can hope that the end of August will produce some better reception. We can of course hope for late SpE openings in September. In the past we have often had them, particularly to Finland. This is rare earlier in the season but I have had reception of this already so although I hate to say so I can't help wondering if the 1968 season may be almost over already!

There is not much good to report with Trops either. An exceptionally wet period in most areas has almost completely put paid to this method of reception as well. All we can do is to look forward optimistically to a better late autumn and winter Trop season. By all laws of averages we should get that to console us.

Log for period 26/7/68 to 15/8/68, SpE:

26/7/68	Italy IA and IB, Spain E2 and Czech R1.
28/7/68	Spain E2.
30/7/68	USSR R1.
31/7/68	Czech R1.
1/8/68	Sweden E2, Czech R1, Hungary R1, Poland R1 and Spain E2.
6/8/68	Sweden E2, Spain E2 and E3, Poland R1.
11/8/68	Spain E2.
12/8/68	Spain E2.
13/8/68	Finland E2, USSR R1 and R2, Czech R1.
14/8/68	Czech R1 and Hungary R1.
15/8/68	USSR R1.

There has also been a lull with E2 Trans-Equatorial Skip. So far we have no further reports. Keep trying—it should still be around for quite a time yet.

On the news front I can now confirm that Poland is using the EBU-type card without circle on R1 and R2. I mentioned this as the possible country last month and we know that this is correct from subsequent captions.

With the recent very poor conditions a few remarks on how to make the best of what DX there is may be helpful. These notes are primarily directed to newcomers to DX TV—I am not suggesting that old hands are not doing their best already!

First patience is most important: if you are lucky enough to have two or more sets leave them tuned to E2, R1 etc. channels and you will not miss the short bursts of activity. Secondly if you really get fed-up with seeing nothing look at the domestic TV on Band I and note any patterning—then rush back to the DX set and I hope that it warms up in time! Next a tip I have found to be very good. SpE DX is at times selective as regards to the exact frequency that is reflected at any given moment, and since the European bandwidth is 5·5 to 6·0Mc/s at times only part of the bandwidth is being reflected to your aerial for each channel. So swing your fine tuner across the full width of each channel: you will often find that there is a signal there after all. Lastly if you are lucky enough to already have two Band I arrays at different heights, or can arrange this, try both aerials. Under poor conditions aerial height can be critical and you will find that sometimes the lower one is better.

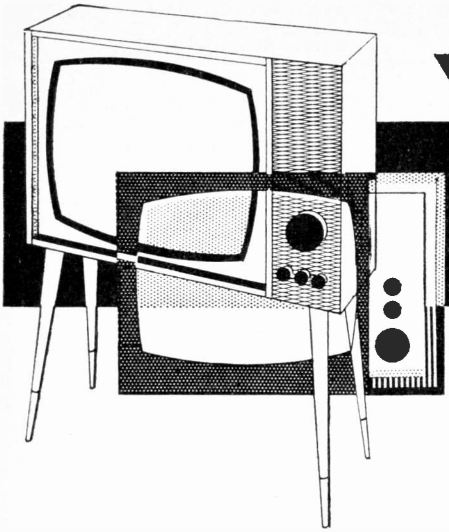
We have had no reports from readers of any startling reception but the following are of interest:

(1) D. Bowers of Saltash reports that his reception of TVE Spain now shows "the news reader of Teledario with a new map behind him of the Western Hemisphere of the Atlantic Ocean in the centre ". He continues to report reception of Canary Islands E3, a good one and rare this year. The rest of his log covers good reception of USSR, Czechoslovakia, Norway, Sweden, Italy, W. Germany and Switzerland. This is one of our better logs of recent date.

(2) A. Glendenning of Hartlepool is a newcomer who is not as yet converted but in spite of a positive-going set and thanks to some test card sketches we have identified the following for him: Spain, Italy, France F4 possibly, W. Germany and Czechoslovakia. We feel that following these successes there will be some modifications on the way soon!

(3) J. Dalby of Stroud has a most interesting report of reception of Rumania R1; the station must be Bacau 600 watts only. It has occasionally been received here before but nevertheless it is very fine reception. Amongst the others in his log he has Canena 2 Santiago TVE 2 Spain.

(4) D. E. Hammond of Chingford mentions in his varied log of most European countries black-and-white squares on E3 819-line system. This can only be RTB Liège Belgium testing, so it looks as if the Belgians still radiate 819 lines at times which is worth noting.



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

MASTERADIO TJ7T

Having cleared a number of faults on this set I am left with one that still baffles me. This fault is on sound in as much that it is distorted (a kind of gurgling effect) which is more pronounced on ITV. BBC-1 is fairly clear but this noise is still in the background. The picture on both channels is very good.

I have changed the sound output and tuner valves, switched vision valves—one for the other—and found that no improvement resulted. H.T. is around 200V.—A. Thurston (Essex).

The symptoms you describe suggest that the 50c/s mains is getting into the sound stages. This can happen in several ways. First, a valve—the 6BW7 or PCL82—could have a heater-cathode leakage. Secondly, the h.t. smoothing could be inadequate: check the 100μF+200μF electrolytic.

Thirdly, hum pickup on wiring which could be running close to the field timebase or mains leads, an unscreened volume control, etc., could cause the trouble.

Similarly, the 4·7MΩ resistor of the PCL82 triode section could go high. Check all these points.

BBC-2 LOFT AERIAL

I intend to fit my own loft aerial. Please give me all the information in order to make a good job of it and the type of aerial required.—R. Poole (Lancashire).

The choice of BBC-2 aerial is governed solely by the prevailing signal conditions, on local screening and standing-wave conditions. Whether or not a BBC-2 aerial will provide adequate signal pick-up when mounted in the roof-space just cannot be determined without taking tests. We suggest that you seek the advice of your radio dealer on this—at least, so far as the type of aerial *likely* to be required at your site. If, say, a twelve-element is needed outside—chimney-mounted—then you can be sure that for the same pick-up in the roof-space an aerial with twice the number of elements will be necessary; but even this is not a rule as so many factors are involved.

ULTRA V1750

The trouble on this set is no contrast. There is plenty of brightness but when the brightness control is advanced, the picture turns like an X-ray. Adjustment of the contrast control makes no difference.—A. Turnbull (Wallsend).

We assume that the picture tends to turn negative—blacks white and whites black. In this event, since the contrast control is inoperative the video valve might well be overloading. This could be caused by trouble in the vision a.g.c. circuits. Check the a.g.c. line, the controlled valves for interelectrode leakage and the contrast control circuit itself.

BUSH T85C

This set gives low sound with what appears to be sound-on-vision and a picture which is concentrated into a thin white line across the screen. I have changed valves ECC83 and PCL82 but no improvement was noted.—W. O'Brien (Lancashire).

Check the sound i.f. alignment and the 16μF audio output capacitor.

Check the continuity of the deflection coils, h.t. to pin 6 of the PCL82, to pin 9 and the bias voltage at pin 2. Check the supply to pin 6 of the ECC83 as the 2μF boost line capacitor could be shorted.

ULTRA 6624

The vertical and horizontal holds are very sensitive when first switched on and then through many hours of use. The valves have been changed but there has been no improvement.—W. Evans (Cheshire).

Since both the line and field holds are affected the trouble would appear to lie in a common stage such as the sync separator. This receives its signals from the anode of the video amplifier. Check the coupling components here (and also make sure that the valve is in good order). If necessary check the video amplifier stage, especially the components in the cathode circuit.

PHILIPS 19TG125A

About two months ago I converted this model for BBC-2 using the correct Philips unit. Although being unable to receive this station due to local conditions, the set was operating satisfactorily on the 405 section. Last week the picture began to break up, taking on a diagonal form with line tearing. Valve substitution and the checking of the parts of the set which normally cause this fault failed to reveal the trouble.

Finally the BBC-2 unit was removed and the original circuit then operated perfectly. From this I assume the fault to be in the converter and would be pleased if you can suggest the likely causes.—W. Davis (S. Wales).

We feel that the trouble is in the video amplifier stage and we would suggest that you check all the components in this section.

EKCO T370

The sound on this set is normal but the picture is unstable in height. Only the bottom is affected, the top half staying constant. The bottom moves about an inch, sometimes staying constant, other times flickering.

Variation of the height control alters the height without affecting the flickering fault.—R. Keen (Norfolk).

Check the upper right 30PL13 valve (although we do not suspect this) and its 500μF bias electrolytic and cathode resistor (270Ω) from pin 2 to chassis.

SOBELL T347

I cannot get the field to lock on this set. The controls take me through the correct frequency but it will not lock on. I have replaced X2 diode also V7 and V13 but no improvement has been noted.—H. Farvis (Bristol).

The X2 rectifier is invariably responsible for the trouble mentioned. However, if you are sure that the replacement is in good condition a check must be made of all the components between the sync separator stage and the sync input to the field generator.

PHILCO 1010

The EY86 heater goes out with consequent loss of picture leaving a white vertical line down the centre of the screen. When switched off then on again all comes back but for only a very short time. I have tried this several times and now the picture duration has shortened and there is no light to be seen from the EY86.

This EY86 is a new valve and I have also changed the PL81 and PY81 with no effect. Also, I should add that the other valves remain alight and the sound is perfect—only the EY86 refuses to function. I have had the line output transformer tested and was told that it was just under 400Ω.—D. Loveland (Kent).

If the PL81 becomes overheated when the e.h.t. fails, change the ECC82 line oscillator valve and check the oscillator components. If the PL81 does not overheat, check R73 1·8kΩ (h.t. feed to PL81 screen pin 8 via a 270Ω resistor). Also check C82 (0·1μF) boost line capacitor.

EKCO T345

The main trouble is sound-on-vision. The vision detector diode X1 appears to be OK but I do not know what resistance it should show. Another trouble is stretching of the top half of the picture while the bottom is compressed. I have changed V11 and V13 but the trouble still persists.

The contrast control which was all right before changing V11 and V13 now tends to break up the picture or cause serious flickering if it is advanced beyond the mid-way position.—E. Brooker (Cheshire).

It would seem that the replacement valves are faulty, causing the contrast and "flickering" symptoms. Have these checked and replaced if necessary.

The vision detector has no bearing on the sound-on-vision effect. Check the oscillator tuning (adjust for maximum sound consistent with minimum sound-on-vision). If this condition cannot be obtained, suspect misalignment of the vision i.f. channel and sound rejectors.

BUSH TV105

This receiver has no raster and no picture but the sound is OK. It was found that the e.h.t. rectifier was not alight and by removing the top cap a small spark could be drawn from the line output transformer. The boost line voltage on pin 3 of the tube is 100V and the h.t. line voltage is 140V at the junction with L42. The negative voltage on the grid of the PL36 is 20V. I changed the PL36 but no improvement resulted. I tested the PY800 and this was found to be in order. MR6 was changed for a BY100 with a 30Ω resistor in series. This gave approximately 160V on the h.t. line.

Upon removing the line coils from the line output transformer the e.h.t. rectifier lit up, the boost line voltage increased to 350V and a large spark could be drawn from the anode cap of the EY86. Replacing this cap made a vertical (field) line on the tube which could not be extinguished by advancing or retarding the brilliance control. On reconnecting the line coils the filament of the EY86 went out again. I have read on many occasions that line coils can be checked in this way but is this positive proof? All the coils in the line output stage appear to have the correct resistance values.—M. Newin (Oxford).

The line output transformer appears to have shorted turns. However it is essential to check associated components e.g. 500pF and 0·22μF capacitors etc.

PETO-SCOTT 940

I cannot get a picture with sufficient height. There is an equal black space at the top and bottom of the screen and the height control is at the end of its travel. The PCL85, 12AU7 and PCF80 valves have been renewed but no improvement has resulted.—W. Lane (Derby).

Check the value of the focus control. This should be 2MΩ. It quite often changes value thus dropping the voltage on the boost line which supplies the height control. Replace the focus control if necessary.

MURPHY V250

I have recently had occasion to replace the line output valve in this set. According to the Mazda valve data book it is necessary to adjust the cathode current when this valve is replaced. I should like to know the correct current and the method of making the adjustment.—C. Doran (London, S.E.20).

One method of adjusting the correct current on 20P4 valves in your receiver is to vary R129 until the e.h.t. reads 11·75kV.

After some years of use R129 is generally burnt out and disturbing it makes it fall apart. Generally, however. 20P4s are not critical but last longer if you adjust R129 for minimum width consistent with a full raster.

COSSOR 933

Within minutes of the picture coming on, the fuses blow. The picture also cramps up at the top and bottom making it very narrow before it finally disappears.—W. C. Wright (Liverpool, 21).

The most common cause of fuse blowing in this receiver is a defective PY82 (19Y3) h.t. rectifier valve. Alternative causes are defects in the line output and efficiency diode stages.

K-B ROYAL STAR

Two brilliant white bands of interference about 3 in. broad appear vertically, one near the right-hand edge and one on the left-hand edge of the screen. These look like cramped up, spiky speech waveforms as seen on an oscilloscope, except that these are vertical. This phenomenon persists after the aerial is removed and can be heard as loud, uneven interference on audio when the gain is advanced.

When connected to the aerial, the raster and picture are still present but very unsteady. Brightness varies, too.—F. Gee (Dorset).

Check the h.t. supply feed to the sound amplifier valves. This is decoupled by an electrolytic capacitor and if this capacitor goes open-circuit the symptoms described can occur.

QUERIES COUPON

This coupon is available until OCTOBER 18, 1968, and must accompany all Queries sent in accordance with the notice on page 43

PRACTICAL TELEVISION, OCTOBER 1968

TEST CASE -71

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

? A Philips 19TG152A gave all the symptoms of severe vision overload, in that the picture would suddenly go negative and devoid of control while both line and field locks would disappear completely. It was thought that a fault had developed somewhere in the vision a.g.c. system and as a consequence this section of the set was carefully tested. No definite fault could be found here although the a.g.c. voltage differed slightly from that of a previous set of the same type handled.

A check was then made of the sync separator in an endeavour to track down the trouble causing the lack of line and field locks; but again all seemed well here. The symptom could be stopped and started by wriggling the final vision i.f. amplifier valve in its holder, and when it came on it was noticed that the screen grid of the video output valve tended to run red hot.

What was the most likely cause of this symptom, and how best could it be proved? See next month's PRACTICAL TELEVISION *for the solution to this problem, and for a further item in the Test Case series.*

SOLUTION TO TEST CASE 70

Page 572 (last month)

As past experience had indicated that an internal leak in the tuner's r.f. amplifier valve will apply a positive potential on to the vision a.g.c. line this valve was replaced with the certain feeling that the fault would thus be cured. Sadly, it remained.

Further investigation showed that the tuner is fed from a 9-pin plug-and-socket system taking all supplies *plus* the a.g.c. input. After quite a bit of fussing around it was proved that the insulation on the plug between the a.g.c. feed pin and an adjacent h.t. supply pin had broken down very slightly (the resistance a matter of megohms) but sufficiently for a positive potential to find its way on to the a.g.c. line and cause the trouble described last month.

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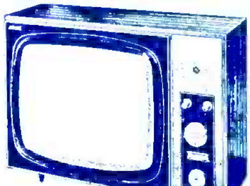

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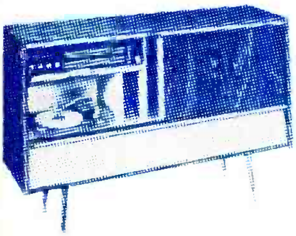

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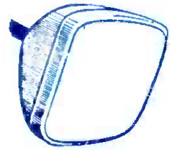

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