Practical TELEVISION

JUNE 1968 2/6

THE ABC OF COLOUR TV

ART
AUTO. CHROMINANCE CONTROL
AUTO. DEGAUSSING
AUTO. PHASE CONTROL
BLIND PATTERNING
BISTABLE SWITCH
BURST BLANKING
BURST GATING
BURST SIGNAL
CHROMINANCE
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ATE S
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ENCODER
GAMMA CORRECTION
GREY SCALE TRACKING
HUE

also NOVEL TV SYSTEMS

Practical Television

JUNE 1968
VOL. 18 No. 9
issue 213

Sound Barrier

THE OTHER DAY we were probing around inside a colleague's ailing TV set, for your editor is still capable (on his good days) of staggering to the workbench to take voltage readings and watch pretty pictures on the 'scope. And it was while trying to prove that the soldering iron is mightier than the pen, or vice versa, that we set the dog next door howling by an explosive guffaw.

This shattering and spontaneous outburst came while standing back to ponder on the meaning of a particular symptom and was sparked off by the sudden clicking into perspective of the aspect of the receiver as viewed from the rear. It was a newish receiver, housed in a tastefully smart cabinet, containing a 23in. picture tube and featuring picturesque and clinical-looking printed circuit sub-assemblies.

It looked quite impressive—until the eye wandered to the side of the c.r.t. where, squatting amidst all this glorious technology like a tatty mongrel at Cruft's, was a loudspeaker of such a size as would seem barely adequate for a transistor portable radio.

We have previously campaigned for sets able to do justice to the sound signal available and although it is obvious that a good general "quality" set is going to cost a good deal more, surely manufacturers could go some way along the line towards improving at least the sound side of their mass-market sets?

A set that we saw in operation recently (and at a press showing at that!) had such poor stability that the transistor output stage could not cope with audio peaks. On loud sound passages, the raster either contracted in all directions or the line started to tear. Apart from this, the distortion from the speaker, above a certain level of gain control setting, was enough not only to set the dog next door howling but any dog who had an ear for music!

It is inconsistent that manufacturers are producing more and better gramophone and tape reproducing equipment (and finding the customers) and marketing suitable receivers for the f.m. radio programmes, yet clutch their purses tightly like timid grand-aunts when it comes to doing something about improving the quality of the sound channels in their TV sets.

W. N. STEVENS—*Editor*

THIS MONTH

THE NEXT ISSUE DATED JULY WILL BE PUBLISHED ON JUNE 21

Practical Wireless and Television Filmshow 1968

AFTER a light-hearted introduction by W. N. Stevens, Editor of PRACTICAL WIRELESS and PRACTICAL TELEVISION, the 1968 Filmshow got under way with the colour film entitled "It's the Tube that makes the Colour" which showed in detail the skill and care that goes into the production of the Mullard ColourScreen tubes. It showed the processes the tube has to go through during its manufacture and brought home to us Mullard's considerable investment in the special plant and machinery required.

After the film Mr. Ian Nicholson of the Mullard Film Division described colour mixing and the meaning of hue, saturation, and reverse compatibility, demonstrating the principles of frame sequential scanning and showing how a coloured scene can be split up into the three primary component colours and reassembled. He also described the characteristics common to NTSC, SECAM and PAL.

Following a break for refreshments, Mr. Nicholson delivered a talk on the PAL system. This included a description of the colour receiver in block diagram form and an outline of the various circuits needed and their functions.

The evening closed with a "Questions Answered" session when readers were able to ask a variety of questions to which W. N. Stevens and Ian Nicholson gave detailed replies.

Science museum gets colour set

Mr. Dennis Neill (right), Director of Thorn Electrical Industries Ltd. and Managing Director of British Radio Corporation Ltd., discusses the BRC all-transistor colour TV receiver with Mr. D. Chilton, Keeper of the Department of Electrical Engineering and Communications at the London Science Museum, at the recent presentation by British Radio Corporation.

New Edition of "Adventures in Learning"

THE Independent Television Authority announce the publication of a new edition of *Adventures in Learning,* the leaflet series about adult education programmes on Independent Television. This edition, which covers the 1968–69 period and replaces the previous issue, contains the latest information available about forthcoming educational programmes; a further edition will be published this summer which will give more detailed information on the schedules after September 1968.

Among the series planned for 1968–69 are London Weekend Television's *Discovering London* (history and topography) and Yorkshire Television's *State of the Nation* dealing with Britain's financial and economic problems.

Also in the latter part of the period covered are two series on education—Granada's *One Step Further,* providing a guide to courses available in further education and Westward Television's *The Privileged?* on university education. With an eye on the US Presidential election in November 1968 Tyne Tees Television are producing a series of seven programmes on the American constitution and electoral system *The Way to the White House.* ATV Network will present a new three-term French refresher course *Deux Mondes,* and in the summer of 1969 a thirteen-programme *Introduction to Antiques.*

Copies of the leaflet and further information may be obtained from the Education Officer, Independent Television Authority, 70 Brompton Road, London, S.W.3.

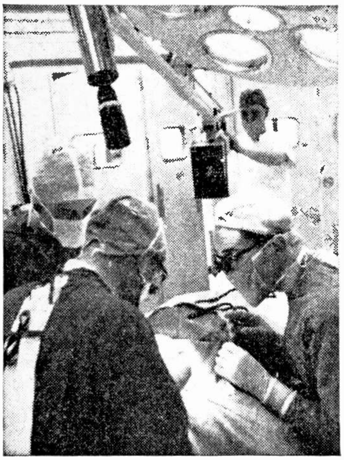
JAPAN SURGES FORWARD

THE Japan Electronics Industries Association's figures show that 1·27 million colour television sets were produced last year.

The report shows that home sales increased four-fold to 890,000 and that 332,000 sets were exported—a 25% increase on the previous year.

Domestic demand for this year is expected to reach 1·6 million and export targets are geared to 500,000.

Eye Surgeons use CCTV



MOORFIELDS Eye Hospital in City Road, London, one of the leading centres for eye surgery in the world, has equipped its new four-theatre surgical suite with Marconi closed-circuit television, in order to provide more effective training facilities for student surgeons.

Each of the new theatres has a V321 camera and a reference monitor incorporated into the opposite ends of a counterbalanced ceiling-mounted boom. The television operator, standing at the foot of the operating table, can, with reference to the monitor, move the camera by remote control into a position over the patient's head. The resulting pictures of the patient's eye are relayed via the television control centre above the theatres, to display monitors in the viewing gallery and in lecture rooms in the main hospital block.

Planar Transistors for Aerial Amplifiers

THREE new silicon planar n-p-n transistors announced by Mullard have been specially developed for use in TV and f.m. aerial amplifiers. Types BFW16, BFW17 and BFW30, they can also be used in applications which have severe intermodulation requirements, e.g. wideband amplifiers for oscilloscopes and low distortion wideband amplifiers for telephony. Types BFW16 and BFW30 are in the Mullard *"Practical Planar"* range of transistors. Features common to all three devices are a high gain with a high f_T and a very low intermodulation factor.

Sweden sets Colour TV date

SWEDEN will have regular colour transmissions in April of 1970 and investment in studio and transmission equipment will reach £2½ million by that date.

Owners of colour TV receivers will have to pay an extra £9 a year in addition to the £15 combined radio and TV licence in operation at present.

Initially, programmes will provide six hours of viewing which will rise to 20 hours a week within three years.

B.A.T.C. Convention

THE British Amateur Television Club will hold its 1968 Amateur Television Convention on Saturday, 14th September, 1968, in the ITA Conference Suite, 70 Brompton Road, London, S.W.3.

THAT'S LIFE

ACCORDING to reports in the Press, the "apprentice of the year" at AEI's Sheffield works has been declared redundant, six weeks after he was presented with a silver shield and told that he had a bright future with the company.

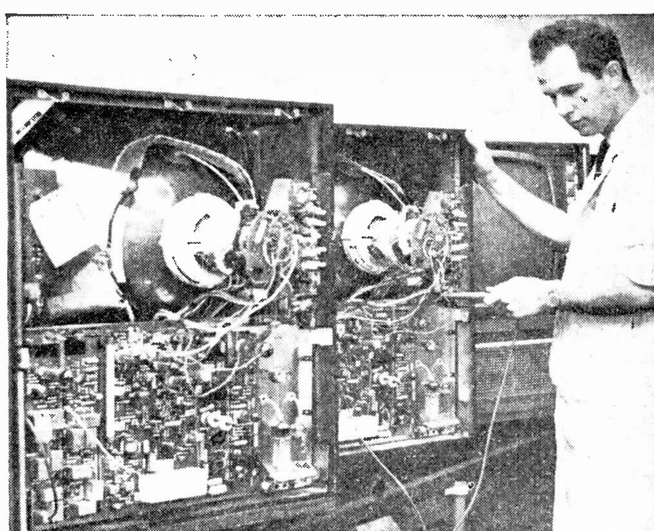
Royal Television Society Premium Awards

THE Royal Television Society has awarded the following Premiums for outstanding papers read before the Society in 1966/67:

The Mullard Premium to E. F. de Haan (Philips) for his paper on "A Survey of Colour Television Display Tubes". The *Wireless World* Premium to W. T. Underhill (The Marconi Co. Ltd.), for his paper on "A Four Tube Colour Camera". The TCC Premium to A. S. McLachlan (GPO Engineering Dept.), for his paper "Interference to Television Reception in the U.H.F. Bands". The Pye Premium to I. Breingan (Ferranti Ltd.), for his paper "Integrated Circuits and their Applications". The *Electronic Engineering* Premium to W. G. Beaton (Corpn. of Glasgow Education Dept.), for his paper "Education and Closed Circuit Television".

These awards were presented to the recipients at the Fleming Memorial Lecture on Thursday, April 18th, 1968, by John Ware, Chairman of the Royal Television Society.

Baird Television at Bradford



HERE we can see the final test at the factory of a 25in. colour receiver. Note the deflection and convergence assemblies mounted on the neck of the c.r.t., the tube base panel and the magnetic screen around the cone of the tube.

The majority of the circuitry is on three printed panels—i.f., decoder, and timebase—mounted vertically across the bottom section of the chassis.

THE ABC OF colour TV

PART 1

G. P. WESTLAND

COLOUR television has introduced a whole range of new terms which most of us will take some little time to get used to. The detailed definitions given in this series are intended to serve as a reference until the new language becomes familiar.

If you have ever mixed with a group of engineers at a radio show or a colour TV demonstration you will probably have been impressed, and perhaps baffled, by the enthusiastic and fast flowing "shop" that inevitably dominates the conversation. Terms like "differential phase" are bandied about with disarming ease, and whilst you are preoccupied trying to make an inspired guess as to exactly what it means two or three more come along so that you are left floundering. In moments of frustration it is rather too easy to dismiss it all as pompous gobbledygook, but in point of fact all scientific terminology is simply a form of shorthand to enable ideas to be expressed in single words or phrases instead of by long and complicated sentences.

A full list of the terms used in colour television would run to several hundred but many of them are highly specialised, such as those used in colorimetry. The list that forms the basis of this article has been shortened to include only terms in everyday use in the receiver side of the industry, or in a few cases items of historical significance.

ART

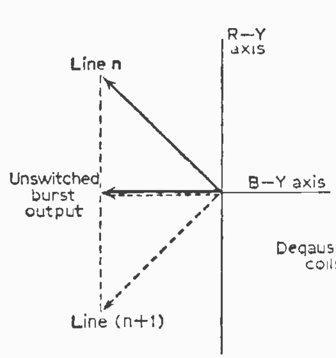
This was a German idea for improving the NTSC system. NTSC is prone to hue errors if the phase of the colour subcarrier gets distorted in transmission or signal processing and so it was proposed to add reference carrier information throughout the line, instead of only on the back porch. This would be distorted by a similar amount to the chrominance information, and if used in place of the local reference oscillator the hue errors would be reduced. Extra circuitry is needed for this system but the expensive crystal and a.p.c. loop in the decoder become redundant giving an overall cost saving. However PAL won the day and ART is no more.

AUTOMATIC CHROMINANCE CONTROL (A.C.C.)

The purpose of the a.c.c. circuit is to maintain the chrominance drive to the c.r.t. constant in the same way as the a.g.c. circuit keeps the video (or luminance) drive constant in monochrome (and also colour) receivers. A.C.C. therefore compensates for changes in chrominance/luminance ratio caused by vagaries of signal propagation and tries to keep the saturation of the picture at the same level.

The a.g.c. control voltage in monochrome receivers is usually obtained by measuring the mean level of the picture information. This is a simple but not particularly good technique. A.C.C. however has to be done properly if at all, and must measure something proportional to 100 per cent colour subcarrier amplitude. The only part of the chrominance signal which remains constant with change of picture information is the height of the burst signal, and this is generally used as a reference. Gated burst is available in every decoder for ident and reference oscillator control, and can be rectified by a separate a.m. or synchronous detector to obtain an a.c.c. output. Synchronous detection gives better noise immunity and must be carried out on the B—Y axis to avoid getting an alternating output from the swinging burst from line to line. See Fig. 1. An alternative approach is to rectify the output of the ident amplifier.

Note that if the contrast control is operated the luminance drive amplitude will change, as desired, but the a.c.c. will keep the chrominance drive constant and so the saturation of the picture will change. A well-designed receiver will have a link between the a.g.c. and a.c.c. circuits so that the



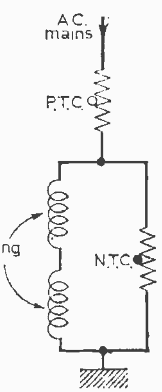


Fig. 1 (left): Demodulating the burst signal on the B-Y axis.

Fig. 2 (right): Typical automatic degaussing circuit.

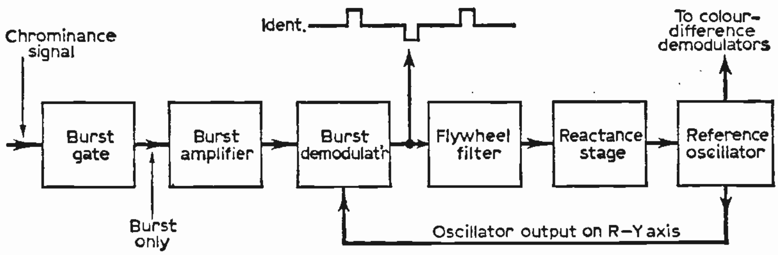


Fig. 3 (right): Block diagram of an a.p.c. loop used to control the decoder reference oscillator.

chrominance / luminance ratio will remain unchanged and hence the saturation will stay the same. This link provides correct "luminance/chrominance tracking".

AUTOMATIC DEGAUSSING

If a shadowmask c.r.t. is to give a completely pure picture the shadowmask itself, and the implosion-safe band round the faceplate seal, must both be demagnetised. Otherwise the picture will have localised areas with a colour cast, and this is particularly unpleasant in monochrome programmes.

Over a period of time the c.r.t. structure is likely to build up a magnetic field, especially if the conscientious housewife uses her vacuum cleaner near the receiver, or Johnny admires the pretty patterns that his permanent magnet will make on the picture. To overcome this it is now common practice to fit degaussing coils on a magnetic screen over the cone of the tube. Every time the receiver is switched on, or in some cases when the system switch is operated, a.c. mains is fed to the coils for an instant and the resultant a.c. field demagnetises the c.r.t. Hence the term automatic degaussing. The current through the coils is commonly 1—2A maximum and dies away to a few milliamps. It is usually controlled by a p.t.c. resistor which heats up to present a high impedance, and the circuit may include a n.t.c. resistor, or a v.d.r., or a backing-off voltage from a transformer. A typical circuit is shown in Fig. 2, although there are plenty of others.

AUTOMATIC PHASE CONTROL (A.P.C.)

We normally talk about an a.p.c. loop such as that shown diagrammatically in Fig. 3. The sole purpose of the loop and its local oscillator is to provide a continuous sinewave carrier in the correct phase for carrying out synchronous detection of the colour subcarrier carrying the chrominance information. The phase of this reference carrier (a detection timing device) is entirely controlled by the incoming burst signal. The burst train is synchronously detected to give a signal burst pulse every line, and this is smoothed in the flywheel filter to give a d.c. output which controls the reactance stage. The change of capacitance of the reactance stage, caused by changes in d.c. control voltage, varies the oscillator frequency. Any change in oscillator frequency will alter the balance of the alternatively positive and negative burst pulses and hence the amplitude and perhaps polarity of the d.c. control voltage. Back to square one. We thus have a feedback loop which tries to maintain the phase of the oscillator at the angle to which it has been set relative to the burst.

BLINDS—HANOVERIAN OR VENETIAN

Blinds are caused when the luminance, hue or saturation of the picture changes from line to line. Due to the interlaced scanning they appear as horizontal striations, or discontinuities, repeated every two lines. If the blinds are bad it is often possible to see the difference in colour when you look closely.

Blinds are symptomatic of decoding errors of various kinds and are caused by crosstalk between the R—Y and B—Y signals. This can arise from maladjustment of the matrix; incorrect axes of demodulation; crosstalk in the PAL switch circuit; or cross coupling between the R—Y and B—Y channels before or at the demodulators. Stray capacitances in the print can be a problem.

With a simple PAL decoder blinds are almost inevitable, but they need not occur at all in a well designed and adjusted PAL decoder. In practice they are often just perceptible and may get slightly worse with ageing. They are, of course, more easily seen in areas of high saturation corresponding to large subcarrier amplitudes.

BISTABLE

So-called because it has two stable states. One valve or transistor of the pair is cut off whilst the other is conducting, or vice versa, so that square-wave outputs of opposite polarities are obtained from the collector circuits (Fig. 4). A bistable is a form of multivibrator with d.c. feedback from cross coupling instead of a.c., and so it has to be triggered from one stable state to the other. In colour television triggering is normally carried out by line flyback pulses because these are conveniently available and are free of signal noise.

The purpose of the bistable is to drive the PAL switching circuit which invents the reference oscillator feed to the R—Y demodulator, or in some cases the R—Y signal itself, from line to line in sympathy with the transmitted signal.

It is necessary to make sure that the switching is, in fact, in the correct phase relative to the burst, and so an ident signal is applied to the bistable circuit. This corrects the phase if it is wrong. (See *Ident* and *PAL switch.*) Note that every time the chrominance signal is interrupted there is a 50:50 chance of the bistable being wrong when the signal is re-applied. The ident signal therefore has to be applied all the time though it actually operates on the bistable relatively seldom.

BURST

This is a vital part of the composite colour signal and consists of ten cycles of sinewave at the same frequency as the colour subcarrier, i.e. 4.43361875Mc/s, added to the back porch of the

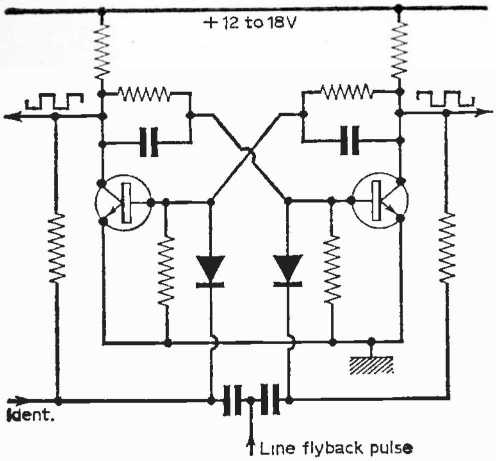


Fig. 4: Bistable circuit to control PAL switching.

line sync pulse. See Fig. 5(a). The burst is used to provide control voltages for four major functions. It locks the local reference oscillator to the correct phase for synchronous detection; provides ident pulses for the PAL switch; operates the automatic colour killer; and is a reference for the a.c.c. It therefore controls all the auxiliary circuits of a PAL decoder.

In order to get control voltages from the burst signal it has first to be detected to convert the train of sinewaves into pulses and d.c. Synchronous detection on the R—Y axis will give alternating pulses (one pulse per line) which can be used for ident purposes, and when smoothed in a flywheel filter will control the reactance stage. Fig. 5(b). Detection on the B—Y axis will give an unswitched output dependent upon the amplitude of the burst which can be smoothed to give a control voltage for the a.c.c. The colour killer circuit can be controlled either by the amplified and a.m. detected ident signal, or by the a.c.c. bias.

BURST BLANKING

This means the suppression of the burst in the chrominance signal after the burst gate so that clamping can be carried out properly during line flyback between the colour-difference output stages and the c.r.t. electrodes.

BURST GATING

This term refers to a circuit which gates out the burst signal from the chrominance signal ready for feeding to the burst amplifier and burst (synchronous) detector.

CHROMINANCE

Pertaining to colour. The chrominance subcarrier carries the *colour* information just as the luminance signal carries the *brightness* information. These are added together by the c.r.t. (or just prior to the c.r.t. in the case of RGB drive) to give the full colour picture. The colour information is transmitted as the colour-difference components R—Y and B—Y. When these are added to the luminance signal (Y) we get R and B drive voltages at the c.r.t. G—Y is derived by matrixing R—Y and B—Y, and when added to Y gives G.

Chrominance circuits include the detector, which extracts the chrominance subcarrier from the overall composite signal, and any other circuits carrying chrominance information such as the bandpass amplifiers and demodulators. The auxiliary circuits of the decoder are operated by burst information and do not carry chrominance signals.

CLAMPING

Clamping is carried out on the colour-difference output signals before they are fed to the grids of the c.r.t. in order to get accurate d.c. coupling. Think for a moment of a typical monochrome receiver with mean-level a.g.c. and a.c. coupling to the video output stage. The mean level of the signal stays the same but the peak-to-peak value changes and so the black level changes too. This is mildly irritating to the critical viewer although in general it serves us well. In a colour receiver, however, changes in d.c. level of the chrominance signal mean changes in the amount of colour information from scene to scene, and so both hue and saturation errors are introduced. Supposing a camera pans slowly across the set, and the colour-difference output stages have imperfect d.c. coupling. If you kept your eyes on a particular coloured object, as the overall content of the picture changed so the colour of that object would change too.

The clamps operate by keeping the signal corresponding to the line flyback period at a particular d.c. potential. They are keyed by line flyback pulses so that they conduct for a short time during flyback. See Fig. 6.

COLOUR-DIFFERENCE SIGNALS

These have already been mentioned under the heading *Chrominance*. They have the form shown in Fig. 7 for the standaard colour-bar test pattern

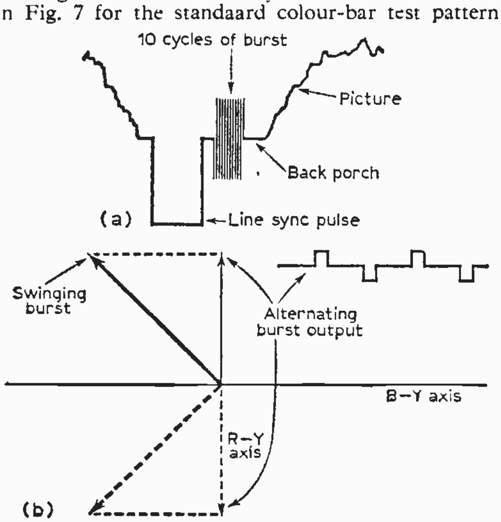


Fig. 5: The burst signal (a) and demodulating (b) the burst signal on the R—Y axis.

and it should be noted that they can be either positive or negative. A positive signal means that there is an extra contribution from that gun of the c.r.t. compared with the monochrome (luminance) signal. For example, a positive R—Y signal means that there is going to be some red in the picture. A negative R—Y signal means that the red gun is going to be held back or even cut off, and so blue and green will predominate. Perhaps this is obvious, but it is an important and fundamental point in understanding the idea of colour-difference signals, and how they add to (or subtract from!) the luminance signal. It is also very helpful to bear in mind when a colour picture is wrong and you are trying to analyse what is missing, or what other fault has occurred.

Colour-difference signals at the receiver should have a bandwidth of about 1·0Mc/s if the full potentialities of the system are exploited, although bandwidths down to 0·5Mc/s give acceptable colour pictures. The bandwidth is governed largely by the i.f. response at the point of chrominance take-off.

COLOUR KILLER

Every colour receiver must have a colour killer. If a colour transmission is present it must switch on the decoder: if no colour is present, the decoder must be switched off.

The point is that the decoder cannot tell the difference between a colour signal and any other kind of signal at the same frequency. So if the chrominance circuits are active during a monochrome transmission any signal near 4·4Mc/s will give rise to a spurious output, and small areas of colour will appear on any fine detail of the picture. Under fringe conditions noise will be processed by the decoder if it is active, and coloured noise is very objectionable on a monochrome picture although it is not nearly so obvious on a colour one.

A colour transmission always has a burst signal present, and so a burst output can be used to control the colour killer. Since the ident feature has to be provided in any case to control the PAL switching, the ident signal can be a.m. detected by a diode to give a suitable control voltage.

Colour killers need care in design in order to avoid "hunting" under noisy fringe conditions; i.e. regular periods of switch on—switch off. Manually preset colour killers are fitted on some receivers, but if not the same effect can be obtained by r.f. detuning.

COMPATIBILITY

All the colour systems which have been talked about so much over the past few years are compatible. This means that monochrome receivers can display colour transmissions in black-and-white to an acceptable standard of picture quality. The only obvious degradation is that the picture will either be slightly restricted in bandwidth, or the presence of the colour subcarrier will cause a slight 4·4Mc/s beat pattern. This is a question of compromise which has to be settled by the designers.

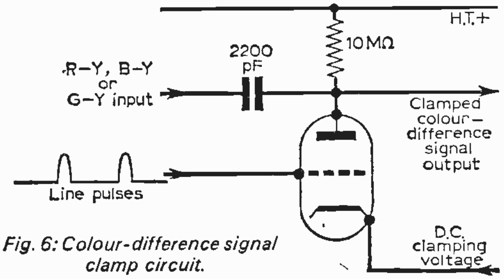


Fig. 6: Colour-difference signal clamp circuit.

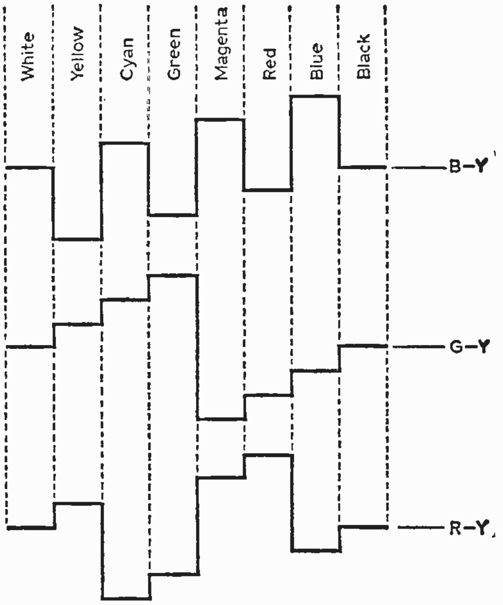


Fig. 7: Colour-difference signals for the standard colour test-bar pattern.

Reverse compatibility means that a colour receiver can display monochrome transmissions accurately in black-and-white. These two requirements are fundamental to a situation where both colour and monochrome receivers have to be catered for simultaneously, and where there are not enough channels for separate colour and monochrome transmissions.

The need for compatibility has governed the form of the composite colour signal, and has made it necessary to use a combination of luminance and colour-difference signal components. In practice it works very well, and in any case results in lower costs of broadcasting.

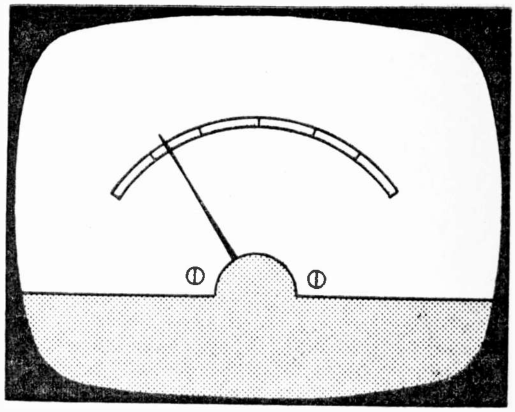
COMPLEMENTARY COLOURS

The complementary colour of, say, red, is the colour which, when added to red, gives white light. Thus the complementary of red is cyan (blue green), of green magenta, and of blue yellow. Note that cyan is obtained from a mixture of green and blue, magenta from blue and red; and yellow from red and green. So if you add red to the right amount of green and blue (cyan) you get white—check; since this is the basis of colour television. Red, green and blue are of course the primary colours, of which more under *Primary Colours.*

TO BE CONTINUED

TELEVISION RECEIVER TESTING

Part 2 by Gordon J. King



TELEVISION automatic gain control (a.g.c. for short) has a twofold purpose. One is to avoid the r.f. and i.f. circuits overloading when the aerial signal is very strong, and the second to effectively balance the signals from various channels—so far as the video and audio circuits are concerned—thereby making it unnecessary to readjust the contrast and volume controls each time the channel is changed.

A.G.C. in radio sets also has a third function, to hold the sound output from the speaker reasonably constant when the propagation and reception conditions are causing the aerial signal strength to rise and fall (i.e., to combat fading). This is not such an important function in television because the nature of the v.h.f. and u.h.f. propagation is such that the signal rarely fades in the same way as that associated with h.f. transmissions.

Television sets today have two a.g.c. systems, one in the sound channel and a separate one in the vision channel. Sometimes a little of the sound a.g.c. is applied to the vision sections of the set to avoid the vision channel suddenly jumping up to maximum sensitivity—and possibly towards instability—should the vision signal fail while the sound one remains. There are other reasons for this, too. Very early sets featured only sound a.g.c., but this was not too bad when there was just a single channel (the BBC) for there was then no problem in connecting an aerial-lead attenuator in those areas where a strong signal was causing overloading symptoms. This became less easy when two channels were available (BBC and ITV) because the signal on one was often much stronger than that on the other, so that when the stronger was attenuated in this way the weaker also suffered unwanted attenuation. Channel-selective attenuators were available, but tended to cause ringing and other symptoms associated with aerial mismatching. The problem was partly solved by the makers equipping their tuners with separate Band I and Band III gain or sensitivity controls. Some sets like this are still found in use.

The introduction of vision a.g.c. was somewhat delayed because of the circuit complications involved in finding a suitable black-signal reference level; but eventually complex gated vision a.g.c. systems were embodied in many sets. It was then discovered that a mean-level, simple a.g.c. system gave acceptable results, so the complex gated systems were mostly abandoned.

It is not proposed here to delve into the theory of a.g.c. systems, but some knowledge of the background and basic principles is necessary to establish a logical approach to testing. On 405-line sound, of course, a.g.c. is achieved by extracting a portion of the sound carrier signal (at i.f.) through a diode to yield a d.c. bias—dependent on signal strength—for controlling the gain of the i.f. amplifier valves. This is possible because an amplitude modulated (a.m.) signal varies about a mean level. A.G.C. is not generally used with the f.m. sound used on 625 lines. A television signal on the other hand has no mean level because the modulation amplitude increases or decreases, depending on whether the signal is of the 405-line standard with positive modulation or of the 625-line standard with negative modulation, with the brightness of the televised scene. However, because the *average* modulation level during the course of a programme remains fairly constant a simple form of a.g.c., not unlike that of the a.m. sound channel, can be used without too much black-to-white compression. This is the mean-level a.g.c. system just mentioned.

On the 625-line standard the mean-level system is even less of a problem because the sync pulses are on the positive side of the modulation envelope, so to speak, so that a peak-conducting a.g.c. rectifier will effectively sample the signal below black level, meaning that the a.g.c. bias will be roughly related to picture black instead of to white.

The gated systems have their a.g.c. rectifiers switched on by line pulses so that conduction occurs when the signal is at the black level (i.e. the back or front porch of the line sync pulses). One or two systems conducted on the black level blanking pulses associated with the field sync pulses. These, of course, were gated by field pulses.

So much, then, for the principles; but how is a.g.c. applied? This is simple, for the d.c. voltage delivered by the a.g.c. rectifier—whatever scheme is adopted—has a negative value (in valved sets, anyway) which increases in strength as the signal itself increases. This is applied as a grid bias (above that of the standing bias) to the r.f. valve in the tuner and to one or two i.f. amplifier valves, and because the gain or sensitivity of the amplifying stage is affected by the grid bias, the greater the applied negative bias, the greater the gain *reduction.*

Thus if one channel is weak the a.g.c. bias will also be weak and the amplifiers will be running almost flat out, giving maximum lift to the weak signal. If another channel is strong, the bias voltage will go more negative, thereby reducing the gain of the amplifiers and stabilising the drive signal—both sound and vision.

There are one or two more aspects which should be mentioned. An important one is that most sets provide some sort of differential delay to the bias applied to the various stages. A not-too-strong signal, for instance, will still produce a bias, and although this may not be very much it will tend to bias-off the controlled valves. If this is done too much to the tuner r.f. valve the signal/noise performance will be impaired, and the picture will carry more background grain than it need do. The solution is provided by delaying the bias applied to the tuner valve—so that the r.f. stage a.g.c. comes on in full force only when the aerial signal is very strong. Diodes are often used in these delaying circuits and the arrangement is that the i.f. valves are the first to receive most of the a.g.c. bias.

Another point is that the contrast control on many sets is activated by the bias produced by the a.g.c. rectifier. This is fair enough on a strong signal where the bias produced is high; but on a weak signal the bias is low, so the contrast control will have none with which to work. The effect is that the contrast control has no effect on the picture, the vision channel gain being at maximum at all settings of the control. This is a perfectly normal action, but can cause some confusion in the minds of enthusiasts. The feeling is that the weak picture is in some way connected with failure of the contrast control to vary the picture, and that if the control was working correctly the picture could be intensified. In actual fact, the symptom is resulting from insufficient aerial signal or a fault in the tuner or i.f. stages causing reduced sensitivity.

The basic a.g.c. system—sound and vision—is shown as a block diagram in Fig. 1. Now, before we concentrate on the actual testing part, let us get clear as to what sort of symptoms can result from its malfunction. If the fault is killing the a.g.c. completely, then we can expect severe sound and vision overload if the aerial signal is strong. If the aerial signal is of medium strength or weak, the fault could show up as unbalance between the channels, calling for readjustment of the contrast and/or volume control from one 405-line channel to another. It should be noted here that most dual-standard sets have some sort of preset balancing control between the 405- and 625-line channels. Some, in fact, have two contrast controls —one for 405 and the other for 625—as, for instance, the latest STC VC51 series. The majority of sets made within the last two or three years have a.g.c. systems which very effectively "iron out" signal unbalance between the channels, so if this is failing to happen it could well be that trouble exists in the a.g.c. circuits.

A strong signal on the 405-line standard can crush the peak-white parts of the picture due to pre-detector overload, giving a symptom similar to that shown in Fig. 2. This can also happen if the control voltage turns positive from the correct negative—see later. On the 625-line standard the sync pulses tend towards crushing instead of picture white and this upsets the line and field locking. In addition to these picture symptoms, a buzz

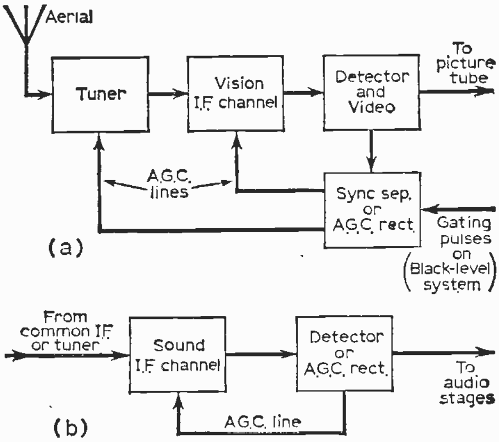


Fig. 1: Block diagram of (a) vision and (b) sound a.g.c.

generally occurs due to the vision signal being intermodulated on to the sound carrier (in the i.f. channel) and the sound endeavours to show itself—due to a similar reason—on the picture. All these things result directly from the overload condition which produces non-linearity of the signal transfer characteristic.

Sound-on-vision interference can usually be tuned out by adjusting the fine tuner control for maximum sound; but if the condition remains at all settings of the control, and there is a tendency towards slight pattern effects on the picture background, the a.g.c. system could have deteriorated without failing completely. This effect on Test Card D—with test-tone on sound—is pictured in Fig. 3.

Sometimes the a.g.c. system is automatically tested when the vision carrier fails (at the transmitter) during a programme. If this results in a noticeable rise in sound volume followed by a return to normal volume when the vision carrier is restored, then the vision a.g.c. system is functioning. This effect occurs because the vision a.g.c. controls the gain of the tuner and the first i.f. amplifier stage, which are both generally common to both the vision *and* the sound signals (on some models the sound and vision signals are separated on 405-lines at the tuner output).

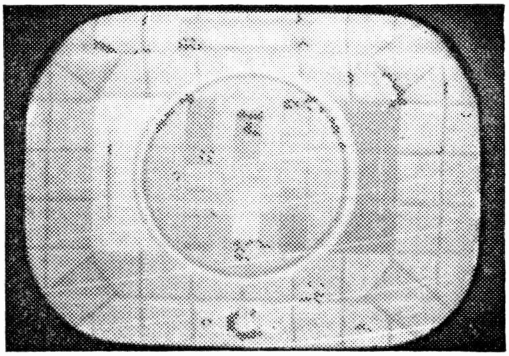


Fig. 2: Overload symptom caused by a.g.c. failure or blocking.

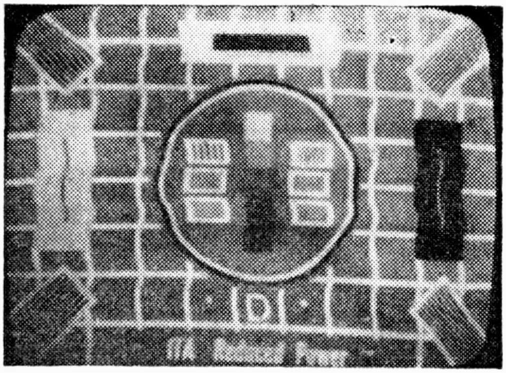


Fig. 3: Sound-on-vision like this can arise due to overloading caused by partial failure of the a.g.c. system.

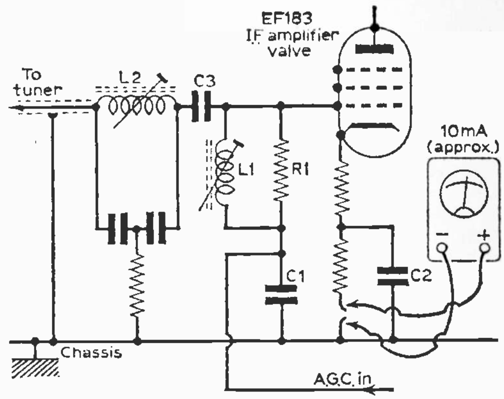


Fig. 5: Alternative a.g.c. test—in the controlled stage.

The basic way of testing the a.g.c. system is simply by connecting a voltmeter between the a.g.c. line and chassis (negative of the meter to the line), as shown in Fig. 4, and noting whether the voltage rises negatively when the aerial is connected to the set—i.e. the signal is applied. The a.g.c. bias should also be seen to alter as the fine tuning control is tuned over the vision carrier frequency.

A very important point here, and one which is not always fully appreciated from the queries we get from readers, is that this test is valid only when a meter of very high resistance is used. It should also be low-reading, having a full-scale deflection of not much more than about 5 volts. A valve voltmeter (or transistor equivalent) is ideal. A low-resistance meter—that is, one incorporating a movement of low sensitivity—will load the a.g.c. circuits badly, alter their characteristics and fail to give any significant deflection. A movement of 1mA, for instance, will give a sensitivity of 1,000 ohms/volt which, when set to read 5 volts full-scale, would look to the a.g.c. circuit as a shunt resistance of 5,000 ohms! Having in mind that the resistors used in a.g.c. circuits have values more of

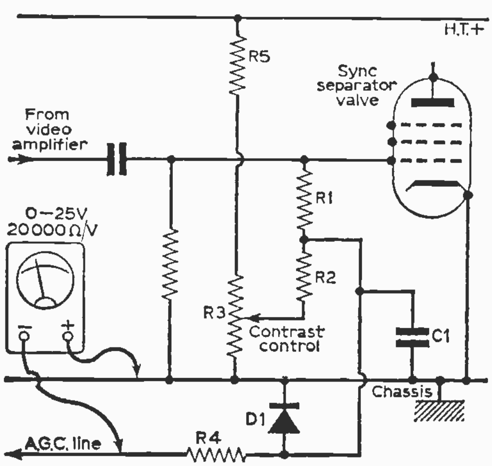


Fig. 4: Basic mean-level circuit, showing method of testing.

millions of ohms than of thousands, it can be appreciated why such a meter would fail to deflect. 20,000 ohms/volt is about the least sensitive meter that could be used for this application, and even then it would be best to run it on the 25V scale, giving a terminal resistance of 500,000 ohms as against the 100,000 ohms on the 5V scale. The minimum sensitivity of the movement in a 20,000 ohms/volt meter is 50μA. However, a valve or transistor voltmeter could have a terminal resistance of a megohm or so on the 5V range—hence its desirability for voltage measurements in high resistance circuits.

Fig. 4 shows the basic a.g.c. source in many sets. Here the control grid of the sync separator acts rather like a rectifier and translates the video signal into a d.c. voltage of a magnitude dependent on the signal strength. The d.c. is tapped off from R1, R2 and R3 and fed through R4 to the controlled valves. C1 and R4 serve to delete traces of signal, leaving only the d.c. R3 is also the contrast control, which is connected across the h.t. supply via R5. Thus when R3 slider is at the chassis end the a.g.c. line is running solely from video signal derived d.c. and the contrast is at minimum. When the control is advanced—slider going towards the R5 end of the control—a positive potential, of strength determined by the setting of the control, is applied to the a.g.c. line through R2 and R4, and since this counters the negative a.g.c. bias the gain of the controlled stages rises. This is the maximum contrast setting.

Diode D1 is an important component since it ensures that the a.g.c. line never goes positive in the absence of video signal. If this diode is not present and the set is running without signal input, the positive potential via the h.t. line and contrast control would run all the controlled valves into grid current and probably destroy them. The return circuit for the diode is often included in the controlled stages.

The simple a.g.c. line voltage check, therefore, will also prove the operation of the contrast control—the measured voltage rising and falling as the control is rotated if all is well—and show whether the *clamp diode,* as D1 is called, is working properly. If the line tends to swing positive as the contrast control is turned clockwise, then this diode must quickly be checked.

Figure 5 shows how the a.g.c. is applied to a controlled valve. Here C1 clamps the bottom of the tuned circuit L1 to chassis signalwise, while R1 applies the a.g.c. bias to the control grid, and since this is a high-value resistor it has very little shunting influence on L1.

This circuit shows an alternative method of checking for a.g.c. action, by connecting a milliammeter in series with the cathode resistor at the chassis end. By connecting the meter in this manner the cathode capacitor C2 serves to bypass the coupling, thereby discouraging feedback troubles and response variations which might otherwise lead to wrong readings.

With zero signal at the set input, the cathode current of the controlled valve is limited only by the standing bias produced by the cathode resistors and for this reason will be fairly high. When signal is applied, however, the stage is further biased by the a.g.c. potential, and if all is well with the system the cathode current will decrease dramatically. This method of testing has the advantage of not requiring a meter of high sensitivity—a milliammeter of 10 to 20mA f.s.d. is suitable.

Still a further method of testing is shown in Fig. 6. Here the a.g.c. line (the common point) is disconnected from the source potential in the set and connected instead to a variable, external potential, comprising the 9-volt battery and 100k potentiometer. The 100k series resistor ensures that the controlled stages are not loaded too heavily by the external circuit. If the potentiometer provides contrast control action, then one can be sure that the controlled stages, at least, are working correctly, thereby isolating them from the source potential in the set.

This arrangement is also useful for checking any differential delay characteristics in the a.g.c. system. The plan is to measure the voltage at the various control take-off points with a high-resistance voltmeter while adjusting the bias with the 100k potentiometer. It is, of course, essential to ensure that any delay diodes remain in circuit, even though the a.g.c. source is disconnected from the line.

It sometimes happens that the a.g.c. system is fully or partly nullified by the reflection of a positive potential on to the line from a controlled valve suffering from grid emission or grid current. For instance, if the valve in Fig. 5 developed grid emission or grid current its control grid would tend to go positive with respect to cathode; this potential would be developed across R1, thereby countering the negative a.g.c. potential.

If the grid emission effect (or leakage) is bad, a high-resistance voltmeter will show a positive potential at the grid side of R1, for instance, and a negative potential at the other end. This would be a reasonable indication that the controlled valve is in need of replacement.

It is possible, too, for a positive potential to get on to the a.g.c. line through an electrically leaky coupling capacitor between the tuner's mixer (pentode section of triode-pentode frequency changer valve) and the first i.f. valve grid. For example, if the anode of the mixer valve is connected direct to L2 in Fig. 5 and C3 is leaky, then a positive potential would tend to counter the negative a.g.c. bias. This is not a particularly uncommon fault, but the defective coupling capacitor is usually located in the tuner itself.

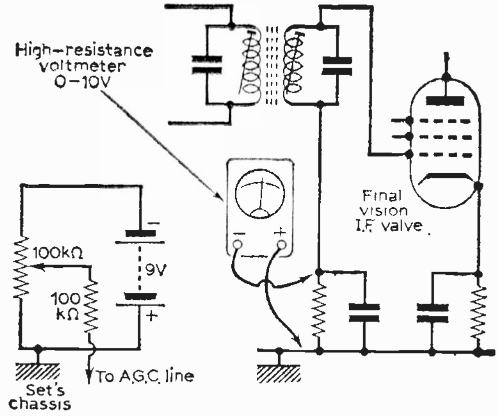


Fig. 6 (left): An external circuit for checking the action of the controlled stages with the a.g.c. source removed. Fig. 7 (right): Checking the anti-blocking circuit on channel changing.

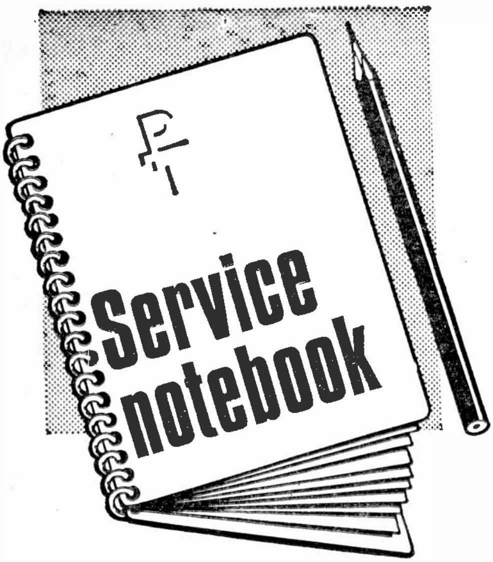
While on a.g.c. systems, reference must be made to the symptom of blocking in the vision channel due to a sudden burst of high amplitude signal, as might occur for instance when changing from one channel to another. This causes the signal amplitude at the video valve to rise faster than the a.g.c. system can take control, thereby overloading the video stage and deleting a great deal of signal at the grid of the sync separator. The result is that the a.g.c. system fails to produce a control voltage under these "signal limiting" conditions so that the set continues to run flat out with an over-bright screen, displaying the symptom of Fig. 2.

Manufacturers sometimes avoid this trouble by introducing a resistor/capacitor parallel circuit—a time-constant network—in the control grid circuit of the final vision i.f. amplifier. This makes the a.g.c. operating time less than that of the overload time. This circuit can be tested, as shown in Fig. 7, by connecting a high-resistance voltmeter across the resistor/capacitor circuit and noting a kick in the reading, with a slow decline, on changing channel.

The condition is sometimes avoided on the 625-line standard by the clamp diode (D1 in Fig. 4) being returned to the vision detector circuit instead of to the chassis or "earth" line. The dual-standard detector switching automatically puts the diode back to chassis on 405 lines. The idea is that a little negative potential from the vision detector is always present on the a.g.c. line on 625, even though on channel or standard changing the a.g.c. may be slow in acting.

All that has so far been said about a.g.c. testing applies to the sound channel as well as to the vision channel. The sound a.g.c. is far less complex and rarely causes serious troubles. In most sets the potential is derived from the sound detector (on the 405-line a.m. signal) as in ordinary broadcast receivers. On 625 lines it might be switched off, being less important on this standard due to the f.m. sound system. The overall sensitivity of the set, however, remains controlled by the vision a.g.c. system.

TO BE CONTINUED



by G. R. WILDING

CALLED to service a modern dual-standard K-B receiver recently we found it giving the classic symptoms of a low-emission e.h.t. rectifier, that is on advancing the brightness control picture size "ballooned" and general brilliance decreased till the screen almost completely blacked out. Of course the reason for these symptoms is that as the rectifier voltage output reduces with increase in tube current demand, electron velocity through the area under the influence of the scan coils reduces. The scan coils can therefore exert greater effect on the beam current and produce a grossly over-sized raster.

A DY86 e.h.t. rectifier is used in this model but on replacing it results were exactly the same as before. Of course if the rectifier receives insufficent power from the line output pentode similar symptoms will appear but accompanied usually by a distinct lack of width. There was no lack of width evident on this receiver but before getting involved it was thought prudent to check both the PL36 line output valve and PY801 boost diode. Replacing these produced no material benefit.

Close inspection of the DY86 in operation showed that the heater was glowing rather less than the usual cherry-red. As the line output transformer was certainly in order the most likely cause of the trouble seemed to be a dry joint or intermittent connection to the DY86 valveholder heater pins. It is a simple matter to prise off the plastic cover to this valveholder. Inspection then showed that although the soldering was perfect there was a miniature resistor connected in series with one heater pin and the transformer winding feeding the heater supply. Its value should be $2{\cdot}7\Omega \pm 0{\cdot}5\Omega$, but in this case it was between 4Ω and 5Ω according to our most accurate assessment. On fitting a replacement, which being such a special value had to be obtained from the makers, the DY86 heater glowed normally and good e.h.t. regulation returned.

Most dual-standard models have a low-value resistor or a miniature choke in series with the e.h.t. rectifier heater lead to equalise its operation on both systems but only very rarely do they cause trouble. The resistors vary widely in value: in the Bush TV141 and TV148 series it is only $0{\cdot}16\Omega$ while in the Decca 101 range it is $4{\cdot}7\Omega$.

Incidentally while on the subject of e.h.t. valve rectifiers the EY87 differs only from the more widely known EY86 in that the glass envelope is externally treated with silicones to avoid flash-over under conditions of high humidity and low atmospheric pressure. Similarly the DY87 differs from the DY86 although these latter valves have only a 1·4V heater instead of the 6·3V of the former types.

Sensitivity controls

Without exception all modern receivers have a preset sensitivity control in addition to the main contrast potentiometer but all too frequently service engineers find them incorrectly adjusted or, at best, far from the optimum setting when called to rectify other faults. If set too low lack of gain with a grainy picture becomes evident; an over-advanced setting on the other hand generally produces sound-on-vision and vision-on-sound while it becomes difficult to separate the darker Test Card squares to obtain good grey-scale tracking. In fact probably 80% of complaints of cross-modulation in modern high-gain receivers are due to over-advanced sensitivity controls.

These presets are needed to enable receivers to operate satisfactorily from a wide range of input signal strengths from areas of high field strength to near fringe conditions. With the exception of models made by the Pye/Ekco group they operate by varying the a.g.c. delay voltage and thus the onset of a.g.c. bias to the u.h.f. and v.h.f. r.f. amplifiers. They should be set to provide maximum gain and freedom from grain with complete absence of cross-modulation and with the main contrast control set appreciably below maximum to permit some user variation and to balance any Band I/III strength disparity.

In most valved Pye/Ekco dual-standard models a rather different system is employed known as high-level control in which the main user contrast control is a 25kΩ potentiometer virtually shunted directly across the video anode load and which can thus tap off the required degree of video tube drive. Hence the name. The associated sensitivity presets are really the equivalents of the main contrast control in the conventional system and back-off the a.g.c. voltage with a positive voltage acting on both the i.f. and r.f. amplifiers. When setting these controls therefore it is important not to over-advance since although the user contrast control can reduce the c.r.t. video drive it cannot effect the pre-video stage signal amplitude and should this be excessive the result will be a "flat" picture suggesting that the tube is poor or that the vision noise limiter is excessively clipping.

These high-level contrast control systems have the advantage that all valve and circuit noise is

—*continued on page 421*

FIBRE OPTIC C.R.T.s

G. BEAUMONT

It was John Logie Baird who first experimented over 40 years ago with bundles of optical fibres for image transference. In fact he was the first to patent an image transference system which consisted of a bundle of small glass fibres arranged so that each fibre would transmit a small portion of an image, this being reproduced at the end of the bundle. The technique lay dormant until the 1950s since when the technology of optical fibres has spread to many disciplines, including electronics where cathode-ray tubes have been developed using fibre optic faceplates.

An example of the principle of fibre optics is found in the illuminated water fountain. When a submerged source of light illuminates the water-jets light passes along the jet due to the phenomenon of total internal reflection. Imperfections in the stream and varying angles of incidence cause the jets to become luminous. A similar situation exists with a rod of glass, and light is guided by a series of multiple internal reflections (see Fig. 1)

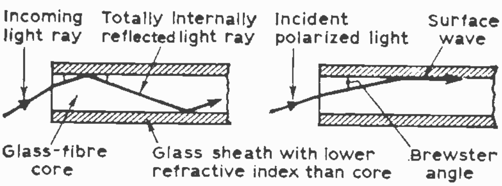


Fig. 1 (left): Process of total internal reflection by which light can be transmitted down optical fibres.

Fig. 2 (right): When polarised light is incident at the Brewster angle surface waves are propagated.

along the length of the rod provided the angle of incidence is less than the critical angle. (The critical angle is the angle at which incident light is caused to become totally internally reflecting and depends on the difference in refractive indices of the glass and its surrounding.) By this means light can be guided down fibres smaller than a human hair.

Flexible Lightguides

The main advance in the technology of optical fibres came in the 1950s when it was recognised that a sheath of lower refractive index than the core was required to overcome problems which arose at the glass-air interface. Lightguides are produced by forming a bundle of such fibres, using a lubricant such as graphite between the fibres and with the space between the fibres darkened. Such guides have fibre diameters of 5—10 microns and are available in various lengths and sizes for numerous applications. Rigid fibre bundles, as one might expect, attenuate the light less (around 10% per ft.) and can accept light incident at angles of 50deg. or more.

Optical Waveguides

Normally the guides are used for ordinary light but they have been used for coherent (e.g. laser) light. Interest in coherent light stems from analogy with radio waves—the information-carrying capacity of light waves being far greater (in proportion to the ratio of wavelengths). It has been found that surface waves can be propagated along the interface of optical fibres (see Fig. 2)—this mode having the advantage that multiple internal reflections, and hence absorption, are avoided. Even so, attenuation is still somewhat high at the present. (An example of this kind of waveguide is the set of fibres connecting the retina of the eye with the optic nerve.)

Use in Oscilloscopes

Recording oscilloscope traces of high-speed events by normal photographic techniques is a very inefficient process. The phosphorescent screen emits light in all directions, the camera only receiving a portion of this. With the very weak traces obtained when recording high-speed events this often results in photography not being possible. The efficiency of the recording process can be increased by making use of the wide acceptance angle of fibres. A stack of fibres is fused into a block for this purpose and used as the faceplate. Acceptance angles of 120deg. can be obtained.

In the c.r.t. shown in the heading 40 million fibres are used in the 3in. faceplate. With other c.r.t.s a spot size of 0·0005in. can be obtained giving a resolution of 6,000 lines. Tubes of this sort are usually magnetically deflected and focused.

Contrast Enhancement

Another application for such faceplates is in increasing picture contrast when high ambient illumination is present. If the outer glass sheath is coated with a black glass, light which is incident at an angle greater than the critical angle will be

—continued on page 421

Our heading photo shows a c.r.t. with fibre optic faceplate for high-speed photography and flying-spot scanning.

LETTERS TO THE EDITOR

COLOUR ON BLACK-AND-WHITE TV

SIR,—In the Royal Institution's lecture series "The Intelligent Eye", televised on BBC-2 on 2nd and 9th January, Professor Richard Gregory demonstrated the illusion of colour on a normal receiver, using very simple apparatus—a spinning disc.

Such colour is subjective, the hue and intensity depending on the individual, according to unbalanced characteristics of the eye. Nevertheless, the sensation can be very apparent. Colleagues of mine saw rings of rich magenta, yellow and blue.

Could not this phenomenon be exploited? While one certainly could not hope for proper colour scenes, I could certainly envisage the production of circles or even captions which would be seen in colour by the majority of viewers. The impact of "commercials" especially would be enhanced thereby.—STEPHEN ALLCOCK (Lytham, Lancashire).

WHO INVENTED TELEVISION?

SIR,—I agree with most of Mr. A. Deverill's brief outline of TV history (PRACTICAL TELEVISION for February), but he may like to know that Paul Nipkow's German patent of 1884 depicts a scanning disc with a spiral of 18 square holes (not 8). This idea of scanning analysis remained a workable theory, as did Campbell-Swinton's proposal for a system with c.r. tubes at transmitter and receiver (1908), described in detail in 1911.

After many false starts with selenium during the nineteenth century, television had to wait for the development of efficient photo-electric cells: the potassium type invented by Elster and Geitel in 1912, and the caesium cell by Ives in 1924. Wireless transmission, reception and amplification techniques, the other essentials, were being perfected during this period. In 1928 Baird demonstrated both colour and stereoscopic TV by disc, and gave us a well-synchronised "low definition" service from 1929, as Mr. Deverill remembers.

"All electronic" TV became possible because of several additions to Braun's simple c.r. tube of 1897, including magnetic focus and deflection by Ryan in 1902, hot cathode and control cylinder by Wehnelt in 1905. Campbell-Swinton suggested (with diagram) the insertion of a "storage mosaic" of photo-electric elements (to be scanned on the back) to make the c.r. tube act as a television camera; Zworykin concentrated on this valuable idea and perfected his Iconoscope by 1933. The Emitron camera of our pioneer "high definition" service of 1936 was of this type.

Tubes in camera and receiver have been improved, and line totals increased, but the basic principles first applied to our 405-line system have been retained in television services throughout the world.—A. O. HOPKINS (Worthing, Sussex).

EXPERIMENTAL TV AERIAL

SIR,—In the January issue of PRACTICAL TELEVISION you published an article by Ivor N. Nathan on an Experimental TV Aerial for Bands III, IV and V. I have made an adaptation of this aerial as follows:

I had no copper wire which would be self-supporting so I used old copper Calor Gas tubing outside diameter about ¼in. I shaped 10ft. of this as a folded dipole, flattened the two ends and trimmed with file and hacksaw.

A three-pin plug (round pin type) was then prepared by sawing off the earth pin, sawing with hacksaw the two remaining pins along the slots in their centres. The two ends of the copper tubing were then filed until they could be fitted tightly in the sawn slots in the plug pins, and then soldered. Co-ax cable was fitted as per the article and the aerial was mounted on a 4ft. long x 3in. x ½in. piece of wood by a bolt through screw hole in plug.

The aerial was mounted in a loft and it picks up the following channels: BBC-1 on Ch.2 from Holme Moss which is quite a distance away, possibly about 30-40 miles as the crow flies; BBC Wales Ch.6 and TWW on Ch.11 from Moel y Parc which of course is only about 6-7 miles away as the crow flies and is visible from my home. Results are excellent being the same as from an aerial mounted in same loft which has BBC-1 dipole, Band III dipole and four other elements!

I could not get any better reception by adding reflectors and directors so it is left with just the folded dipole. Maybe my remarks could be of help to some of your readers. Thank you for an excellent magazine which I have found to be well worth its price.—E. W. DAVIES (Denbighshire, Wales).

HELP AND PRAISE

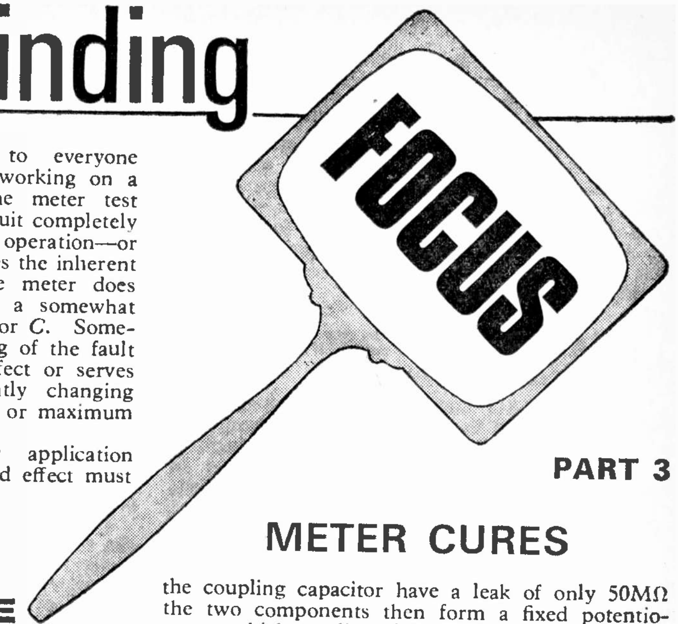
SIR,—While looking through my PRACTICAL TELEVISIONS over the past five years, I find I have some missing. I wonder if any readers could supply me with the August 1967, April and July 1963 issues.

While reading through my PRACTICAL TELEVISIONS a thought occurred to me regarding pre-amps. Has any experimenter ever made a pre-amp to pick up any of ITV's other programmes such as Southern or Midland TV in this area? Maybe one of the backroom boys can come up with the answer.

I look forward to my PRACTICAL TELEVISION each month, especially "Your Problems Solved" and "Test Case". I have indexed all your answers to problems and test cases and find they are a great help to me when I have a set that puzzles me. It's only a hobby of mine, but I really enjoy it, much to my friends' delight.—F. PARRY (London, S.E.25).

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

fault finding



PART 3

METER CURES

BY S.GEORGE

IT happens quite frequently to everyone engaged in servicing that while working on a faulty receiver application of the meter test prod to a particular point in the circuit completely clears the fault and restores normal operation—or or at least seems to. In many instances the inherent self-capacitance or resistance of the meter does indeed cure the fault by replacing a somewhat similar value deficiency in circuit *R* or *C*. Sometimes, however, the apparent clearing of the fault only confirms the presence of a defect or serves to mask the basic fault by slightly changing operational conditions, i.e., sensitivity or maximum output.

In all instances where meter application apparently clears a fault the produced effect must be carefully related to the actual receiver circuitry. For instance, reducing the value of a resistor by shunting the meter across it does not necessarily mean that any improvement obtained is due to the effective lowering of the component's resistance.

As a first example to show how misleading some meter applications can be, it was found when servicing a straightforward *RC* coupled a.f. amplifier with low output volume that on contacting the screen pin of the first pentode to make a voltage test output at least doubled. This particular pentode had extremely high anode and screen feed resistors giving proportionately low standing voltages, and their measurement could not be really accurate due to the loading imposed by the meter. The first assumption therefore was that as slightly lowering the screen grid voltage by meter application had increased output the screen feed resistor had fallen in value, thereby increasing the screen-grid voltage excessively in relation to the low anode voltage. However, a subsequent Megger test on the resistors involved showed that this was not the case. Lowering the screen grid voltage increased output because the *anode* voltage was unduly low through an *increased* value anode load resistor. The amplifier's original volume was restored when this latter component was replaced.

Similarly, many instances of distorted sound can be improved by merely contacting the grid of the output pentode—but this does not imply that the existing grid leak is excessive, or that the meter is effectively replacing some loss in shunt capacitance. Most instances of distortion reduced in this manner are due to the presence of a positive voltage on the valve grid being attenuated by the meter resistance. A positive voltage here is due either to (a) the valve being slightly soft and drawing grid current or (b) a slight leakage in the grid capacitor from the preceding stage. This leak need only be very small to introduce distortion, for as a.f. grid resistors average about 0·5MΩ should the coupling capacitor have a leak of only 50MΩ the two components then form a fixed potentiometer which applies about 1% of the preceding valve's anode voltage to the grid of the coupled valve. Such a voltage could amount to 2V and thus materially reduce the standing fixed bias.

METER CAPACITANCE

Keeping to a.f. faults, it may often be found that signs of instability or parasitic oscillation in the output stage causing shrill, distorted reproduction may be greatly reduced or even completely cured on contacting the grid or anode of the output valve. In such cases it is the self-capacitance and not the resistance of the meter that is effective, acting as a bypass to circulating r.f. or i.f. currents. The trouble here is inadequate decoupling, and this meter application does not necessarily imply that the cause is in the a.f. output stage. Almost certainly the basic cause of such r.f. currents circulating in the a.f. stage is an open-circuit decoupler in the detector or a previous stage, an unearthed screened lead, faulty valve or even misplaced wiring coupling a proportion of signal carrier to the demodulated a.f. waveform. In such instances, the meter "cure" only masks the true fault, and on working back towards the frequency-changer the slight instability will be detectable in each stage till the root source is located. Of course meter applications only produce significant effects in high-impedance circuits where the resistance or reactance of the instrument is comparable in value, so they have much less effect on transistor a.f. stages where the input and output impedances are much lower.

Meter self-capacitance, greatly increased by hand capacitance effects on the live rest-prod, is often very useful when tracking r.f. or i.f. instability due to an open-circuit or dry-jointed decoupling capacitor, for if meter application across such a component results in a major reduction of the fault symptom it generally suggests that the seat of the trouble has been found. Of course such a capacitance application is very far from ideal: trailing meter leads can introduce cross-coupling, while the slight meter inductance can introduce unwanted effects, but in practice in the field this simple test often proves helpful. The alternative is to directly "stab" a replacement across each suspect in turn, but it is difficult to ensure that both ends simultaneously make good electrical contact without risking a sizeable electric shock. Undoubtedly there is a sure and large market for a simple two-pronged device which would enable various sizes of capacitor to be test shunted across suspects quickly and positively.

CHECKING TUBE DRIVE CIRCUITS

Meter cures are commonly encountered when making checks on the c.r.t. for often examples of low brightness level with the brilliance control at maximum, or even cases of complete loss of raster, are restored on contacting the tube cathode pin when making voltage tests. Of course, due to the extra capacitive loading the effect on picture quality will be disastrous, but the actual defect being investigated, inadequate brilliance level or a totally blank screen, will be restored. The only conclusion to be drawn from such a test is that as the raster brilliance level depends on the c.r.t. cathode-grid potential either the tube grid voltage is too low (even at maximum brilliance control setting) or the cathode voltage is too high, the latter seemingly the most likely and indeed indicated by the meter application.

In many receivers the video amplifier anode is directly coupled to the c.r.t. cathode, so that the voltage of the latter is dominated or completely dependent on that of the former. In such receivers therefore excessive tube cathode voltage could be caused by a reduction in video valve anode current producing a reduced voltage drop across the video load thereby maintaining video anode voltage close to that of the h.t. rail.

This could spring from many causes—a low-emission valve, open-circuit screen-grid feed resistor or excessive bias due to a defect in the video cathode circuit. This last possibility could arise through the actual cathode resistor going open-circuit and valve current being maintained via the electrolytic bypass capacitor leaking excessively due to the strain imposed. However, the first automatic action must be replacement of the video output valve.

As you will have noticed when replacing such valves cold in a fully warmed-up receiver, after switching on again no raster is visible till the new valve assumes normal operating temperature, when the resulting drop in anode voltage similarly reduces c.r.t cathode voltage.

However, even if direct coupling between video valve and c.r.t. is employed, meter application to the latter point will fail to produce any significant effect unless such coupling is via a high-value resistor. In most instances, as shown in Fig. 8, the coupling feed is in the form of a high value *RC* combination to attenuate the lower video frequencies.

In those receivers that use pure a.c. coupling to the tube cathode the video anode voltage is completely separated from tube cathode potential, so the voltage at the latter point provides no indication as to the working or otherwise of the video valve.

Of course the fact that reducing the c.r.t. cathode voltage by meter application increases the maximum obtainable brightness level does not of necessity imply that this voltage is above normal—it could be that the c.r.t. grid voltage is insufficient, even at peak value, i.e. with brilliance control fully advanced. However, in practice this very seldom occurs, for the voltage swing covered by the brilliance control is a very wide one indeed so that even major variations in the value of series limiting resistors associated with the control will still not prevent it from swinging the effective bias from black to peak white.

Occasionally a break or hair-line crack develops in the track of the brightness control but such a fault immediately becomes evident.

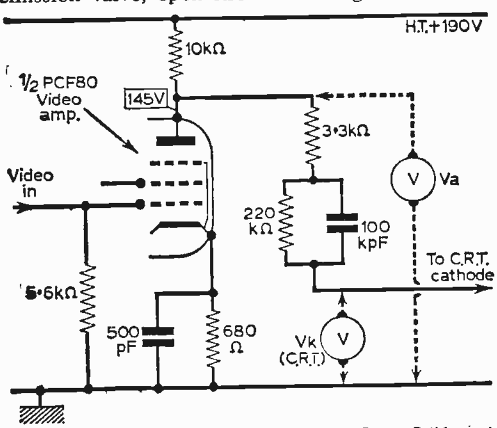


Fig. 8: A meter with a resistance of 400kΩ (2kΩ/V on the 200V range) would reduce anode voltage Va by less than 3V but would reduce c.r.t. cathode voltage Vk by more than 50V due to the high-impedance feed. Meter application to the c.r.t. cathode will thus greatly increase the brilliance level.

TUBE INTERELECTRODE LEAKS

Frequently the opposite kind of fault develops in receivers, that is, it becomes impossible to black out the raster fully even with the brilliance control at minimum setting. In practically all instances this is not due to a circuit fault, but to interelectrode leakage in the tube itself. Such leaks may be from the first anode to grid, grid to cathode or cathode to heater.

When the leakage is from the first anode to grid, together with an attendant reduction in first anode voltage, there is often a reduction in available height since both the first anode supply and the field generator are fed from the boost h.t. rail, and the leakage current imposes an additional load (see Fig 9). A simple and quick check which will confirm the existence of first anode leakage and also show if any height loss is due to this cause is to temporarily insert a further high-value resistor in series with the first anode feed. If this results in both a further improvement towards peak black level and a height increase it can be taken that an appreciable leak exists.

Grid-cathode leakage on the other hand is always

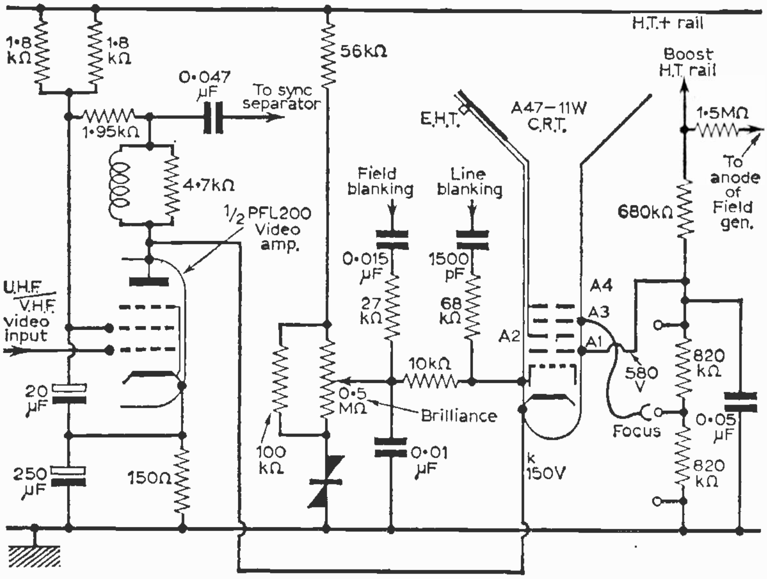


Fig. 9: Directly-coupled video feed and power supply in a modern, dual-standard (Philips chassis) receiver. Due to absence of series RC compensation in the video feed meter application to the c.r.t. cathode will produce negligible voltage variation. Note how a possible c.r.t. first anode leak could limit height by imposing an additional current drain on the boost h.t. supply.

shown up by the voltage on the latter electrode varying as grid voltage is varied by brilliance control operation.

Cathode-heater leakage, though once quite common, is now extremely rare, and although an isolation transformer will greatly minimise the defect, as with all cases of tube leakage, the only real cure is tube replacement.

TIMEBASE FAULTS

One of the commonest line or field timebase faults is inability to obtain the correct frequency or the need for the hold control to be at one end of its travel before a locked position is obtained, thus leaving no allowance for optimum setting or thermal drift.

In most instances if valve replacement fails to effect a cure there may be an internal adjustment, either an additional preset or a shorting link across a resistor, which will enable a centre locking point to be obtained. Failing that you may find that on making voltage tests meter application to points in the grid or anode circuits of the generator valves will alter the oscillation frequency so that the timebase can be locked at a midway control point. However, should such meter application effectively parallel a resistor it must not be assumed that this particular component has increased in value. Timebase frequency is determined by several components, so that a variation in the value of one can be compensated for by a variation in the value of another. Thus there could be a reduction in value or slight leakage in the main charging capacitor or change in value of any fixed resistor in series with the hold control.

While meter application to many circuit points will cure the symptoms of the defect, it may also inhibit sync locking, reduce output or alter the sawtooth scan-flyback ratio.

Experience shows that high resistance, low watt, current-carrying resistors are most prone to value change after years of use, so concentrate on these first; but probably the quickest way of curing this fault is to automatically replace all components that determine oscillation frequency rather than to unsolder one end of each suspect, then test and reconnect till you come to the culprit.

When tracing cases of poor linearity or inadequate height it may be found that contacting certain points in the circuit reduces the fault symptoms, but again such indications must be treated warily, for the apparent improvement may be simply due to reduction or change in the negative feedback characteristics. With all linearity defects, the drill is first to check the operation of all linearity controls and then progressively replace all suspects in the feedback loops.

A.G.C. FAULTS

When investigating instances of low gain or intermittent variations in signal strength, meter application to the a.g.c. rail will vary gain according to the input strength, contrast control setting and

—continued on page 407

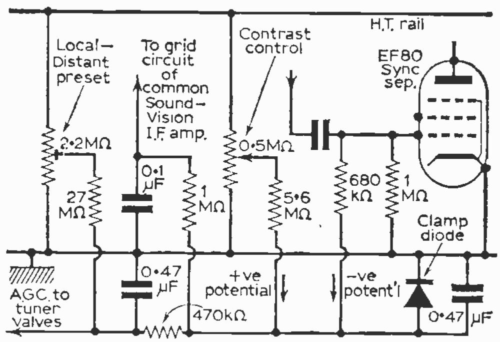


Fig. 10: Typical modern mean-level a.g.c. circuit (H.M.V. Imp portable). Negative potential developed across the sync separator grid resistor is offset by a positive potential tapped from the contrast control. Local-distant preset determines a.g.c. delay to tuner valves. Meter application to clamp diode anode would reduce bias on strong signals till contrast was sufficiently advanced to overcome negative potential.

TRADE NEWS • TRADE NEWS • TRADE NEWS

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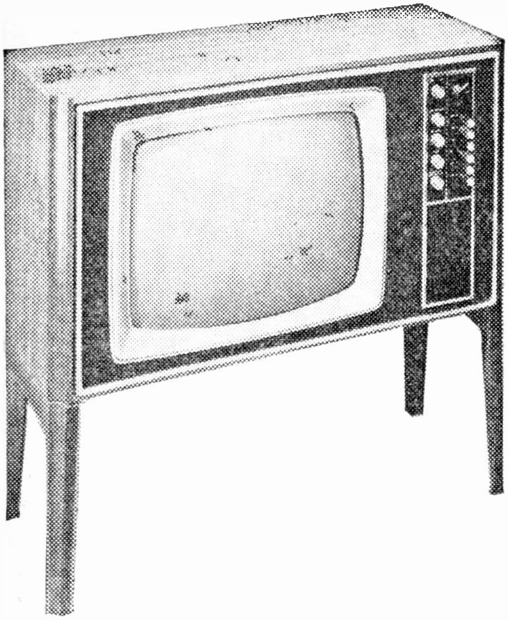
19in. COLOUR RECEIVERS FROM B.R.C.



AMONG the first 19in. colour TV receivers to be marketed by British Radio Corporation is the Marconiphone Model 4701 retailing at a recommended price of 284 guineas (see photograph). Fully transistorised, Model 4701 has push-button channel selection and is designed for the high quality reception of the PAL colour system, on 625 lines, of BBC-1, BBC-2, and ITA-1. In addition, Model 4701 will receive the normal black-and-white programmes on v.h.f. and u.h.f.

Marconiphone Model 4701 incorporates the Thorn 2000 modular chassis, which uses 90 transistors and has been described in July and September 1967 issues of P.TV. Power consumption is 40% lower than with a valved chassis.

Incorporating the Mazda 19in. Rimguard Shadowmask colour tube, Model 4701 has a walnut veneered cabinet with matching stand. The front of the set is of black leathercloth with chrome trim.

Apart from the normal on/off, volume and brilliance controls, Model 4701 has only two extra controls, a saturation or colour intensity control, and the exclusive Personal Tint Control.

Other 19in. colour models released by B.R.C. are the Ultra 6701, Ferguson 3701 and HMV 2701, These have similar specifications.

COLOUR WITH HI-FI OR PORTABLE

MR. J. H. PORTLOCK, managing director of Technomark Ltd. announced recently that his company will be introducing colour TV to the UK market—probably July/August of this year. These sets will be for 625-line operation only.

They plan to introduce a Bang & Olufsen set with Hi-Fi sound from Denmark and a Sony portable colour television receiver from Japan.

COLOUR TUBE REBUILDS FROM VACUONICS

VACUONICS Limited, Newtown Street, Old Hill, Staffordshire, announce that a 25in. domestic colour television tube has been successfully rebuilt by them.

This company specialise in the rebuilding of television tubes for the trade and this news could possibly mean a big breakthrough in the cost of colour tube replacements.

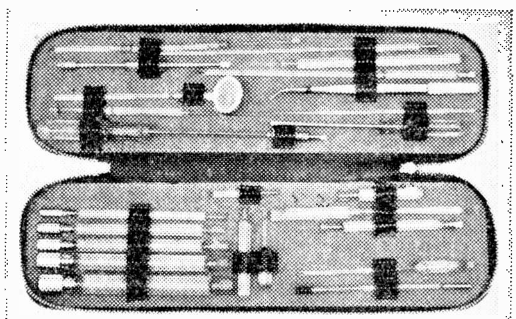
Colour television tubes are the most expensive single component in the receiver, and it is envisaged that rebuilt tubes of this type will cost about half that of a manufacturer's replacement, but still be covered by the same period of guarantee.

Consequently a considerable saving should be able to be passed on to the consumer when a new tube is required.

Because of the new techniques involved in the process, and the non-availability of the materials required in Europe, the necessary electronic components for this colour tube were supplied by Messrs Griffiths Electronics Inc., Linden, New Jersey, USA through their agents in this country, C.E.A. Group of Birmingham.

The completed tube was tested fully in the Television Department of the Wolverhampton College of Technology by Mr W. J. Anderson, to whom the directors of Vacuonics Ltd. are extremely grateful.

COMPREHENSIVE TRIMMING KIT



THE new "777" television and radio trimming and adjusting kit from Henri Picard & Frère, 34/35 Furnival Street, London, E.C.4., contains a comprehensive selection of 23 tools in a zip-up folding case, which opens flat to reveal all the tools, each in its own holder.

The kit has been assembled by Henri Picard with the servicing technician in mind. The majority of the tools are constructed of a high-impact plastics material which not only has excellent insulating properties but is also exceptionally durable.

The selection includes assorted double and single-ended box keys, double and single-headed screw-adjusters, an electrician's screw-driver, a flexible screw-driver, an angled inspection mirror with an extension handle, tweezers and a jamming search tool. Price is £6 17s. 4d.

INSIDE tv TODAY

PART 9 M. D. BENEDICT

OUTSIDE BROADCASTS—2

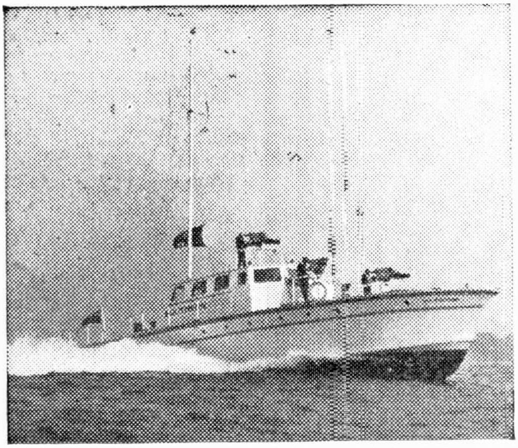
WHEN Sir Francis Chichester arrived back in Plymouth from his single-handed voyage around the world ITV used one of its most interesting facilities—the *Southerner*, an outside broadcast ship. Equipment from one of Southern ITV's o.b. vehicles is loaded into the *Southerner*, a turbo-jet propelled seventy-one foot motor vessel capable of carrying three cameras and a videotape recorder, as well as mixing equipment, radio-link transmitter and steerable aerial and a diesel generator, at up to 34 knots! She is often used for sea sports in the south-coast area, where her unique equipment gives her a great advantage over temporarily installed equipment.

Removing equipment from a m.c.r. and placing it elsewhere is occasionally undertaken where extra facilities or more space is needed. Derigging, as it is known, involves removing camera control units, vision mixer, sound mixer, handling equipment and monitor racks from the m.c.r. and placing them in a convenient room adjacent to the scene of action. Derigging allows extra cameras to be added or several o.b. units to be linked together to form a larger unit.

Other facilities found at o.b.s are camera towers which enable the cameras to see over the crowds and get a better view. Special narrow-angle lenses are used to give closeups from a long distance; lenses with a focal length up to 40in. or even more have been used and zoom lenses are particularly popular as they allow one camera to cover all action within its area without changing lenses. Zoom lenses with a zoom ratio of 18:1 have been made for television use, though 10:1 is the normal ratio.

Cameras are also required to move around and two types of camera dollies are in use. When movement in a house or in confined space is required, particularly when tracking shots in such areas are required, a small dolly capable of turning in very confined spaces and able to carry camera and cameraman through even the narrowest (2ft. 3in. wide) household doorway is used. In larger indoor areas and outside when craning movements are needed the Falcon o.b. dolly is used. It, too, carries camera and cameraman and is of space frame construction but can be derigged to take up less space for transportation to the site. Other mountings to be found are the rolling tripod, found in many simple studios as well as o.b.s. It can be used as a stationary or movable mounting, and is simple and cheap. For fixed mountings, pan and tilt heads bolted to scaffold-sized poles allow the camera mountings to be built into the frame of scaffold camera towers. An alternative is a base, like the pedestal found in the studio, but with a flat square base instead of wheels. This is used where the camera is stationary without requiring attachment to other structures. Height adjustment is provided. On some sites it is desirable to use a mounting with variable height, for example when the camera is required to overhang the area or track above the heads of the performers. For sites such as these a hydraulic tower, similar to those used for repair to street lights, would be used. These are usually mounted in the back of a lorry and allow the camera and cameraman mounted on the platform to be raised and lowered as well as to be moved out from the base on the lorry. Naturally these towers are available in various sizes, the largest reaching nearly 80ft. Being hydraulically operated, they move smoothly and so can alter height when on the air.

More than any other branch of television, outside broadcasting requires a tremendous amount of planning by both production and engineering staff. When the idea for an o.b. is first considered the producer has some idea of the site and its possibilities, but his first job is to visit it along with the director and perhaps the senior engineer if the technical requirements are highly complex. At this point the director has to work out the best position for his cameras to cover all the action. From this point onwards the technical requirements for the programme start to become obvious. Naturally for many programmes the site is well known and it is a matter of checking arrangements so that everything should be as before. However, with a new site the director and senior engineer have to work out the position and height of camera towers, often built by a local building contractor. The availability of the required camera dollies, which lenses the cameras will carry (there are rarely enough zoom lenses to go round) and many other points. Vision links to the studio have to be arranged with the GPO, who may not be able to assist, in which case radio links would then be consulted about the number and position of each link vehicle. When the sound and vision signals eventually reach the permanent television distribution network, lines have to be booked to carry the signal to the studio centre. Power may be available on site but an electrician must be available to connect the m.c.r. power cable direct into the electrical switchroom of a large building. If no power is available a mobile diesel generator is hired from a specialist. Lighting, too, may be required, although simple lights fitting on to the front of a camera are always carried in the m.c.r. and allow a simple medium shot of a commentator to be obtained after dark.



Southern ITV's "Southerner", an outside broadcast ship.

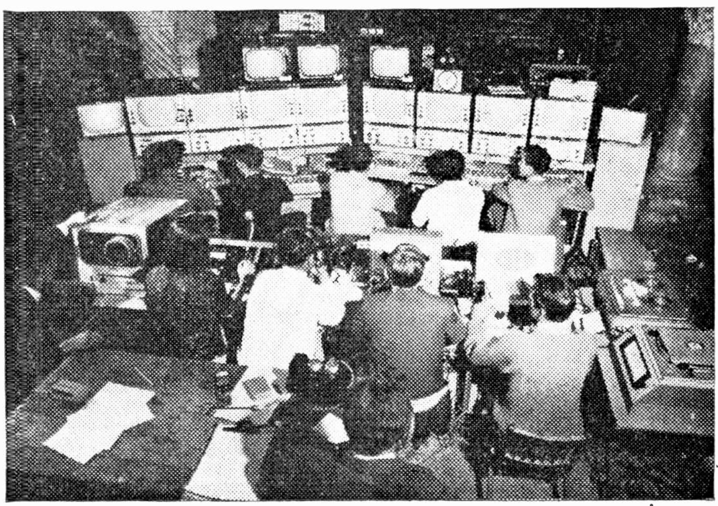
All actual equipment on site, each camera lens, each microphone, all the camera power, and microphone cables, have to be decided upon so the routes around the site must be planned. Purely administrative problems of obtaining the right extra facilities have to be arranged as in many cases the demand for facilities exceeds the supply. Each item to be used in the programme must be taken along to the site, for on o.b.s it is not possible to use the wardrobe, make-up, property and scenery departments which are to be found in any studio centre.

After all the planning is complete the m.c.r. and tenders set off to the site. On arrival the riggers, who also drive the vehicles, start to rig the apparatus. All heavy manual work is done by riggers except for the actual fitting of cameras on their mountings. Cables are connected and the power fed to the scanner, allowing the equipment to be warmed up and aligned ready for rehearsal. While this is going on connections and links to the studio are rigged from the Post Office connection point. On some sites these are permanently connected to a wall box which accepts all the connections from the m.c.r. Alternatively semi-permanent or temporary connections are made via special boxes. In some sites such as scramble or auto-cross courses, and the less popular horse-racing courses where there is a likelihood of another broadcast from that site, the box is left, usually attached to a convenient telegraph pole. Radio links are set up and aligned by pointing the receiving dish in approximately the correct direction according to the maps and then panning the dish until the maximum output is reached. This is also done at the transmitting end, radio telephones being used to guide the operators.

Sound for outside broadcasts usually consists of commentary and effects, but of course this is not always the case. Commentary positions must be provided so that the commentator can see all that is going on, as well as being able to view a monitor showing the programme. In some cases permanent commentary positions may be provided, particularly at race tracks and motor racing tracks. If not it may be necessary to construct a special shelter. In order to reduce noise from outside a special lip microphone is used. Ribbon microphones held close to the face discriminate against external noises and allow such a microphone to be used in very noisy surroundings. A special bar fixed to the microphone and pressed against the upper lip ensures that the microphone is held at the correct distance from the mouth.

Effects are usually picked up by directional microphones, in particular rifle microphones which look like a tube about 3ft. long, making them very suitable for mounting on a camera. As the cameraman points his camera, following the action, the sound effects from that shot will also be picked up.

Hand and neck microphones are used for interviews and comments straight to camera but in some cases a radio microphone would be used to avoid trailing cables and increasing the mobility of the wearer. Most m.c.r.s also provide a tape recorder which may be used for reproducing prerecorded effects, music for the titles, credits, and many other uses. Naturally when remote cameras are used a sound link is necessary to carry programme sound to and from the remote site. Whilst the cameramen and riggers are rigging the vision equipment the sound crew are hard at work rigging their apparatus and testing it. As the sound crews are responsible for talkback and telephone



Right: Temporary control room set up by Southern Television in the crypt of Canterbury Cathedral for their coverage of the enthronement of the 100th Archbishop of Canterbury. Engineers in the foreground watch ten camera monitors. Left to right in the second row are supervisory engineers, production assistant, director and two sound engineers.

communications, both within the site and back to the studio and radio links, they thus have one of the most responsible jobs on o.b.s.

Full rehearsals are not often possible by the nature of the events covered, but practising by the competitors usually gives a guide to whether the cameras are providing the required shots and careful planning by the director and clear instruction to all concerned give everyone a good idea of what is required. From the start of transmission it is then up to the director to guide the cameramen, and the cameramen to offer the sort of shots that they know the director requires.

One development in the o.b. field is along the trail blazed by ATV with their Monoculus unit. From a large van full of equipment and the normal-sized cameras Ampex have reduced the size and weight of equipment by using the latest techniques and including microcircuits to produce a Plumbicon camera and combined pulse generator and four-head, fully professional videotape recorder which can be carried by one man! Thus with the Ampex 3000 system the flexibility of such a unit is now similar to a sound film camera unit. No doubt many filming techniques will now be adapted to this and other new equipment of a similar nature.

Although most broadcasting organisations are developing colour equipment, much work is going on with lightweight equipment. Vans of 30 cwt., less than half the size of the normal vehicles, can now carry three or four cameras and associated equipment. This is possible by using the smaller Plumbicon cameras or 3in. image orthicons, which have recently been improved by using a new target material. Smaller cameras mean smaller c.c.u.s and power supplies so further reducing the space required. Such units are proving popular for the simpler broadcasts—football matches rarely need more than three cameras, for example—as well as being cheaper to build in the first place.

With the development of one-camera units, three- or four-camera units and five- or six-camera units it will become possible to deploy facilities more economically by suiting the equipment to the scale of the coverage required.

One aspect of o.b.s not yet mentioned is the coverage of national events using several m.c.r.s. For coverage of the funeral of Sir Winston Churchill, for example, both the BBC and ITV used many o.b. units placed around the route taken by the funeral procession.

Each o.b. was tied to a central mixing point. The BBC's mixing point was a derig in the crypt of Westminster Abbey. The BBC technicians derigged a special vehicle called a mobile central control room—m.c.c.r.—which is able to combine a large number of remote sources, usually m.c.r.s, as well as providing slavelocking facilities. These were used so that mixing between each o.b. point was possible.

Coverage of events such as these demands much planning and close liaison with the police and other authorities. Richard Dimbleby added his commentary at the Westminster Abbey central point. It is not realised that the feed to his monitors failed so that for a considerable time he was commentating without seeing the transmitted picture! Antony Craxton, the BBC's producer, controlled directors in each m.c.r. and co-ordinated the whole affair from Westminster Abbey. As might be expected the interconnections for this programme between each o.b. and the m.c.c.r., the Television Centre and its telecine and videotape recording facilities were a planner's nightmare, made doubly complex by the ITV's coverage, which was on a similar scale, so that twice the facilities were required!

It is not realised that o.b.s are often indoors in a theatre or auditorium. In this case it is often possible to undertake productions as complex as those in a proper television studio so that outside broadcast staff need a great deal of expertise in a wide variety of skills.

TO BE CONTINUED

FAULT FINDING FOCUS

—*continued from page 403*

point of meter connection. While not showing anything resembling accurate a.g.c. bias measurements, the effect of such a meter application on results plus the slight scale indications can very easily test the actual operation of the a.g.c. circuit.

Practically all modern receivers derive a mean-level negative voltage from the sync separator grid circuit, since the signal at this point closely relates to input signal amplitude. This control potential is fed to the common vision-and-sound i.f. valve and, to a reduced or delayed extent, to the tuner valves and is usually varied by being "backed off" by a slight positive voltage tapped from the contrast control which is shunted across h.t. and chassis (see Fig. 10). A slightly different contrast control arrangement is used in some recent Pye-Ekco models which use a "high-level" contrast system. In the absence of any negative bias voltage, the a.g.c. rail is generally prevented from being positive to chassis by a clamp diode which conducts and short-circuits any positive potential from the contrast control to chassis.

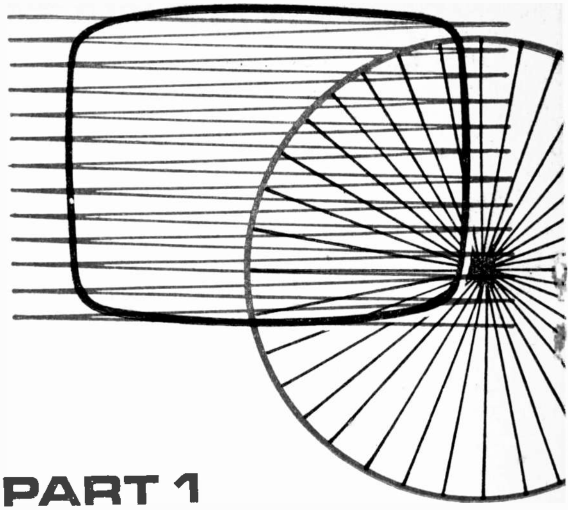
With a strong input signal, therefore, a distinct negative potential should be detected at the feed point to the controlled i.f. valve, and this potential should reduce to zero as (a) the contrast control is advanced, (b) the aerial plug is removed, or (c) the channel selector is changed to a weak or blank station position. Further, on strong inputs when this distinct negative voltage is indicated meter application should increase gain by lowering the effective a.g.c. potential.

The a.g.c. systems of transistorised r.f. and i.f. circuits are of course completely different, and it is only possible to make two generalisations: (1) forward a.g.c. is invariably employed in which the control potential is used to *increase* the collector current and reduce the collector voltage and hence gain because of a series resistor in the collector circuit, and (2) due to the lower impedances of transistor circuits meter application produces correspondingly smaller effects.

As well as being a measuring instrument, therefore, a meter can be very helpful as an indicator of the presence and polarity of small voltages in high-impedance circuits, while when correctly interpreted the effect of applying it across selected points in a receiver can often assist in localising the faulty stage or component.

TO BE CONTINUED

Novel



PART 1

IN spite of the fact that without scanning there would be no television, this vital process is today taken for granted and the early enthusiasm to perfect picture quality by improving optical analysis nowadays seems to be absent. The "advance" from our 30-year-old 405-line system to the CCIR standard of 625 lines is merely one of increase in the number of lines; the structure due to line separation is still visible, though finer, and this means that much picture detail is lost. Should we expect more for the 5½Mc/s given to each u.h.f. channel (a channel bandwidth enough for hundreds of sound stations)? Baird used only one station in the m.w. band. Can we learn economy from the past?

Mosaics of Elements

Nearly a hundred years ago the discovery by May and Willoughby-Smith that selenium is light sensitive encouraged experimenters to devise mosaics

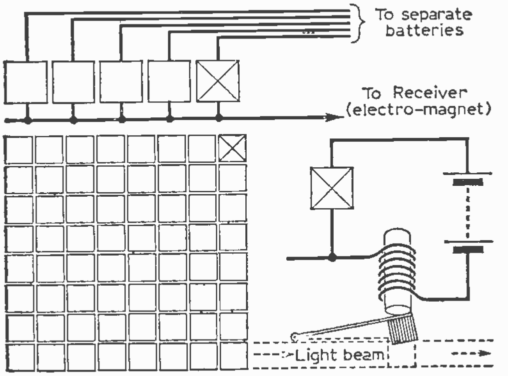


Fig. 1: A mosaic (left) of selenium plates with (right) simple light-shutter control at the receiver.

of selenium plates, copying the structure of the human eye. Just as each of the photo-perceptors ("rods" and "cones") of the retina is connected by its own thread of the optic nerve to the sensorium of the brain, so each small plate, responding to its detail of the focused image, would signal its brightness to a counterpart in a receiver mosaic.

"Metallic" selenium (resembling solder) is photoconductive; its resistance, high in darkness, falls under illumination, allowing current in a battery circuit to increase. The current change was too weak, sluggish and irregular to provide active "elements" in a mosaic. In 1876 Siemens converted selenium to a crystalline form, and invented a "cell" with two spirals of wire covered with a thin layer of the more active substance.

Television pioneers began to try the new cell and variants of it in mosaic formation: Senlacq in 1879, and in 1880 Ayrton and Perry, Carey, Carley, Middleton and Rhumer. Fig. 1 conveys the mosaic idea, and how each element was connected in a circuit including a battery and a light control in a receiver mosaic.

Early Light Cells and Receivers

Efforts were made to improve the performance of selenium, chiefly by using different metals for the spirals and by depositing it upon a mesh or thin plate. Bidwell and Graham Bell in 1880, and Mercadier in 1881, made the best known of these early light cells.

Although the mosaic idea of analysis was shared by many, each experimenter devised a different kind of receiver. Carley tried a small light bulb for each element, but most employed a steady source of light and an electromagnet to vary the light admitted to a screen. Two alternative methods for each element were: (1) to vary the size of a light-admitting aperture; and (2) to plane-polarise the light and control its planar rotation and therefore brightness.

Ayrton and Perry used both methods, in the second the polished pole of each small magnet acting as a light reflector (the "Kerr effect" of 1877). Carey's receiver was used to print a picture on sensitised paper beneath which a metal plate returned the current to earth. Middleton employed thermoelectric couples at transmitter and receiver, with radiant heat forming a crude image on a special type of mirror.

Early inventors aspired only to pictures without movement, like the newly perfected "photograph"; the simple light controls in too-few elements could only form crude silhouettes, disappointing compared with the pictures projected by the popular "magic

TV SYSTEMS

A.O. HOPKINS

lantern". The visual retina has some millions of perceptors; a mosaic of even a few hundred elements would have been inadequate, despite the complex network of wires, so the idea was abandoned after a few years of trial.

Better Cells, Moving Analysis

In 1883 to improve cell response to light by decreasing lag and increasing current Fritt sandwiched a film of selenium between transparent gold leaf, and other improvements were made by Liesegang, Presser, Rhumer and Righi.

Meanwhile photography was trying to depict movement by making use of the visual persistence of the eye's retina; optical apparatus with moving parts was being invented. In 1882 Muybridge demonstrated photographic movement using a battery of cameras, and Marcy made a single camera to get the same result. Later (in 1889) Frieze-Greene and Evans projected moving pictures from cine film.

The early successes in optical art inspired fresh efforts in television experiment; the improved cells might be good enough to use singly to react to a rapid succession of light variations from a scene. In 1882 Atkinson constructed the first mirror-drum, but did not publicise his research. (Weiller was credited with this invention in 1889.)

Zig-zag Analysis

In the early 1880s the general idea was to analyse the image by sweeping reflection side-to-side, zig-zag, as in Fig. 2. Sczcepanik was the first to use two small reflectors oscillating at right-angles at different speeds as at (a); others working on these lines were Paiva, Rosniz and Senlacq. Leblanc was the first to employ a single reflector mounted to oscillate about two axes (at right-angles) simultaneously; the principle of this double movement is seen in the gimbal-like mounting at (b).

Zig-zag analysis has the disadvantage of slowing down when it reverses direction, making the trace uneven. Whatever its shape, a flat picture has two optical dimensions; however the eye sweeps across it the details should be equally clear in both dimensions, which means "all directions".

All-directional Analysis

Multidirectional analysis, by sweeping through the centre and back rapidly with slower rotation, has been tried several times over the years. The trace is usually represented as at (a) in Fig. 3 but the lines could not be straight at this spacing; the rotation introduces curvature as at (b) in which the trace can be followed from 1 to 2 to 3 and so on to 12. A compact method was to vibrate a small reflector by electromagnets at the centre of a revolving plate.

Parallel Scan

In 1883, probably with the idea of a simple, evenly sustained analysis free from the faults of overlap and obtrusive structure, Nipkow thought out his method of scanning by a spiral of apertures in a rotating disc, the well-known origin of our present-day "high definition" scanning analysis. With this

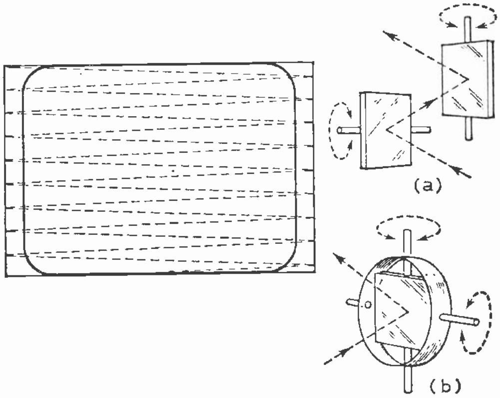


Fig. 2: Before scanning—zig-zag optical analysis of the pictures by reflection from two reflectors oscillating at right angles as shown at (a) or from a single double-movement reflector as shown at (b).

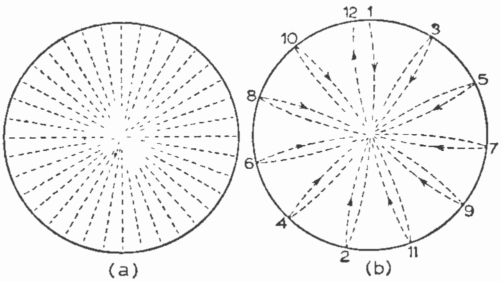


Fig. 3: Analysis in all directions. Multi-directional analysis through the optical centre, in theory as at (a), in practice traces follow curved paths as shown at (b).

original idea, described in his patent of 1884, came simple, single-rotation apparatus, stimulating others to scan methodically. The familiar, slightly curved, parallel lines traced by the disc are represented in Fig. 4. Optical analysis is unidirectional, continuous in the "line" direction; lateral analysis depends upon precise line contiguity, but remains discontinuous. To test this limitation assume that across $x \ldots x$

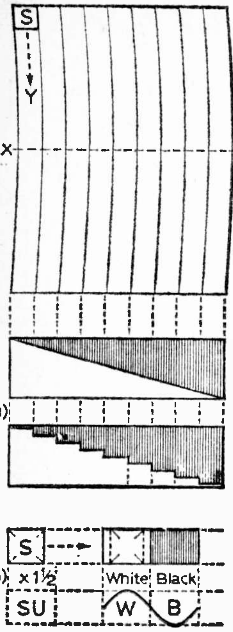
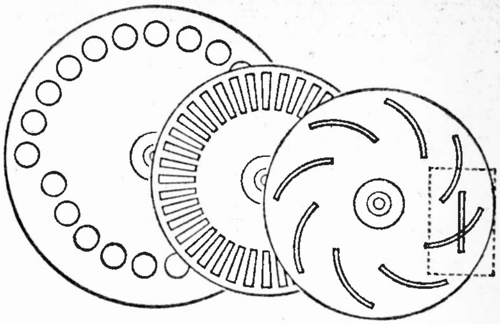


Fig. 4 (left): Parallel scan-analysis by scanning aperture S is continuous along lines. (a) Lateral definition (across x-x) is discontinuous, i.e. stepped. (b) Definition along lines is limited at maximum frequency (half cycle) to scan unit, SU=S x 1½.

Fig. 6 (right): Baird's lens-wheel, shutter-disc and curved-slot disc; the mechanical parts of the first TV camera. The scan was along the vertical slot.



light at the scene decreases gradually, as shown below the lines at (a); the scanning spot decreases the light in steps. Line separation, the current fault in all television pictures, reduces their quality still further.

Low Definition

Along the scan analysis is continuous, resolution for finest details reaching its limit at maximum frequency. At (b) part of a line (turned horizontal) contains two details, one white, one black. The square aperture *S* resolves them within one cycle covering *W* and *B*, the real scan unit areas, as shown. The "details" are not square elements in a mosaic, for the square aperture (or circular spot on a modern screen) cannot resolve small areas its own size; analysing by movement it must extricate itself between scan units, each 1½ times its own length.

Jumping forward to 1929 when Baird used Nipkow discs for transmission and reception at the start of his first "low definition" TV service, scanning was vertical as in Fig. 4, but the aspect ratio was 7:3; the 30 lines used were each expected to contain 70 elements for bandwidth calculation. The 12½ pictures per second should have contained 30 x 70 x 12½ elements, about 26,000, setting a frequency limit of 13kc/s. In practice the normal sound broadcast limit of 9 kc/s was adequate, since only 18,000 scan units could be generated by *S* (if such a pattern were wanted) as proved by (b). In an earlier article in PRACTICAL TV I explained how current bandwidth calculation based on the "boxed in" spot idea causes line separation.

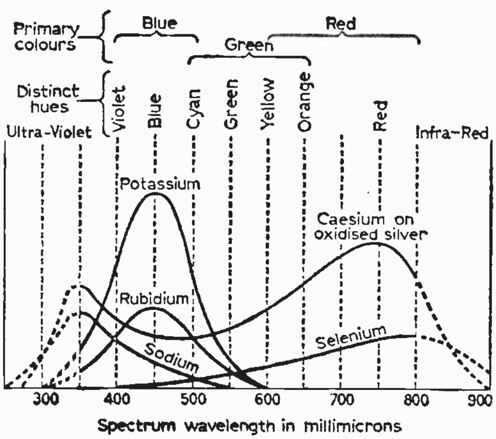


Fig. 5: Colour sensitivity of photoelectric cells.

Cells for Light and Sound

Returning to the nineteenth century, the improved selenium cells were not good enough for the scanning inventions described. With lighting strong enough for good signals the current could not be modulated to a useful frequency; faster modulation was only possible with weak light and current. Without amplification, experiments with discs and other mechanical devices, including the mirror-drum, ceased before the end of the century.

By 1912 Elster and Geitel had made the first photoemissive cell with a thin layer of potassium in a glass bulb containing hydrogen. Amplification by means of the thermionic valve reached a practical stage about this time, so this cell, and others containing an alkali metal, had many applications leading eventually to their use in early sound devices for films and the start of modern television. Rubidium and sodium were found to be less active than potassium. The relative sensitivity of the alkali metals to light of different colours differs greatly and in Fig. 5 the response of the metals mentioned to the three primary colours (which combine to give white light) and also the most familiar hues (whose wavelengths are given in millimicrons) is shown.

Caesium was very weak until Ives, in 1924, deposited a film of it on a metal cathode; this soon developed into the efficient caesium-on-oxidised-silver cell which is in general use for high-frequency light devices including telecine scanners. This cell is most sensitive to red and orange light, but the response can be levelled out by green and blue filters of suitable density.

Baird's Lens-wheel

With efficient high-frequency cells, and amplification techniques developed for the transmission and reception of wireless broadcasts, the early 1920s offered television a fresh start.

Baird decided that parallel scanning was the practical way, as is evident from his earliest apparatus, the essential parts of which are depicted in Fig. 6. This historic machine, which transmitted the first TV picture in 1925, can be seen in the Science

—continued on page 424

Servicing TELEVISION Receivers

No. 146 - SOBELL/G.E.C. 1000/2000 SERIES

by L. Lawry-Johns

WHILST this article is intended to cover the Sobell 1000DS, 1002DS and 1005DS as well as the equivalent McMichael 3001DS, Masteradio D4003 and G.E.C. 2000DS and 2001DS, with certain reservations most of the information will be found to be applicable to a large number of preceding and succeeding models in the Sobell, McMichael, G.E.C. and Masteradio ranges. For example the 1000DS was developed from the ST196DS(T) series and in turn was replaced by the 1010 series. This can be repeated for the other brand names so all in all we have a fairly large family in our net. Still later models however used a completely different hybrid chassis featuring transistorised i.f. strips etc. and a different layout altogether.

Brief circuit description

Two types of v.h.f. tuner may be encountered, both using a PCC189 and a PCF801, in the 1000DS series. Different valves may be found used in earlier and later series and the valve types should be positively identified in each case. One type of tuner is the now common type of small turret tuner whilst the other is the rounded semi-incremental type more common to earlier Sobell designs. More will be said of these later. The i.f. printed panel occupies the lower left side to a point rather to the right of the centre line whilst the timebase panel is on the right. The i.f. panel carries the vision strip up to the video amplifier — sync separator (PFL200 on all 1000 series models) and the sound strip to the PCL84 sound output (pentode section) — a.g.c. clamp (triode section).

It is as well to clarify the functions of the valves fitted on this i.f. strip. V3 EF183 is the common vision-and-sound i.f. amplifier on both 625 and 405. V4 EF184 is the vision only amplifier on 405 but of course must concern the sound as well on 625. The intercarrier 625 sound is taken from the video amplifier PFL200 cathode circuit and so all the valves on the i.f. panel have some bearing upon the 625 (at present BBC-2 only) sound signals. This also includes the GR1 (OA70) vision detector diode. V5 is the PFL200 already mentioned as the video amplifier and sync separator. V6 EF80 is the sound i.f. amplifier for both systems. V7 EH90 functions as an audio amplifier on 405 and a detector on 625. V8 PCL84 has already been mentioned (audio output and a.g.c.). The two diodes GR2 OA79 and GR3 OA81 concern the 405 system only, GR2 being the detector diode and GR3 the sound noise limiter.

The smaller panel on the right contains V12 PCF802 which is the line oscillator (pentode sine-wave oscillator with triode control stage) and V9 PCL85 which is the field oscillator-output valve. Also on this panel is the discriminator diode unit

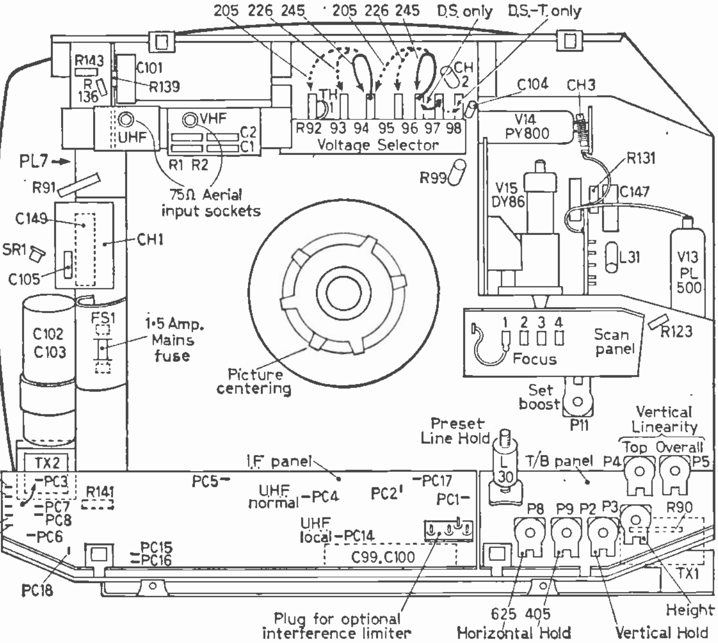


Fig. 1: Rear chassis view.

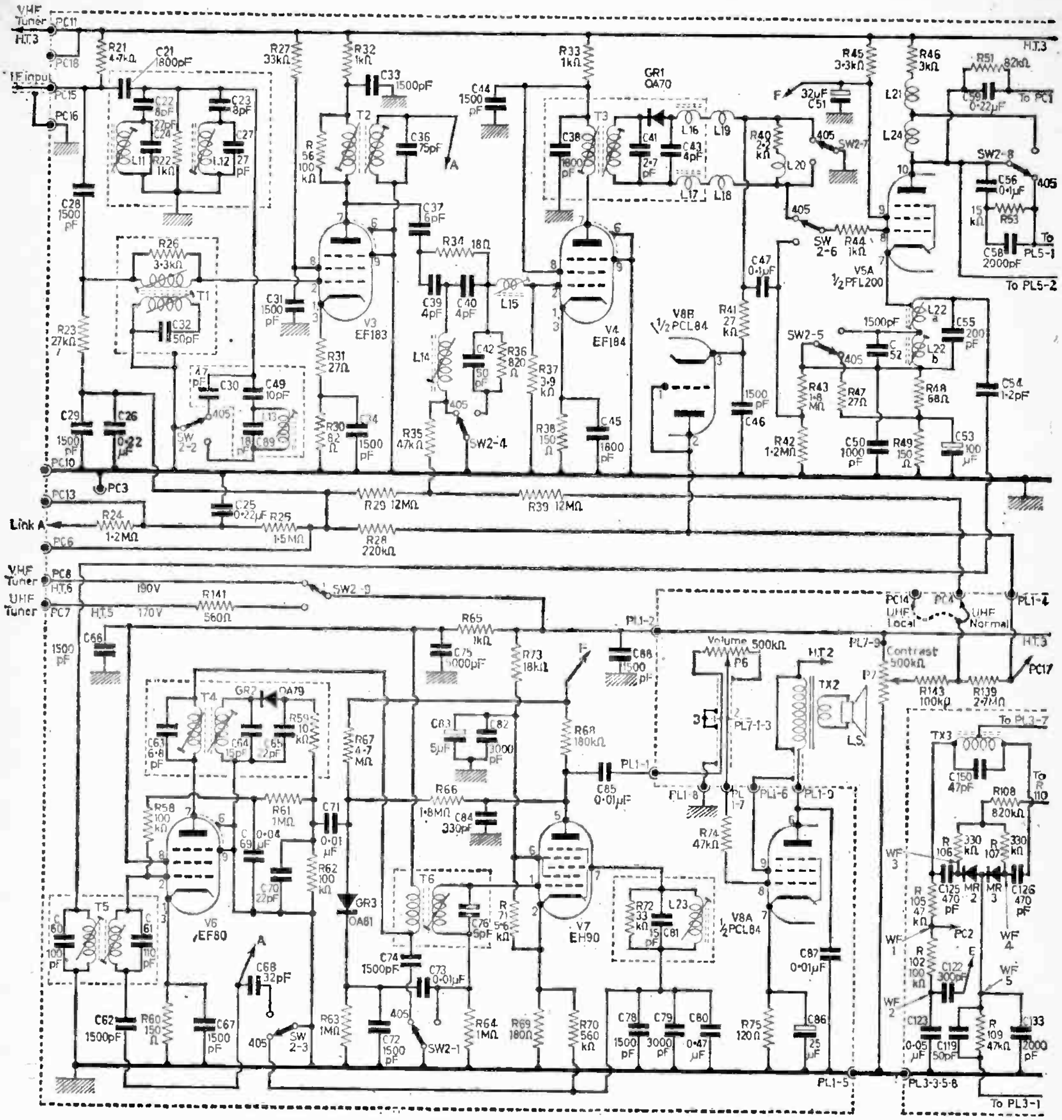
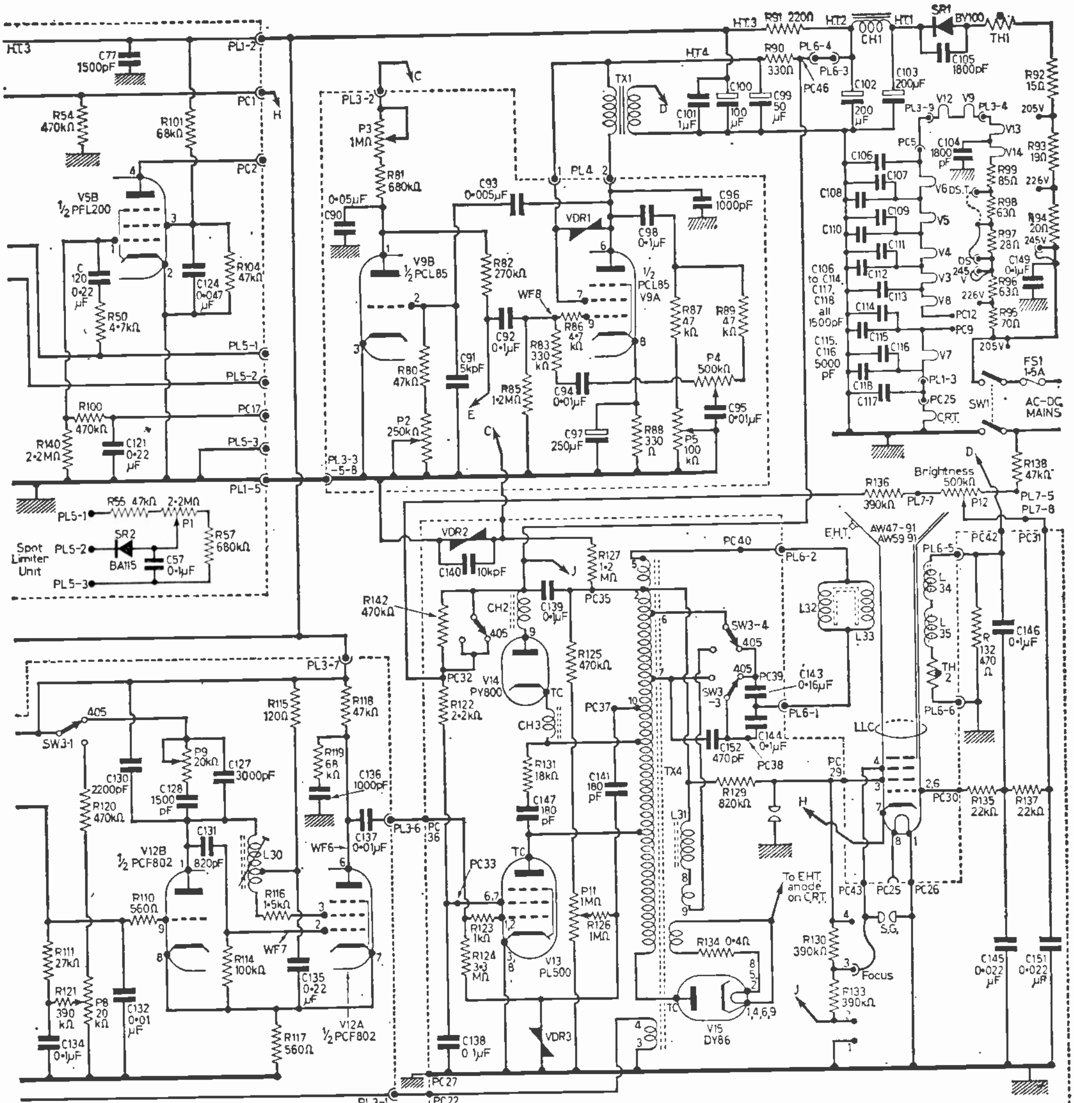


Fig. 2: Circuit diagram of the main chassis assembly.

type P3/2D which is a pair of diodes in series (MR2- MR3). These form the heart of the flywheel sync circuit, controlling within limits the frequency of the PCF802. Also of immediate interest on this panel are the preset controls. Note the position of P5 the overall vertical linearity control as we will be mentioning this later. The small panel above contains several line output components; the focus resistors and settings, the set-boost preset control and amongst other items two VDRs. One of these is VDR2 which is intended to stabilise the height, the other VDR3 to stabilise the line drive under varying conditions, the mean level being set by the set-boost control P11. Also on the panel is R122, the screen feed resistor of the line output valve.

This small panel is suspended from the line output stage assembly which houses the line output transformer, the PL500 line output valve, the PY800 efficiency diode and the DY86 (or DY87) e.h.t. rectifier.

The top centre section is of particular interest being occupied mainly by the voltage selector or dropper. Attention is directed to TH1 on the left side, hiding away behind the end tag of the dropper. In fact it hides so well at times that it just isn't there at all! TH1 is a thermistor (VA1075) wired from the dropper to the rectifier. Its purpose is to prevent a heavy surge at switch-on, presenting as it does when cold a comparatively high resistance. As current passes it warms up thus causing



Sobell 1000 and G.E.C. 2000 series of receivers.

its resistance to fall as in all negative temperature coefficient thermistors. Thus a slowly rising h.t. voltage characteristic is provided. The thermistor in this case takes the form of a round disc, the connecting wires coming from each face. Unfortunately the disc has a habit of parting company with its connecting wires and falls to the bottom of the set thus dropping out of sight and out of the circuit. The valve heaters continue to glow but of course the set won't operate without a supply to the rectifier.

No heaters

Suspended under the right-hand side of the dropper is R99 which is 85Ω, wire wound. Whilst this item does not do a disappearing act like TH1, it does become open-circuited thus stopping the current to the valve heaters. Thus when the symptoms are "no valves lighting up", run along the dropper to prove the presence of mains voltage and then check both ends of R99. If a u.h.f. tuner unit is fitted, the right-hand section of the dropper R98 is shorted across which means that a 63Ω section is not being used. There is no objection to shorting out R99 and opening the link across R98 to bring this into operation. If the mains setting is 245V the very small rise in heater current will not be harmful.

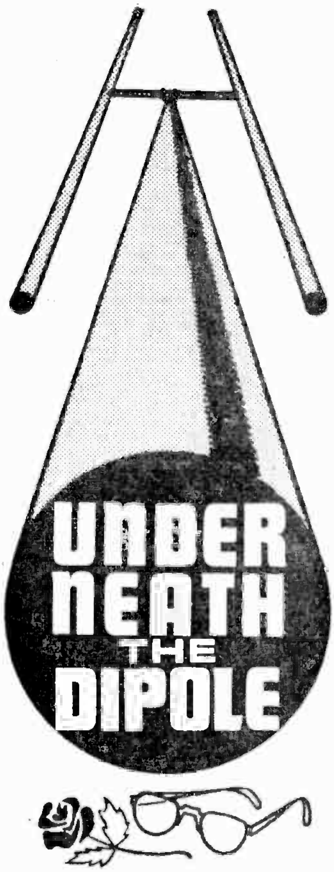
TO BE CONTINUED

THIS is the era of science and education, the day and age of the technologist. *But what, you may ask, are technologists? Are they the backroom boys of engineering, electricity or electronics? Are they skilled craftsmen, technicians or mere machine minders? Or are they inventors, designers or dons?* This is a matter which should be carefully considered by the top brass of every stratum of education from the Minister of Education and Science to the dons of the universities, high masters of public schools, headmasters of private schools to headmistresses of girls' schools, mistresses of kindergartens, even mums and dads.

It is therefore of enormous importance that there should be a clear understanding by the top brass of policies in all grades of education as well as industry. Unlike the outgoing Minister of Education and Science Pat Gordon Walker who with Jennie Lee (Arts) consistently ignored engineers, the Minister of Technology Anthony Wedgwood Benn has made enormous steps forward in the technological field during the last few months, steps which are known by the photographic industry but have only just come to light in the electronics industry and to your reporter Iconos. In February 1967 Mr. Wedgwood Benn set up a unit called the Central Unit for Scientific Photography (C.U.S.P.) the general aim of which was to encourage and support the wider application of scientific photography in industry and research. The advice and services of the Unit were to be available to organisations and experts in the field of scientific photography. At that time the Minister thought that as C.U.S.P.'s work became more widely known it would be able to play an increasingly important part in industrial collaboration.

Scientific photography

The words "scientific photography" may mislead one to thinking in terms of stills or microphotographs. The real facts were made public at a joint meeting in London in March 1968 of the Royal Photographic Society and a number of top scientists of the Royal Aircraft Establishment. At this meeting only a few weeks ago a brilliant lecture was given by Mr. E. S. Mallett, B.Sc., who included video tape, high-speed motion picture photography and advanced optics designs in an integrated combination which achieved hundreds of photographs per second. Such photographic advances have already been used in various industrial fields such as car tyres, metal fatigue, industrial machinery, and the strains and



stresses of structures, humans and animals in modern life!

C.U.S.P.'s contributions are not a one-way traffic, however. The Royal Photographic Society meeting was not a large one but the debate was lively including caustic remarks from the audience on the failure of universities to use electronic aids in a more effective manner than is done at present. This is due to the educational top brass having little respect for technologists. Ever since educational cinema films became available in England in 1903 (when an American, Charles Urban, first introduced them) films have been treated almost with contempt. Tutors regarded film showings as being good excuses for absenting themselves to relax with a smoke instead of taking part in the proceedings. In order to take part in the act it would be necessary for a tutor to see the film (or television lecture or television tape) beforehand to work out his introductory "patter" and final summing up: this is rarely possible.

The Air flop

As the television *University of the Air* is rather a flop and the interchange of university or school lectures by coaxial cable all over the country would cost in GPO line hire about £90,000,000 per year, video tape is the only communication medium which could do the job; if, that is, all the universities and schools used the same standard tape machines, with compatible tape widths, speeds, lines, frequencies. This is where organisations such as C.U.S.P. can solve problems. One suggestion made at that Royal Photographic Society meeting was that a reasonably good-quality, helican-scan tape picture and sound could be transferred from a good TV monitor via a telerecorder film camera to 16mm. picture film with magnetic sound stripe. The resultant 16mm. film print could be played off on 16mm. telecine machines for reproduction on classroom monitors or film projectors with proper technical organisation and tutors would be able to see in advance a preview of the filmed lecture. His participation in the act would give the impact which is as essential in the training business as it is in show business.

Confidence trick!

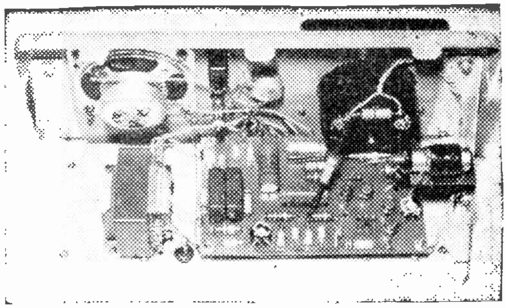
Revelations of untalented pop groups importing or adding elderly professional musicians from the top symphony orchestra class as long as they're not in the picture do not surprise people who are in the business professionally. But this is a kind of confidence trick which will not fool those viewers who can tell the difference between music shot "for real, before your very eyes" and that polished-up beforehand on tape or disc and mimed later before the cameras.

Iconos

X-RAY RADIATION METER

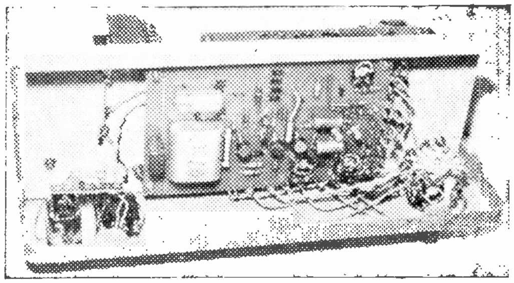
by Martin L. MICHAELIS, M.A.

Part 2



▲ Above chassis view.

▼ Under chassis view.



Last month the basic circuit together with a description of its operation was given. This month the setting-up adjustments are detailed and constructional drawings given. First, however, a correction is necessary to the circuit shown in Fig. 2 last month where the polarity of zener diode D10 and silicon diodes D13–D16 was shown incorrectly. D10 anode should be connected to chassis with its cathode connected to the junction of R14, C6. D16 anode should be connected to R27 and the four diodes D13–D16 reversed so that D13 cathode is connected to R25. The circuit description under the heading Approximator needs revision as follows: "there are four silicon thresholds between Tr11 emitter and the *anode* of D16; the voltage at D16 *anode* is thus a true replica of the actual d.c. potential at Tr8 base, and thus serves as our approximator output". The diodes are shown connected correctly in Figs. 3 and 4.

PULSE AMPLIFIER ADJUSTMENTS

These adjustments must be made *before* aligning the ratemeter circuit board. The first step is to set the correct operating conditions for the g.m. tube. For this purpose, adjust VR1 as described last month under the section headed "operating points". TC1, which consists of twisted insulated connecting wire, should be removed entirely or completely untwisted and bent apart. The assessment of whether the g.m. tube is functioning at the respective settings of VR1 is best made by using headphones (any impedance) connected to P2 and with the loudspeaker switched off. Now connect a calibrated oscilloscope across R7 (between Tr2 emitter and chassis). Carefully adjust TC1 by progressively twisting the wires together until the amplitude of the displayed pulses reaches 7·5V (positive). Caution: *switch off* and wait ten seconds before making any adjustment to TC1. Do not touch or alter TC1 when the unit is switched on. Apart from the serious danger of electric shock, this could damage the g.m. tube on account of the large additional capacitance of the fingers.

If it is not possible to obtain a pulse amplitude of 7·5V across R7 when TC1 has reached about 1pF (about three twists of normal plastic insulated connecting wire) do not make TC1 any larger but leave it at three twists and increase the setting of VR1 until the oscilloscope across R7 displays 7·5V positive pulses. To observe the pulse amplitude, use either the triggered mode of the oscilloscope, or switch off the horizontal deflection entirely so that the pulses produce only a vertical line. It is important to keep the brightness of the spot to the minimum really necessary in this mode.

If, on the other hand, the pulse amplitude already exceeds 7·5V with TC1 completely untwisted, remove TC1 entirely, place a capacitor of about 1—4pF (500V ceramic) across R6, and adjust VR1 to make the pulse amplitude 7·5V, after first getting as close as possible with the value of the capacitor across R6.

The g.m. tube is now set to its correct operating point. Next transfer the oscilloscope connection so that it is across R9. Adjust VR2 so that the displayed pulses have an amplitude of exactly 6V. The amplifier gain is then set correctly for all outputs

LOUDSPEAKER IMPEDANCE

The values of R11 and R10 are correct for a loudspeaker with 70 to 125Ω matching impedance. It is, however, immaterial whether a loudspeaker with a speech coil of this impedance is used, or a speech coil of different (lower or higher) impedance with a suitable transformer. The prototype was a miniature 3in. loudspeaker with a 100Ω speech coil.

R12 across P2 determines the volume of the ticks in the loudspeaker. A complete short-circuit across P2 gives very loud ticks in the speaker, whilst omission of R12, leaving R11 alone as emitter resistor, gives rather quiet ticks. A value of 33Ω for R12 was found to give a good compromise in the prototype. Any value of R12 greater than

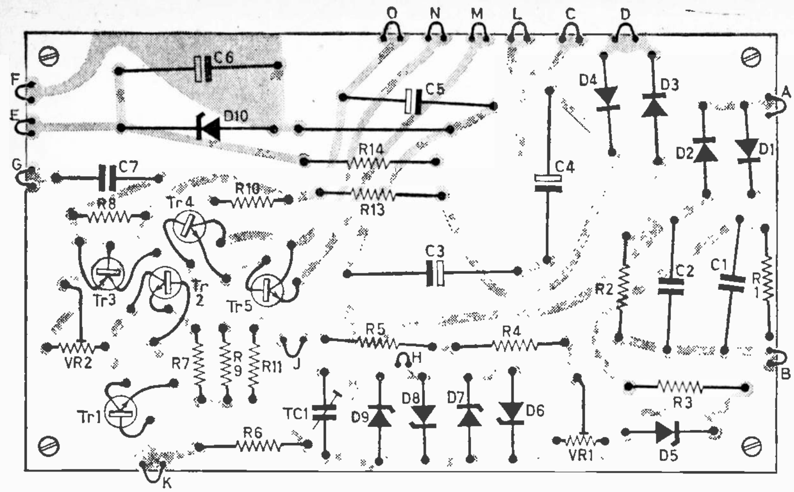


Fig. 3 (left): Power supply and amplifier board layout viewed from the print side. Actual size 6 x 3½ in.

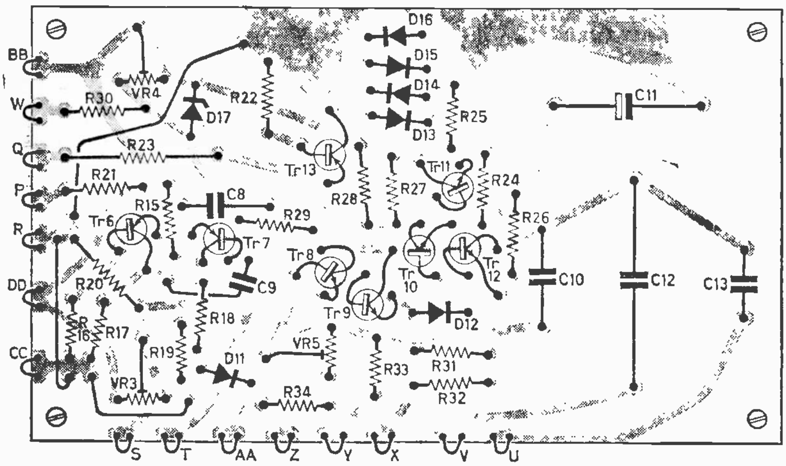


Fig. 4 (left): Rate meter printed board viewed from the print side. Actual size 6 x 3½ in.

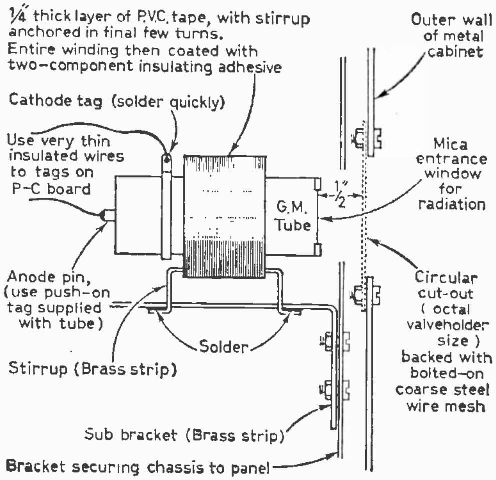


Fig. 5: Mounting details for the g.m. tube.

22Ω hardly affects the output level at P2, which is nominally 5V positive.

EXPANDER CIRCUIT ADJUSTMENT

Connect an oscilloscope across R19. Use a high-impedance signal probe and switch to the internal positive trigger mode of the oscilloscope. Preferably place a radioactive sample close to the g.m. tube (old watch with radium luminous paint, Cobalt-60 standard sample, etc.) to obtain a conveniently observable pulse repetition rate. Commence with VR3 shorted out. Nothing but possibly some very small transient waves will be visible on the oscilloscope. Now advance VR3 slowly to increasing resistance values. At some point, approximately square pulses of about 100μS duration will appear. These are the partially squared g.m. tube pulses direct, i.e. the expander is still not firing to produce the properly squared 500μS pulses. Continue to advance VR3 until the expander just commences to fire, indicated by the onset of erratic jumping between 100 and 500μS pulse length on the oscilloscope display. Carefully note the setting of VR3 at this point (preferably by measuring the voltage at Tr7 base with a high-impedance valve voltmeter connected across the track of VR3; if the valve voltmeter does not possess a floating return lead it must be connected across R20 with one side to chassis and this calls for a higher range with less accurate readability of the small fractional changes due to VR3, but is still usable with care). Now continue to advance VR3 to still higher resistance values. The display should now consist of uniform 500μS square pulses which do not change with further advance of VR3 until a point is reached where they commence to decrease in amplitude and just beyond this the circuit becomes unstable and may burst

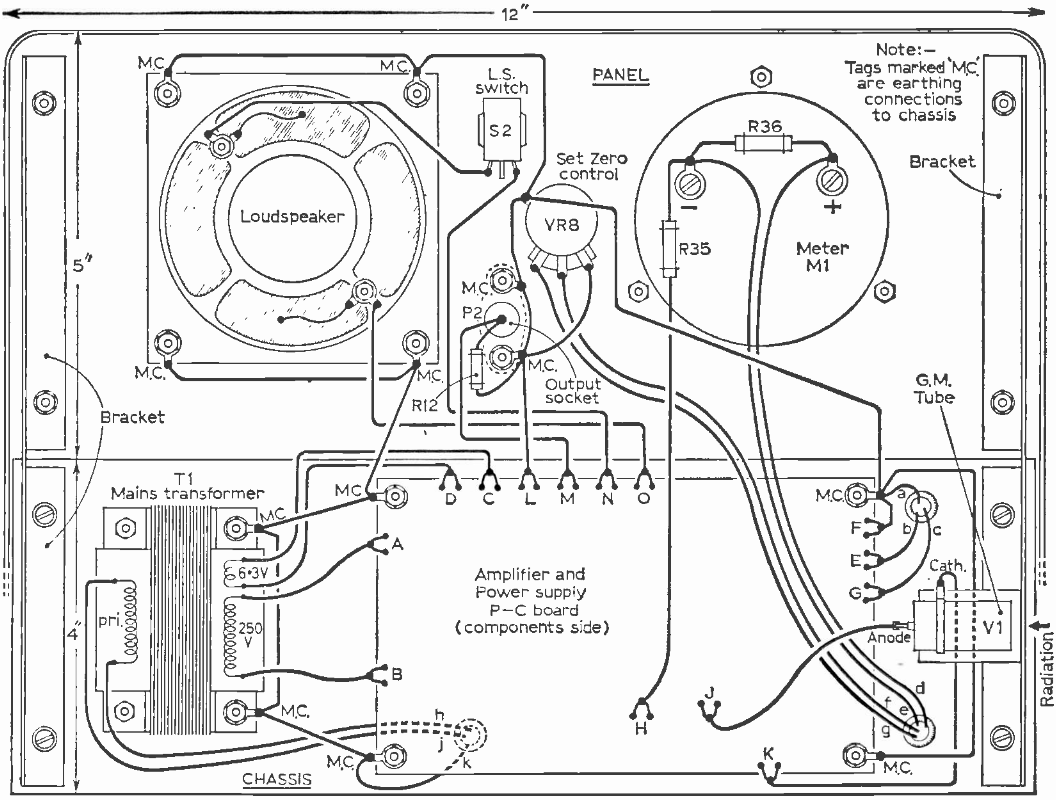


Fig. 6: Wiring above chassis. The power supply and amplifier printed board is mounted on top of the chassis

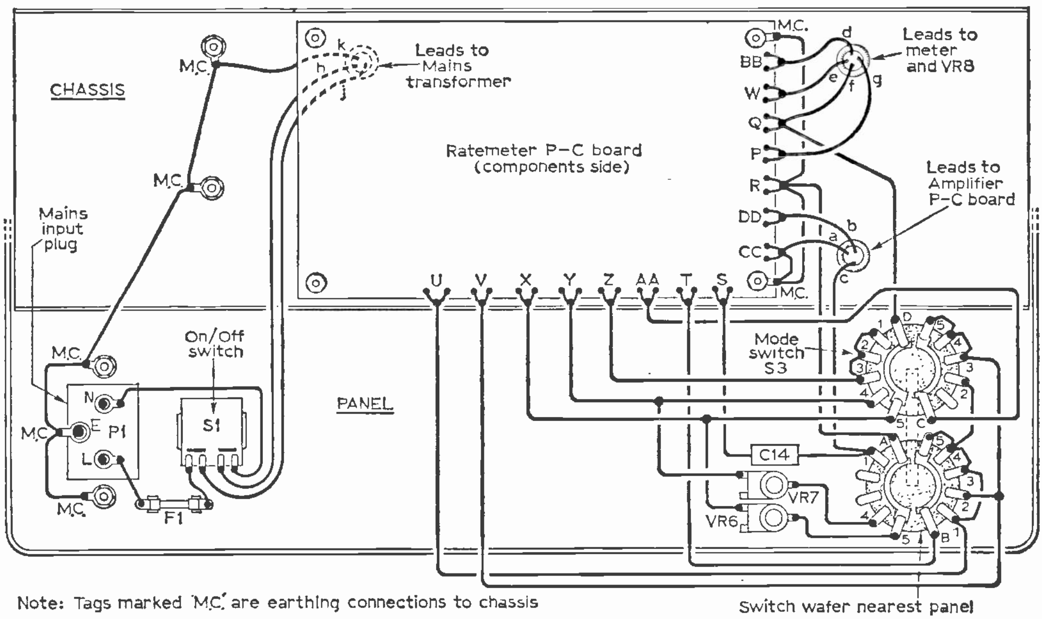


Fig. 7: Wiring below chassis. The ratemeter printed board is mounted beneath the chassis.

into self-oscillation. Once again note the setting of VR3 at the point where the 500μS pulses just commence to reduce in amplitude.

The correct setting for VR3 is midway between the two noted points, which should be at least 600mV apart. If they are closer than 600mV, the value of C9 needs alteration. This does not affect the pulse width, which is determined solely by C8. However, it is not possible to say in advance whether C9 will need increase or decrease, because a definite value is optimum, the stable firing range becoming restricted for larger or smaller values of C9. The optimum value for C9 depends on the precise characteristics of the transistors, and thus may be slightly different even for different samples of the same nominal transistor type. However, the choice of suitable transistors is not critical as such (see parts list). If a transistor meter is available, select a pair of transistors with the highest possible current gain β, or use the higher value of β in the position Tr6. The expander is now working correctly.

ALIGNMENT OF OPERATIONAL AMPLIFIER

First of all adjust the subsidiary zeroing controls VR6 and VR7. These are necessary to compensate for the different voltage drops across the different range resistors when the same base bias current required for setting the operating point is passed through them. Unsolder the wires at tags U and V of the ratemeter circuit board. Solder or clip a short circuit link from S3A1 to chassis to mute the expander on all settings of S3. Switch S3 to set zero and adjust VR8 on the front panel for exact zero reading of the meter. Now switch to position 4 (500μr/h) and adjust VR7 to return the meter reading to exactly zero *without disturbing* VR8. Then switch to position 5 (1000μr/h) and adjust VR6 to return the meter pointer to exactly zero, without disturbing VR7 or VR8. Check that the meter pointer now remains exactly at zero on the scale in all five switch settings. If not, repeat the adjustments in sequence until this condition is satisfied. Remove the chassis link from S3A1 and solder wires V and U back on to the ratemeter circuit board.

OPERATIONAL AMPLIFIER CALIBRATION

If a standard Cobalt-60 radioactive source is available place it at such a distance from the g.m. tube window that the radiation dose rate there is 1000μr/h (the supplier of the Cobalt-60 source, the Radiochemical Center, Amersham. Bucks, will supply the necessary distance/dose rate calibration graph; a sample of about 2·5μCi activity is satisfactory). Alternatively, assume that 1000μr/h will correspond to a pulse rate of 16·67c/s for the specified g.m. tube. In this case, obtain pulses at this frequency either from a calibrated pulse generator able to tune down to this value or as follows: feed the mains frequency (50c/s) into the Y amplifier of the oscilloscope and synchronise exactly three cycles across the screen. The timebase is now running at 16·67c/s. Take positive flyback pulses (e.g. from the flyback blanking generator or from some suitable point of the timebase circuit of the oscilloscope). Pass these via a 100 to 200pF ceramic capacitor to a voltage divider of about 1MΩ total resistance, to obtain differentiated positive pulses of about 5 to 10V amplitude. Unsolder the g.m. tube cathode lead from tag K of the amplifier circuit board and connect the reference pulses between this tag and chassis. Switch S3 to the highest range (1000μk/h) and adjust VR4 for exactly full-scale deflection on the meter. Before doing this make sure that the zero point is set correctly with VR8 in position 1 of S3, and wait at least five minutes after moving S3 to position 5 before adjusting VR4.

If full-scale deflection is reached abruptly near minimum resistance of VR4, or if maximum resistance of VR4 still does not give full-scale deflection, the pulse duration of the expander must be changed. Increase of C8 increases the meter reading, and vice versa. If it is necessary to change C8 in this manner, the expander must be realigned afterwards as already described before finally adjusting VR4 and then proceeding with the calibration of the operational amplifier.

The middle range in position 4 of S3 (500μr/h) will be correct too as soon as the top range has been aligned as described, as long as R33 is *selected* to be exactly twice the value of R31 + R32. The lowest range will similarly be correct when the net resistance of VR5, R34 and the input impedance of the operational amplifier is exactly ten times R31 + R32.

The trimmer potentiometer VR5 is provided to compensate for the now not negligible possible differences of input impedance of the operational amplifier. The simplest method of making the adjustment is to compare the time constants. For this purpose, mute the expander again by reconnecting a short-circuit between S3A1 and chassis. Switch S3 to position 5 after first zeroing with VR8 in position 1 and then switching off. Now switch on again, to make the meter slam over to full-scale deflection. Have a stop-watch or wrist-watch with seconds hand ready, and start timing when the meter pointer crosses the full-scale mark on its way down. Stop the timing when the meter reads any convenient lower mark, e.g. half scale or quarter scale. This will be about 30 to 60 seconds later. Now re-zero the meter in position 1, switch off, turn S3 to position 3, switch on again and time the new period which elapses between full scale and crossing of the *same* lower scale mark by the pointer. This must be ten times as long as the former period. Adjust VR5 accordingly; increase VR5 if the run is too fast, and vice versa.

This requires some patience, since each run takes five to ten minutes. It is possible to speed things up by using position 2, not 3 for S3. The approximator capacitor C13 is then used alone, so that the timed rundowns in positions 5 and 2 should be equal, not in the ratio 1:10. However, this is valid only if C13 is *exactly* ten times smaller than C12 i.e. it calls for accurate previous measurement of the actual capacitances of C12 and C13 on a good bridge, followed by padding of C12 or C13 to achieve exactly 10:1 capacitance ratio.

As far as the circuit operation is concerned neither the actual capacitances of C12 and C13 nor their ratio affect the accuracy of the instrument as a whole. A ±20% capacitance tolerance range is here quoted for both components. Only the insulation factor is vitally important. This must be of a high order so that electrolytics are quite unsuitable.

PREPARING THE METER SCALE

This is the final step of the alignment procedure for the complete instrument. For all adjustments described so far, the meter was assumed to have still retained its original linear scale reading 0 to 500μA as specified, or some other linearly calibrated range if a different meter movement is adapted by modifying its internal shunt. We must now provide the final meter scale reading μr/h. This will not be quite linear; it is inevitably slightly cramped near zero and opened-out near full scale. Proceed as follows.

Connect a high impedance valve voltmeter to Tr8 base (return lead to chassis). Switch S3 to position 1 ("set zero") and adjust VR8 until the meter M1 reads exactly zero on its existing scale. Take the valve voltmeter reading. Now advance VR8 until the meter M1 reads exactly full scale on its existing scale. Take another reading of the valve voltmeter. Determine the difference between the two taken valve voltmeter readings and divide this difference by ten. Note the corresponding ten linearly interpolated valve voltmeter readings in a column on a piece of paper. Adjust VR8 so that the valve voltmeter shows each of these readings in turn, and note the corresponding readings of the meter M1 against its existing scale. Enter these readings in a second adjacent column on the piece of paper.

Now switch off, take out the meter M1, open it and take out the scaleplate. Measure the total angular length of the scale arc. This will be 90deg. in most cases (use a protractor). Next divide the total scale arc angle into ten sub-intervals in the same ratios as the ten meter readings noted in the second column on the piece of paper. With the help of a protractor, ruler and compasses, mark out a correspondingly divided scale arc on smooth drawing card, enter the numerical markings 0-100, 0-500 and 0-1,000μr/h for the three respective ranges, glue over the former scale arc with a thin film of suitable glue, e.g. Durofix, coat with clear varnish, allow to dry, reinsert in the meter movement and return the meter into the radiation meter unit.

The instrument is now completely finished, aligned and calibrated. It is most important to carry out all adjustments in the order given, not in some other arbitrary order. If all these instructions have been followed carefully and the adjustments made exactly, the completed instrument may be relied upon to give high-precision performance which will satisfy even a large number of professional requirements in atomic physics. ■

NEXT MONTH IN

Practical TELEVISION

PULSE AND PATTERN GENERATOR

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COLOUR RECEIVER A.G.C.

While the mean-level a.g.c. system has been found generally acceptable for monochrome reception on colour an a.g.c. system that samples the signal at some definite level is required if accurate colour reproduction is to be obtained. Current colour receivers all use the sync tip system, described in this article, in which the sync tips are the reference level for a.g.c. action. In addition on 405 lines many receivers use a ringing circuit, also described, to give gated a.g.c. action.

X-RAY RADIATION

Following his X-ray radiation meter constructional feature Martin Michaelis starts a short series on electromagnetic radiation with special reference to television problems.

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DX-TV

A MONTHLY FEATURE FOR DX ENTHUSIASTS

by Charles Rafarel

CONDITIONS for the past month have at least shown a little improvement over the dreadful results of the previous period; not much Trop. activity but at least there was a little more Sp.E. about to keep us happy whilst we wait for the 1968 openings. These usually build up in April in time for May when things should get pretty "lively". This year however the April build-up has been slow and we may well have to be patient until early June this year before we get any real joy. I base this prediction on comparison with previous years' logs for April which have shown somewhat more activity than this time. Last year the first good long-duration opening for Sp.E. was on the 17th of May. Here is the log for Sp.E. reception for the period 17/3/68 to 19/4/68:

18/3/68 Czechoslovakia R1 and Poland Bydgoszcz R1.

5, 11, 12 and 14/4/68 Czechoslovakia R1.

12 and 13/4/68 Austria Jauerling E2a.

13/4/68 Sweden E2.

The best days for the Trops. were the 11th and 17th April, but the openings were far from good and only France could be received here.

NEWS and REPORTS

F2 news once again: BBC Ch.B1 (sound only) was received in New Zealand on the 7th and 8th March last. Still no pictures however.

Since by the time that you read these words we shall be at the predicted sunspot maximum or thereabouts I think that we should devote extra space to F2 reception. R. Bunney has the following to say:

At sunspot maximum the F2 layer of the ionosphere (200 to 350km. above the earth) becomes ionised to such an extent that waves up to about 50Mc/s in temperate climates and 80Mc/s in tropical climates may be reflected back to earth some thousands of kilometres away. Also highly ionised clouds of particles in the E layer (Sp.E.) can cause reflections of signals up to 80Mc/s, but these clouds are unrelated to sunspot activity and have a diurnal and seasonal trend which differs in the arctic, temperate and equatorial regions. The range of F2 signals is upwards of 4,500km. whilst Sp.E. is between 650 and 2,500km.

Tropical sunset fading occurs frequently on paths which lie partly or wholly in the low latitudes and is most probably due to Spread-F or Equatorial Sp.E. In the tropical regions after local sunset the F2 layer rises rapidly in height and numerous separate clouds of ionisation are then formed within it. Ionograms (graphs showing the relationship between the equivalent height of reflection and the signal) taken locally show a pattern of diffused echoes reflected over a wide range of heights. Such a pattern is usually associated with Spread-F in contrast to the more clearly defined F2 layer reflections of more normal conditions.

The Spread-F zone probably extends from 30° north to 30° south of the Equator. The incidence of Spread-F varies not only with locality but also with time and it may cause DX after local ground sunset particularly at sunspot maximum. The reason that we are not seeing any signals is that they are not reaching us: we know about the DX-TV reception in Cyprus but the location there is much further south and the Spread-F is sufficient to reflect African signals as far as Cyprus while the electron density is not sufficient further north to reflect them to the British Isles. Another point is that all F2 and Spread-F DX-TV in Cyprus comes from the south and our contacts there specifically mention no reception from the north; all the southern signals come from tropical and near tropical areas.

Based on this I conclude that any F2 or Spread-F DX-TV will be from Africa or other areas to the south including perhaps South America, India, etc, and not, much as many DXers would like it, from the USA.

News includes one important item. East Germany D.D.R. Helpterberg E3 has changed from horizontal to vertical polarisation which may account for its complete absence last season in many areas, and it seems that the original test card has been superseded by the graded-grid D.F.F. card which originates in Berlin.

Two new u.h.f. stations in service are W. Germany Lübeck Ch.33 240kW and France Ch.28 Chamonix 50kW, both with horizontal polarisation. The latest lists prefix all Dutch stations on u.h.f. with the letter c indicating colour transmissions at certain periods of the day.

Two more F2 DX reports this month, once again from Cyprus. A newcomer, Mr. M. Bell, reports Nigeria Ch.E4 on 8/3/68; he assumes that this was Spread-F/Transequatorial propagation as the signal was too constant for Sp.E. The sound was excellent but the images were extremely "smeary" with rapid flutter. Our old friend Mr. A. Papaeftychoiu has been doing very well once again; he confirms Amman Jordan E3 as a Trop. and he says that the Test Card type C is marked Jordan in European script to the right of the C and in Arabic to the left and is transmitted from 16.30 to 17.00 G.M.T. The subsequent programme finishes with the national anthem and a photo of the King. Via F2 he now confirms reception of Rhodesia on E3 and E4. From our lists the stations must be Bulawayo and Salisbury respectively so this is really splendid reception.

DATA PANEL-26

ECUADOR SOUTH AMERICA

TV station HCJB-TV Ch.A4 525 lines, 60 fields, negative modulation. Vision 67·25Mc/s e.r.p. 8·0kW horizontal. Sound 71·75 Mc/s e.r.p. 4·0kW. Situated 3,650 metres above sea level on Mont Pickincha. Programmes Daily 18.05 to 22.30 E.S.T. Sundays 15.50 to 22.30 E.S.T. This station situated just below the equator is a "possible" by virtue of Transequatorial F2 and Spread-F mentioned above. The photo and the details are from Mr. E. Baker of Blyth, Northumberland.

FIBRE OPTIC C.R.T.s

—continued from page 399

absorbed and not transmitted. Normally, light from room illumination falls on to the tube glass and is scattered by the granular phosphor so that viewing of traces is difficult. With the fibre plate (see Fig. 3) all side illumination is absorbed and does not reach the tube screen. If such a screen could be produced economically it might find application in television sets, particularly portables for daylight viewing. Improved contrast would also be useful in radar screens, again for daylight viewing.

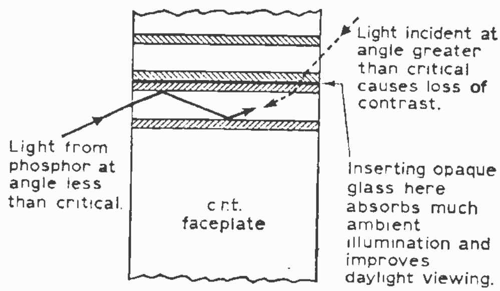


Fig. 3: How the use of isolated fibres can improve the contrast of television pictures.

Fibre Lasers

Light amplification by stimulated emission, which occurs in neodymium-doped glass amongst other materials, also occurs in neodymium-doped fibres. The fibre laser shows promise of application as a light source and light pulse amplifier in optical data processing systems of the future. ■

SERVICE NOTEBOOK

—continued from page 398

generally swamped throughout the receiver, while user adjustment produces no effect on the v.h.f. or u.h.f. sound levels; but, as stated, care must be taken not to over-advance the preset sensitivity. This technique is used in most valved Pye, Ekco and Ferranti convertible and dual-standard models, the most widely encountered version always being recognisable by the large contrast control knob protruding through the top of the cabinet back and with the large printed-circuit chassis being hinged at the base. In the current transistorised versions, although the high-level system is still employed a.g.c. to the r.f. transistor is delayed to give optimum signal-to-noise ratio and the preset control determines the a.g.c. operating point so that the a.g.c. voltage is the sum of both the signal and manual control potentials.

When adjusting presets in any make of receiver an extremely narrow-bladed screwdriver is essential; the average "grub-screw" type is generally far too wide and can easily irreparably damage these miniature controls. A watchmaker's type is ideal but should have an insulated handle since the blade insert point usually carries a high potential.

TO BE CONTINUED

USING A SIGNAL TRACER

VIVIAN CAPEL

AMONG the many test instruments available to both amateur and professional engineer alike the signal tracer is probably one of the most neglected. Only a few out of the numerous instrument makers list a signal tracer in their catalogues, and only occasionally is one to be found in the professional workshop. Because the tracer is not an exact measuring instrument in the same way as the multirange meter, the *CR* bridge and the oscilloscope, and because of its limitations, its use may be considered a haphazard method of servicing.

This neglect is undeserved, as it can be a very useful instrument for quickly localising faults in radio, TV, and tape recorders, as well as other uses. Where it is used it is often regarded as second only to the multirange meter as an effective general fault-finding instrument for its ease of operation and variety of applications.

In essence the signal tracer is merely an a.f. amplifier which in some cases can also be switched to operate as an untuned r.f. amplifier. A basic requirement is that extremely low-level signals can be satisfactorily amplified. This means high gain and therefore the use of several stages of amplification. Also, in view of the possible low signal input, the earlier stages need to have a very low inherent noise level.

Generally, the output is fed to a loudspeaker that is self-contained within the instrument so that the signals can actually be heard. Other refinements can be added and are sometimes found with commercial models. These include meters, magic-eyes and other visual indications. Either valve or transistor circuits can be used for the tracer, although transistors may present a problem in achieving the high input impedance which is necessary. If this is done, as it can be by using special circuit configurations, then the transistor tracer will prove to be very convenient to operate.

An important part of the tracer equipment is the probe. For checking a.f. circuits this is fairly straightforward, consisting of a suitable capacitance to couple the circuit under test to the input circuit of the tracer. Matters are rather more complicated, however, when working at r.f. The connection of the probe must exert as little influence as possible on the circuit under test. Coupling capacitance must be kept as low as possible, otherwise detuning of the tuned circuits in the equipment under test will take place leading to misleading results. Likewise, the impedance must be kept high, otherwise when checking in high-impedance circuits a drastic drop in signal level could occur, once more giving a false impression.

To avoid hum and other difficulties the input lead from the probe to the tracer must be screened, but this means a high shunt capacitance to r.f. signals and even if this is isolated by a low-value series capacitor in the probe it will form a potential divider (see Fig. 1) with the series capacitance and cause a high loss of signal. The answer to this problem is to build a detector into the probe so that only a.f. signals are presented to the probe lead.

Because of the insensitivity of many diodes to very low signal levels it is desirable to amplify the signal before detection. For this reason many probes include a stage of amplification. As this is designed to cope with low signal levels, there may be some arrangement for bypassing it when dealing with higher r.f. signals to prevent overloading. Also there must be some means of converting the probe for straight a.f. uses and many probes have switching incorporated to effect the changeover. Other instruments' use separate probes for r.f. or a.f., the appropriate one being selected for the purpose required. In other models the makers have preferred not to pack so much into the probe, and so this consists merely of different coupling capacitors for a.f. or r.f. use. In order to overcome lead capacitance, special low-loss screened cable is used which has a very thin centre conductor with a substantial space between it and the screening, thereby resulting in a thick cable. In such instruments the first stage or two operate at radio frequency, and detection takes place part way through the amplifier. The detector is switched in by means of an r.f./a.f. switch on the instrument which also alters the value of the coupling components in the pre-detector stages.

Whatever the features of the particular design of the individual instrument, the method of using it will be the same. The most obvious use and the one no doubt for which the signal tracer was first intended is fault location in sound circuits, although as we shall see there are other uses to which it may be put.

In a case where there is complete loss of sound, the tracer is earthed to the chassis of the equipment under test and then, beginning at the anode of the output stage, the probe is moved back through the stages going from anode to control grid. When going beyond the detector of course the instrument is switched to r.f. This process is

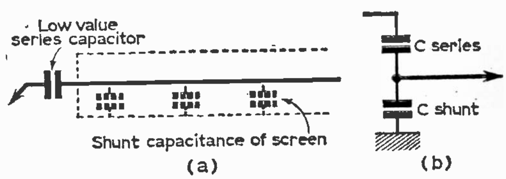


Fig. 1: Lead capacitance with low-value coupling capacitor (a) forms capacitive potential divider (b) at r.f. Remedy—diode in probe or low-capacitance cable.

continued until signals are heard, and thus it will be indicated that the fault lies between this point and the one preceding it.

The same process is adopted in cases of low gain. As we go back, each stage should show a big difference in gain. If there is little or no difference or even a loss over a stage then of course this is indicated as the source of the trouble. Some care must be taken not to be misled here, however, as some loss is to be expected over the inter-stage coupling. Then there may be less signal on the grid of one stage than there was on the anode of the preceding one. Likewise a loss may be expected over the detector. These of course should be slight, and if the loss is serious then a fault in the coupling circuit can be presumed.

Particular care must be taken to avoid misleading results when investigating transistor circuits. First, the earth terminal of the tracer must be connected to the signal earth point of the circuit, which, in most cases, will be the positive battery terminal. Allowance must next be made for the different impedance of base and collector circuits in transistor amplifiers. Transistors are, of course, current amplifying devices whereas we are picking up signal voltages with the signal tracer. If the impedance of the collector circuit is less than that of the base, as it is in many cases, then there will be less signal voltage than may be expected and it may be falsely assumed that the gain of the transistor is at fault. When checking transistor circuits, then, it is best to go from collector to previous collector, or to compare base with the base of the preceding stage. The impedances of the respective circuits can be expected to be roughly the same and so a reasonably accurate comparison of signal levels will be possible.

Distortion is a fault which the signal tracer is particularly useful in tracking down. Once more the stage-by-stage procedure is used, with the operator listening carefully to determine the point at which the distortion is introduced. It is important that the signal tracer has a reasonably good-quality output stage and loudspeaker, as otherwise distortion introduced in the instrument itself will confuse matters when looking for distortion in other equipment.

With all the faults we have so far mentioned the stage-by-stage method working back from the output stage is the conventional mode of working. If desired, however, further time can be saved by first of all selecting a point halfway back through the receiver, for example at the volume control or the detector. If the fault is present at this point then one can work back through the r.f. stages without having spent time probing the a.f. circuits. On the other hand if the fault is not found here then one can work forward through the a.f. stages.

Tracking down the above faults is perhaps an obvious use of the signal tracer. There are however other less obvious tests that can be made with its aid. The source of noise of various types can quickly be located, as well as hum. Not only can hum in the circuits be localised but the presence of hum fields as well can be detected.

This facility is especially useful for the home constructor. For example, it may be required to fit a microphone transformer in an amplifier in order to convert high-impedance working to low. Hum fields will vary considerably in different locations, and unless a transformer with a mumetal screen is used great care will have to be used in choosing the site, involving much trial and error work. The best position can easily be found by temporarily fitting a small coil of wire to the signal tracer probe, turning the gain up and then exploring the most likely positions on the amplifier chassis. The position giving rise to the least amount of hum will of course be the best one.

Another use for the tracer is checking the effectiveness of cathode bypass capacitors, screen decoupling capacitors and h.t. decouplers without unsoldering or removing them from the circuit. This is done by simply placing the probe on the decoupled point in the circuit with the tracer switched to a.f. If the decoupling is completely effective then there should be no signal heard at all with the tracer gain up to its maximum. This should always be so when the capacitor is a high-value electrolytic. Sometimes lower value paper or polyester capacitors are used for decoupling when some form of frequency selective feedback is required. In this case some signal will be heard although it will be deficient in certain frequencies, most likely the high ones.

Many engineers and home constructors have had the rather annoying experience of replacing a volume control involving, as it usually does, cutting the spindle to size and making numerous soldered joints (especially if a double pole switch is incorporated, or the control is a combined one) and then finding that when fitted the replacement control is noisy. This is not uncommon, as unfortunately all new controls are not as silent as they should be. This experience can be prevented by checking the control, with the signal tracer, before fitting. One end of the track is connected to the earth terminal and the probe is connected to the wiper, and then the control is rotated several times over the whole of its travel. A service firm the writer was once connected with insisted that its engineers always checked controls in this manner before fitting them and as a result saved many man-hours that otherwise would have been wasted.

Often the service engineer has tape recorder microphones and pickup cartridges brought to him for testing, but without the recorder or amplifier from which they have been taken. These too can be quickly checked by connecting them up across the signal tracer. To facilitate this and also the volume control test a crocodile clip can be made to clip over the end of the probe so that it can be attached to the item being tested, thus leaving the hands free.

Intermittent faults, especially those that take a long time to appear, and when they do last only for a short period, can be a major headache as there is little time for conventional troubleshooting. The mere connection of a meter probe may be sufficient to clear the fault for a further long period. The signal tracer can be a big help in such cases. Using the crocodile clip, the meter probe can be connected to some suitable point in the circuit, say on to the volume control, and then the set soak-tested.

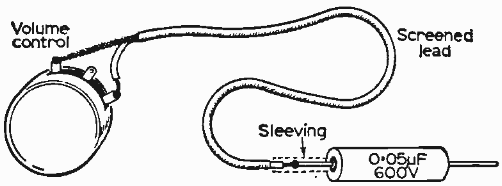


Fig. 2: Screened lead connected to the volume control with a capacitor at the free end enables the a.f. stages to be used as a signal tracer.

When the fault appears it is then immediately apparent whether it is originating before or after the point where the tracer is connected. The tracer can then be used to probe other points in order to narrow the field down further for as long as the fault remains. Even if, as often happens, the fault clears as soon as a further connection is made, at least some narrowing down will have been accomplished. Then the probe can be reconnected to another point and a further soak-test carried out and so on until the source of the trouble is isolated.

So far we have discussed the use of the signal tracer in sound circuits. It can however be used to good effect in other circuits in the television receiver, although of course for more detailed fault-finding the oscilloscope will be the principle instrument for checking on waveforms.

In cases of loss of vision the signal tracer can be used in the same way as when looking for sound faults. Starting at the video output valve the probe can be used on preceding stages back to and beyond the detector. The presence of the field sync pulse will give the characteristic vision buzz when a signal is present. Loss of gain too can be investigated in the same way, although the effect will be somewhat different than when checking sound circuits. Owing to the much greater bandwidth, the amplification of individual stages will be less. Care will therefore have to be taken not to be misled into thinking a fault exists because of this lower stage gain.

The path of the sync signal from the video circuits through the sync separator to the respective timebases can also be checked, although of course there will be no indication of its shape. In the same way a test can be made as to whether the timebase generators are working and also the coupling circuits. Because of the large pulse waveforms present it is not recommended that the tracer be used in the timebase output circuits, especially the line output stage.

Sometimes if a signal tracer is not available one can be improvised for checking faults as we have described in the vision and timebase circuits of television receivers by using the receiver a.f. stages. There is no need for an elaborate probe. All that is necessary (see Fig. 2) is a length of wire connected across the volume control at one end and to a wire-ended capacitor at the other end, which is used as a probe. If there is an a.f. stage before the volume control then advantage can be taken of this to give extra gain by connecting the lead to its grid circuit instead of to the volume control.

From this it can be seen that a signal tracer is a valuable and useful addition to any workshop. ■

NOVEL TV SYSTEMS

—continued from page 410

Museum. A wheel of lenses collected as much light as possible and swept the focused rays across a moving aperture at the intersection of a curved aperture in a rotating disc and a fixed slot in the box housing the light cell. A high-speed shutter-disc in this first TV camera chopped the light into regular pulsations, which improved the reproduction of light variations by the neon discharge lamp in the first TV receiver, also mechanical but of simpler construction. Simple moving objects, including a ventriloquist's dummy, were transmitted and in January 1926 human faces were televised with 30 scanning lines. Baird had developed an efficient synchronising system, consisting of a strong negative pulse at the start of each line sweep.

A few months later, in the USA, Dr. Jenkins achieved similar results with his prismatic discs, a pair of which, sweeping the focused beam at right angles at different speeds, scanned the two dimensions to trace 48 lines. He had no integral synchronism, relying upon mains-synchronised motors, which limited reception to the supply area.

In Britain Baird's 30-line experimental service, commencing in 1929, used the Nipkow disc at transmitter and receiver, but by 1932 when the BBC continued the broadcast the mirror-drum was used at the transmitter and also for reception on larger screens.

TV Lamps and Grid Cells

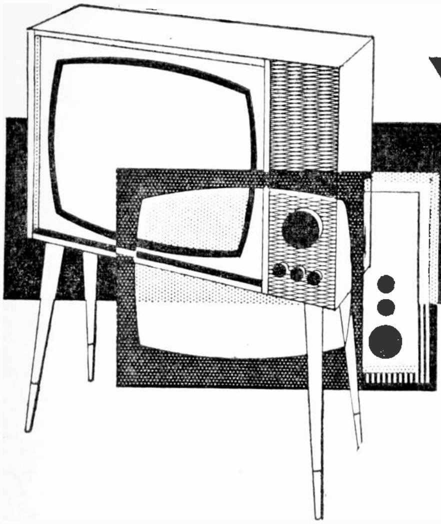
Discharge lamps glow with varying light when the applied e.m.f. is between "striking" and "extinction". The familiar red glow of neon flashed on at about 150 volts, and the light ranged between "bright" and "dim" through a grid swing of about 40 volts. To improve the colour (nearer white), argon, helium or hydrogen were mixed with neon. For a disc receiver the lamp had a rectangular fine mesh screen (aspect ratio 7:3) to be viewed through a magnifying lens. For projection from a mirror drum the glow was concentrated to a "crater", the name given to the lamp. A simple, efficient discharge lamp containing mercury vapour was made by sealing a small globule of mercury in an evacuated glass tube with a small electrode at each end; the flashing light could be made less blue by a pink or yellow filter.

For projection to larger screens the concentrated white light of a cine projection lamp was plane polarised and controlled by a "grid cell" between two Nicol prisms. These cells contained nitrobenzene and two metal plates which applied the "Kerr effect" to the polarised beam between them.

Television at last?

Older readers may remember this "early TV" period, when the aim was to discover an easier way of scanning for higher definition, or even a new principle of optical analysis, economical in bandwidth, which would spread television quickly by inexpensive apparatus. They may also recall the activity among many wireless enthusiasts as they dipped into their spares box to experiment in this new radio hobby; the excitement of constructing optical rotors, assembling mirrors and lenses, and using photoelectric cells and lamps red, white or blue!

TO BE CONTINUED



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

PYE CTM17S

Is it possible to replace the carbon potentiometers usually found in timebase and vision controls with the more stable wire-wound types? I ask this because I have this receiver which is suffering from bad "hold" on vertical timebase and no contrast. The carbon pot. vertical hold control has presumably been replaced by a linear type of component and I would like you to advise whether I should restore this as in the original circuit.

Could you please also tell me where the Channel 1 and 9 trimming holes are located on the front of this tuner type 841130?—J. Levy (Kenton, Middlesex).

It is quite permissible to replace carbon controls in the timebase by wirewound controls where these are available. As an alternative, controls appear to last longer if packed with grease before use. We agree that it is difficult to find the correct circuit for your particular model since many chassis types were incorporated in the same cabinet about this time. The individual channel trimming cores are as numbered around the fine tuner spindle. Generally it is sufficient to tune all BBC stations at once on number 5 and all ITA stations at once on number 13.

K-B TV15

When the set has been running for about two hours, the field starts to creep upwards and fold over. This continues until the picture is about three inches wide and manipulation of the usual presets and hold control has no effect.

Sometimes the fault appears to be in the line, and in this case, the picture shrinks in from the right about two inches.—J. Philips (Manchester, 9).

Check that the field and line timebase valves are well up to standard. Also check the booster diode and the h.t. rectifier. However, it is possible that the set is suffering from power cuts, which still occur in some areas. Check that the mains tapping on the set matches the mains voltage.

SOBELL 1000DST

Although the picture is quite good, there is a black band top and bottom and a gap of about 1½in. each side of the picture. I have had all the valves tested and have also tested all the resistors in the timebase panel.

The height control fails to fill the screen.—T. Locke (Birmingham).

We would say that one of the field timebase valves is faulty, but since you say that you have had all the valves tested you will have to look elsewhere. Check the feed from the boosted h.t. supply to the field generator. This goes via the height control and an increase in value of a resistor in this section could cause the effect.

EKCO T221

This set displays white lines across the screen, otherwise the sound and picture are good. The 5kΩ wire element on the a.g.c. preset control became o/c at one end but when rejoined there were still white lines present. I have changed the 20L1, 20P4, U301, 20F2 and 20P5 without any improvement as regards the lines.—P. Davies (Swansea, Glamorgan).

Your fault is probably due to failure of the field flyback suppression capacitor, this is a 0·001μF connected between the brightness circuits and the field oscillator stage, and is located beneath the chassis adjacent to the main smoothing capacitor.

BAIRD 484

I can get only the sound on this receiver. There is no sign of a picture or even a raster. Also, one section of the dropper resistor is glowing red.—G. Kelly (Liverpool, 6).

It seems that you have a short on the h.t. line somewhere. Check this with an ohmmeter and with the set disconnected from the mains. A capacitor or transformer may be leaking to earth (chassis). Another cause of the trouble is excessive line output valve current due to lack of line drive resulting from a bad line oscillator circuit.

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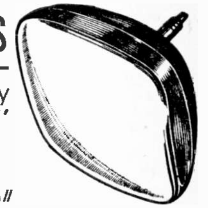

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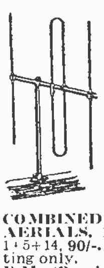

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SOBELL T23

The trouble here is sound-on-vision on both Channels 5 and 8. In addition there is what appears to be r.f. patterning on BBC Channel 5.

Operating the fine tuner, which is also the f.m. radio tuner, enables the effect to be tuned out completely and continued operation of the fine tuner, towards the top of the radio tuning dial, introduces vision-on-sound.

The sound-on-vision fault is most marked with higher frequency sound and on dark backgrounds and for some strange reason does not seem to appear when the adverts are on Channel 8!

I am in an area of good signal strength and have tried attenuating the signal without effect. —P. Maguire (Newcastle upon Tyne, 5).

Overloading due to a very strong signal could still be responsible in spite of the attenuator. A single attenuator may not be enough. You may have to use two in series, depending upon the network employed. However, the trouble could well be aggravated by slight misalignment in the vision (and possibly sound) i.f. channels. The general alignment should be checked and corrected if necessary.

STELLA ST2029A

This set has been working perfectly for the last year on Channels 2 and 10 (Dover). The fault now is that there is sound and vision of Channel 10 only receivable at position 9 and on position 10 there is no trace of a signal. The vision of Channel 2 is still O.K. at position 2 but the sound is marred by a strong hum. The sound of Channel 2 is now receivable at position 1, which was not possible before the fault.— O. Welch (Ramsgate, Kent).

The trouble is certainly caused by a drift in the tuner, and the components around the oscillator section of the frequency changer should be suspected. The drift in frequency appears to be related to both channels in use, although, of course, the effect would be greater on the higher frequency Band III channel.

PYE VT4

The picture has a "satin" like appearance with the right-hand edge of the screen being darker than the rest of the picture.

The white spot suppressor is set at minimum and advancing this control turns the picture negative, spreading from the right-hand side of the screen.

The contrast control is set at about half-way and reducing this control brings gradation almost right but the picture begins to break up. Advancing the contrast control increases the "satin" like appearance.

The horizontal and vertical holds are critical and the picture appears to be overdriven but voltages in the video section seem to be about right.—R. Dobson (London, N.16).

Your trouble could be due to faulty main smoothing or a defective cathode ray tube. Another frequent offender producing similar symptoms is failure of the 25μF cathode bias capacitor across the 47Ω resistor from cathode to chassis of the PL81 line output valve.

DECCA DR121

This set works very well. There is however, one minor defect—the picture is about $\frac{3}{4}$in. too far to the right of the centre of the screen.—H. Miller (Leamington Spa, Warwickshire).

On the tube neck is a picture centring magnet consisting of two thin, concentric rings of magnetic material. These rotate against each other and the idea is to set them both (by rotating them relative to each other) until the test card is correctly positioned in the centre of the screen. Care must be taken to avoid electric shock from the 18,000 volts on the tube final anode and the higher power lower voltages inside the set.

ALBA 895

The above set has been functioning normally with good results for nearly 2 years.

Recently it has been possible to receive BBC-2 in this area and some difficulty is being experienced with this set on the switch over from BBC-1 and ITV to the u.h.f. channels. A special u.h.f. aerial of the correct channel range has been installed. On switching on initially it is possible to receive all three stations and the switch-over is normal. After it has been running approximately 3 hours it is not always possible to affect a switch over to BBC-2 the sound being evident with no picture but *moiré* patterned screen. If the set is switched off until cooled down BBC-2 can be obtained.

On all three stations when first switched on the picture rolls vertically getting slower and finally locking.

Valve PCF801 has been renewed with some little benefit. The brightness of the BBC-2 picture blips with scene changes.—T. Davison (Durham).

From your description of the symptoms, the fault could lie practically anywhere in the tuner unit, but is more likely associated with the h.t. feed, which should be your first line of approach. On this model, a variable capacitance diode controls the oscillator tuning, and the voltage feed to this is from the tapping on the fine tuner, which has a series 82kΩ resistor from the h.t. line. H.T. is also applied via main switching, and to the u.h.f. tuner via a 100kΩ resistor with a shorting switch section across it.

You will see the need for absolutely clean switch action, especially as the h.t.-carrying contacts quickly become tarnished.

On some earlier models a PC97 was used in the tuner unit, and this valve is prone to cause some of the troubles you have described.

PHILIPS 1768

I am having difficulty with the locking of the field and line. They both lock firmly but so that the picture is split up into four pieces, one in each corner of the screen so that in effect there is a large black cross in the middle of the screen. —W. Shacklin (Manchester, 11).

You should check the 250+60μF main smoothing capacitor, especially if the right side of the raster shows a pronounced curve when the picture is reduced in width.

FERGUSON 406T

The picture on this receiver is too tall and seems to be cramped at the bottom. Also, I cannot seem to obtain correct adjustment of the contrast control.—P. Clenton (Bristol).

Remove aerial, turn down contrast control and gradually turn up brightness control from zero until a raster (illumination) is only just visible on the screen. Leave the brightness control so set, plug in aerial and then turn up contrast control for the best contrast ratio (picture black and white). If the vertical linearity preset will not clear the bottom cramping, when adjusted in conjunction with the height control, check the field output valve and the components on its cathode circuit.

FERGUSON 217T

The picture is broken up and unintelligible, the line timebase is functioning perfectly but the picture will not synchronise when the horizontal hold is adjusted. The vertical hold is functioning perfectly.—R. Bolton (Ramsgate, Kent).

It is possible that the line hold control is failing to adjust the line oscillator to the correct frequency. In this case, alteration in value of a resistor in series with the line hold control should be suspected. However, if the line speed can be achieved correctly with the control, check the capacitor in the circuit between the sync separator and the line oscillator, carrying the sync signal.

STELLA 2017U

This receiver has a blank screen except for a vertical narrow line which appears to contain the 405 lines and which is affected by brightness. I have substituted PL81, PY81, EY86 and PCL80 but no difference was noted. When a neon is placed near the top cap of the EY86, it glows strongly. It does not glow when held near the tube cathode.

The sound remains perfect.—N. Morgan (Betws-y-Coed, Wales).

If the line output and oscillator valves and booster diode are in good order, check the h.t. line voltage. If this is less than 210V, check the h.t. rectifier and replace if low. If the trouble persists, check the screen feed to the PL81 and associated small resistors in this area of the set. If the trouble is still not revealed, suspect shorting turns in the line output transformer.

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This coupon is available until JUNE 21st, 1968, and must accompany all Queries sent in accordance with the notice on page 425.

PRACTICAL TELEVISION, JUNE, 1968

TEST CASE -67

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 GEC BT302 was received with the complaint "lack of picture, brightness excessive and sound normal". It was, in fact, found that quite a bright raster could be obtained even with the brightness control turned almost fully anticlockwise. For this reason, therefore, it was thought that the tube might be suffering from heater/cathode or, more likely, grid/cathode leakage, but insulation tests across the tube pins gave normal readings.*

With the set running, voltage tests were then made relative to chassis at both grid and cathode, and it was found that there was quite a large difference between these voltages, with the cathode being less than 60V instead of the more normal 110/120V.

The video output valve was suspected of passing excessive current, and this appeared to be the case since the anode load resistor was of correct value. The valve itself was perfectly sound, and the biasing components were normal.

What, then, could have been responsible for the excessive current in the video output valve, resulting in the abnormally low anode voltage, and hence tube cathode voltage? 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 66
Page 381 (last month)

Because the position of the aerial downlead at the rear of the set had quite a bearing on the fault symptom, as mentioned last month, the possibility of instability in the r.f./i.f. sections of the set was considered. Although the sound was free from whistles and the vision from patterns, it was noticed that a slight change in picture brightness occurred each time the aerial lead was moved close to the i.f. output side of the set. This was proved to be caused by a slight change in video output valve biasing, resulting, in fact, from an oscillation in the final i.f. valve being rectified by the vision detector.

This trouble was cured by replacing the screen grid decoupling capacitor on the final vision i.f. valve, which also restored the field lock to normal.

The d.c. resulting from the oscillation at the output of the video detector was changing the operating conditions of the video output valve to such a degree as to attenuate the field sync pulses without unduly affecting the picture and line signals.

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