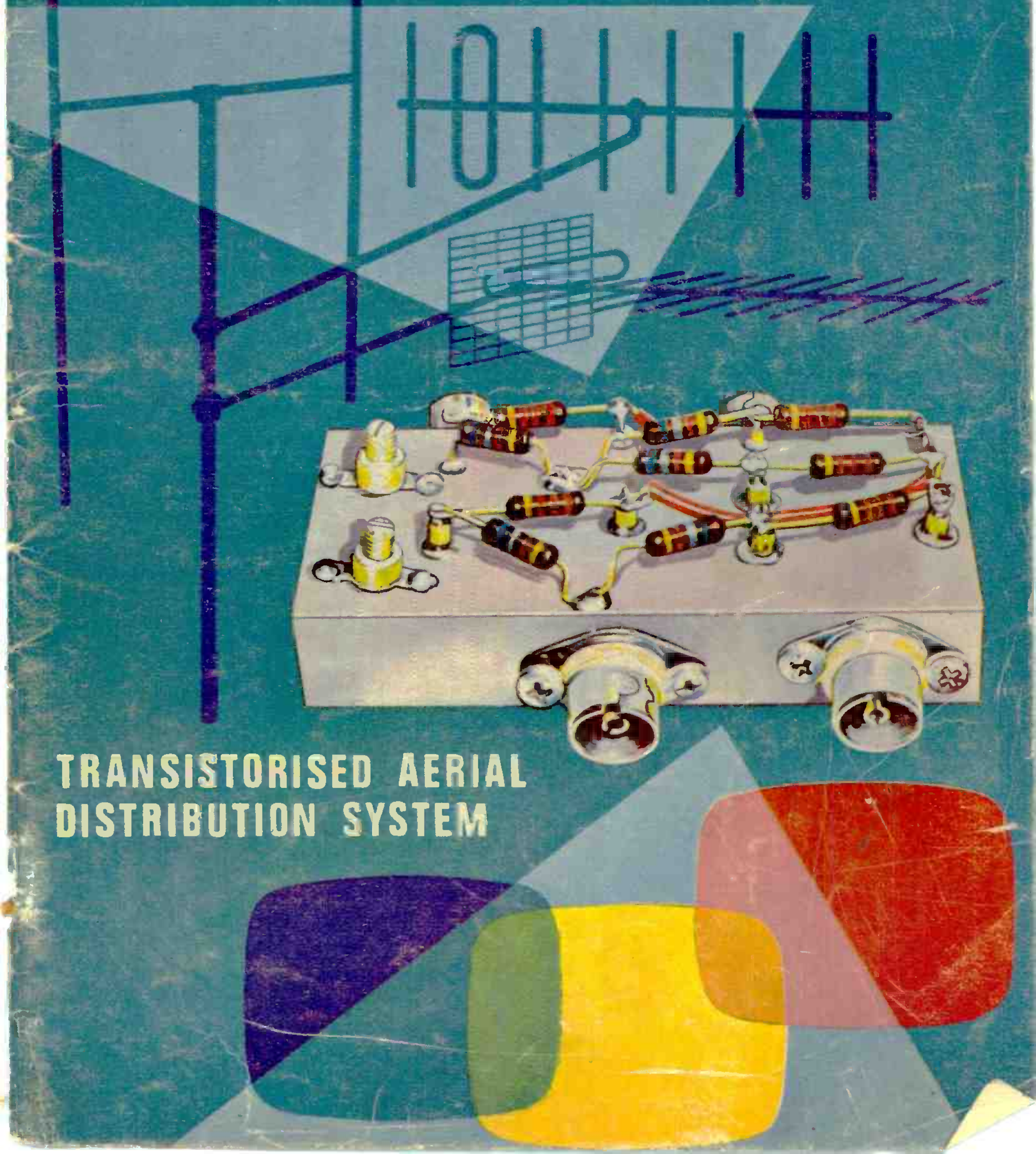
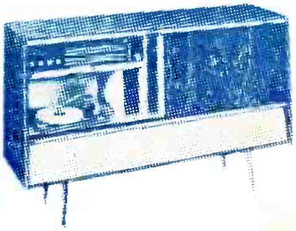
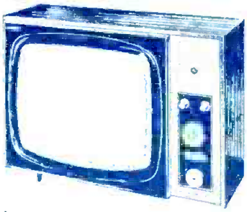
Practical TELEVISION

AUGUST 1968

2/6







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Practical Television

AUGUST 1968
VOL. 18 No. 11
issue 215

Time for a Change?

IN A FEW weeks' time those concerned professionally in radio and TV will begin the annual pilgrimage to the indepedent private exhibitions staged in London by the manufacturers. And we are more certain than ever that the whole set-up is wrong.

First, we still bemoan the gradual erosion of the old national shows at Earls Court to the stage where not enough exhibitors were left to make a reasonable display. The chance this year to show off colour TV with a fanfare to the public is a wasted opportunity.

Secondly, although set makers appear in one context content to go their own ways, they remain stubbornly insistent on maintaining the old traditional "show time period" for their trade exhibitions. This is a relic of the past which ill fits the get-with-it image the manufacturers like to project. An August show time was ideal when the public could click through the turnstiles. It is far from ideal for trade-only shows. In the past, set makers have been caught on the wrong foot more than once—either by overproducing and creating an unsaleable stockpile or (as recently experienced) underproducing and arousing frustration and suspicion in retailers and public alike.

Dealers place their orders at the radio shows. By then set makers have decided on their production runs and this necessarily involves a good deal of "guesstimation" since the bulk of orders have not yet been placed. In order to stock their shops with new models in time for the peak buying months dealers must receive the goods quite quickly for optimum sales or face the prospect of waiting while potential customers pass by.

Now that the shows are not trying to meet the conflicting requirements of trade and public why not move them to the Spring? Dealers could then place orders knowing that by the time supplies start coming through the peak buying season will be approaching instead of receding. Set makers would have more leeway to plan production and a firmer basis on which to anticipate sales.

This more effective and efficient arrangement might even (happy thought!) encourage set makers to get together and run a public exhibition in the Autumn to back up the business done in the Spring!

W. N. STEVENS, *Editor*.

THIS MONTH

THE NEXT ISSUE DATED SEPTEMBER WILL BE PUBLISHED ON AUGUST 23

SONY PRODUCE REVOLUTIONARY COLOUR TUBE

THE Sony Corporation of Japan have recently announced a new type of three-beam, single-gun colour TV display tube.

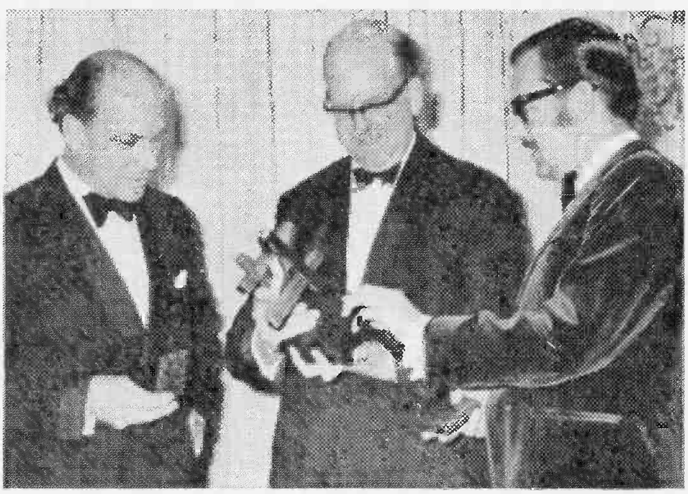
This new tube, named the "Trinitron", is claimed to be based on entirely new concepts to either the Chromatron or Shadowmask colour tubes, and the Japanese claim that the new techniques provide brighter pictures while the single gun idea may substantially reduce production costs.

Sony Co.'s engineers say that the new system employs a single electron gun that emits three electron beams simultaneously, making them converge on systems of two large diameter electron lenses and two electron prisms. The large diameter of these lenses is said to result in much more brightness and sharpness of picture.

A technique of colour separation known as "aperture grill" has been developed with the co-operation of the Dainippon Screen Manufacturing Co. of Kyoto, Japan. This aperture is said to ensure better transparency and so help improve the brightness of the picture.

Also claimed is the fact that the new display system is relatively simple to set up and converge. There is the prospect of a colour receiver fitted with a 13in. Trinitron being on the market in Japan later this year.

Royal Television Society Awards



THE Royal Television Society awards for 1968 were presented at the Society's annual ball at the Dorchester Hotel, Park Lane, London, recently.

The photograph shows from left: Aubrey Buxton, who received the Society's Silver Medal for outstanding artistic merit behind the camera for "Survival" for Anglia Television Ltd. C. B. B. Wood, Head of Television Section, Physics Group, BBC Research Department, who received the Geoffrey Parr Award for his team's outstanding work in improving the quality of reproduction by television of colour film.

Alan Whicker who received the Society's Silver Medal for outstanding artistic merit in front of the camera in "Whicker's World".

TV Societies announce closer ties

THE Royal Television Society in London and the German Television Society in Darmstadt will in future work closer together to provide an exchange of knowledge between their members and more active co-operation at conventions and exhibitions in Europe.

This move was announced recently by the Royal Television Society in London. The aim of the association between the Societies is to strengthen the link between West German and British television industries.

Commenting on this, Dr. Walter Bruch, Chairman of the German Society, said 'The Royal Television Society with its world-wide reputation was taken as an example when we formed our own Society in 1952. Already a very friendly relationship exists between our two societies and we welcome the opportunity to extend the exchange of knowledge, and to increase active participation in Society events. Television has gained a very important place in our modern life. In view of the many outstanding achievements and contributions scientists and engineers in the United Kingdom have made to the development of television, this new closer contact will certainly enrich our activities. We are very honoured by this move.'

Newton (Northumberland) BBC-2 Relay Station

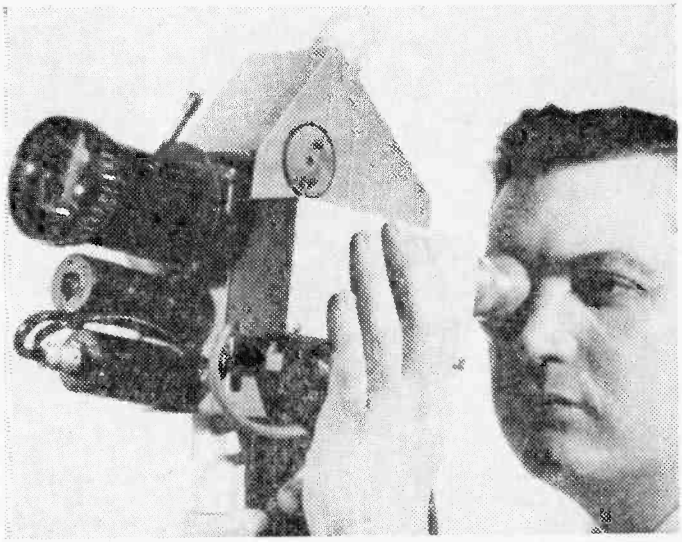
THE BBC has placed an order with Bewley & Scott Limited, of Gateshead, for the construction of the building for the Newton BBC-2 relay station. This new relay station is to be built near Newton, about 3 miles east of Corbridge. It will transmit BBC-2 on channel 26, with vertical polarisation, and is expected to be brought into service at about the end of this year. At a later date it will also transmit BBC-1 and ITV programmes on 625 lines.

Here it is—the Minicamera

THIS experimental miniature live colour TV camera from Philips weighs about three kilogrammes and is comparable in dimensions and weight with a 16mm film camera. It was designed as a test bed for the three new miniature Plumbicon TV camera pick-up tubes, developed by scientists at the research laboratories of Philips at Eindhoven, The Netherlands.

In the other photograph the comparative sizes of a Standard Plumbicon Tube and the new miniature Plumbicon can be seen. The miniature tube is 5in. long compared with the 8in. of the standard 1¼in. Plumbicon tube.

The range of Philips colour cameras is now being handled by Pye TVT in the U.K.



RADIO AND TV MAINTENANCE COURSES

THE London Borough of Brent Wesley Evening Institute, Wesley Road, London, N.W.10, are holding a Radio & Television course on Monday and Wednesday evenings from 7 to 9 p.m. commencing 23rd and 25th September 1968.

The fees are 50s. for one or two evenings weekly for the session. This session ends May 23rd 1969. The course covers the theory and some practical work. It is mainly intended for amateurs.

Wesley Road is a short turning off the Harrow Road, about 800 yards east (Londonwards) of the junction with the North Circular Road.

Readers may enrol now by post by writing to 44 Worcester Crescent, Mill Hill, London, N.W.7. Cheques and Postal Orders should be made payable to the "Brent Borough Treasurer".

DO U.S. COLOUR TV MEN FACE RADIATION HAZARD?

AN interim statement has been issued by the American National Council on Radiation Protection and Measurements (NCRP) following recent publicity in the U.S. on the problem of X-ray radiation hazards from colour TV receivers.

In 1959 an NCRP statement recommended that the exposure rate at any readily accessible point 5cm. from the surface of any home TV receiver should not exceed 0·5 mr/h under normal operating conditions, and NCRP observes that recent events indicate that changes in colour TV design and manufacture have brought about conditions in which some receivers have not met these limits.

When the original statement was published the main source of X-ray emission was the front of the picture tube but more recently voltage regulators and rectifiers have become of greater significance. It is stressed that even a slight increase in the e.h.t. results in great increases in exposure rate. For example if the e.h.t. is increased from 25kV to 30kV the exposure rate may increase by 10- or 20-fold.

The NCRP suggest that special attention should be given to the possible exposure of TV repairmen since their training may not have alerted them to the fact that X-rays may be emitted from certain components in TV receivers.

New telerection aerials

CONTINUED research and development by Telerection Products of Weymouth has resulted in a new range of u.h.f. aerials of outstanding design and mechanical construction to meet with the requirements of the BBC, GPO and CCIR.

Models now in production include:—Model GT.17 for Group A, 12 Element; GT.18 for Group B, 14 Element; GT.19 for Group C, 16 Element.

To avoid the installation of individual arrays where transmitters are co-sited, the T.20, a combined v.h.f. and u.h.f. aerial, was developed, eliminating unsightly additions to existing aerial masts.

The most recent and most significant development is a complete range of u.h.f. fringe aerials, with an average forward gain of 15-16dB, and a back-to-front ratio of better than 18dB.

TRANSISTORISED AERIAL DISTRIBUTION SYSTEM

Part 1

by J.W.Thompson

AT the beginning of this year the writer was asked to inspect a television aerial distribution system in a students' hall of residence at Reading University. Four television receivers were connected to the system and the fault symptoms were as follows: BBC-1 low contrast; ITA no picture; and BBC-2 severe noise on vision and sound. The distribution amplifiers, which had been installed four years previously, used valve circuitry throughout and were continuously connected to a mains power supply. It was therefore not very surprising to find that all the nine valves were in very poor condition having each been running for a total of thirty-five thousand hours! Furthermore a brief look at the aerial system revealed that the ITA aerial was irreparably corroded by chimney fumes.

Having assessed the problem a plan of action had to be thought out. The first and most obvious remedy as far as the ITA reception was concerned was to replace the ITA Band III aerial. The effect of this was to produce an ITA picture of reasonable strength but barely watchable due to picture noise: the picture was actually better *without* the amplifier connected in circuit! Buying a new set of valves was seriously considered but in the long run this would not have been economically sensible. For one thing further valves would have had to be bought at regular intervals in the future and also a great deal of electricity would have been wasted in keeping the valve heaters going. I thus decided to build a completely new amplifier using the latest techniques in transistor circuitry.

An amplifier for the v.h.f. Bands I, II and III may be most economically constructed by the use of ferrite, wideband transformers; K. Royal and Gordon J. King have discussed these devices in previous issues of PRACTICAL TELEVISION, and all we need say here is that they may be used as 4:1 impedance-matching transformers with a flat response from about 0·5Mc/s to 70Mc/s. The insertion loss increases to 2dB at about 200Mc/s. and is thus such a small loss as to be almost negligible.

The design of a u.h.f. distribution amplifier presents some serious problems. A short length of wire may present quite a significant inductance to u.h.f. signals and stray capacitances may cause serious losses. It was finally decided to use $\lambda/4$ trough-lines in the tuned circuits of the amplifier for maximum stability. Trough-line construction is not very easy but the advantages gained are well worthwhile.

Choice of Transistor

The next problem was the choice of suitable transistors. It would have been up-to-the-minute to have used silicon transistors but at the time none could be found at a reasonable price. The German firm Siemens provided the best solution with their range of germanium u.h.f. transistors. The AF239, an improved version of the AF139, is used in the v.h.f. section of the amplifier, and two AFY42 transistors are used for the u.h.f. section. The noise figure (approximate) for the AFY42 at 860Mc/s is 4·5dB, compared to 6dB for the AF239, 9dB for the AF186 and 10dB for the AF139, so it can be seen that the AFY42 transistor is very good in this respect.

The circuits evolved for the u.h.f. and v.h.f. distribution amplifiers are shown in Fig. 1 (a) and (b) respectively from which it will be seen that all the transistors are operated in the common-base mode. The associated power supply circuit is shown in Fig. 1 (c).

Construction

The construction of the amplifier is difficult and should not be attempted without a heavy soldering iron (>60watts). The case is made from copper or brass, the thickness of which is not particularly critical being governed mainly by the ease with which it can be cut. The full under-chassis layout is shown in Fig. 5, and the photograph should help bring the layout into perspective. Solder together as much of the chassis as possible, and fit the feedthrough capacitors, before attempting to squeeze in the transistors. They are very heat-sensitive, so the chassis temperature should never become so high that it is too hot to touch; i.e. greater than about 70° C. Heatsink tweezers are *essential* when soldering the transistor leads. The trough-line dimensions are *very critical* and should be followed exactly if a full u.h.f. tuning range is to be obtained. Beware of excessive stray capacitances, particularly in the u.h.f. section of the amplifier.

Testing

Having checked your layout and construction, testing may begin. The number of checks that can be carried out depends mainly on the complexity of the test gear available, but a great deal can be discovered about an aerial amplifier with a simple voltmeter and a few resistors. First connect the positive lead of a 9V battery to the top of C10 and the negative lead to the chassis. If a milliammeter is available check the current consumption, which should be about 20mA. Next measure the voltage between the emitter of each transistor and the positive line. This should in each case be around 1·5V; if it is greatly different from this figure check that the transistor concerned is correctly connected and that the associated base bias resistors are intact. As a further check the voltage between the base of each transistor and the chassis should be 1·75V.

Given a v.h.f. signal generator and a sampling

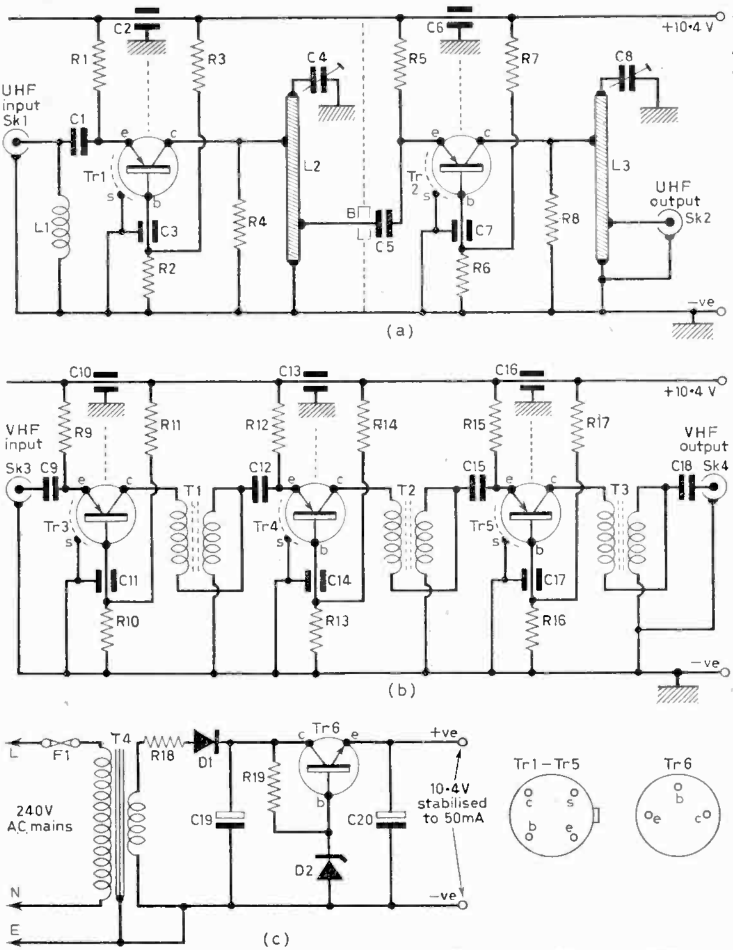


Fig. 1 (left): Circuit diagram of (a) the u.h.f. amplifier, (b), the v.h.f. amplifier and (c) the power supply with stabilisation.

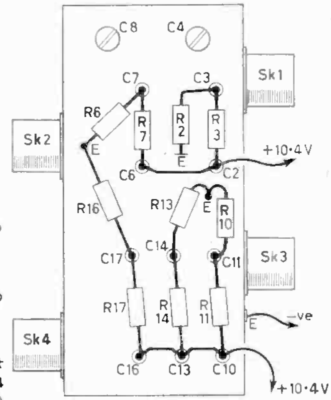
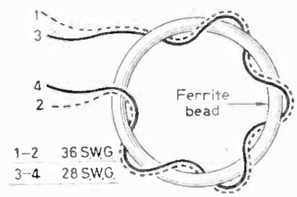


Fig. 2: Above chassis view.



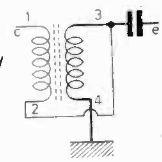
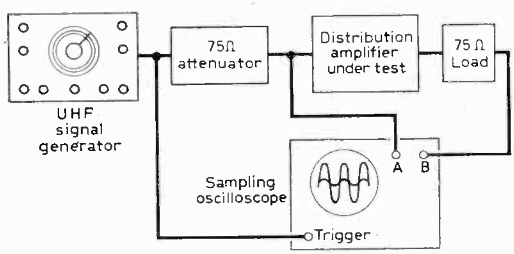


Fig. 3: T1, T2 and T3 winding details.

oscilloscope direct gain measurements at different frequencies can be made. The prototype amplifier was tested in this way (see Fig. 3). An indication of gain can however be obtained much more simply. Switch on a television receiver and if possible disconnect its a.g.c. line. Turn down the contrast control until the contrast is *just* out of the limiting condition. Plug the appropriate section of the amplifier into the aerial lead and observe the increased signal strength.

Then fit various 75Ω attenuators until the contrast is back to its original level. The level of attenuation required to do this is approximately equal to the voltage gain of the amplifier at the frequency of measurement. For example, if a ×8 voltage attenuator is found to be necessary to balance out the gain of the amplifier the voltage gain is about ×8. Unfortunately this procedure can give very misleading results on the u.h.f. channels and the only way to find out the gain of the amplifier in this case is to see how many receivers can be run from it. Fig. 6 gives details of suitable voltage attenuators together with the necessary formulæ for the calculation of resistor values.



Test frequency Mc/s	10	27	50	90	150	200	250	350	480
Voltage gain	7·15	16·7	25	25	11	9·8	8·35	1·2	11·0

Approximate input voltage = 30mV

VHF section — UHF section of amplifier

Fig. 4: Testing the gain of the prototype.

Splitters

When more than one receiver is to be run from a single aerial system it is not possible simply to

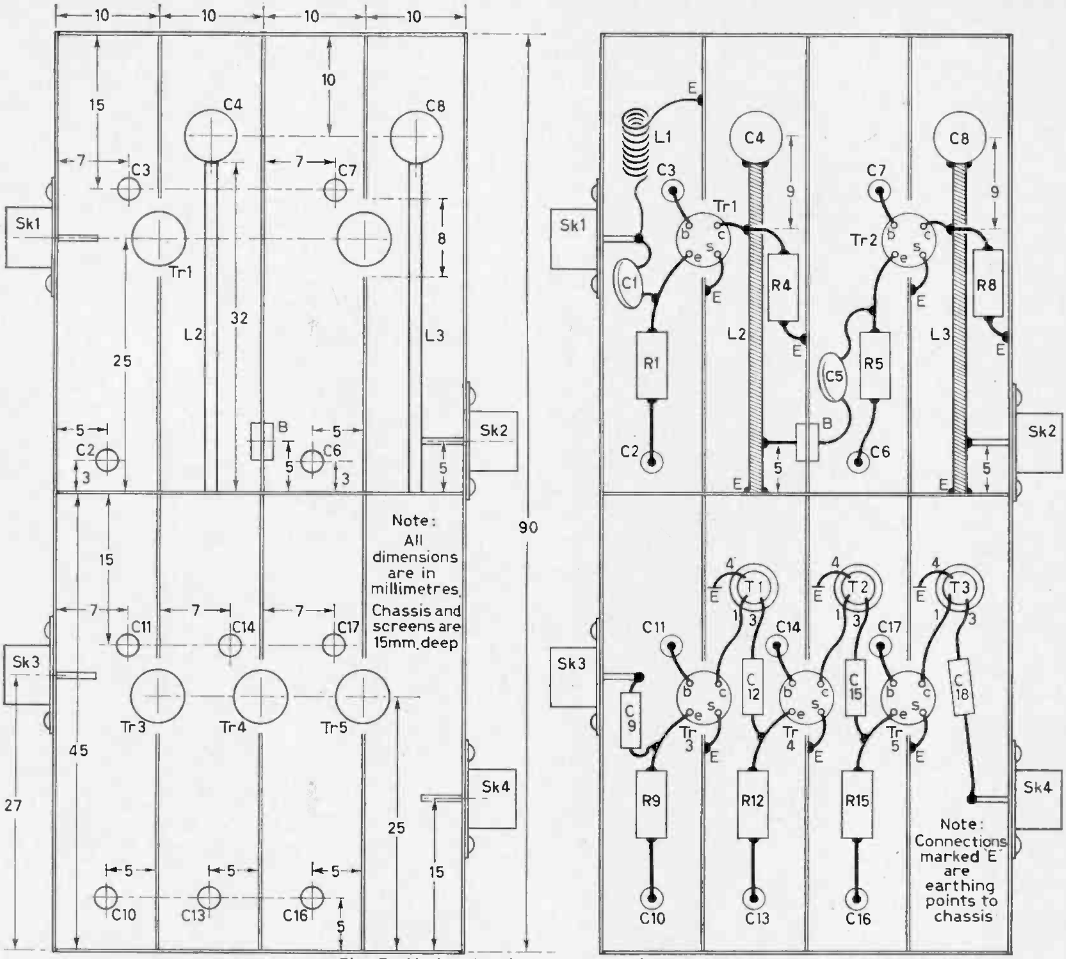
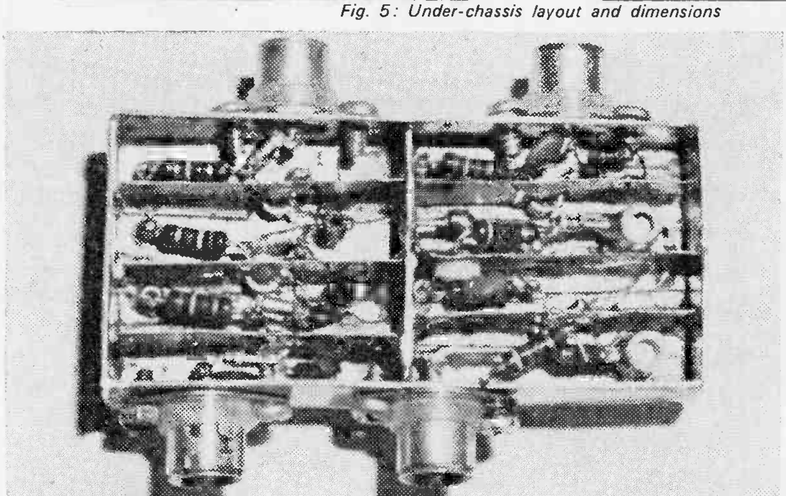
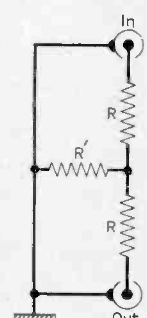


Fig. 5: Under-chassis layout and dimensions



Photograph showing the layout below chassis.



$$R = \frac{Z(N-1)}{(N+1)}$$

$$R' = \frac{2ZN}{(N+1)(N-1)}$$

Fig. 6: General formulae for voltage attenuators. Z is the feeder impedance and N the attenuation ratio.

COMPONENTS LIST

Resistors:

R1	680Ω
R2	6·8kΩ
R3	2·2kΩ
R4	8·2kΩ
R5	680Ω
R6	6·8kΩ
R7	2·2kΩ
R8	8·2kΩ
R9	680Ω
R10	6·8kΩ
R11	2·2kΩ
R12	680Ω
R13	6·8kΩ
R14	2·2kΩ
R15	680Ω
R16	6·8kΩ
R17	2·2kΩ
R18	4·7Ω
R19	330Ω

All ½ watt 5% low-noise carbon film

Capacitors:

C1	5·6pF	subminiature
C2	1,000pF	feedthrough
C3	1,000pF	feedthrough
C4	1–8pF	low-loss ceramic tubular trimmer
C5	5·6pF	subminiature
C6	1,000pF	feedthrough
C7	1,000pF	feedthrough
C8	1-8pF	low-loss ceramic tubular trimmer
C9	200pF	subminiature
C10	1,000pF	feedthrough
C11	1,000pF	feedthrough
C12	200pF	subminiature
C13	1,000pF	feedthrough
C14	1,000pF	feedthrough
C15	200pF	subminiature
C16	1,000pF	feedthrough
C17	1,000pF	feedthrough
C18	200pF	subminiature
C19	1,000μF	25V electrolytic
C20	100μF	15V electrolytic

Semiconductors:

Tr 1	AFY42
Tr 2	AFY42
Tr 3	AF239
Tr 4	AF239
Tr 5	AF239
Tr 6	BF110 or BFY51
D1	1N4001 or 1S100 50–100 p.i.v., >100mA
D2	1S2110A 11V, 0·4 watt zener

Miscellaneous

B	Thin polythene bush 8mm. diameter with hole in centre for C5 lead to pass through
F1	150mA fuse
L1	6 turns 30 s.w.g. enamelled copper 2mm. internal diameter
L2, L3	32mm. copper wire 1mm. thick (20 s.w.g.)
T1-T3	Ferrite wideband transformers. Take a 9in. length of 28 s.w.g. enamelled wire and a 9in. length of 36 s.w.g. enamelled wire and wind together (bifilar) as shown in Fig. 3 four times round a ferrite bead
T4	12V mains transformer (bell type suitable)
Sk1-4	Low-loss coaxial sockets with polythene centres

connect all the coaxial feeders in parallel. Some form of resistive splitter network must be used, and a suitable design for a four-way splitter is shown in Fig. 7. The general formula for splitter networks is:

$$R = \frac{Z\,(n-1)}{(n+1)}$$

where Z is the characteristic impedance of the coaxial feeder (usually 75Ω), n is the number of outlets required and R is the resistance of each resistor in the network.

Number of Receivers Fed

The number of receivers that this particular distribution amplifier will accommodate depends very much on the initial signal strength available on any particular channel. This must be found out by experiment, but it may be possible to run as many as ten receivers simultaneously in some areas—the average number will be about six. This will not however apply to u.h.f. reception where we would be doing well to run four receivers at a time. If this number is not sufficient two u.h.f. amplifiers as described may be cascaded.

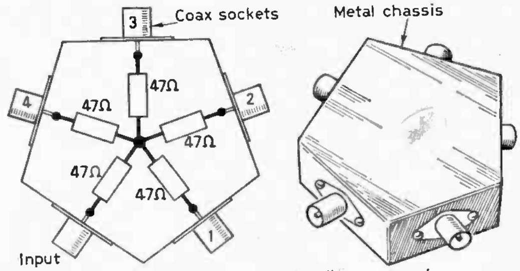
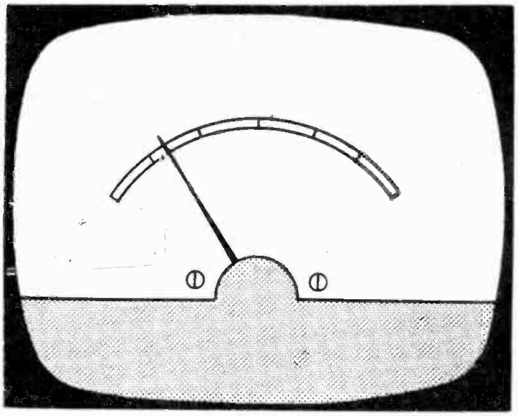


Fig. 7: Four-way resistive splitter network.

TO BE CONTINUED

TELEVISION RECEIVER TESTING

Part 4 by Gordon J. King



SENSITIVITY TESTS

THE term sensitivity indicates a measure of how much signal input voltage is required to produce a stipulated output signal voltage. In the case of the sound channel the input signal for testing is usually modulated to a depth of 30% and the audio signal amplitude related to this measured across the output load. This means that the sound detector and audio stages are also included in the channel over which the sensitivity is being assessed. A slightly different technique is adopted in the vision channel and when testing the sensitivity of individual stages.

Basic Concept

The elementary concept of sensitivity is illustrated in Fig. 1. Here the input signal is applied to the channel under test from a signal generator and the output is indicated on a suitable meter. Let us suppose that the channel under test is in fact the sound channel. In this case the signal generator would be adjusted to the frequency of the sound signal of a channel normally received on the set; it would be modulated to a depth of 30%; and the output meter would represent an audio voltmeter connected across the output load —that is in place of the speaker. This meter would, of course, have to respond fully to the frequency of the modulation, but since a modulation of 400c/s is fairly standard for this sort of testing almost any reasonable a.c. voltmeter can be used as the indicator.

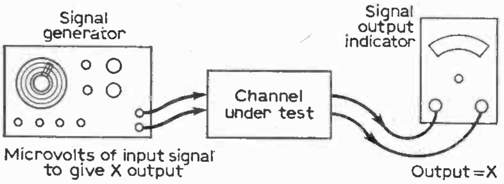


Fig. 1: The basic concept of sensitivity. The idea is to find the input signal (sound and vision) required to produce a specified standard output.

Contemporary television sound channels can yield up to 3 watts of audio without severe overload (albeit at 10% or more harmonic distortion!), which means that the sensitivity could be related to any signal voltage from a very low value, corresponding to milliwatts output, up to a much higher value, corresponding to watts output. The actual power in the output load—usually the speaker—is equal to the voltage across it squared and divided by the impedance or resistance of the load. For example 2V of audio developed across 4Ω is equal to exactly 1W (e.g. $2 \times 2 = 4$, divided by $4 = 1$). Thus the sound channel would have a sensitivity of 50μV relative to 1W output or 2V output across 4Ω if this indication is given on the output indicator when the r.f. input signal, modulated to a depth of 30% at 400c/s, has a root-mean square (r.m.s.) value of 50μV.

The first rule about sensitivity measurement therefore is that the amplitude of the output signal must be expressed either in watts or fractions thereof or in voltage *across a stipulated load value*. It does not mean much simply to say "my set has a sensitivity of 50μV". Lots of sets could have this sensitivity, but some will have it with watts of output and others with milliwatts of output!

Audio Standards

Although the audio standard for sensitivity testing is 50mW some manufacturers base the sensitivity of their sets on some other value of output voltage or power. It is not uncommon to find for example an instruction something like this in a service manual: "Turn up the input signal for a reading of 0·5V across the output load resistor." If it requires an input signal of say 10μV to achieve this, then that particular manufacturer would say that his set has a sound channel sensitivity of 10μV—which is perfectly true *provided* the output signal is given in the specification. On the other hand if a manufacturer says his set has a sensitivity of 10μV then it is assumed that this input yields an output of 50mW.

It must be mentioned here however that the test output is not always standardised at 50mW. In America and some other countries other levels are stipulated as standards, depending on the power of the audio channel. For example the American Institute of Radio Engineers give 50mW for a channel of up to a maximum of 1W output and 500mW for more powerful channels, while a standard as low as 5mW is specified when the audio power output is limited by the channel to 100mW.

Actually of course 50mW across say 4Ω represents a quite small audio voltage—approximately 140mV—and a sensitive audio voltmeter is needed to indicate it. For this reason the standard output is often increased to bring it into the realm of servicing test equipment.

Testing Sound Sensitivity

Modern sets have a sound channel sensitivity of at least 50μV to yield 500mW output, but to check this accurately the input signal must be correctly loaded into the aerial socket and the output stage must be correctly loaded across a resistor equal to the designed-for speaker impedance.

The best way of testing is to remove or disconnect the speaker from the secondary of the output transformer and in its place connect a resistor of suitable power rating across which the audio indicator can be connected, as shown in Fig. 2 at A. Some testmeters and electronic testmeters incorporate a power-measuring range, some with switched loads, and the instrument used by the author is of this kind (Avo Electronic Testmeter). Thus since this sort of meter incorporates its own load all that is necessary is to remove the speaker and connect the instrument in place, suitably switched to the required power range and load resistance. The Avo incidentally gives quite a good indication at 50mW.

An alternative method of getting an audio indication on a less sensitive a.c. voltmeter is shown at B in Fig. 2. Here almost any reasonable a.c. voltmeter will give some sort of indication to audio signal at the anode of the output valve, but coupling must be through a capacitor—C in the diagram—of about 0·1μF to block d.c. from the meter. This scheme however cannot be used for absolute sensitivity assessments because there are so many variables such as the turns ratio of the transformer, the transformer loss and the response of the a.c. voltmeter to signals at 400c/s. The a.c. voltage at the anode is some 50 times greater than that across the secondary load, so one could expect a reading of some 10V.

Vision Sensitivity Tests

In the vision channel the signal ends up by changing the bias of the picture tube at high frequency, up to 3 or 5Mc/s depending on the standard. Let us suppose that the brightness control is adjusted with no signal input until the raster just blacks out. Now with the signal connected the tube bias will be modified, and if the signal represents a white scene a white raster will appear on the screen. This is because a constant signal voltage is under these conditions presented to the tube via the vision detector and video amplifier.

Since the circuits coupling the signal tend to lose some of the d.c. (on purpose) the vision signal is best checked across the vision detector load resistor on a high-resistance voltmeter as shown in Fig. 3. For full vision drive a certain voltage will be developed across the load resistor, depending on the design of the set and the gain of the video amplifier stage, and a voltage often chosen to represent full drive to the tube cathode via the video amplifier is 1V across the detector load.

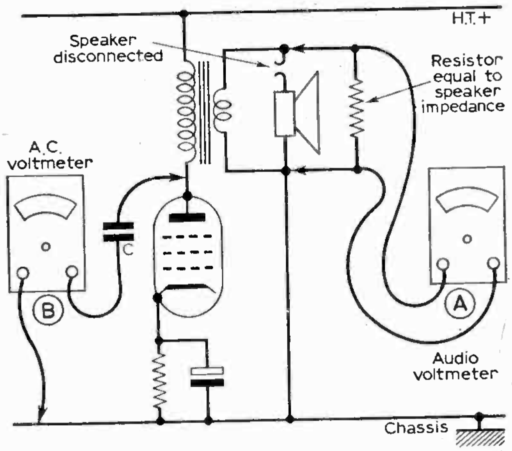


Fig. 2: Ways of indicating the amount of signal present at the output of the sound channel.

If the tube requires say a swing of 50V between cathode and grid for full modulation and there is 1V across the detector load, then the video amplifier will have to have a gain of 50 times. It is not uncommon to find video gains below this value, which calls for a greater signal swing across the detector load resistor—up to 2V or sometimes more. Some picture tubes are also less sensitive than others thereby calling for a greater signal swing across the load or more gain in the video amplifier or both.

Anyway, a voltage *change* of 1V across the detector load is a fair basis upon which to assess the vision channel sensitivity. The d.c. voltmeter would be connected as shown in Fig. 3, the input signal tuned to correspond to the vision frequency of a channel commonly used by the set and the input signal amplitude turned slowly up from zero until there is a change of 1V on the meter (that is assuming that the meter has a residual reading when the input signal is zero). The r.f. voltage necessary to achieve this condition can be looked upon as the vision channel sensitivity and should not be much higher than 10μV on modern sets.

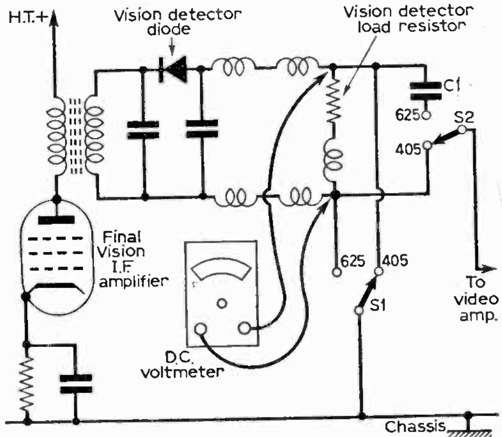


Fig. 3: Metering sensitivity in the vision channel.

This can be checked on both standards (where the set is dual-standard) but it may be necessary to reverse the meter leads on changing standard. The detector standards switching in Fig. 3 is performed by switches S1 and S2—the former simply changes the earthing point of the load and the latter selects the opposite end of the detector for signal feed. It will be seen here that the d.c. is removed on the 625-line standard by the introduction of capacitor C1 into the video output circuit (e.g. the feed to the video amplifier valve). This is the general practice, hence the desirability of checking the vision signal actually across the load resistor proper.

Nevertheless some makers' instructions call for the connection of a high-resistance voltmeter or valve voltmeter to the anode of the video amplifier valve via a resistor of some 6·8kΩ. A change of voltage occurs here, too, when some form of d.c. restoration is employed, such as grid current in the video amplifier valve or the action of an associated diode. Fairly reasonable d.c. coupling—although somewhat attenuated to minimise aircraft fading effects and the like—is used on the 405-line standard, but semi-a.c. coupling—due to the use of a coupling capacitor, such as C1 in Fig. 3—is generally found on the 625-line standard.

Lack of Sensitivity

It might well be asked how a knowledge of the overall sound-and-vision sensitivity can help in a servicing operation. Well, once the overall sensitivity is known a lack of sound and/or vision sensitivity can more easily be traced to a specific section of the receiver. Let us suppose that a set with normally high sensitivity suddenly develops the symptoms of low sensitivity—on sound and/or vision. If the sensitivity before the fault was say 10μV vision, and with the fault present it is 100μV (for the same standard output—e.g. 1V across the vision detector load), the trouble could lie anywhere between the aerial input of the tuner and the final vision i.f. amplifier.

The first move would be to check the sensitivity from the input of the i.f. amplifier—that is from the output of the tuner—at the vision i.f. The tuner should give a gain of at least 10 times so if it is found that the i.f. sensitivity is also around 100μV then something would certainly be amiss with the tuner itself. If on the other hand it needs an i.f. input of 1,000μV to produce a 1V change across the detector load resistor the tuner would be yielding its 10 times gain and the i.f. channel would then be suspect. The next move would be to inject the i.f. signal into the second i.f. amplifier and if it still needed about the same signal strength (1,000μV) to produce 1V across the detector load the fault would probably lie in the first i.f. amplifier stage.

In other words the sensitivity can be checked forward along the sound and vision channels, the sensitivity normally falling progressively from stage to stage towards the detector. If this natural drop in sensitivity fails to occur over a particular stage then that stage should be thoroughly examined.

Caution regarding the matching of the signal generator to the various stages is necessary. Most signal generators have a 75Ω output which matches directly into the tuner aerial socket so there is no trouble of matching here. However, a low impedance of this value could well damp the grid circuit of an i.f. amplifier stage and reduce its gain yield; but even so some degree of signal amplification should be given, sufficient usually to indicate whether or not the stage is at fault. For absolute gain measurements from stage to stage in the manner described above a matching pad would have to be used between the generator and the i.f. amplifier input, and it would also be necessary to take into account the degree of attenuation applied to the generator signal by the pad. However such accurate measurements are rarely necessary for bread-and-butter servicing—all that one generally needs to know conclusively is whether a particular stage is amplifying or not.

The same philosophy can be applied to the sound channel but if the signal (modulated) is taken right into the audio sections then trouble in this section could account for an apparent sensitivity shortcoming. It is possible to eliminate the audio sections by monitoring the rectified i.f. signal across the sound detector load as in the vision channel; but here again the signal amplitude will only be in the order of 1V so that a sensitive, high-resistance voltmeter—preferably a valve voltmeter—will be needed to measure it. A low-resistance meter (below say 20,000 ohms/volt) apart from severely shunting the load resistor would probably have an insufficiently low full-scale deflection range anyway.

The sensitivity of an audio channel can easily be assessed by means of an audio output meter and an audio signal generator. For ordinary television sound channels the input voltage (at the grid of the first audio amplifier) required to produce 2W output can be taken as the audio sensitivity, and this could be as low as 200mV depending on the design of the system.

Testing Alignment

The sensitivity of the sound and vision channels is closely related to the alignment and also of course to how well the set is tuned in and whether the contrast and volume controls are fully advanced. Thus before any sensitivity measurements are made it is essential to make sure that the set is correctly tuned (to the generator signal) and that the volume, contrast and sensitivity (if used) controls are turned full on. It will be appreciated that the a.g.c. systems will hold the output sound and vision signals down below overload level so that the smallest input signal consistent with the "standard" output must always be used.

Sometimes it is recommended that the a.g.c. lines be disconnected and a small standing bias applied to the controlled stages from a battery connected across a potentiometer as shown in Fig. 4. However for normal servicing sensitivity checks this can often be obviated by keeping the r.f. input signal at a level below full action of the a.g.c. system.

Now the vision channel is by no means peaked to the vision i.f. but is flatly tuned over almost

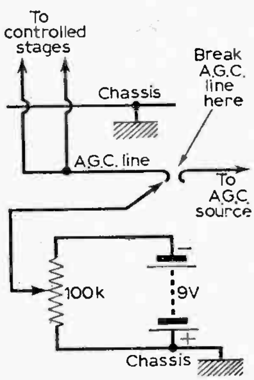


Fig. 4 (left): It is possible to cut the a.g.c. line as shown and adjust the bias on the controlled valves by means of a potentiometer connected across a battery. Take care to observe the correct polarity or the controlled valves will be fed with a positive bias instead of the correct negative bias.

3 or 5Mc/s depending on the line standard—405 and 625 lines respectively. In both cases though the response is tailored by the tuned circuits and i.f. transformers so that the vision i.f. falls at about 6dB down the response curve, as shown in Fig. 5, to take into account vestigial sideband transmission. This diagram illustrates the basic alignment on the 625-line standard where the difference between the sound and vision i.f.s is 6Mc/s, eventually forming the intercarrier sound signal. On the 405-line standard the sound and vision carriers are interposed; that is the sound i.f. is higher than the vision i.f.—the converse of the 625-line standard—and the difference between them is only 3·5Mc/s. While the vision i.f. channel is designed to pass the sound carrier (at about 40dB down—see Fig. 5) on the 625-line standard, the sound is thoroughly notched out by a sound rejector on the 405-line standard.

The intercarrier sound signal is created in the 625-line system at the vision detector by its non-linear action on the sound and vision carriers, producing a 6Mc/s signal which is in fact the intercarrier signal as described in Part 3 of this series. This intercarrier signal is passed on, generally via the video amplifier, to the sound intercarrier amplifier—tuned accurately to 6Mc/s—which on the 405-line standard acts as an ordinary sound i.f. amplifier.

Some of the symptoms of incorrect tuned-circuit alignment were detailed in Part 3, and it is not intended here to repeat this information. A great deal about the alignment can be gleaned by studying the reproduced Test Card C or D and by adjusting the 405 fine-tuning control and the 625 u.h.f. tuning or channel selector control or press-button tuning.

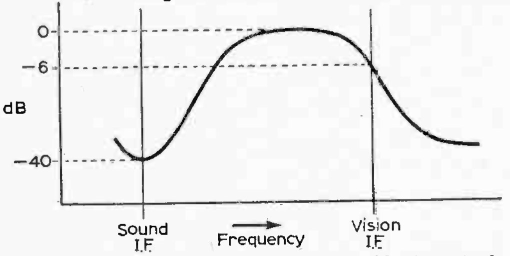


Fig. 5: Basic response curve in the vision i.f. channel of a 625-line set or on the 625-line position of a dual-standard set. Note that the sound i.f. falls in a trough at about 40dB down from the top of the curve, while the vision carrier is about 6dB down on the other side of the curve. Adjusting the u.h.f. tuning causes both carriers to move along the response, thereby resulting in the sound i.f. rising from its trough and the vision i.f. changing from its correct -6dB position.

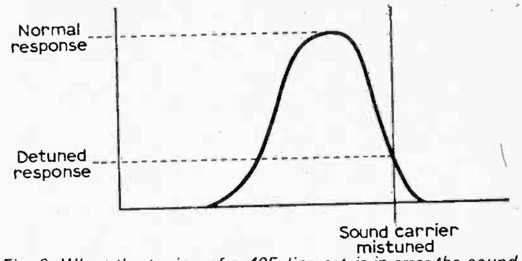


Fig. 6: When the tuning of a 405-line set is in error the sound carrier moves away from the sound response curve as shown. This reduces the sound sensitivity and encourages sound-on-vision interference. On the 625-line standard the 6Mc/s intercarrier signal remains exactly at that frequency in spite of mistuning within the passband.

It is worth remembering that operating the fine-tuning control on 405 lines shifts the vision carrier along the vision i.f. response curve, thereby detuning the sound completely with the vision remaining (although possibly badly distorted), while operating the u.h.f. tuning shifts both carriers along the vision i.f. response curve without affecting the intercarrier sound signal at all. Whatever happens to the tuning within the passband the intercarrier signal will always remain at 6Mc/s because this is set at the transmitter by the difference between the vision and sound carriers—nothing can alter that at the set.

Fig. 6 shows what can happen to the 405 sound signal in the sound response curve due to mistuning. On the 625 standard the worst that can happen is a reduction in the amplitude of the intercarrier signal due to the carrier ratios in the vision response curve deviating from the ideal shown in Fig. 5. The detuned sound carrier can also bring sidebands of the vision signal into the range of the sound i.f. response, resulting in vision-on-sound interference, which was considered last month.

While old hands well conversant with the art can bring a set into fair alignment by eye and ear so to speak, it calls for the service manual (or service sheet) and suitable test instruments to do the job properly, especially as far as dual-standard sets and colour models are concerned. Colour sets have the extra complication of having to handle the chroma subcarrier in the vision i.f. channel at a specific amplitude, which is about 4dB down from the top of the response curve. Unless this is accurately achieved poor colour and pattern interference will almost certainly mar the pictures. However, this is another story for the present.

If the 625 tuning is impaired the sound i.f. will rise from its −40dB dip, the vision i.f. will go up or down the side of the response curve depending on the direction of mistuning, and the sound will weaken (but, note, not from the effect of detuning in the intercarrier channel) and almost certainly be accompanied by intercarrier buzz (see Part 3 last month). There will also be patterns on the pictures. If these symptoms are present even when the tuning is adjusted correctly then the set is certainly in need of overall realignment!

TO BE CONTINUED

AROUND THE I.E.A. EXHIBITION

by Colin Riches

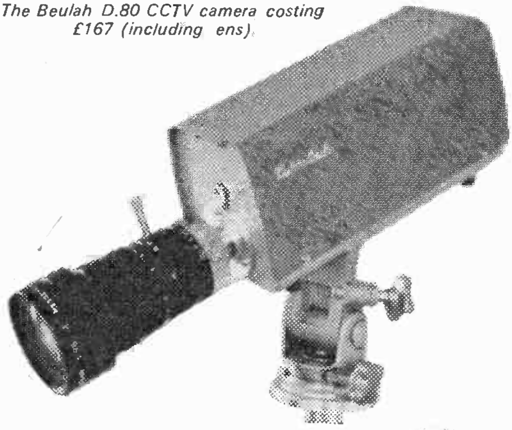
THIS year's I.E.A. Exhibition occupied the full 250,000 square feet of Olympia. One thousand firms from fifteen different countries were represented, but we have taken a small selection of these firms and their products that we think will be of interest particularly to readers of Practical Television.

The items are divided up into CCTV, Test Gear, Video Recording and Tubes, special attention being paid to the new Isocon tube.

CCTV

Beulah Electronics had on show their D.80 television camera, claimed to be the lowest-priced to be produced in the UK. It employs two nuvistors, and has fully automatic wide range light control and stabiliser power supply. It automatically adjusts itself to light values from bright sunlight to ten foot-candles and, even at five foot-candles of light, an acceptable noise-free picture can be obtained. Resolution is more than 5Mc/s and video output is 1V.

The Beulah D.80 CCTV camera costing £167 (including ens).

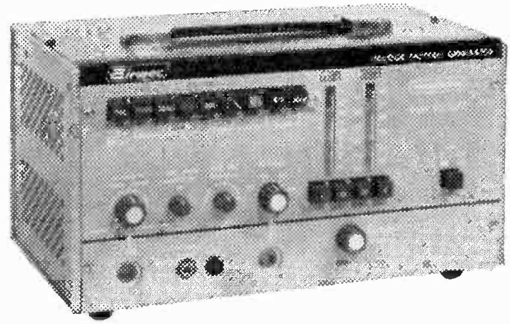


The D.80 can be supplied with an r.f. output to enable it to be used with a domestic TV set. Size of the camera is 10 × 5½ × 4½in. The price, fitted with an f1·9 lens, is £167 0s. 9d. With r.f. unit, £173 0s. 9d.

Also on the Beulah stand was a new transistorised video monitor with 5Mc/s resolution and ±3% vertical and horizontal linearity. Price is £102 for the 8½in. monitor and £108 for the 11in. monitor. Black level clamp circuitry can be fitted as an optional extra.

Thermionic Products of Southampton exhibited a range of *Shibaden* television equipment, which ranged from the HV50 hand-held CCTV camera costing £173 to a TV camera and complete control unit including zoom lens for £1,116. Automatic panning units and video tape recorders were also featured. The HV50 is about the size of an 8mm. cine camera and employs 23 transistors, and 10 diodes in the circuitry. The scanning system is ramdom interlace (525 or 625-lines). Resolution is 400-lines.

Rediffusion Industrial Services were showing their RT100 CCTV camera and VM 1002 video monitor. Specifically designed for industrial and educational uses the RT100 camera has a bandwidth of 8Mc/s, geometry within 1% and full silicon transistorisation. It operates from 240V a.c. power supplies and two other versions are available which operate from 24V d.c. and 110V a.c. at 60c/s. Price of the basic RT100, including a vidicon tube but less lens, is £200.



Airmec's colour pattern generator type FG387Z providing amongst other facilities, six vertical colour bars.

The VM1002 video monitor is a 23in. type to augment the RT100 camera. It is fitted in a teak cabinet and is also, with the camera, available on rental terms. The VM1002 has a 600Ω sound input and bridging to feed an 8 × 3in. speaker. Operating on 405/625-line standards at 240V, the VM1002 is priced at £110.

On the **Marconi** stand CCTV systems were exhibited, including systems for the training of personnel, industrial surveillance and the guiding of missiles. Other firms exhibiting CCTV equipment were **GEC/AEI** who also included displays of studio equipment, **Epsylon Industries** who showed their *Telecheque* CCTV system and their VC10T camera together with video monitors, and **KGM Vidiaids** who displayed a selection of CCTV cameras, monitors and associated equipment.

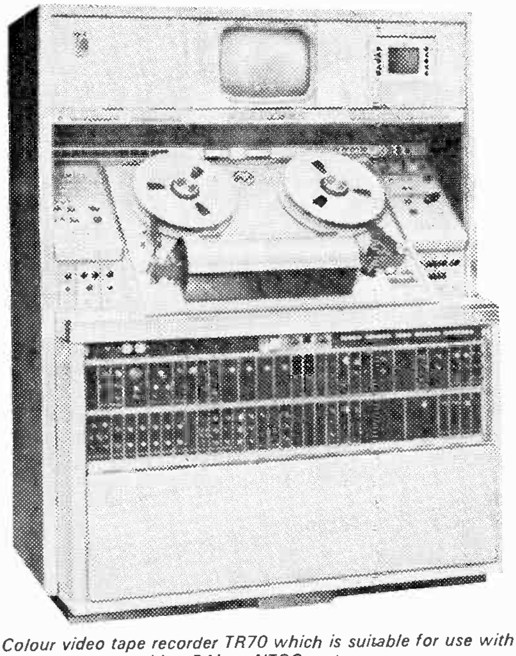
KGM's display included new instruments for colour TV calibration, educational TV, a restyled range of CCTV cameras etc. In the field of TV, KGM (known until recently as AIDS) demonstrated their range of equipment and also had a display of the uses to which CCTV can be put.

Shown for the first time by KGM was a cross-hatch generator for colour television setting-up and a spot marker for enabling lecturers to "point" to any spot on the monitor screen when using CCTV as a visual aid.

Epsylon Industries were showing a wide range of CCTV equipment, comprising cameras, monitors, pulse generators, video distribution amplifiers, pulse distribution amplifiers and video equalising amplifiers. Of principal interest was the VC10T high resolution camera channel which works on 405, 525 and 625-line standards with a video bandwidth of 10Mc/s. Sensitivity is 1·0 foot-candles and the resolution (625-line system) is 650 lines/picture height in the centre of the picture at 40% modulation and 550 lines/picture height in the corners in the direction of the line scan, with 400 lines at any part of the picture in the direction of the field scan. Size is 11 × 3½ × 6in. and weight 9½lbs. Also provided for this unit is the VC10T power and remote control unit which operates directly with the camera.

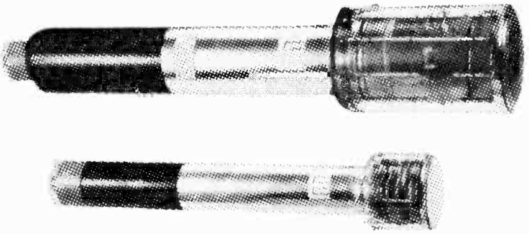
TEST GEAR

Several exhibitors had displays of test equipment. **Telonic Industries** were showing a u.h.f. sweep generator for TV tuner alignment which incorporated a feature known as "auto-track" which compels the centre frequency of the generator to follow that of the TV tuner with which it is being used. Thus the operator does not need to retune the sweep generator.



Colour video tape recorder TR70 which is suitable for use with either PAL or NTSC systems.

A PAL subcarrier and synchronising generator set complete with chroma and V & H lock was shown by **Richmond Hill Laboratories**, a Canadian company. Here a new system called *Unipulse* distributes the seven synchronising waveforms required for PAL in a single cable. Built-in coding and de-coding allow precise phasing and timing at each source, the company stated.



The large and small models of the EEV Image Isocons—the camera tubes that "see in the dark".

Airmec Instruments were showing their colour pattern generator type FG387Z, which provides test signals on all the following subcarrier frequencies and i.f. channels: 33-68, 174-225, 470-823Mc/s. Also provided by the FG387Z is a colour picture in either red, blue or green for the adjustment of colour purity. Six vertical colour bars are obtainable (yellow, cyan, green, magenta, red and blue) for the alignment of PAL decoder and colour matrix in the receiver. A cross-hatch pattern for adjustment of convergence and linearity and a monochrome pattern of shaded vertical bars can be obtained and a sound carrier (unmodulated) spaced 6Mc/s from the video carrier and a sound channel carrier frequency modulated at 1kc/s are provided.

VIDEO RECORDING

Among the exhibits on the **RCA** stand was the Company's most advanced *colour* video tape recorder, the TR70 which, it turned out was being demonstrated for the first time at any exhibition in the UK. Model TR70 is a high-band machine operating on a quadruplex method of video recording.

TUBES

Mazda were exhibiting a range of new tubes. The current production shadowmask tube types CTA 1950 (A49-11X) and CTA 2550 (A63-11X) were shown, together with the latest monochrome tubes in 16in., 19in., and 23in. sizes. The 20in. monochrome tube type CME 2013 was shown for the first time in the UK and it is said to be the first 20in. "squared-up" tube type to be manufactured in Britain. This tube is rated at 20kV with a 6·3V heater at 0·3A. It

continued on page 496

LETTERS TO THE EDITOR

FAULT-FINDING FOCUS

SIR,—In the April edition of this journal, you show, on page 295 in Fig. 2 (the graphs of the voltages appearing at the output of R and C) an incorrect drawing.

I would like to point out that the V/R graph should be drawn as shown in Fig. 1 left.—J. E. LAMBOURNE (Cwmaman), Aberdare).

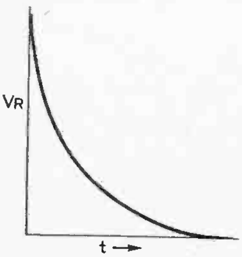


Fig. 1: Here we see the graph as it should have been shown.

[*We would like to thank Mr. Lambourne for bringing this error to our attention. He is of course quite correct in saying that the graph should be drawn as shown in the figure above.*] —Editor.

DID BRITAIN INVENT TELEVISION?

SIR,—Mr. D. Courtney's letter in PRACTICAL TELEVISION for April refers to picture telegraphy, which dates back to 1880 when Carey reproduced simple pictures on sensitised paper. Earlier, in 1850, Bakewell transmitted stylus-traced pictures by wire. Fulton perfected "still" telegraphy; his Fultograph was first used by the BBC in 1928. The first vision-phone was between Paris and Lyons in 1930, using a Baird scanner and televisor at each end of the line; "low definition" gave excellent "face to face" pictures.

Ruhmer deserves mention as a television pioneer, as do others who tried to add vision to the telephone. Ruhmer invented a photo-conductive cell in 1902, using steatic (soapstone) as insulator for the selenium-coated wires. Like all early experimenters he found selenium useless in the scanner (sluggish, with weak photo-signals), and had to wait for the invention of the potassium cell in 1912, and then for electronic amplification to be developed.

Potassium cells work well for sound reproduction, but respond only to blue light, giving unreal tone values in television pictures. The invention of the caesium-on-oxidised-silver cell in 1924 made possible the perfection of TV scanners and cameras for true tone-value transmission.

Among the many experimental systems which failed to develop into our modern television were the Diaphote, Pantelegraph, Scophony, Telautograph, Telectroscope, Telehor, Telekino and Telorama.—A. O. HOPKINS (Worthing, Sussex).

AROUND THE IEA EXHIBITION

—*continued from page 495*

uses a Mazda unipotential gun and has a scanning angle of 110°. It is a Rimguard III self-protected tube with metal mounting lugs, designed for push-through presentation in the same manner as its 19in. predecessor.

Mazda also showed a "squared-up" version of their successful 16in. CME 1602, which will be known as a 17in., though the screen is very much flatter and squarer than the familiar 17in. tubes of ten years ago.

Exhibited on the **Brimar** stand were several new tubes for instrumentation, including D3-130GJ, a 1in. instrument tube which allows permanent waveform monitoring for rapid fault location, to be built economically into large equipments. A 5in. flying-spot scanner tube was shown. Its light output is 150μW (at Va_3=15kV, Ia_3=4·5μA) and the small spot size is 0·1mm. diameter of 60% of peak luminance (with Va_3=15kV, Ia_3=4·5μA). The minimum useful screen size is 88mm.×68mm. Heater rating is 6·3V at 0·3A. Electrostatic focusing is employed and deflection is magnetic, using a very small deflection angle. The aluminised screen uses the new Brimar X10 (this is the development number) yellow-green phosphor which is of short persistence, 2μS down to 10%.

IMAGE ISOCON

On the **English Electric Valve** stand, the *Image Isocon* was exhibited. This is a television camera tube that will produce pictures under lighting conditions approaching near darkness. It was, in fact, one of the subjects of this year's Queen's Award to Industry.

The largest model, the 4·5in. version (the diameter being measured across the photocathode which receives the light input), is installed in image intensifiers made by Marconi for hospitals. When connected to ordinary X-ray equipment, the isocons produce pin-sharp still or cine pictures of parts of the human body while the patient is subjected to only one fiftieth of the normal X-ray dosage.

The smaller 3in. version has been designed for use in TV cameras operating in extremely low light levels and may be used to keep watch over prisons, airfields, warehouses, etc. The television cameras are fitted with the isocons then linked to a central guard-house where a single man can keep watch over several large areas at the same time.

In astronomy, the *Isocon* has already produced pictures of the moon and stars. To enable this to be accomplished, a TV camera was attached to a telescope and took, in 1/25 of a second, pictures of the moon and the stars which would normally take several minutes. At the Exhibition stand, the *Isocon* was demonstrated in a special studio. This studio had variable intensity lighting which ranged from strong sunlight to complete darkness. The demonstrations showed how the camera can pick up and display dark scenes and also handle without any damage, a "blinding" effect, such as the headlamps of a car which may flash across the scene being televised. ■

THE ABC OF colour TV

PART 3

G. P. WESTLAND

Ident Signal

The term ident is used to describe the train of alternating pulses obtained from the burst signal by demodulation on the R-Y axis. See Fig. 12. These ident pulses are usually fed to a tuned ident amplifier which produces a sinewave ident signal and thence to the bistable switch circuit. If the bistable is in the wrong phase on a particular line of the picture the ident signal suppresses the triggering until it is in the correct phase.

The ident pulses can be smoothed in a flywheel filter to provide a d.c. output to control the reference oscillator a.p.c. loop. They can also be detected using a simple diode circuit to provide a d.c. bias for "unkilling" the chrominance circuits when a colour signal is present.

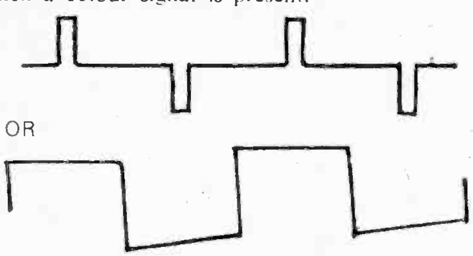


Fig. 12: Two typical ident pulse trains.

Illuminant C

We are only able to see an object if light shines on to it and is reflected back into our eyes. The light energy excites the rods and cones in the eye, and the optic nerve conveys the messages to the brain. The brain then translates these messages into an image. Generally speaking we are only concerned with white light—daylight or artificial—but for special effects other hues are used, such as stage lighting in the theatre.

The point about all this is that it is essential for the colour receiver to be adjusted to match the white light used in the studio because otherwise the drive to the three guns of the c.r.t. will be incorrectly proportioned and the colours will be distorted. This is not too important on highly saturated colours, but pastel tones, such as flesh tints, will have serious errors.

The PAL television system specifies illuminant C as the normalising illuminant. In other words all colour transmissions are based on the use of white C in the studio, and the highlight end of the receiver's grey scale must be adjusted to give white light of this same hue. White C is a neutral white with a slight hint of warmth in it. If it looks at all greenish, or a cold blue, it is certainly not white C.

In practice it is not feasible to supply light of this hue for use in the studio, and still less on outside broadcasts! Consequently the signals are coded before transmission as though they had, in fact, originated under white C conditions, and this gives near enough the right answer.

The use of white C in a colour receiver means that monochrome pictures will appear slightly lacking in contrast, but this is a small price to pay for getting really good colour pictures.

I Signal Component

This is of historical interest only. The NTSC system incorporates the ingenious idea of exploiting the characteristics of the human eye. The eye can detect fine detail much more easily in colours near the I axis than it can in colours near the Q axis. The colour information is therefore coded in terms of wideband I and narrowband Q colour-difference signals in order to reduce the crosstalk between the two signals without loss of visible information.

For reasons of cost very few NTSC receivers take advantage of the full potentiality of the system, and it is now universal practice to use the same restricted bandwidth in both channels.

Luminance

This means brightness. If the R, G and B outputs of the colour camera are added in the proportion $0{\cdot}3R+0{\cdot}59G+0{\cdot}11B$ and are fed to a monochrome display the viewer will see virtually the same picture as would be obtained from an ordinary black-and-white (monochrome) camera. The luminance signal is termed the Y signal, and in a typical colour receiver is supplied to the cathodes of the three guns. The drive to each cathode has, of course, to be adjusted in proportion to the R, G and B phosphor efficiencies of the particular c.r.t. See also grey-scale tracking.

The term luminance is applied to items such as the luminance detector, luminance delay line, and the luminance output stage. The luminance bandwidth must either be restricted to about 4·0Mc/s or must incorporate a notch at 4·4Mc/s in order to prevent a fine beat pattern from being too obtrusive on the picture caused by the presence of the colour subcarrier.

Matrix

Matrixing is a process of adding or subtracting —i.e. mixing. The chrominance matrix in the decoder mixes the colour signal from one line of the picture with the signal from the previous line (stored up in the chrominance delay line). When the two signals are added a pure B-Y output is obtained, and when subtracted the result is pure R-Y. When this process is done correctly

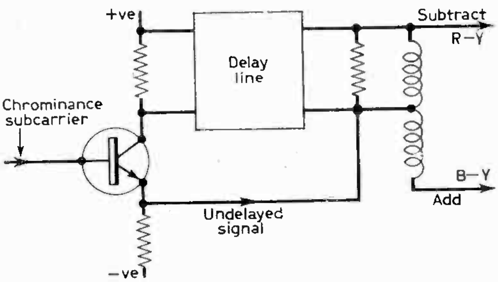


Fig. 13: Chrominance matrixing in the decoder to separate the B-Y and R-Y signals.

no crosstalk occurs between the two colour-difference signals, and the two new signals are of constant phase. This makes subsequent demodulation much less critical, and certain propagation errors are cancelled out. This kind of matrixing is used in both PAL and chrominance locked-oscillator decoders. See Fig 13.

A subsequent matrixing operation is carried out in which −(R-Y) and − (B-Y) signals are added together to give the + (G-Y) colour-difference signal. The final matrixing operation, generally done in the c.r.t. itself, is to mix the luminance (Y) signal with each of the colour-difference signals to recreate the original R, G and B signals.

Mixed Highs

This rather curious term refers to the high-frequency components of the composite colour-video signal. Due to the characteristics of the human eye it is not necessary to transmit colour-difference signals of wide bandwidth provided that the luminance signal has a bandwidth of 4·0Mc/s or more. Narrowband colour superimposed upon wideband luminance will give an apparently sharp full-colour picture.

The wideband luminance signal, including components corresponding to fine detail, is obtained by mixing the full bandwidth outputs of the R. G and B camera tubes before these signals have been band limited for coding into the form R-Y and B-Y. Hence the term "mixed highs."

Modulation

This refers to the information impressed upon, and carried by, the signal carrier. There are three common methods of modulation—amplitude, frequency, and phase. In each case the amplitude, frequency, or phase of the carrier is varied by an amount proportional to the amplitude of the information that it is desired to transmit, and at a rate dependent upon the frequency of the signal information.

In U.K. colour transmissions the sound is f.m., the luminance signal a.m., and the chrominance signal is a mixture of amplitude and phase modulation. The amplitude of the colour subcarrier tells you the saturation at any instant, i.e. the amount of colour, and the phase tells you the hue. The phase is a measure of the relative proportions of R-Y and B-Y signal components, and thus defines the hue.

Monochrome

This simply means one colour—in this case white. It is quicker to talk about a monochrome picture etc. than to keep on saying "black-and-white".

NIR

This is a colour-television system devised by the Russians and based on a mixture of NTSC and Secam. It came to the fore during the protracted negotiations between the French and the Russians aimed at using a common system; primarily for political reasons, one suspects. This pact was finally cancelled by the Russians.

NIR did not appear to have any substantial advantages over other systems and has not been

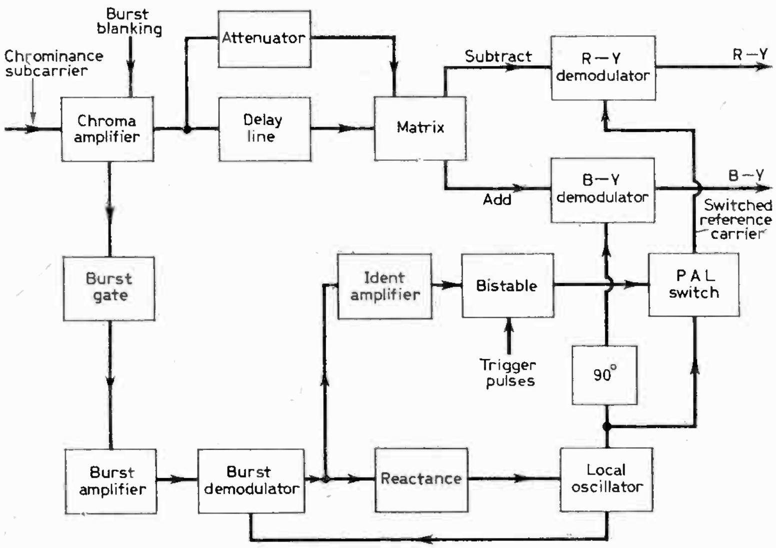


Fig. 14: Block diagram of a PALd decoder.

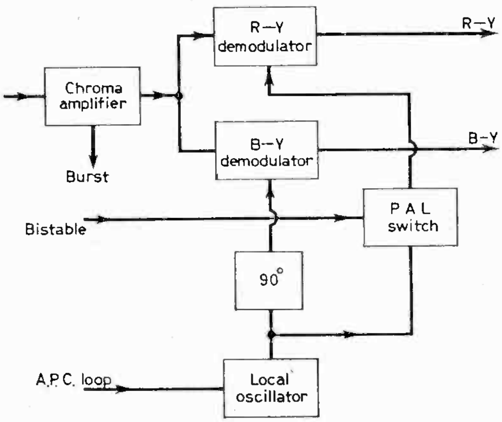


Fig. 15: Showing how the chrominance signal path is simplified in a PALs decoder.

adopted. It had good immunity to differential-phase errors but a suspect performance under fringe conditions. Space does not permit a description of the system, but it was based on the idea of transmitting colour-difference signals in a form that enabled a subcarrier of constant phase to be extracted in the receiver. This suffered the same phase changes in transmission as the hue information, and so phase errors were cancelled out. The a.p.c. loop and local reference oscillator of other decoding techniques were redundant.

PALd

Readers of PRACTICAL TELEVISION will not need much reminding of what PAL is all about. However, it may be useful to include here a block diagram of a PALd decoder, shown in Fig. 14, just to point out the difference between it and the simple PAL, or PALs, approach. So far we have not seen any PALs decoders on the market, but if a price war breaks out they may put in an appearance to save the cost of the chrominance delay line.

PALs

Simple PAL is the poor man's PAL, or perhaps even the profit-hungry man's PAL! Its immunity to subcarrier phase errors is not as good as in PALd, but it is still a lot better than NTSC. The snag is that it is rather difficult to design and align a decoder so that no blinds occur, and even if you succeed the stability has to be of a very

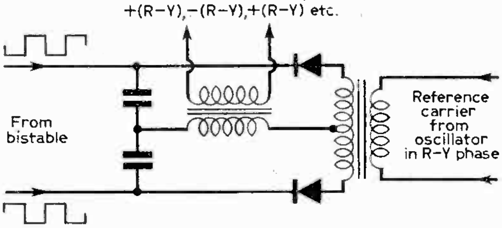


Fig. 16: A PAL R-Y switch circuit.

high order to maintain this desirable state of affairs. A PALs decoder is illustrated in Fig. 15, and it will be seen that the main difference is the absence of the delay line and matrix. This means that both R-Y and B-Y signals are present at each demodulator, and so crosstalk is to some extent inevitable: hence the tendency for blinds to occur.

PAL switching

PAL is, of course, a form of NTSC, but the one feature that gives it a high degree of immunity to various forms of distortion, and makes a hue control unnecessary, is the inversion of the R-Y signal from line to line, +(R-Y), −(R-Y), +(R-Y), etc.

In the receiver it is necessary to extract the R-Y component in the correct polarity on every line, and so the incoming R-Y signal has to be switched 180° on alternate lines. The burst signal varies in phase by ± 45° about the B-Y axis, and so when it is synchronously detected a train of alternating pulses is obtained, called ident, which can be used to synchronise the PAL switch in the decoder. (See *Ident*).

A typical switching circuit is shown in Fig. 16, and this can be used either to invert the phase of the local reference carrier, which gives an output of opposite polarity from the demodulator, or to invert the R-Y signal itself. Most German receivers switch the signal, and most British ones switch the carrier. You have to weigh up the advantages of switching a large amplitude narrow-band carrier or a small amplitude signal with a bandwidth of about 1·0Mc/s. The dangers are radiation of carrier harmonics, or phase changes of the signal.

Primary Colours

Everyone is familiar with the idea of mixing two or more colours to obtain a different one. There is an infinite range of possibilities. Printers use up to five different coloured inks in order to get high-quality reproductions, and these inks are their primary colours for a particular process.

It is a fortunate fact that when dealing with coloured light direct, rather than via the use of light absorbent inks or pigments, it is possible to reproduce nearly all the colours that occur in nature by using only three primary colours. When choosing primaries for NTSC, PAL or any other TV system, it is necessary to compromise between those which give the best possible coverage of the colour gamut, and those which give the best performance as phosphors on the screen of the c.r.t. Red, green and blue have been universally adopted as the transmission primaries, and these are fairly closely matched in all colour c.r.t.s. Any c.r.t. can be used on any system so far adopted.

An exact match is not essential because the decoder outputs can always be adjusted to some extent, at extra cost and complication. However, if the phosphor hues depart too much from the transmission primaries fairly obvious distortions will be introduced.

TO BE CONTINUED

S.M.P.T.E.

ICONOS REPORTS

Los Angeles

IT is not possible to comment on every paper that was presented. A splendid start was made by Lemons and Levin of the Sylvania Electric Products revealing the enormous progress that has lately been made with tungsten - halogen incandescent lamps in replacement of the bulky normal incandescent lamps at present used in TV and film studios, which blacken so quickly even before the filaments fail. Similar developments have recently taken place in England under a joint development scheme with Thorn and Mazda, but it was interesting to note the progress in the U.S.A. This was followed by a useful paper on the consequent new types of studio luminaires (lanterns, spotlights, floods) and the use of selective colour reflectors in the new lamp fittings, presented by Larry Davee of Century Projector Company, New York.

This was followed up later with *Power Supplies and Distribution Systems for Triple Purpose Stages*, the first of several papers given by members of the B.K.S.T.S. Presented by Thomas Earle-Knight, Chief Engineer of Pinewood Studios, this clearly set out methods for supplying and controlling power supplies for production stages to make them suitable for making films for the cinema or for television or for live or v.t.r. television. This was followed by another paper of British origin, *What Now in Film Production?*, which dealt with the policy decision, planning and budgeting which follow (or, possibly, lead) trends in production techniques. This startling and controversial paper by E. A. R. Herren, Managing Director of Pinewood Studios, was presented without slide or film illustrations but with vigour and caused quite a stir.

Another paper on studio planning was *The First Total-Concept Motion Picture Studio*, given by Gary Essert of Hollywood's Kaleidoscope. The studio complex described covered three film sound stages, two TV stages, an animation studio, 26 editing rooms, ten videotape editing rooms, two theatres, sound dubbing facilities, workshops, and so on. It was therefore a completely integrated unit for all types of production.

Multi-purpose Stages were also tackled by Michael Rettinger, as well-known in Britain as he is in U.S.A. as a consultant on acoustics. His specialist paper dealt with problems of post-synchronisation of film scene dialogue, music scoring and reverberation. This paper led to Joseph Kelly's *Automated Dialogue Replacement* presented by Emory Cohen of Glen Glenn Sound Co. Papers which followed included *Current Procedures for Providing Sound Effects*, a British paper presented by Edmond Chilton. This revealed the first news of startling developments of the Mellotron sound effects machine, to which will be added cassette devices for continuous or spot-start effects.

On Tuesday morning there was a symposium on *Automated Projection Equipment* with Frank Riffle as "Moderator" and A. Boudouris, John Servies and Bernard Bentley as panellists.

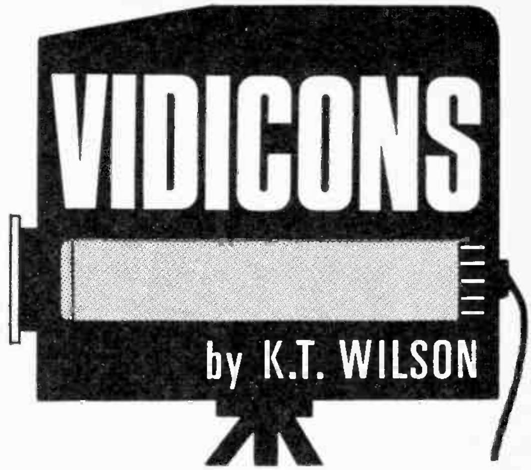
Several excellent papers on the use of film, v.t.r. and closed-circuit or on-air television for educational purposes were presented and it was quickly evident that the British educational authorities are well behind the Americans in this respect. *Industrial and Educational Equipment* by James J. Prevel of the U.S. Office of Education dealt with various avenues for improving the quality of instruction through technology. Several other papers dealt with other aspects in the educational field. One of the most important was a splendid paper by E. B. Crutchfield of University of Virginia, Charlottesville on *Non-broadcast Television Facilities for Educational Institutions*. Mr. Crutchfield was very aware of the most effective way of using film, teaching machines, v.t.r. or live television—by a show business type of presentation instead of the botched up methods used in U.K. until quite recently, when a real technical committee was instituted about five years later than it should have been!

A wide range of photographic and electronic usages was dealt with in subjects concerned with surgical, medical, X-ray and even psychiatric subjects. Many aspects of closed-circuit television were dealt with, some of them of a quite surprising character such as *Some Possibilities for the Use of White as a Primary in Colour Television Systems* by C. B. Rubinstein and D. E. Pearson of Bell Telephone Labs. Slides illustrated the possibilities of this technique for specialised subjects such as those giving extremely accurate rending of all possible small variations of red as a colour.

Two other British papers dealt with *Recovery of Film Cleaning Solvent* by Dr. Frank P. Gloyns of Denham Laboratories and *A Mobile Colour Picture Signal Source* concerning a mobile Cintel colour telecine unit described by Bernard J. Rogers of Rank-Bush-Murphy. As Mr. Rogers was unable to attend, the paper was read by Baynham Honri, a Past President of the B.K.S.T.S. Dr. Gloyns' paper described the use of ultrasonic methods of cleaning dust and dirt from negative and positive film, for which a highly expensive solvent, trichloroethane, was necessary. Its remarkable recovery and reclaim from the exhaust fumes from the machine is a most important factor in the economics of a film processing laboratory.

The entire party from the U.K. were hospitably welcomed in a luxurious penthouse suite at the Century Plaza Hotel by G. Carleton Hunt, President of the S.M.P.T.E. It must be mentioned that the S.M.P.T.E. had put at the disposal of the B.K.S.T.S. a special exhibition stand on which were set up a 16mm. film projector plus two automatic slide machines for displaying films and slides of British studios, laboratories and equipment.

There were 86 exhibition stands for television, film, processing and camera equipment.



UNTIL the invention of the vidicon in the research laboratories of the Radio Corporation of America (RCA) the smallest television pick-up tube had been the 3in. image orthicon with a 3in. maximum diameter and a length of about 15in. The early vidicons, 1in. in diameter and only $6\frac{1}{2}$in. long, represented a great advance in miniaturisation, though early vidicon cameras using valves were not exactly miniature by modern standards. The truly miniature TV camera (or "creepie-peepie"!) now uses a $\frac{1}{2}$in. diameter vidicon 4in. long and completely transistorised circuitry.

Though the vidicon follows the same basic principle as the CPS Emitron and the image orthicon in being a charge-storage tube in which the information that is scanned by the electron beam has been stored up between scans, it differs greatly in the way in which the light reaching the tube is converted into a pattern of electric charge. In the vidicon this depends on *photoconductivity*, which is the variation in resistance of a material with variation in the intensity of the light falling on it.

PHOTOCONDUCTION

As is so often the case the effects of photoconductivity were discovered during investigations into something quite different. The transatlantic telegraph cable laid in the 1860s had a very slow signalling rate due to its stray capacitance. Each pulse transmitted ended up at the receiving end as a slow rise and fall of current, making fast signalling impossible and causing errors because of the difficulty in distinguishing dots from dashes. Until the great mathematician and engineer Oliver Heaviside showed that this could be overcome by adding series inductance at intervals in the cable (entirely contrary to what might be suggested by common sense) so making the cable into a delay line with a definite impedance, all sorts of experiments went on using different materials to see if the weak signals could be reformed in any way. It was known that some substances did not obey Ohm's law well, and the experimenters hoped to find a substance across which there would be a sharp rise in voltage when the rise in current was received. When they came to work on the semiconductor (as we would now call it) *selenium* they were puzzled to find most inconsistent results. The resistance of their sample of selenium varied from one day to another and from one minute to another in a way which seemed to be unaccountable. It was not until one worker noticed that the resistance of the selenium rose every time his shadow passed across it that it was realised that the resistance of a piece of selenium depends on the amount of light falling on it.

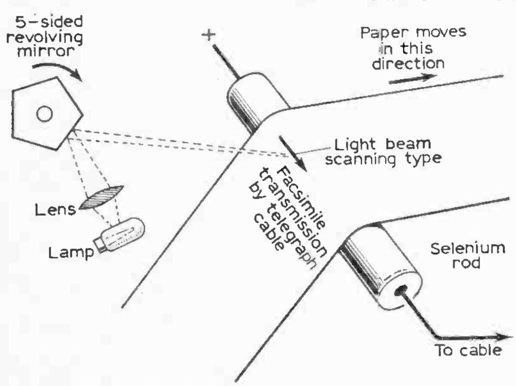


Fig. 1: Use of photoconductive selenium rod for newspaper picture telegraphy.

This effect was termed photoconductivity and has been widely used ever since. It was used before 1914 to transmit newspaper photographs over telegraph wires by scanning a negative with a moving beam of light and focusing the transmitted light on to a rod of selenium which transmitted a current to a cable (Fig. 1). Similar mechanisms using more modern photoconductors are still in use. Even in recent times a new use for selenium has been found in the electrostatic copying machine, where a selenium plate exposed to a document acquires electric charge by photoconduction in places where the original document has ink. This charge can then be transferred to dry paper and a copy made by spraying dry plastic powdered "ink" on the paper. This "ink" is retained where the paper is charged (just as a polythene object rubbed with a duster can pick up scraps of paper) and is melted into the paper by a heater. This principle has developed into the sophisticated office copier of the Xerox (trade mark of Rank Xerox Ltd. and Xerox Corporation of USA) type.

The photoconductivity of selenium is useless for television purposes however because there is a time-lag of about one-tenth of a second between the light falling on the selenium and the resistance decreasing. Furthermore the response is not linear, that is doubling the amount of light does not cause the conductivity change to be doubled; and selenium responds mainly to red light and infra-red (which means that a TV picture would show red or hot objects as *white* and other colours as *dark*). These overwhelming disadvantages of selenium rule it out as a material for use in the vidicon; but later work undertaken when transistor technology had provided fresh knowledge of semiconductor materials showed that selenium purified in the same way as the germanium and silicon used in transistors and doped with a measured quantity of impurity material could

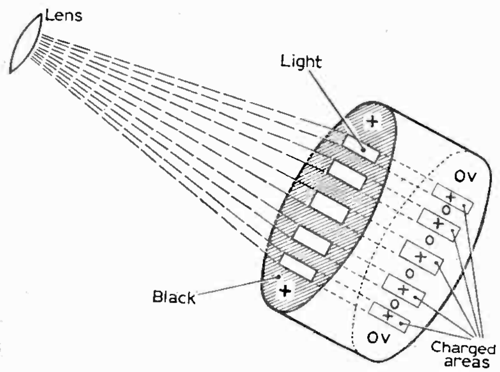


Fig. 2: Action of vidicon photoconductive layer.

become a very useful photoconductor. This work, also carried out by RCA, resulted in the Selenicon tube; but that is another story!

VIDICON PHOTOCONDUCTIVE LAYER

The material which was eventually used for making vidicon photoconductors was antimony trisulphide, a yellow poisonous powder obtained from sulphur and the metalloid (neither metal nor non-metal) antimony which is very similar chemically to arsenic. Antimony trisulphide has a quicker response, is reasonably linear, and has a response to colour which is similar to that of the human eye. If we take a plate of antimony trisulphide and focus on it an image of a well-lighted scene the conductivity of any portion of the plate will depend on the intensity of the light reaching it.

Imagine now that one side of the antimony trisulphide plate can be held at a positive voltage. In darkness the other side of the plate can be brought to earth potential by contacting it with an earthed plate and then removing the plate; as long as the plate is in darkness the earthed side should stay at earth potential. When a pattern of dark and light bars is projected on to the plate, however, the conductivity of the antimony trisulphide will increase in the regions of the light bars and the opposite side in these regions will rise to the positive voltage of the front. On the rear surface there will thus appear a pattern of voltage which will be zero volts where a dark bar is projected and a positive voltage where a light bar is projected (Fig. 2). There will also be leakage across the plate so that the exact voltage on the back of the plate due to a light bar will depend on the value of illumination: the brighter the bar the more positive will be the voltage up to the limit set by the voltage on the front of the plate.

Now let us see how this principle is applied in a vidicon (Fig. 3). A plate of antimony trisulphide would be too thick so a very thin film is used. This is supported on the glass plate which forms the front part of the tube. Since an electrical connection must be made to the surface of antimony trisulphide which touches the glass a transparent conducting coating has to be applied to the glass first. Early tubes used very thin films of gold but nowadays the film is of tin oxide, made by spraying tin chloride dissolved in alcohol on to the hot glass plates. The tin oxide film is very hard, quite transparent and conducts well (about 100Ω across two opposite sides of a square).

In the early days of the vidicon the endplate was fixed to the tube, the tin oxide layer put on and contact made to a metal pin inserted in the glass. The antimony trisulphide was then heated during pumping in a side arm attached to the tube until sufficient had evaporated on to the endplate to form a film of the required thickness. The side arm was then removed leaving a sealed tip of glass. Modern practice is to coat the endplates with tin oxide, add the antimony trisulphide layer by evaporation in a bell-jar containing argon gas (better than using a vacuum because the antimony trisulphide tends to split up in a vacuum) and then sealing the endplates on to their tubes. This process took some time to develop, however, for ordinary glass sealing methods could not be used as the films on the endplates were destroyed by the temperature of glass sealing. The method finally employed was to "glue" the endplates to the tubes using the soft metal indium which also serves to act as the contact to the tin oxide layer. A metal ring, which makes contact with the indium and serves as the "target" contact, is then clamped round the joint, the target being the antimony trisulphide layer.

ACTION OF THE ELECTRON BEAM

Before a pattern of voltage can be established on the target layer the side opposite to the endplate must be brought to earth potential. This is done by means of the electron beam which acts as a "contact" connecting the target to the cathode of the electron gun. If the cathode is earthed then the face of the target is also earthed. Each time the electron beam scans the target, therefore, it brings the voltage all over the rear surface of the target to zero. Between scans the image which is projected on to the endplate by the lens causes a voltage pattern to appear on the back surface of the target, the most positive areas of the target corresponding to the brightest areas of the image.

The landing of the electron beam has another effect. Imagine a set of identical capacitors connected as shown in Fig. 4. When the switch contact is rotated, each capacitor will charge up so that the upper plate is at +20V and the lower at 0V, but in the course of this charging a current must flow in each load resistor and the amount of the current will be proportional to the voltage of the lower plate before discharge. The target

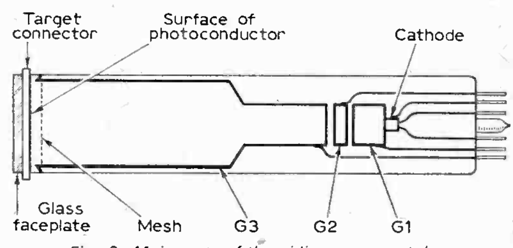


Fig. 3: Main parts of the vidicon camera tube.

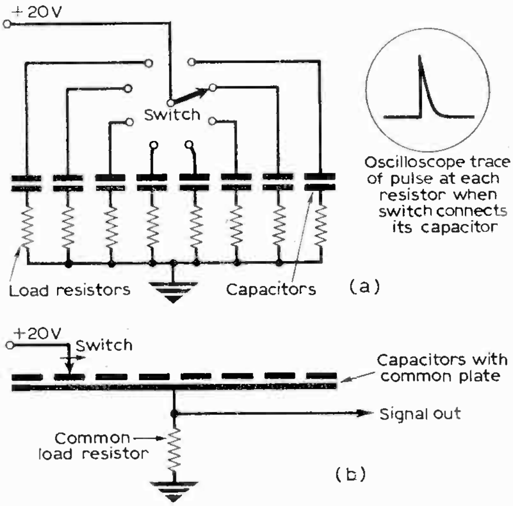


Fig. 4: Extracting the video signal from the vidicon.

of a vidicon acts as if it were a set of capacitors with one set of plates joined and connected to the +20V and the other set contacted by the electron beam which acts as the switch contact.

If the target connection is returned to the +20V supply through a load resistor the current of the beam which charges the target will flow through this resistor, causing a voltage to appear across it. This voltage must be proportional to the voltage to which the target discharged, which in turn is proportional to the light which fell on the target before scanning. As this process takes place for every portion of the target which is scanned the signal appearing at the target load resistor is the video signal. It is important to note that the amplitude of this video signal at any time is proportional to the light falling on a portion of the target in the time *between* scans; it is this fact which makes the vidicon and other charge-storage tubes so sensitive.

SETTING UP A VIDICON

When a vidicon is to be used in a camera a definite procedure must be followed for best results. The camera should of course be designed so that the focusing and scanning coils are fixed correctly in relation to the shoulder which locates against the target connection of the vidicon. Many vidicons of modern design have one extra contact to the electron gun: this enables the voltage on the target mesh to be varied separately from that of the long anode cylinder, with beneficial results to focusing particularly in the corners of the picture. It is not difficult to modify older types of cameras to take advantage of this facility.

The vidicon is inserted into the camera until the target connector is fully home. There is no preferred angular position (unlike the image orthicon where the shoulder base pins must engage) unless the base connector is clamped. With the base connector fitted and the lens in place the target and beam current controls are set at zero and the camera switched on. The monitor should be set with brilliance and contrast control in positions which give an acceptable picture (contrast about three-quarter way up, brilliance until a raster is just visible) and the hold controls of the monitor set to lock to the camera output.

The lens cap is then removed and the lens iris set at full aperture for normal room lighting. The target potential of the vidicon (marked "sensitivity" or "contrast") should also be set to three-quarters of the maximum. The beam current is next increased (which means the control grid bias decreased) until some sort of image appears on the monitor. The focus of this image should then be improved by using the lens focus and the electronic focus of the camera.

If the image seems to be framed by a defocused area this is usually due to misplaced scan coils causing some of the internal components to be scanned, so the scan and focus assembly should be moved. In some cameras a permanent magnet shift system may have to be adjusted to centre the scan system of the vidicon so that an unframed picture is obtained and the scan width and height may have to be adjusted. The magnet system, along with the beam alignment control in the camera, should be set so that movement of the beam focus control causes the picture to move in and out of focus only, or in a circle centred round the centre of the screen.

Target voltage and beam current controls should then be adjusted alternately until a picture of satisfactory contrast is obtained. The beam control should be sufficiently high to avoid any washed-out appearance in the highlights but not turned beyond this point. If the target voltage control has to be turned right up or to the point where the picture is very noisy (assuming that the video amplifier is of good low-noise performance) the illumination of the room must be increased or a wider lens aperture used. Finally all controls including the contrast control of the monitor should be re-adjusted.

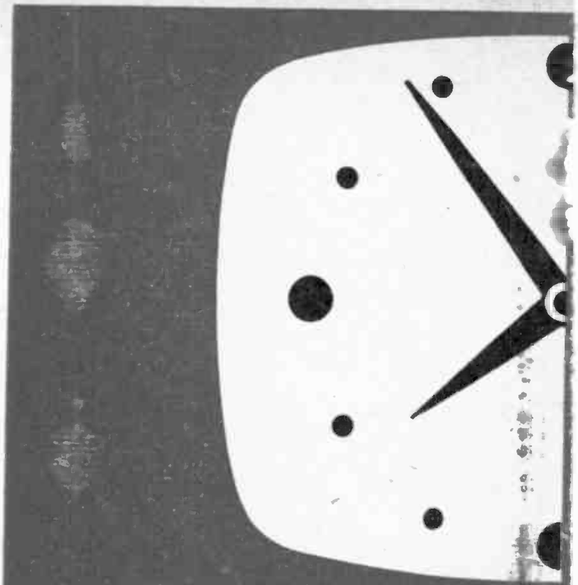
VIDICON FAULTS

Vidicons are made in large numbers and the reject rate is also high so that a very large number of vidicons can appear on the amateur market. Vidicons which have been rejected for low gun emission, open-circuit leads or complete lack of photoconductivity are usually destroyed by the manufacturers but anyone buying a vidicon from a source other than a reputable dealer should see it working first. The usual causes for rejecting working vidicons are spots and excessive lag, faults which appear in all vidicons to some extent.

Vidicon spots are usually portions of impurity on the photoconductor or blockage in the target mesh. For most purposes one small spot (0·001in.) on the outer portion of the target of a vidicon would not lead to its rejection but two or more would and for many purposes a spot on or near the centre of the tube face would cause a possible £60 studio vidicon to become a £5 "ham" one. For most amateur purposes spots are relatively harmless faults and such a vidicon is a good investment bearing in mind the fairly long life and rugged nature of the vidicon.

Lag is excessive storage in the photoconductive layer. This results in moving objects having luminous trails behind them and causes severe

—continued on page 510



TIME-DEL

BY M.

RECEIVERS that operate normally from switch-on then gradually or suddenly develop a fault after a period of use are commonly encountered in service work. The time delay before the fault develops can be anything from several minutes to a few hours, while the actual defect may be only quite minor or a complete cessation of results. Usually the commencement of the symptoms can be regularly timed from switch-on and are primarily caused by thermal effects.

These faults are not intermittent defects, for whereas these come and go spasmodically a true time-delay fault will only appear a certain time after switching on from cold and will remain until the set is switched off. In most instances the cause is a defective valve failing to operate normally when it reaches a certain temperature or a circuit fault causing the valve to be over-run so that its operation gradually deteriorates or even comes to an abrupt stop, e.g., failure to oscillate in a timebase circuit.

However, many instances of this thermal delay can be traced to one or more of the following: (a) components subject to high temperature from adjacent high-wattage resistors or output pentodes; (b) components or leads only slightly separated from other points so that when slight local heat expansion occurs a partial short-circuit can occur; and (c) short-circuits or more rarely open-circuits that develop in transformers, chokes or scan coils.

The most common time-delay fault is a gradual narrowing of the picture after some minutes of use till ultimately there is a black band on one or both sides of the raster. While a faulty line output pentode is the cause in probably 70 per cent of cases, the remainder will be due either to a reduced value screen feed resistor over-running this valve or a metal rectifier reducing its output as its working temperature increases.

Next on the list of common time-delay faults is the raster that becomes cramped at the base, possibly turning into a complete fold-over after some prolonged use. This is generally caused by a slightly soft field output pentode, although in a high proportion of cases the prime cause is a reduced value cathode resistor under biasing the valve and leading to its failure. Therefore when this valve needs replacement always check the cathode resistor.

Similarly sound distortion that becomes evident when the set gets really warmed up usually indicates a defective sound output pentode and/or reduced value cathode resistor.

But what of other less common time lag faults? Probably the quickest to develop, and one which can prove quite puzzling to diagnose, is cessation of line whistle within a minute or so of it developing after switch-on. The cause is rarely a valve, but instead a diode or diodes in the flywheel line sync discriminator circuit developing a high forward resistance and thus preventing the line oscillator from operating by failing to provide its correct bias.

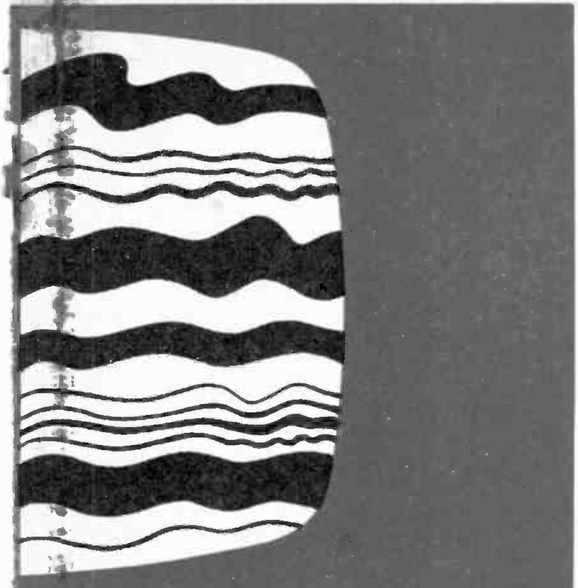
Another fault that usually develops fairly quickly is a partial short-circuit across the heater chain, either by a heater-cathode short-circuit in a valve or more rarely by failure of a heater circuit decoupling capacitor. In most instances this fault will cause the tube to black out, since generally being last in the heater chain a short-circuit from any higher point will deprive it of heater current. If the service manual is to hand the faulty valve will be easy to locate for it will be the last one in the heater circuit still glowing. On replacing this valve it is worthwhile checking whether any cathode resistor or bypass capacitor has been damaged by the shorting a.c.

In those receivers with a transistorised receiver section which receives power from the voltage developed across a resistor terminating the heater chain to chassis, the c.r.t. will be placed above this resistor so that a short-circuit across the transistor l.t. feed resistor—possibly due to a faulty smoothing electrolytic—would leave a blank raster.

When valves develop heater-cathode short-circuits after some minutes of use they are generally placed well down in the heater chain. Valves placed high up which develop this fault usually break down immediately the set is switched on.

Another fault which shows up soon after switching on, or to be more accurate after changing channels, which often amounts to the same thing, is a "sticky" fine tuner mechanism in which the spring-loaded plunger fails to follow the operating knob movement. This leads to difficulty in getting the optimum tuning position, often followed by a slow drift away after a few minutes resulting in sound-on-vision or vision-on-sound.

A somewhat similar but extremely long-term effect can sometimes be produced by rotary v.h.f. tuners with a preset fine tuning adjustment, as the writer encountered recently. The set was a modern Ekco receiver using the popular and reliable one-piece hinged chassis. A spring-loaded knob protrudes through the back; this, when depressed, engages with square-headed screws on the rotary



AY FAULTS

3.HULL

coil assembly, and by turning this knob each channel coil can be tuned-in. Once set these adjustments normally stay put for a long while and only need altering if the frequency changer valve is replaced. The owner's complaint was a strong sound buzz which turned out to be vision-on-sound. We readjusted the fine tuners by means of the spring-loaded plunger, restoring normal results. But within three days the owner complained that the fault had returned. Again the trouble was cured by fine tuner readjustment, but as there was a possibility that a capacitor in the local oscillator circuit might be changing value or grit might be preventing the correct seating of the channel settings we then made a careful inspection of the setting mechanism and found that a small adjustment screw associated with the plunger was slightly loose. On securing it with locking compound the fine tuner settings remained 'spot on' and no further trouble was experienced.

While on the subject of tuners it is worth remembering that instances of sets taking an unduly long time to commence working from cold can be due to a low-emission frequency changer valve which only starts oscillating when really hot. This is similar to instances of battery-powered receivers which only work when the supply voltage is close to maximum—again due to a low-emission frequency changer.

Another fault that becomes evident soon after switching on is change in the line or field timebase locking position. Usually the line hold control is most susceptible to this trouble, generally due to a change in value of an associated high-value, low-wattage, current-carrying resistor as its temperature rises. An intermittent variation in timebase frequency, on the other hand, is most likely to be due to a varying value or dry-jointed capacitor in the oscillator circuit.

Quite often we come across receivers that suddenly produce a minor symptom after some operating time, maybe a slight reduction in height, width, volume or picture contrast. Once valves have been eliminated probably the best move is to inspect all components in the suspect stages for signs of deterioration, especially if mounted close to high-wattage resistors. Be suspicious of all electrolytics whose outer covering is discoloured or looks dried up and change any capacitors whose wax coating seems soft and greasy. Resolder any suspect joints and slightly move wiring or components that seem to have only slight clearance from others. Especially in printed circuit receivers check carefully for solder blobs or wire strands that could cause minor short-circuits as the set warms up and some slight thermal expansion occurs.

As an example the writer can recall a Pye receiver that would work normally for about 15 minutes after which the picture would suddenly disappear to leave a blank raster with normal sound. This was clearly a video fault, and on inspecting the chassis we found that the 4·7kΩ video anode load resistor was only loosely held by its leads through the printed panel. Expecting this poorly connected component to be the cause of the fault, we resoldered it in circuit whereupon reception continued normally for about 20 minutes. However, picture modulation then again vanished, but this time we were able to see that the video load resistor was cooking. Further tests showed that the cause of the excessive current through the resistor and the lack of picture was a complete short-circuit across the video pentode's cathode resistor. Subsequent tests showed that both the capacitors shunting the valve's cathode resistor were perfect, the fault being due to a short somewhere in the cathode printed circuitry that developed when the set warmed up. After considerable work we eventually located a small blob of solder close to the video pentode valve-holder that shorted out the cathode bias resistor when the immediate area of the panel expanded slightly when warm.

To eliminate such possibilities carefully brush printed panels with a fairly stiff, clean brush, and if any components have been replaced look for solder blobs or splashes which may have dropped off the repairer's iron. In this connection, always be extremely careful when soldering replacement sections to a mains dropper, for the tags on these components are always difficult to solder to and very often one or two solder splashes fall on the chassis. I find it a wise precaution to place a small piece of rag under the dropper resistor before soldering.

As an example of how variable and surprising thermal effects can be, we recently came across an older Decca receiver which developed picture roll after about half an hour. In this model the triode sections of two separate ECL80s are used as the field generator and naturally our first move was to replace both. However, the fault still developed after a half-hour delay, and after a great deal of subsequent testing we found that a chassis mounted field linearity control had a hair-line crack in its carbon track which opened when the component got warm to open-circuit its con-

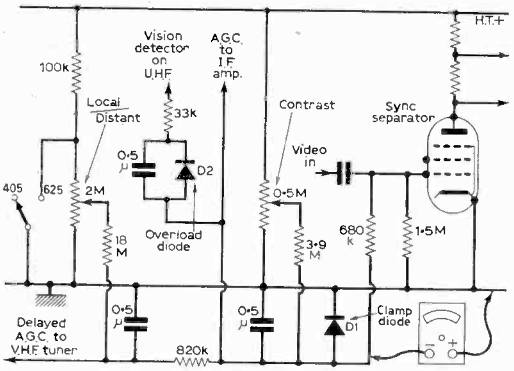


Fig. 1: Typical modern a.g.c. system (Thorn 900 Series). Simultaneous contrast and a.g.c. increase indicates a receiver section fault. Contrast increase with a.g.c. decrease is caused by a fault in the a.g.c. circuit.

nections and produce the field roll.

One of the great difficulties with so many minor faults is that their presence fails to significantly alter normal working valve voltages. If, however, the fault is an increase or decrease in gain, any voltage variations detected on the a.g.c. line will indicate whether such output changes are due to changes in receiver amplification or to a defect in the a.g.c. system. For example, an increase in sound or vision output will be accompanied by a slight increase in a.g.c. bias when the fault is actually in the receiver section. but will be accompanied and caused by a slight drop in a.g.c. bias when the a.g.c. circuitry is at fault (see Fig. 1).

Variation in receiver gain can be caused by spasmodic connection of a screen, anode or cathode decoupling capacitor, by a dry-jointed damping resistor or fixed tuning capacitor shunted across a coil or i.f. transformer. or by a dry joint almost anywhere in the receiver circuitry. Variation in a.g.c. voltage simulating varying gain symptoms can be caused by a defective smoothing capacitor or clamp diode. or by alteration in value of a resistor supplying either the actual negative control voltage or the positive backing-off voltage tapped from the contrast control. When in doubt it may be advisable to short out the a.g.c. rail. possibly using a set-top aerial to prevent overloading.

If variations of gain occur look for possible attendant symptoms which may help to pinpoint the actual trouble. For example a dry-jointed i.f. transformer damping resistor or fixed tuning capacitor could introduce visible impairment of resolution when out of circuit. while coincident variations in sound and vision signal strength would naturally limit investigation up to the common i.f. stage.

Whenever possible take voltage measurements in the faulty or suspect stage before the fault develops. and leave the meter in circuit at a vital point so long as it does not materially affect results.

As an example of the importance of making such voltage tests we must cite the case of a 405-only H.M.V. receiver which would work normally for about twenty minutes after which picture contrast would suddenly reduce to a just about perceptible level, insufficient to keep the timebases locked. although sound would continue unaltered. Obviously the fault lay in the EF80 vision i.f. stage or the PCL84 video stage. and our first move was to replace both of these valves.

The fault developed again after the usual delay, so in case heat from nearby valves was causing the video diode to break down. immediately the fault appeared we switched off and tested the resistance of the diode in both directions. The diode proved to be perfect, but as video stages generally tend to be more troublesome than i.f. amplifier stages we still concentrated on the former.

Being 405-only. a short-circuit across the cathode bias resistor could cause almost complete loss of signal as in the Pye receiver previously mentioned, so we connected our voltmeter on the 10V range across the cathode valveholder pin and chassis. When the receiver was working normally we obtained a reading of about 4V. which would increase as the contrast control was advanced thereby increasing the positive-going video drive to the valve grid. while on removing the aerial plug the measured potential dropped to almost zero. These simple tests are extremely useful and demonstrate how the positive-going v.h.f. detector output increases anode current as signal strength is increased.

After the usual twenty minutes or so however the picture practically vanished again while simultaneously the valve's cathode voltage increased to almost full-scale deflection on the 10V range and could not be altered by operating the contrast control. Obviously the valve's anode current had dramatically increased or the cathode resistor had increased in value: but in the latter case the contrast control would still have had some effect while we would have expected that picture highlights at least would have been able to overcome such a big increase in bias.

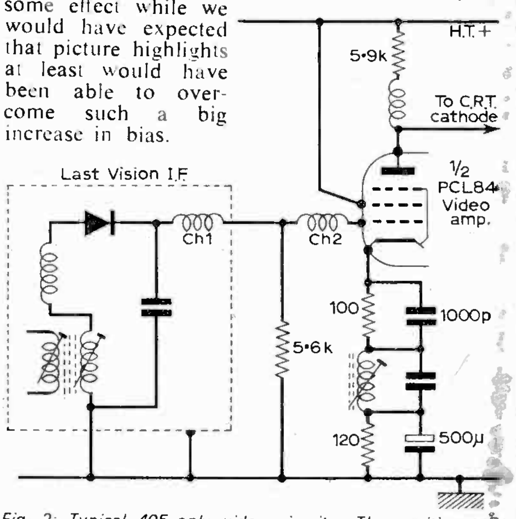


Fig. 2: Typical 405-only video circuit. The positive-going output from the diode detector produces an increased voltage at the video amplifier cathode as contrast is advanced. In one case of vision failing after 20 minutes coincident increase in this voltage indicated the probable cause.

The other possibility was that the big increase in valve current occurred because the grid was no longer tied to chassis thus leaving the valve unbiased. On switching off we made a resistance check from the valve grid to chassis and found it to be virtually open-circuit, the cause being a miniature video choke which went open-circuit when it warmed up sufficiently (see Fig. 2). We have often heard of these chokes going permanently open-circuit, although we have never come across an instance ourselves, but we were surprised to find one which would go open-circuit when warm and return to continuity again when cold. The cause was a badly soldered joint on the miniature former to which the fine wire was attached. A few minutes' work with a soldering iron restored good contact and the end to the trouble.

No outline of time-delay faults however brief would be complete without some reference to the effect of shorting turns and deteriorating insulation in line and field output transformers, blocking oscillators, width controls and scan coils, which can develop as the components get warm. It is a remarkable fact that while temperature increase in a conductor raises its resistance by only a small percentage per degree, an equivalent increase in the temperature of an insulator will reduce its value by many times this coefficient.

Although the line output transformers used in modern receivers are far more reliable than their predecessors, some failures do occur. With modern circuits shorted turns or bad insulation on the line transformer usually results in width contraction, a tendency to overheat, plus bad regulation resulting in the picture blooming when the brilliance is well advanced. In receivers where the line output pentode also functions as one half of the multivibrator circuit, shorting turns or leakage will also produce a shift in the line locking position.

When only a few turns are shorted, it is virtually impossible to detect this by measurement since the variation between different samples will exceed the probable reduction in resistance. The only real remedy, after eliminating all other possibilities, is to try a new replacement—but be sure to check all other possibilities first.

Owing to the lower operating voltages, partial shorts in field output transformers are far less common, but their presence is usually indicated by reduced height and bad linearity.

Shorting turns or poor insulation in a blocking oscillator transformer that progressively deteriorates can produce a shift in timebase locking position or, in extreme cases, can cause failure to oscillate.

Some older receivers employed width coils which commonly developed short-circuited turns or heavy leaks to the mounting frame, often resulting in very limited width or even total loss of scan. When found to run warm they should always be suspect, and for test purposes can simply be cut out of circuit.

Finally, shorting turns or leakage between the line and field scan coils is easily identifiable by causing raster distortion as well as reduced amplitude. ■

PART TWO

X-RAY RADIATION

MARTIN L. MICHAELIS M.A.

WHEN considering electromagnetic radiation wavelengths such as those used for radio and TV transmissions we are accustomed to visualising their behaviour in terms of *waves*. We define a wavelength λ and a frequency f for any such wave in terms of the familiar formula: wavelength(λ)$\times$frequency(f)=velocity of light (c). The waves consist of interlinked closed loops of electric and magnetic lines of force so that we can express intensities in the familiar units of electric fields, namely Volts/meter (V/m) or convenient sub-units.

This way of picturing electromagnetic radiation is only one side of the story. It assumes that the emission is a *steady, continuous* stream whose intensity can be reduced indefinitely without change in character. But this is not true. We saw last month that all electromagnetic radiation is produced by charged particles dropping through *definite* energy jumps of magnitude $E=h\times f$ where f is the frequency and h is Planck's Constant. This amount of energy E is known as the *quantum energy* for the particular frequency f. The radiation process is in fact a succession of individually instantaneous emissions of energy packets of this magnitude, known as *photons*. These photons may be considered as particles in their own right. Only when their quantity per unit time of observation is very large can we legitimately picture the emission process as continuous and express it in terms of clearly defined waves.

We have seen that the quantum energy becomes very small for appreciably large wavelengths, so that an enormous number of photons must be emitted for a given radiated transmitter power at say 50Mc/s. The wave picture is thus certainly valid here for normal purposes and consideration in terms of individual photons is usually unnecessary. Let us look at some typical figures in order to determine the circumstances in which it becomes necessary to consider individual photons. This is evidently demanded when the total powers concerned are so small that only a limited number of photons are involved per cycle of the frequency concerned. The wave picture then breaks down as a practical model, and we have to express intensities no longer in terms of Volts/meter but in *photons per second or minute*. Either form is equally valid for the copious photon streams of ordinary practical wireless and TV transmissions.

Consider first of all a TV transmitter operating at 50Mc/s and beaming an e.r.p. (effective radiated power) of 25kW. The quantum energy for this frequency comes out at $3{\cdot}31\times10^{-27}$ watts, so that the total power is radiated as individual photons each carrying this tiny energy contribution. The aerial array must therefore be radiating $7{\cdot}6\times10^{30}$ photons per second into the beam, corresponding to 25kW e.r.p. Now consider a receiving aerial array of 1m.^{2} impact area presented to the beam and located at a distance of 25km. from the TV transmitter. This aerial array subtends a solid angle of 16×10^{-10} sterad at the transmitter, which we will asume to be beaming into a forward lobe of π sterad (about 4:1 forward gain of the transmitting array). The receiving aerial will thus be picking up 4×10^{21} of the photons emitted each second by the transmitting aerial 25km. away, and this enormous rate of photon pick-up is more than adequate for expression in terms of continuous waves. So far so good. But what happens when we desire to use the same TV transmitter to communicate with a receiver on a spaceship at the other end of a diameter of the earth's orbit round the sun—a quite practical and topical desire in modern technology?

We may take the diameter of the earth's orbit as 25×10^7km., i.e. a factor 10^7 larger than our previous receiver range of 25km. According to the familiar inverse square law, the intensity picked up by the receiving aerial will be 10^{14} times smaller than previously, i.e. we are now receiving only 4×10^7 photons per second with the aerial array on the spaceship. The frequency we are considering is 50Mc/s, so that we are now receiving only about one photon per cycle. This is quite inadequate for defining a wave for each cycle, let alone any rapid modulation of that wave. We need a quite different form of receiver to process a signal under these conditions in order to extract any communications content from it. This receiver must determine carrier intensity (amplitude) modulations *by counting photons*. This is governed by statistical laws.

Counting Photons

In common with any other type of particle emission the intervals between the emission of successive photons are statistically random but possess a definite long-term average value corresponding to the intensity of the complete radiation process. The basic statistical law here states that if the long-term average interval would imply N photons being emitted in a certain time of observation, then the *actual* number of photons obtained in that time will fall within the range $N \pm \sqrt{N}$ for half of all repeated observations for the same time. For the other half of all such repeated observations, the actual number of photons will be greater or smaller than the limits of this tolerance range. Thus the *most probable statistical fluctuation* in N expected photons will be $\sqrt{N}$ photons extra or less.

Modulation

If we wish to express the amplitude of a carrier wave to $\pm 5\%$ accuracy for purposes of interpreting its amplitude modulation we must have at least 400 photons during one cycle because the square root of 400 is 20, which is just 5% of 400. For any smaller number of photons per cycle the most probable statistical fluctuation would exceed 5% and thus mask the modulation since an intensity change of 5% can then no longer be interpreted unambiguously as significant modulation because it is equally likely to take place by chance without any relation to the transmitter communication signal. If we wish to determine the carrier amplitude to $\pm 1\%$, we require ten thousand photons per cycle.

For the transmission of television pictures over large distances in space, e.g. from the recent Venus probe back to earth, we may take $\pm 5\%$ amplitude resolution as satisfactory for reasonable definition. This allows 20 shades of grey. For this resolution we require 400 photons per cycle, as we have just seen. One cycle of the highest interpretable modulation frequency must thus contain at least 400 photons. We have seen that our 50Mc/s, 25kW TV transmitter on earth will produce about one photon per carrier frequency cycle at Venus, or vice versa. Thus the maximum interpretable modulation frequency with this system is 1/400 of the 50Mc/s carrier frequency, i.e. 125kc/s. All higher modulation frequencies would be completely drowned in statistical photon noise at the receiving end.

Noise

Any other source of noise in the transmitter, receiver, or due to other sources radiating on the same frequency may be expressed as an additional rate of arrival of indistinguishable background photons at the receiver. To take a typical numerical figure for our Venus-Earth TV picture transmission, the receiver may be picking-up background photons at five times the rate of arrival from the wanted transmitter. A 5% intensity change of the wanted transmission is then only a 1% intensity change of the total photon stream picked up by the receiver. For significant interpretation of such a 1% change we require ten thousand photons (square root of ten thousand is 1% of ten thousand). The maximum useable modulation frequency for our 50Mc/s, 25kW transmitter communicating between Venus and Earth is now only one ten thousandth of the carrier frequency, i.e. 5kc/s. A single field of a 625-line TV picture with 5 million picture elements would thus take about 10 minutes to transmit over this system, as it did in the actual transmissions recently made from Venus.

Higher modulation frequencies and thus faster transmission are possible only by increasing the rate of arrival of photons at the receiver, either by increasing the power or by reducing the frequency of the carrier wave in as far as absorption and other propagation considerations permit this. As a further measure the beam angle may be reduced, which amounts to power increase; or steps can be taken to reduce the background photons from unwanted sources (masers cooled to liquid helium temperature as the receiver, for example, to reduce thermal noise).

We may extend our calculations by considering the performance of our 50Mc/s, 25kW 4:1 forward-beamed TV transmitter when attempting to use it for communication from Earth to the nearest star situated about 4×10^{13}km. distant. The same 1m.^2 receiving aerial on that star will then pick up about 1 photon in every 10 minutes from our transmitter. This will be quite undetectable by any feasible means because the background rate of arrival of similar photons from all other sources will be millions of times greater, calling for transmission times of years for only a single picture element. Calculations show that if we boost the e.r.p. to 60MW and restrict ourselves to 60 Baud telegraphy with 50% distortion tolerance we would just succeed in communicating with the nearest star in this manner, *still neglecting any background.*

Lasers have the advantage of much more compact forward beaming, providing an illuminated circle of only some 150 meters diameter on the moon. The higher quantum energy of the shorter wavelengths of laser light offsets this beaming advantage to some extent since we get fewer photons per cycle for a given power, but calculations show that a 2kW laser could send about 100 photons per second into a substantial aerial system (optical telescope) on the nearest star of one of its planets, which would suffice for a 60 Baud telegraphy signal with only 10% distortion. Television picture transmission would still not be feasible.

X-ray Photons

The individual photon treatment of ordinary television transmission frequencies becomes necessary only over interplanetary ranges because the quantum energies involved at these low frequencies are so small that customary transmitter powers always lead to vast photon arrival rates at the receiver over terrestrial ranges. Conditions are rather different for electromagnetic radiation at X-ray frequencies. First of all the quantum energy is here 125×10^9 greater (25keV X-rays from a colour TV receiver shunt triode) than for a 50Mc/s transmission. Secondly our aerials are now single atoms with dimensions much smaller than the 1m.^2 receiving array considered for the 50Mc/s transmission. Thirdly the absorption by even small interposed amounts of matter (glass bulb of the valve emitting the X-rays, entrance window of X-ray detector, etc.) is comparable to or greater than the absorptive power of interplanetary propagation paths for 50Mc/s signals. All these factors operating together drastically reduce the number of photons picked up per minute by an X-ray detector so that the conditions existing over interplanetary ranges for 50Mc/s prevail over ranges of a few centimeters or meters for the 25keV X-rays ($6{\cdot}25 \times 10^{12}$Mc/s) from the shunt stabiliser triode of a colour TV receiver. Our detection and measuring system for these X-rays is thus always concerned with counting individual photons, not with the measurement of electric field strengths.

Ionising Power

If this is so and we are concerned with very restricted numbers of photons in X-ray measurements, we may well ask why this radiation is so dangerous to health. If we can tolerate countless trillions of 50Mc/s photons passing through our bodies when we happen to take a walk in the vicinity of a TV broadcasting station, why do these very few X-ray photons upset our health?

The answer to this question lies in the relative magnitudes of the quantum energies of the respective frequencies. If this is less than the excitation energy of the outermost electrons of typical atoms, i.e. if the frequencies are smaller than those of visible light, individual atoms are unable to absorb energy at these frequencies or to respond in any way. There is no question of numerous small-energy photons "piling up" for a concerted attack on an outer electron of a single atom. Photons are absorbed entirely and individually, or not at all, just as they are emitted individually. Some atoms and especially combinations of atoms in complex molecules do have rotation and vibration resonances in the microwave range. The larger a molecule, the lower its effective resonance frequency. In this sense any electrical conductor may be treated as a single molecule of macroscopic dimensions, since the electrons are free to move throughout its bulk, thus belonging to the conductor as a whole and not to any particular atom in it. Thus only these conductors have very low resonance frequencies in accordance with their physical dimensions and can radiate or absorb normal radio frequencies efficiently.

Returning to single atoms, we must have quantum energies at least as great as those of visible light if single photons are to be capable of disturbing the outermost electrons and thus modifying the linkages of these atoms to their immediate neighbours in molecules. The longest wavelengths of electromagnetic radiation which can produce this effect, known as *ionisation*, on a large scale are those just shorter than visible light, i.e. ultra-violet light. However, the absorption is here so efficient that the ultra-violet radiation can penetrate little deeper than the upper layers of skin. The effect of over-exposure to ultra-violet radiation is thus primarily skin burn, which affects health by secondary effects due to disturbance of the biological functions of the skin.

If we expose the body to progressively shorter wavelengths of electromagnetic radiation, now known as X-rays, the penetration depth increases with the rising quantum energy and the effects produced in atoms and molecules by the absorption of these high-energy photons become increasingly devastating. Photons with quantum energies above about 10keV, i.e. X-rays from any atoms heavier than Copper (see Table 1 last month) can penetrate living tissues sufficiently for ionisation of chromosome molecules in the cell nuclei on an extensive scale. These chromosomes carry all information for genetic and metabolic processes, and a single cell is ultimately the parent of large numbers of offspring. Thus in principle a *single* X-ray photon which modifies a chromosome molecule in a single cell could suffice to produce severe damage. Malignant growths can be induced on account of the disturbance of the metabolic information, or any other form of pathological metabolic disturbance. The range of possible secondary illnesses is thus practically unlimited. The chances of such destructive encounters between X-ray photons and important molecules in living cells are governed by statistical laws. The organism as a whole possesses powers of regeneration, because the same information is stored in many cells, so that destruction of a certain proportion of cells can still be tolerated. Nevertheless the tolerable number of X-ray photons which a healthy body can cope with is restricted. X-ray photons in the same numbers as the 50Mc/s photons emitted at close range by a 25kW, 50Mc/s TV transmitter would be *instantly lethal*.

TO BE CONTINUED

VIDICONS

—*continued from page 503*

streaking when the camera is panned. Lag never gets better and usually gets worse: it is due to a fundamental fault in the photoconductor and a laggy tube is best avoided. Unfortunately it is seldom possible to find out why a tube has been rejected in the first place and the chances of getting a lag-reject are therefore fairly even. Generally speaking a laggy tube (and remember that *all* vidicons suffer from lag at low light levels) performs best with the lowest target voltage usable and the highest possible illumination. Where no rapid movement takes place in a scene such a tube may prove quite acceptable, but its life may be less than that of a tube rejected for spots.

ODD VIDICONS

Occasionally vidicons which have been made for special purposes appear on the market. Half-inch vidicons are usually useable if suitable scan and focus coils can be made up but are not readily replaced since no firm in the UK is producing them. Some 1½in. and 2in. vidicons have been made and should be avoided; there are no replacements or camera parts to match.

Plumbicons (see article in Practical TV, September 1967) may be available in small quantities soon. They are 1⅛in. in diameter, 8in. long and have a photosensitive layer which is more opaque and more yellow in colour than that of the standard vidicon. At the moment they are worth their weight in gold on the amateur market!

Finally, do not worry if no two vidicons have the same colour of target but vary from dark brown to clear light blue. This is a normal variation on target thickness between batches and does not appear to cause any defects. ■

Servicing TELEVISION Receivers

No. 148 - THORN 900 CHASSIS

by L. Lawry-Johns

RECEIVERS using this chassis include the Ferguson Models 3623-3627 plus some variations, the HMV 2620-2624, Marconiphone 4611 and 4612 and Ultra Models 6625-6629. Some models have radio facilities which necessitate additional switching and circuitry and one of three basic types of v.h.f. tuner may be encountered, one of which is a push-button type (TV only).

The main feature of this design is its one-piece "cool" chassis. There are no mains dropping resistors, the valve heaters being fed from the 150V tapping on a small autotransformer on the left-hand side as viewed from the rear. Also featured is a heat-operated cut-out, referred to as a fusible resistor. This is basically a 14Ω wire-wound resistor in series with the h.t. line. When excessive current is passed by this resistor the solder joining two wires melts allowing them to spring apart. This opens the h.t. line and stops the receiver working from the h.t. point of view until the fault is found and the wires again joined with a soldering iron (not by wrapping fuse wire round them). A 1·5A fuse is also fitted in the mains supply from the on/off switch to the auto-transformer.

Some models use a flywheel sync unit which is a small assembly on the right side using an EF80 valve and a couple of diodes in one envelope (W401 and W402, type FSY11A), with the preset line hold control R413 prominently mounted.

SERVICING

It is rarely necessary to remove the chassis completely for normal servicing. There is a chassis fixing nut on either side at the bottom. The top is pivoted in slots which allows the chassis to be raised and swung out. In addition the cabinet can be turned on its side allowing complete access to the printed panel except for the tracks which run under the frame. This is a useful facility as it means that the flexible cable(s) which operate the system switch can be left undisturbed. It is of course necessary to lift the chassis up out of the top slots completely and disconnect the bonding strips when the tube has to be replaced: an operation which has been found necessary quite early in the life of a number of these sets. In most models it is possible to remove the cover of the v.h.f. tuner unit without removing the tuner. This enables the turret contacts to be cleaned with the minimum of trouble. Some models use twin-panel tubes, some use implosion-proof tubes whilst others have a moulded Diakon implosion guard. These generally do not require attention but there are some which employ a window at the front and where this is found a bottom member can be removed to facilitate cleaning when necessary. Those using a moulded Diakon implosion guard and those with the stretched p.v.c. skin guard may be cleaned with a soft damp cloth and perhaps a little soap only. On no account use any abrasive cleaner. Many variations of tube fixing will be found but examination will show what comes out with the tube and what stays in.

Some common troubles: Heater line faults

One fairly common fault in the heater line which can be nasty if it continues over any period of time is excessive heater current resulting in all the valves and the tube heater being overrun. If the valve heaters appear to glow brighter than normal either put a meter in series with the heater chain which should show 300mA or a little under,

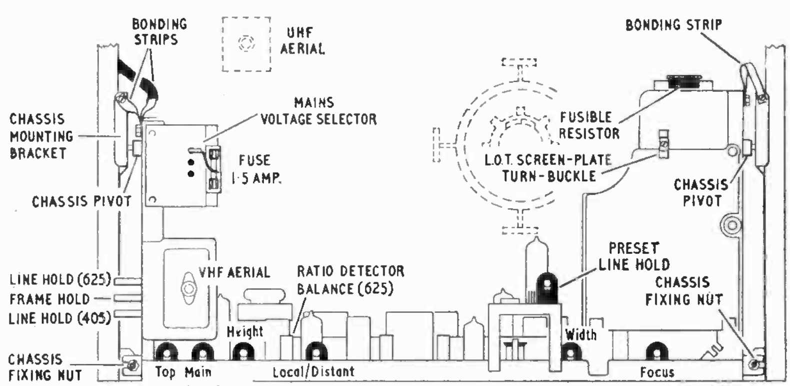


Fig. 1: Preset adjustments. Flywheel unit with preset line hold on fringe models only.

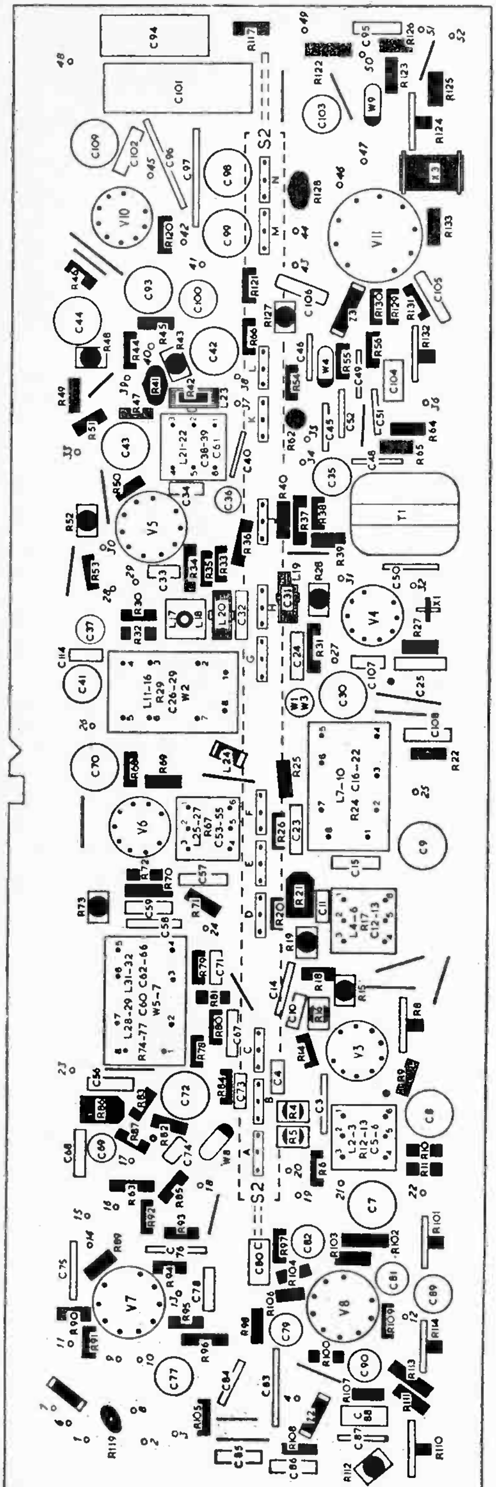


Fig. 2: Printed board layout.

or check the voltage at autotransformer T5 150V tap (or tag 7 on the panel). The voltage should not exceed 150V at normal running. If the voltage is higher with the mains tapping set correctly change the transformer. This develops shorted turns and causes overrunning. This fault can cause premature valve and tube failure.

Another nasty one is when the heater track which runs from the PCL85 (V8) to the thermistor X3 along the rear edge of the panel shorts to frame. This immediately blows the PCL85 as well as the fuse (or instead of it) and at first leaves the repairer a little mystified. One is accustomed to finding the thermistor the first item in the heater chain or at least the efficiency diode (PY801) but in this circuit the supply from the transformer is to the PCL85 heater and then along to the thermistor. If the track cannot be cleared easily, part it at the two ends and connect a lead from the PCL85 to the thermistor.

Loss of vision signals

Another common one, not so awkward, is that R28 (5kΩ) changes value. This is the h.t. supply resistor to the vision i.f. amplifier V4 PCF808 (pentode section). When it goes high it causes loss of vision signals or leaves them extremely weak. If a replacement overheats change V4 which sometimes develops an internal short.

Intermittent loss of sound

If the picture is normal but the sound is intermittent particularly with movement of the board or i.f. transformers but the circuit is functioning from the detector onward, suspect V6 EF184 and check it. Quite often however we have found the fault in one of the sound i.f. transformers. If close inspection fails to reveal a dry joint which can be remade, a new transformer is necessary.

Improper switching

Incorrect operation of the flexible cable which operates the system switch can cause several, some strange, effects. These effects vary according to which contacts make or fail to break. Failure to switch to 625 with the 405 picture enormously enlarged is one effect. The remedy is to more efficiently clamp the cable so that the outer sheath does not move. Modified clamps can be obtained from the makers or a metal skin can be inserted to tighten the grip.

Autotransformer

The vibration caused by T5 working loose can be very annoying. If tightening the clamp screw does not help matters some packing may be introduced and the transformer tightened down on it.

The line output stage

Two types of line output transformer may be found fitted, the conventional type with an EY86 e.h.t. rectifier or a "jelly-pot" type with an e.h.t. rectifier consisting of a tray containing three pencil-type selenium rectifiers. The latter (tray) can be detached from the main unit quickly for replacement and the obnoxious smell given off by a faulty selenium rectifier is usually a sure pointer to the source of the cause of a no picture condition.

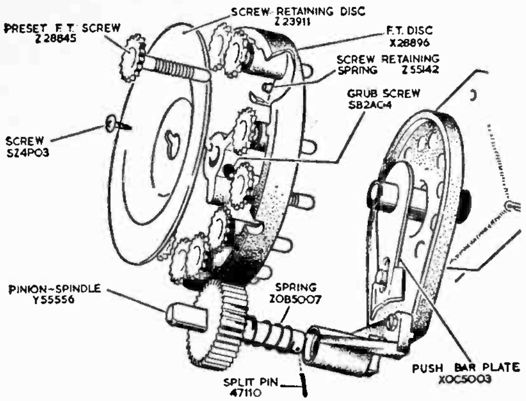


Fig. 3: Preset fine tuning mechanism.

The PL500 is a frequent source of trouble causing the conditions of no picture, lack of width and varying picture size. It also has the irritating habit of developing an intermittent short which damages R128 (2·2kΩ) its screen feed resistor.

The PY801 should not escape attention when the line output stage is found inoperative. We use as many PY801 and PY800 valves as we do PL500 (PL504) and PL36, the latter not being used in these sets of course.

An inoperative line output stage will often be restored to partial working by removing the PY801 top cap. This of course should stop the circuit functioning completely but if C101 (0·22μF) is shorted an h.t. path is provided and some sort of working will result when the PY801 is rendered inoperative by removing its top cap.

The line output stage can of course be rendered inoperative by several faults, including a defective line output transformer and lack of line drive from V4B line oscillator. The maker's remarks upon the line output transformer are as follows: Access to the line output transformer assembly is facilitated by removal of the screening plate which is secured by a turn-buckle. The transformer assembly is secured by two nuts or screws which are accessible without removing the chassis. In some receivers a jelly-pot transformer and selenium-type e.h.t. rectifiers are fitted. Extreme care should be exercised when removing or resoldering the connecting leads to the transformer tags. Use a small, low-consumption iron, and do not bear down on the tags heavily or apply the bit for longer than is necessary to produce sound joints. The e.h.t. rectifier assembly is a plug-in unit. If one of the clip-in rectifiers becomes faulty all three should be replaced; before removal carefully note polarity. Important: shorting the e.h.t. supply or drawing arcs with a screwdriver (earthed) during servicing will damage the selenium rectifiers.

Line hold

Standard version: If difficulty is experienced locking the picture horizontally check the PCF808 (V4) and the line hold control itself (405 R58 250kΩ; 625 R60 100kΩ). If the controls are at one end of their travel check R62 620kΩ.

Flywheel sync version: R62 is not fitted. The

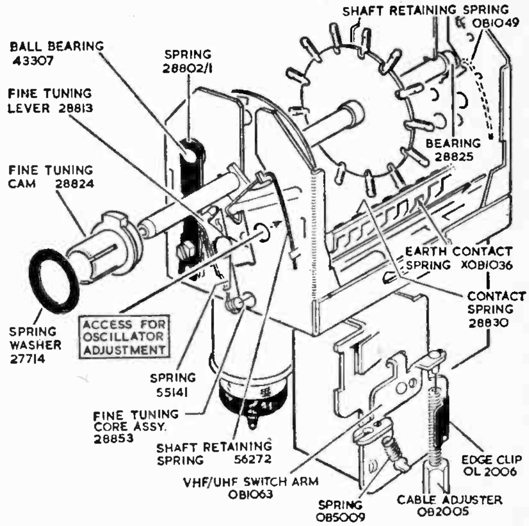


Fig. 4: Rotary tuner with fine manual tuning.

control bias is determined by the operating conditions of V401 (EF80). Thus R413 becomes a preset line hold. In the event of poor or absent line sync check the EF80, W401/W402 (FSY11A) and the capacitor C407 (0·5μF) which often becomes leaky.

The field time base

The heart of the field timebase is the PCL85. Most of the troubles which beset the timebase can be cleared by replacement of the valve (V8). The symptoms may vary from complete loss of scan, resulting in a solitary white line across the centre of the screen, to loss of hold or irregular scanning.

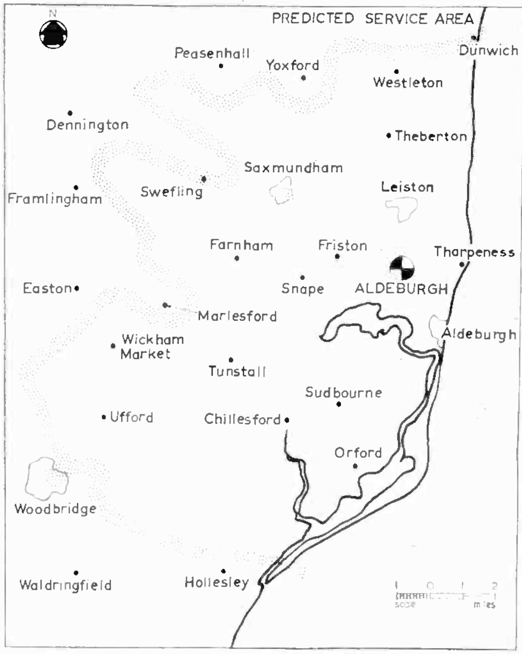
Faced with a single white line condition the average engineer would carry out the following routine. Replace the PCL85. If the condition is unaltered, take the voltage readings at pins 1, 6, 7 and 8. The next action would depend upon these readings. The pin 1 voltage should be about 75V. If absent check at height control. If this is about 230V check C100 for shorts. If however the voltage is well up at the boost line end of the control and low at the pin 1 end of R102, suspect the PCL85 of non-oscillation. Check C79-C80-C81-C82-C83, and compare other voltages. For example pin 6 should be about 190V. If very low check T3 primary (300Ω) assuming the pin 7 voltage is correct at about 200V. If again this is absent check R119 which may be open-circuit and C91 for shorts. The pin 8 voltage is also very important. Its proper reading is 17V. If it is much over this check C82 which could be leaky (this would explain also the low voltage at pin 1) and also check the bias resistor R112 (360Ω).

Reduced scan

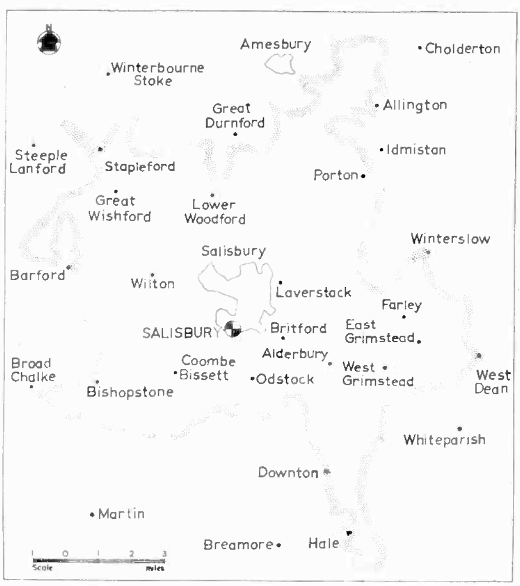
If the bottom is compressed check C89, the PCL85, C88 and R114. If the loss is even top and bottom check the PCL85 and C82 for slight leakage.

TO BE CONTINUED

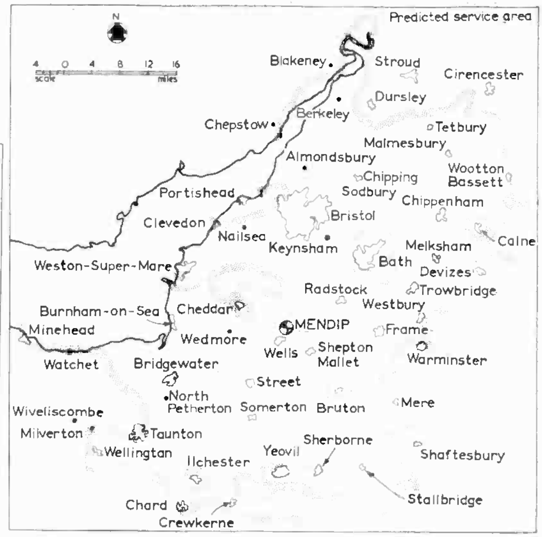
LATEST B B C-2 TRANSMITTERS



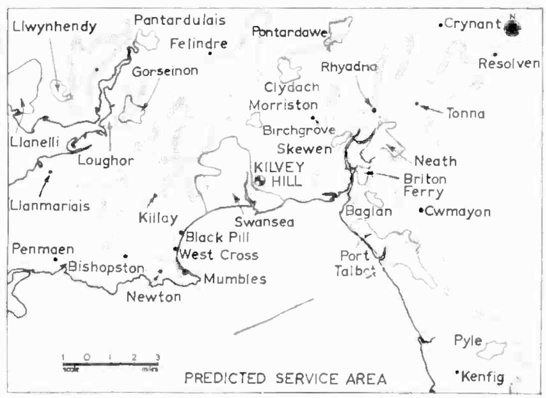
ALDEBURGH. Channel 26 vertically polarised. Maximum vision e.r.p. 2·5kW (directional aerial).



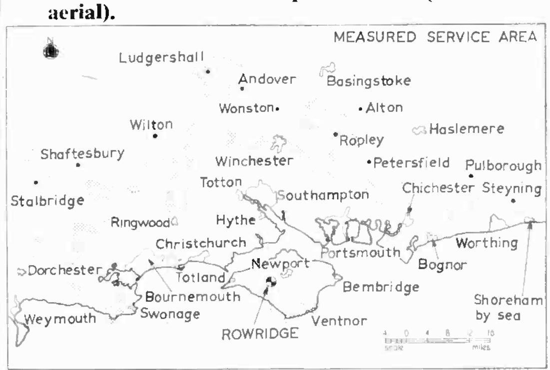
SALISBURY. Channel 63 vertically polarised. Vision 807·25Mc/s and sound 813·25Mc/s. Maximum vision e.r.p. 2·5kW.



MENDIP. Channel 64 horizontally polarised. Vision 815·25Mc/s and sound 821·25Mc/s. Maximum vision e.r.p. 500kW.



KILVEY HILL. Channel 26 vertically polarised. Vision 511·25Mc/s and sound 517·25Mc/s. Maximum vision e.r.p. 2·5kW (directional aerial).



ROWRIDGE. Channel 24 horizontally polarised. Vision 495·25Mc/s and sound 501·25Mc/s. Maximum vision e.r.p. 500kW (directional aerial).

INSIDE tv TODAY

PART 10 M. D. BENEDICT

WHICHEVER of the programme sources described in the previous articles is to be used for transmission of a particular programme, they are all transmitted at their correct time through a control room. Although producing the same result with the viewers at home networking, as this is called, differs tremendously between the BBC and ITV. Whereas the BBC mainly work as a single unit putting out one programme at a time covering the whole country, ITV consists of programme contractors in various towns all over the country each putting out a different programme at the same time. Naturally some programmes are transmitted by several or all of the companies at the same time, but most films, as well as all of the advertisements, come from the local programme contractor.

With the BBC's technique of networking almost all programmes for BBC-1 and BBC-2 are put out from Network Control Rooms 1 and 2 at the Television Centre in London. In principle the techniques adopted by both BBC-1 and BBC-2 are similar and BBC-1's networking facilities are similar to those of BBC-2 except for colour working on BBC-2.

All studios, all lines from video tape and telecine areas, many lines from the nearby studios, Lime Grove, and the Television Theatre at Shepherd's Bush, London, and lines from the centre of London which are connected to the distribution and contribution network are all fed into a large room called the Central Apparatus Room (c.a.r.) where all these lines are switched from various sources and destinations. This includes all incoming lines to the studios, recording areas, and in particular the lines to the Presentation Area. Monitoring facilities allow the sound and vision levels to be checked whilst various telephone communication systems allow c.a.r. staff to contact almost any source.

Conversion between standards

Near to c.a.r. are the various standards converters; optical converters using television cameras on one standard and viewing a display monitor on another, as well as the new all-electronic converters which break up the picture into its basic components and reassemble it on another line standard.

As a result of pioneering work by the BBC engineers electronic converters now exist to work between all line standards and the various field standards. Effecting a conversion between signals on 405 and 625 lines is comparatively simple and is achieved by laying down the information of a line of video signal in a special store called a line store. This consists of the equivalent of a rotating switch feeding a large number of capacitors. The "switch" rotates as the video signal is fed in so that each capacitor is charged up to a voltage corresponding to the voltage of an element of the original picture. When the switch rotates again the charges are read out so that a similar signal is reproduced. However the rate at which the switch operates may be different from the original feed in rates. Thus the signal is laid down at one rate, that of the incoming line standard, and read out at the rate of the outgoing line standard, a change between 405 and 625 lines in this way being achieved. Over 550 "capacitors" are used and the switching is all electronic. A 625- to 405-line conversion is equally simple, and in fact all BBC-1 programmes now originate on 625 lines and are converted to 405 lines for transmission. The 625- and 405-line standards both use a 50c/s field rate and, in fact, the outgoing field syncs start at the same time as the incoming so that the signals are locked together at field rate. When it comes to converting between standards using the 50c/s field frequency and the American 60/s field frequency, however, a much more complex approach is needed. A delay line system is used whereby the main video signal is delayed by various amounts. An electronic switch works at 10c/s rate and switches the output point of the delay line to select the required delay so that a 50c/s picture can be built up by combining the correctly delayed 525-line, 60c/s fields. 525 to 625 conversion then follows to achieve a complete conversion. Unfortunately this system leaves a border around the edge of the 625-line picture that is unavoidable using the techniques described. Hence a more complex technique is being devised for future use to avoid this trouble.

Before the recent introduction of this technique an optical converter was required to translate between 60c/s and 50c/s pictures. These were high-quality display monitors operating on one line standard, viewed by a camera on the required line standard. As the field rates differed a strong 10c/s flicker appeared on the output of such converters. Two techniques to avoid this were developed. The first generated a narrow peak white pulse which was added to the video signal and appeared next to the display on the monitor. The camera viewed this pulse along with the display and the level of the signal from this pulse was held constant thus reducing the flicker. After mixed blanking pulses were added to the signal in the camera the reference pulse was blanked out and did not appear on the output. Naturally, this was done after the pulse was sampled. An alternative technique involved generating a specially shaped 10c/s compensating waveform and applying it to a variable-gain amplifier. Optical conversion could at its best be very good but involved long and highly skilled alignment to achieve such results.

Network Control Rooms

As well as the converters, c.a.r. staff look after several caption scanners used for viewing the various test cards and apology captions, or any other source which is always required, both for transmission and internal use. The basic function of the c.a.r. however is to act as the nerve centre for the network and internal distribution of sound and vision lines within a studio centre.

Each programme, BBC-1 and BBC-2, has its own presentation studio and Network Control Room (n.c.r.), as well as announcement booths complete with simple vision and sound mixing facilities and caption cameras. N.C.R. simply switches from one programme source to the next with only a simple caption in between. Simple links would be done using the announcer's booth, the announcer doing his own vision mixing, but for complex links the presentation studio would be used. This studio is used for short programmes such as *Points of View* and *Late Night Line Up* as well as for the weather and programme trailers.

Smaller and simpler versions of the c.a.r. area exist in each regional studio centre within the BBC and similarly each independent television studio centre has an area operating in a similar manner. A Presentation and Network (or Master) Control Room perform different functions within ITV as the Presentation Control Room deals with the complete programme sent to the local ITA transmitter and, in particular, is concerned with cueing of adverts and programme links. Master control deals with the networking of programmes to the rest of the ITV distribution network.

BBC Techniques

Naturally by nature of the different operational techniques BBC and ITV procedure prior to transmission is not the same. BBC technique usually follows these lines. If a film is to be transmitted, the film is supplied to the telecine area where it is loaded into the telecine channel to be used for transmission and then run through by the same operator who will run it on the air to check for quality and rehearse any changes in gain or lift that are required. This is done some time, maybe days, before transmission, but about 30 minutes before transmission the various technical arrangements start. This period, called line-up, starts with a good check of the telecine channel alignment. Meanwhile the channel is connected to an outgoing line via the duplexer to allow changeovers in long feature films. C.A.R. checks the signal from the channel via the line from the telecine area. Sound and vision levels are measured and corrected to a standard, and the correct channel identified by breaking these signals momentarily when asked to do so by c.a.r. staff. Telephone and intercom systems allow this to be achieved easily. When satisfied, c.a.r. offer the signal to the network control room, which then selects that source on to one of the four inputs to the vision mixer and sound mixer which, in this particular case, are combined as the corresponding sound and vision faders are adjacent. Telephone lines are extended through c.a.r. to network control so that another identification check can be made by the telecine operator, and talkback is positively identified to make sure that the operator is listening to the correct control room. Finally the start of the programme is run to check that the film is, in fact, the correct episode of the correct programme as is printed in the Radio Times.

After this check the machine runs back to the start and awaits the cue from the network director. Video tape is similarly treated except that since no picture is generated when the machine is not running it is often practice to use a small industrial vidicon camera channel which views a caption with the details of the machine and programme. Alternatively a complex electronically generated test signal may be fed out from the machine.

Programme Cueing

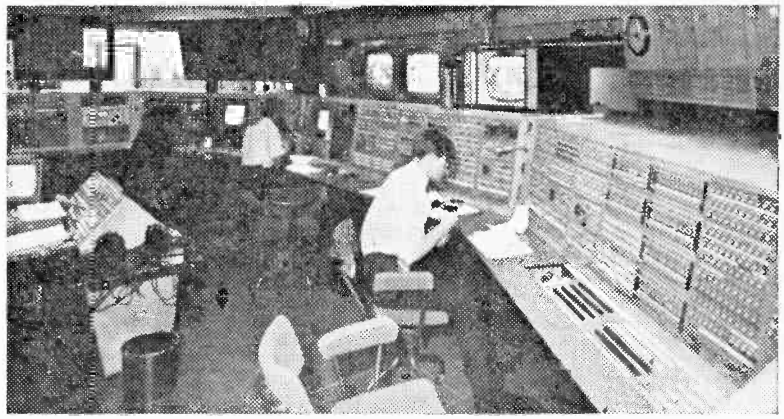
Live studio programmes are similarly connected to network control and checked, but it is usual to use cue dots for starting the programme on time. Cue dots are an electronically-generated hole "cut" in the top left-hand corner of the picture, the part usually hidden by the tube mask of domestic receivers; the hole is filled by a black-and-white stripe. About 30 seconds before the programme is required to start the network director switches the cue dot into the outgoing picture so that the studio about to go on the air views it and stands by ready to start. At exactly ten seconds before the start the network director removes the cue dot and the studio director starts his countdown process. If the programme starts with video-tape recorded sequences, he runs the v.t.r. when the cue dot disappears; if film, it is run at eight seconds before the programme starts, and so on. As a check the cue dot reappears at five seconds, and at zero seconds it is taken away, the studio will be selected on the network sound and vision mixer and the programme will start. This complex practice allows any studio (or o.b.) anywhere in the country to know exactly when to start their programme without telephone lines being required.

Synchronising Different Sources

O.B.s and studios remote from the studio centre and its pulse generators (there are ten remote studios in London alone) are not in sync with the television centre studio pulses. Non-sync sources, as these are called, cannot be mixed, superimposed or wiped unless a special technique, called Genlock, is used. Genlock is one mode of operation of the pulse generators which are also to be found in the c.a.r. As mentioned in the article on Cameras (October 1967) four sets of pulses are required for every television camera and every telecine channel. These are generated by a pulse generator and a distribution system ensures that the studio with its cameras and any telecine channel or video-tape machine are fed by the same pulse generator set. Each set in fact contains two complete pulse generators to allow for an urgent changeover should a fault occur in one of these.

Normally pulse generators may be operated in four ways. For BBC-1 and ITV it is customary

Right: General view of the main control desk in the central apparatus room at the BBC Television Centre. BBC photo.



for the master oscillator in the pulse generator to be controlled so that the field syncs remain in phase with the mains. In some domestic receivers poor smoothing leads to hum bars on the picture; locking the field rate to the mains makes this less noticeable. When both the studio centre and outside sources are in mains lock, one, usually the remote source, can be steered into a close synchronisation called field phasing. The remote source's pulse generator is brought manually into near sync with the studio centre pulse generator by telephone control during line up. Field phasing helps to reduce field rolling when the field scan circuits in monitors and receivers momentarily lose lock on a cut between sources differing considerably in phase.

For increased stability the pulse generator master oscillator may be crystal controlled. However, no exact field phasing is then possible as the two sets of pulses would soon drift apart. For reasons of colour working, BBC-2 has always operated in the crystal mode, as has BBC-1 and ITV during recording and when the mains frequency is low. BBC practice is to operate the pulse generators with an external source corresponding to the master oscillator frequency. This is now of very high stability and phasing of a remote source is practical as the rate of drifting out of phase is very low.

To make a remote source truly synchronous Genlock may be used. With this technique the pulse generator is controlled to bring its sync pulses into step with the incoming signal. When this is achieved it remains in sync. Simple Genlock suffers from the disadvantage that it takes place very quickly, causing some disturbances to video-tape recorders and film recorders which may be recording (or replaying) when the Genlock occurs. It is also susceptible to loss of incoming signal, causing a disturbance whether that source is on the air or not. In a large studio centre it has been found necessary to isolate the various pulse generator chains so that a Genlock on one chain does not affect studios or the on-air signal, or recordings, as they would be using another chain. Several chains are provided and by careful planning it should be possible for one chain to remain stable for recording and a second to be Genlocked as required without disturbing other sources. A third chain would be used for transmission only. In addition, a multi-standard centre must duplicate these facilities for 625 lines and have 525-line operation available for American programmes recorded or sent direct by satellite.

To reduce the dependence on many pulse generators the BBC designed a slower Genlock which was fairly successful except that it would not lock fast enough to Genlock to a video-tape replay during the 6-7 seconds of stable picture before the start of recording. A new system called Natslock has been introduced in which the remote pulse generator is controlled to hold it in sync at the studio centre. A very stable crystal oscillator operating at the frequency of the colour subcarrier, 4·43361875Mc/s. is used. For colour working an exact relationship between subcarrier and line frequency is required to make the subcarrier less noticeable on a black-and-white receiver so that pulse generators for colour use the subcarrier oscillator divided down to control the line frequency.

Natslock Operation

With Natslock the stability is so great that very little correction of phase and frequency is required between the local and remote syncs. A phase comparator at the studio centre decides whether the remote pulse generator is Fast, Slightly Fast, Correct Speed, Slightly Slow or Slow. Tones corresponding to each mode are sent by an ordinary telephone control line to the remote pulse generator to alter its speed by the required amount. To be exact, the tones alter the division ratio of the divider chains which produce the master oscillator frequency for the pulse generator. When the comparator detects close synchronism it sends the slightly slow or fast tone until the exact synchronism is achieved and the corresponding tone sent. From this point the signals are held in step. In addition any consistent errors are corrected slowly by an a.f.c. system applied to the oscillator thus pulling the remote oscillator into the same frequency as that of the studio centre so that even if the control signal is lost synchronism is retained for a considerable period. Both these BBC techniques use special units feeding the master oscillator frequency to the standard pulse generator. ITV companies tend to use the straightforward commercially made pulse generators used with fast Genlock. This is more suitable for the ITV Network with its smaller studio centres and large number of remote programme sources.

TO BE CONTINUED

UNDERNEATH THE DIPOLE

ARTISTIC, technical and commercial progress in production for television is leaping forward at a tremendous pace in 1968, though the improving standards may not reach our screens in large numbers until 1969. There have been gradual production policy changes by the front offices of television programme networks in the U.S.A., Great Britain and Europe generally in response to the immense world market for their product, whether it was originally filmed, taped or transferred from tape to film, and whether it is available in colour or black-and-white, 35mm. film or 16mm. film dubbed into different languages or with superimposed subtitles.

The British film production industry has prospered not only because it makes film series for television on a big scale but because audiences in the U.S.A. and elsewhere have become accustomed or acclimatised to seeing many old British films on their television networks. This fact was mentioned many times at the Conference of the Society of Motion Picture and Television Engineers, Los Angeles, reported elsewhere in this issue of PRACTICAL TV. Exports of British film and television productions are now made to TV stations and networks in nearly two hundred countries. A few are valuable big time sales but many are small countries with TV stations which can only afford insignificant rental payments for 16mm. prints. The ABC-TV series *The Avengers* has been sold to about 70 different countries and is said to have received over $5 million from U.S.A. for three series, plus the same amount from Europe and the rest of the world, plus another $6 million for further bookings to more TV stations and for re-releases in the next few years. This and other series have already brought into ABC-TV about $25 million for overseas sales alone, nearly half of which has been for *The Avengers*.

BBC Television Enterprises is the overseas division sales department which already promotes exports to 92 countries, bringing in about $4 million a year and rising rapidly. Many of the subjects sold abroad are not in the international drama series category, excepting its coverage of international sporting events such as Rugby League matches, Henley Royal Regatta and "Match of the Day", but *Z-Cars*, *Dr. Finlay* and *Dr. Who* are. BBC have mainly taped these subjects on 405 lines (or 625 lines for BBC-2), making transfers to film from the tape. However they have ordered sets of the Arriflex electronic cam multiple camera system which, with television aids and controls, enables 35mm. motion pictures to be directly photographed almost as quickly as the taping of production in the live television mode. It is the partial application of television techniques to film studios (and vice versa) which is necessary for supplying the world television market with what it wants in the forms it requires. Big and important networks will want 35mm. film in colour. Small TV stations may settle for 16mm. film in black-and-white.

Within a few hours of returning to England I turned on my colour television set to make a comparison with the colour television I had seen in Los Angeles. This had varied in quality from station to station and was often distorted and subject to reflection troubles, ringing, phase distortion, violently out-of-balance colour, and with poor focus. At most originating television stations it was good though, particularly at CBS.

Returning home colour picture balance and quality seemed much more acceptable and the picture seemed (by comparison) so sharp that it practically cut you! I have the feeling that the inferiority of American colour television is not entirely due to the NTSC system (the adoption of which the BBC supported at one time) but to lower standards accepted for components in receivers, circuit testing, colour tube testing and factory "tweaking" as compared with British sets as now manufactured by most firms. The NTSC colour system reminds me of the original situation faced when optical sound-track recording for cinema films was used in film studios. The distortion introduced in processing and printing required close contact printing, no printer slippage and critical printer light assessment. Then suddenly twin-push-pull optical recording was introduced, when the distortion on one side of a push-pull photographic track was neutralised by a similar (but opposing) distortion on the other associated track. The PAL television carrier system—phase alternation—does the same kind of thing. It also prods the manufacturers of TV receivers into maintaining acceptable standards instead of blaming the TV studios and transmitters for poor quality colour.

No wonder British colour TV sets are expensive instruments. Nevertheless, let us hope that the manufacturers will *not* do what they do with black-and-white receivers—cut anything out that will reduce the price as long as there's a picture; don't bother with d.c. restoration or black-level clamp! The BBC can be congratulated on the very high technical standards of their colour television transmissions.

Iconos

DX-TV

A MONTHLY FEATURE FOR DX ENTHUSIASTS

by Charles Rafarel

We really have been back in business again during the current period. As I thought, we have had to wait until June before getting any decent openings. The first "good" one was on 2nd proving that I was about right! Now to a further prediction which I hope will be proved to be wrong: I think that 1968 may well be a short season for SpE with a corresponding early finish so we had better make the best of it whilst it lasts! But back to current conditions: here is the rundown for the period 20/5/68 to 20/6/68:

24/5/68 Spain E2 and E3.
30/5/68 Spain E2 and E3.
2/6/68 Spain E2, E3 and E4; Italy IA and IB; USSR R1 and R2.
3/6/68 Norway E2 and E3; Sweden E2, E3 and E4; Spain E2 and E4 and Spain TVE2 E2 (see below).
4/6/68 Spain E2, E3 and E4.
6/6/68 Spain E3 and mystery station (see below).
7/6/68 Poland R1 and R2.
9/6/68 Italy IA and IB; Spain E2, E3 and E4; Czechoslovakia R1.
14/6/68 Czechoslovakia R1; USSR R1 and R2; Portugal E2 and E3; Sweden E2, E3 and E4; Hungary R1; Austria E2a; East Germany E3 and E4; Norway E2, E3 and E4; Italy IA and IB.
15/6/68 Poland R1 and R2; Norway E2, E3 and E4; Sweden E2, E3 and E4; Spain E2, E3 and E4.
16/6/68 Czechoslovakia R1; Poland R1; Spain E3 and E4.
17/6/68 West Germany E2, E3 and E4; Switzerland E2 and E3; Italy IA and IB; Portugal E2 and E3; Spain E2, E3 and E4.
18/6/68 Norway E2; Finland E2 (back again at last!); Poland R1 and R2; Czechoslovakia R1 and R2.
19/6/68 Spain E2, E3 and E4; Italy IA and IB.
20/6/68 Czechoslovakia R1; Hungary R1; USSR R1 and R2; Spain E2 and E3.

The less said about Trops this month the better as they could hardly have been worse. The four-week-old strike of French TV has not helped in assessing conditions here. All ORTF have had is test cards at odd times of the day and as far as I know no second chain u.h.f. at all; conditions have to be really good here for any Trops other than French.

We have big news of TVE Spain: there is now a second chain transmitter on Ch. E2, 60kW relaying the second programme already on u.h.f. The station is at Santiago, N.W. Spain, and is easily identifiable from its test card usually on the air around 20.00 BST. The card is the standard TVE one but with a black rectangle with the words 2 Cadena (2nd Chain) on it in white above the centre circle; it also has some as yet illegible words in white at the bottom at times.

We have another problem for identification of TVE 1st programme from test cards. For the past fortnight we have had an alternative to the standard card, a Telefunken type card similar to those of W. Germany and Austria but with the following differences: on this card, the contrast wedges forming the square in the centre circle with the black ends pointing to the left at the top and to the right at the bottom, downwards in the vertical sense at the left and upwards at the right. If you compare this with the W. German and Austrian cards you will see what I mean and avoid any confusion. The TVE card also has a narrow black-and-white striped band around its edges and has no writing on it. It seems to be used just as an alternative at intervals.

The TVE 1st chain is now also radiating a checkerboard pattern like NTS Holland and narrow black-and-white vertical bars like Sweden. All these are transmitted at various times. I do not know how long this confusing situation will continue, but you have been warned!

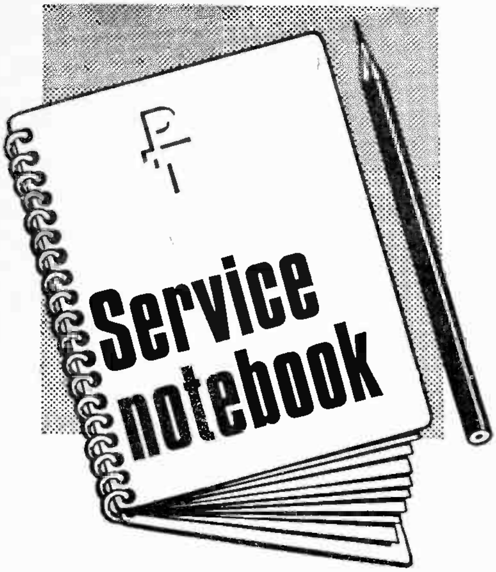
F2 TRANS-EQUATORIAL SKIP

I have recently received a photo—and what a photo!—taken by our good DX TV friends J. E. Brawn, C. S. Breiter and W. Ruurds (ZS6UR) of the TVE test card as seen in Johannesburg, S.A., on 25/5/68 at over 5,000 miles. A really splendid achievement! They also report reception of Salisbury Ch. E4 as well.

Nearer home in Cyprus M. Bell reports that he has had confirmation of Rhodesia Bulawayo Ch. E3 and speaks of a mystery 625-line, 60 field signal on Ch. E3 with aerial towards the East. He saw a test card with the word "Sempie or Empie" on it followed by an opening caption of an island with a TV mast rising from it. The sound seemed to be Hindi: the 64,000 dollar question is was it possibly from Ceylon? He has a photo which when developed may help.

Much nearer home—in fact my own and Maurice Ophie's, also of Bournemouth! For myself, date 6/6/68 time 20.59 Ch. E3/A2 aerial to South West, a very "smeared" and weak programme with three people on screen and—wait for it!—line speed 525, field speed 60c/s (no doubt about this). For M. Ophie, date 9/6/68, time 00.15 BST, Ch. E3/A2, a similar experience. In some ways he was luckier than I with his after midnight reception. Although his signal seems to have been a little weaker I got clobbered by a sudden burst of SpE from Spain E3; this after a day of nil SpE! I never thought I would ever feel ill-disposed towards SpE. Perhaps after all

—continued on page 521



by G. R. WILDING

A READER inquires as to the purpose of the S-capacitors or S-correctors referred to in many service manuals and what the initial S stands for. Well the S stands for symmetrical and the capacitors are employed in the line output circuit to correct for the non-linearity of scan needed with the use of relatively flat-faced wide-angle tubes. With these tubes a smaller beam deflection angle is needed to sweep a section of the line at the ends of the scan than in the centre. If a perfectly linear sawtooth drive waveform was applied to the scan coils, therefore, the scan would be extended at both ends compared to the centre.

To cure this effect it is usual practice to include a capacitor in series with the scan coils. As this is selected to resonate at about half the line frequency, in dual-standard models a different value capacitor is switched in for each system. In the Thorn 950 chassis the S-capacitors have a value of 0·3μF on 405 lines and 0·1μF on 625 lines. The action of the capacitors is shown in Fig. 1.

Correction occurs because the series connection of the capacitor with the scan coils introduces a parabolic modification to the basic sawtooth waveform. They are termed symmetrical correctors to distinguish them from the asymmetrical line linearity controls which affect only one side or other of the horizontal sweep according to the placement of the associated magnet.

Fading on u.h.f.

"BBC/ITA normal" was the 'phone call "but BBC-2 starts off normal then the picture fades away after about 10 minutes." Whenever a fault develops after a brief interval, be it field fold-over, reduction in width or distortion in sound, we generally assume a faulty output-type valve to be drawing grid current. Defective voltage amplifiers, on the other hand, tend to improve their gain as working temperature increases.

As the symptom seemed to indicate that the fault must lie in the 625 tuner however and you never can tell with u.h.f., we checked our valve stock and drove over. On inspection the fault was exactly as described, but as the BBC-2 picture faded it seemed to gradually merge into the background raster with the highlight outlines vaguely remaining rather than to fail from gradually reducing gain. There was no attendant increase in grain and the entire appearance of the picture seemed to indicate a video fault, even though on switching over 405 results were still normal.

The video amplifier in this model using a Thorn 900 chassis was a PFL200 and we felt compelled to change it. Immediately we did so 625 results became normal and stayed without any sign of fading.

The explanation lay in the change of grid coupling on system change. On 405 there is direct freed from the vision detector but on 625 the video grid feed is via a 0·1μF capacitor. When grid current developed in the PFL200 after a period of use it charged up the grid capacitor and increasingly changed the valve's bias to produce the signal fading symptom.

Locating components

The PCL85 field output valve in an Ekco T433 was running excessively hot and causing field fold-over. Tests showed that it was insufficiently biased, for the resistance measured from the pentode cathode valveholder pin to chassis was 270Ω instead of the 390Ω of the cathode bias resistor. It appeared therefore that this resistor had decreased in value—the normal change with carbon resistors—or that the shunting 200μF

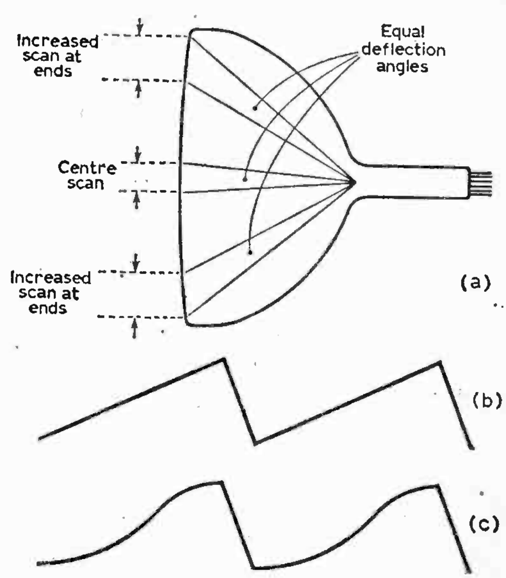


Fig. 1: (a) Showing increased sweep obtained at end of scan compared to that at centre for equal deflection angle. (b) Sawtooth scan waveform. (c) Sawtooth waveform modified by S-capacitor in series with scan coils, introducing a parabolic component

decoupling capacitor had a severe leak, quite a likelihood with low working voltage, high-value electrolytics.

The resistor changing value was the more likely of the two causes of the fault, but as it did not appear to be mounted adjacent to the PCL85 valveholder we first had to locate it before unsoldering one of its ends and thus electrically separating the two paralleled components.

When tracing components in a printed-circuit or wired chassis we usually find it quickest to use an ohmmeter rather than to attempt to follow the actual wiring. The best drill is to switch the ohmmeter to its lowest range, put one test-prod to a point known to be connected to the wanted component—in our case, it was cathode pin 8 on the PCL85 valveholder—and then run the other test-prod along all possible points of component connection. In this manner we speedily located the resistor and on unsoldering one end found that it had reduced to the previously measured figure, while on then applying the ohmmeter to the now isolated electrolytic we obtained a normal "charging-up" meter deflection with no subsequent signs of leakage.

On replacing the resistor and testing there was still some slight sign of fold-over and cramping at the bottom of the raster and it was found necessary to replace the valve as well. In most instances of reduced value cathode resistor, the resulting over-running of the valve makes replacement essential, while quite frequently excessive current consumption by the valve starts off the resistor's value change in the first place; thereafter it is a cumulative process.

Hum-bar

We came across a brand new receiver the other day which had a raster darker across the centre for a depth of about 4in. than it was at top and bottom—in fact a fairly mild hum-bar. These hum-bars can be caused by heater/cathode leakage in any valve from the r.f. amplifier to the c.r.t., so as a first check we replaced every "possible", with no improvement. Even though hum level was normal and field locking perfect we next "check shunted" a $32\mu F$ capacitor across each of the main smoothing and reservoir capacitors.

When shunting high-value electrolytics in this manner we generally use only a $32\mu F$ capacitor to avoid putting strain on the rectifier, for whether the suspect is completely open-circuit or just deficient in capacitance such a value will show up a defective component just as clearly as a full-value equivalent. This is particularly important when shunting the reservoir capacitor fed from a silicon type rectifier since the surge at connection could quite easily damage it.

However, we found all electrolytics to be in order so we then checked to find at what precise point in the circuit the hum was entering. Starting with the c.r.t. we found an immediate improvement though not a complete cure on contacting a $0{\cdot}1\mu F$ capacitor from pin 2 (grid) to chassis. There was a $0{\cdot}01\mu F$ capacitor already decoupling the h.t. feed to this point, but this component was quite in order.

Further tests then confirmed that the a.c. modulation was getting to the raster at this point, but even on increasing the value of our test capacitor to $0{\cdot}5\mu F$ the hum-bar still persisted. Obviously there was something wrong in the immediate c.r.t. grid circuit. Tracing through the circuit diagram in the service manual we found it to be quite conventional with the grid potential being variable by the brightness control, the bottom of this potentiometer being returned to the mains on/off switch by a $47k\Omega$ resistor to quickly eliminate the switch-off spot. However closer inspection of the receiver chassis showed that this resistor had been returned to the live switch tag instead of the neutral tag, and on transposing the connections the raster became perfect.

TO BE CONTINUED

DX-TV

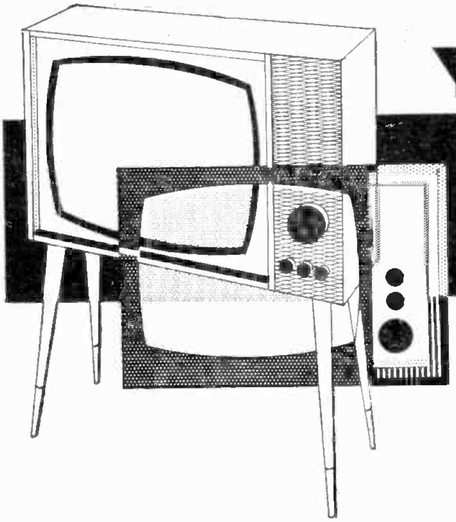
—*continued from page 519*

I have some sympathy for domestic viewers and their interference problems!

These two signals must have come from outside Europe: the question is from where? From aerial direction the possibles seem to be among the following: Brazil Ch. A2 Recife 25kW, Rio de Janeiro 100kW or Belo Horizonte 20kW; Argentine Buenos Aires A2 100kW; or Venezuela A2 Caracas or Maracaibo both 60kW. Aerial direction would seem to rule out Venezuela and the signal must lie amongst the others. My guess is most possibly Recife Brazil as the nearest but not the highest power.

F2 again? I have seen a photo taken by R. Bunney of reception on 20/9/68 and 29/10/68 Ch. E3 of a 625-line 50 field sawtooth pattern with very severe "smearing" and aerial to the South. The question here: is it of African origin? He has also had a test card F with illegible white lettering on it below the circle on Chs. E2 and E4 on 15/5/68 at 13.42 BST. Has anybody seen this or has any ideas as to the origin?

Due to lack of space we must hold over readers' reports until next month.



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

PHILIPS 1746U

Could you say whether this set is capable of receiving the local ITV transmission (Chillerton Down, Isle of Wight Channel 11) and state why the tuner turret is locked in a certain position so that the knob can only be turned to one position either side of the "12 o'clock" dot?—C. Court (Sussex).

The tuner is locked by a pair of studs on the turret. If you remove the cover from the tuner you will see these on the flat end-plate. One position is for BBC-1 and the other for ITV. It would seem, however, that the ITV coil does not correspond to your local channel, and you may have to obtain the correct coil set for Channel 11 if such coils are not present in the turret positions that cannot be selected due to the stops.

ALBA T655

This set gives a very good BBC-1 picture but I cannot get ITV picture to form with the normal controls.

Could you say how to obtain Channel 8 signals by the internal trimmer and if this can be accomplished by the removal of only the back cover?

I have recently changed the PCC84 and PCF80 which has, I suppose, upset the Band III trimming.—S. Dore (Denbighshire).

Switch to Channel 8 and set the fine tuner midway. Remove both knobs and insert a non-metallic trimming tool into the exposed hole and tune in Channel 8 for maximum sound.

BUSH TV148U

I am experiencing considerable grain on the BBC-2 picture. The other two stations seem to be all right.—D. Smith (Stockport, Cheshire).

Whilst the BBC-2 aerial could be inadequate for the prevailing reception conditions (compare your aerial with others in the vicinity) the u.h.f. tuner could be faulty.

Ask your dealer to check these points and the cable connection to the i.f. panel.

DECCA DR41

This set suffers from wavy verticals which are very bad on Channel 9 but only slight on Channel 1. Also there are curved verticals to the left of the screen, the top and bottom curving away to the left. These are however more pronounced at the top. I have changed PL36, PY81 and EY86 and the sync separator with no better results.—C. Gibson (London, N.W.6).

The aerial is obviously inefficient and should be changed to a more efficient type of directional nature to differentiate against reflected signals.

ULTRA 6618

There is no picture or sound but the raster is good. After the set has been in operation for some minutes the circular white component on the back of the rear hinged panel begins to glow. The line output valve PL500 appears to be normal and does not overheat.—F. Tollerton (Lancashire).

If the raster is normal the W10 rectifier cannot be at fault and we suggest that you check the h.t. line to the common i.f. stage and tuner units for shorts. i.e. the voltages at V3 and either side of resistors R1, and R2, R4 and R5, etc.

K-B LFT50

I have fitted a new Cyldon tuner in this receiver and get good pictures on Channels 4 and 8. I had good sound but now this has disappeared. I have tried new valves to no avail.

Also one day when I switched the set on it fused all the lights in the house but did not blow the set fuse. I put a new mains lead on the set and for a while this seemed to cure the trouble. Now, however, after being switched on for a time it will fuse the house lights again.—M. Morran (Nottinghamshire).

We would advise you to replace the 0·1μF 300V a.c. filter capacitor C107. The only set fuse is in the h.t. line circuit.

Check the sound i.f. decoupling capacitors (0·001μF pin 7 to chassis).

GEC 2028 COLOUR RECEIVER

Articles in "Practical Television" and elsewhere imply that colour television receivers must be adjusted for convergence, etc., in the final viewing position. The suppliers of my receiver inform me that this does not hold good for this model because the automatic degaussing device offsets any bad magnetic influence effectively. Is this true please?

In operation, I note a trailing outline fringe to the right of the brightly coloured images. Does this imply a defect in the delay line and is it possible to adjust this?

Also, some shades of brighter red/orange are streaky and grainy as if hard driven and this effect remains at varying settings of contrast and colour controls. Is this due to adjustment or simply because the red gun is more sensitive?

I am in a good reception area some five miles from the TV masts and suffer no reflections that I am aware of.—J. Cook (Cardiff, Wales).

The automatic degaussing circuits will not correct misconvergence if this was present on installation. It is good practice for the installing engineer to try and improve both static and dynamic convergence when the set is installed, although in practice with your type of receiver it has been found that provided dynamic convergence has been correctly set in the workshop, only the static magnets may need adjusting.

Your trailing outlines indicate some form of misalignment. This could be a chominance amplifier of too narrow bandwidth, or a falling off in the i.f. response at sub-carrier frequency. This latter would account for your graininess on bright red objects, which could be due either to noise in the colour circuits or to beat patterns with the adjacent inter-carrier sound.

STELLA ST917U

This receiver works perfectly for months but breaks down for a week or so then rights itself for another few months. The faults are as follows:

The picture will suddenly break up into thick bright lines leaving one vertical band about 1in. wide (very bright) in the centre; another less bright band extends to about 4in. from each edge. Faintly on the screen is a multiple picture (ghosting) with about five images and the whole lot is very unstable and jumps about all over the place.

Rotating the line hold control will remove the bands and reduce the ghosting to three or two images, but the picture still remains unstable.

I have renewed the ECL80, EL86 and EY81 with no difference.—A. Brown (Kent).

We would advise you to note the effect of disconnecting the interference limiter control which is connected in the line hold circuit and often causes trouble.

If this is not at fault, check the 330kΩ resistor in the hold circuit and the associated capacitors.

Check the seating of the tuner unit valves. Clean the pins and the turret contacts and check for any dry joints.

Check the common i.f. amplifier for poor connections, intermittent contacts and supply resistors.

Resolder the i.f. coil conections if necessary.

ULTRA 6600

A 625-line conversion kit was obtained and fitted as per the maker's instructions and upon switching on it was apparent that contrast was lacking on all channels. After an hour's use the picture suddenly contracted to the top of the screen with a double image. This was corrected by shorting the choke mounted above the line output transformer.

After this contrast was worse again with BBC-2 and ITA being very grey with no brilliance. BBC-1 will adjust fairly reasonably but shows a negative picture if the brilliance is advanced too much.

I suspected the aerials but have run another 405-line set with satisfactory results.—E. Graham (Wolverhampton).

The u.h.f. aerial could be at fault, of course. Much more signal strength is required for BBC-2 to give the same picture strength as BBC-1 or ITV. If the u.h.f. aerial is checked OK, have a look at the video amplifier section, as there is a suggestion that this valve could be low emission or in some other way faulty.

FERGUSON 306T

The picture blows up when the brightness control is turned up. Also a slight lack of width is noted.

Valves EY86, PL81, PY82 and PY33 have been changed. They did not remedy this fault but improved the picture quality.—R. Starck (Dorset).

Low efficiency of the line output stage is responsible for the symptoms mentioned. If you are certain that the line output valve and booster diode is up to full standard you should check the h.t. rail voltage. If this is much below 210V attention should be directed to the h.t. rectifier and associated components, including the anode surge limiting resistors, electrolytics and so forth. Also make certain that the mains tapping suits your local mains supply voltage. This is important. If the trouble persists, check the resistors on the line output valve, including screen grid, and the booster reservoir capacitor.

BUSH TV53

The set overheated and took longer to warm up than normal. The line output transformer was badly burned with wax running from it. The screen displayed a raster with white lines across it. Valve PL81 overheated with a blue blur flickering inside. When the brightness control was turned up the raster disappeared and the sound remained normal.

On removing the chassis I found the carbon resistor from pin 1 of the PL81 had burnt black and I cannot read its value.

I have replaced the line output transformer and several valves but no improvement has been noted.—P. Annett (Derbyshire).

We very much doubt if the line output transformer required replacing.

The resistor to pin 8 of the PL81 valve base is a 3·3kΩ. Check the PCF80 video amplifier on the rear left side, the detector and overload diodes, etc.

FERGUSON 204T

Originally both channels were perfect, then I had to replace C11 (100pF) and R8 (lkΩ) after they had burned out. Only the BBC-1 station now comes in well with no sound or vision on Southern ITV.

Could you say which out of C3, C13, C14, C25, C26 has to be adjusted and which coils out of L1, L2, L4, L5, L6, L7 have to be adjusted?—C. Shergold (Sussex).

It is impossible to say what adjustments *might* be necessary in the tuner to restore Band III response. Indeed the presets should not be altered as these are delicately balanced on a special test rig at the factory to give balanced response over all the channels and if you alter them you may never again be able to obtain correct reception on all channels.

It would seem to us, assuming that you have not made these adjustments, that the original fault has not been corrected. Check this, for a low-gain tuner will respond to BBC and possibly not ITV!

ENGLISH ELECTRIC C46AFM

The sound did not appear until the set had been switched on for several minutes. This state grew progressively worse until the sound did not appear for about half an hour. The next development was that sound and vision failed but were restored on adjusting the core of bandpass transformer coil L36. The picture is excellent but the sound volume is inadequate on Band III and further attempts to improve it by adjustment of L36 only produce distortion and ultimate loss of sound and vision. Turning the volume control fully up to obtain reasonable volume produces "buzz" which, incidentally, varies with the video signal content.

I have checked by substitution valves V11, V12, V13 and V15 and have also renewed resistor R98 without effect.—J. Stahl (Cheshire).

The fault appears to be due to faulty decoupling. Check the 0·001μF decoupling capacitors particularly those associated with the first i.f. (sound) pin 8 to chassis.

TEST CASE -69

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

? *VINTAGE HMV Model 1890 was suffering from reduced height and excessive cramping at the bottom of the screen. The field timebase valves checked normal, but it was found that the cathode resistor of the output valve had dropped from 330Ω to about 200Ω. This resistor was replaced, but the results remained exactly as before. The parallel 100μF capacitor was replaced, but again without any improvement.*

It was found, however, that the height control needed to be set at maximum, but that as it was turned down (for reduced height) but the degree of cramping at the bottom of the picture also became less apparent.

What faults other than in the field output stage could produce these symptoms? See next month's PRACTICAL TELEVISION *for the solution to this problem and for another item in the Test Case series.*

SOLUTION TO TEST CASE 68
Page 476 (last month)

The apparent oscillator drift in the Murphy V350 was not in the tuner section at all. An eventual oscilloscope test of the sound/vision i.f. channel alignment showed that the response curves were very undulating, with a strong peak at one particular frequency.

It was found to be impossible to correct this condition by adjusting the trimmers in accordance with the maker's alignment instructions: in fact the i.f. channels had a tendency to burst into oscillation when the trimmers (tuning cores) were adjusted.

The decoupling capacitors in the i.f. channels were then checked by substituting each one in turn with a suitable replacement. The trouble cleared completely when the one in the common i.f. stage was replaced. The circuits were finally realigned and the set performed perfectly afterwards.

It should be noted here that often more than one decoupling capacitor is responsible for semi-instability effects, resulting in tuning drift symptoms, and it is essential that replacements of the correct type are used, the leads of which should be cut to about the same length as used on the originals.

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This coupon is available until AUGUST 23rd, 1968, and must accompany all Queries sent in accordance with the notice on page 523

PRACTICAL TELEVISION, AUGUST, 1968

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