Practical TELEVISION

JULY 1968

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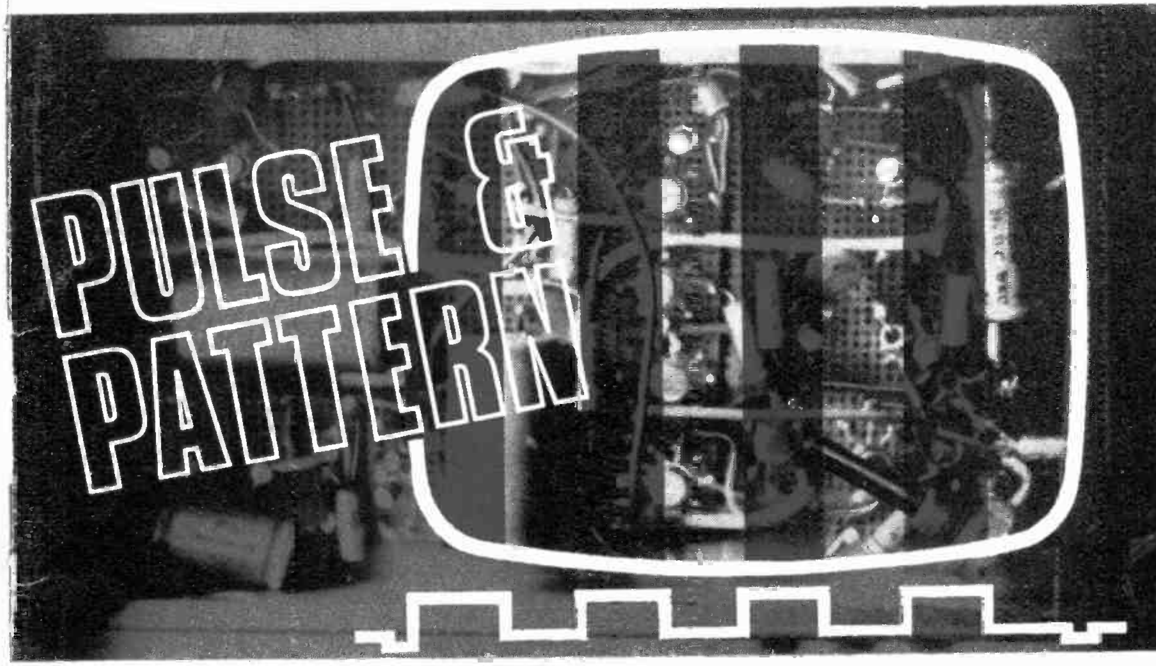

ALSO

COLOUR RECEIVER A.G.C.

Practical Television

JULY 1968
VOL. 18 No. 10
issue 214

Perfection at last?

LAST MONTH we aired our views on the subject of the inadequate sound channels provided on many current receivers. Since then it has occurred to us that we could go a stage further. Let's campaign not only for better sound on the average set but for real hi-fi circuitry for the connoisseurs. There would then be a place in the sun for the TV counterparts of the audio fanatics!

To many technicians and those versed in the technical side of TV, looking at a broadcast signal on the average domestic receiver is absolute purgatory. They shudder at the merest ghost as though it were a real spectre, cringe if the contrast is a little excessive or inadequate, ogle at overshoot with bulging eyes and are aghast if the aspect ratio is not right. They are sickened by smear, stunned by snow, saddened by soft focus.

This is natural for those who understand what the signal *should* look like and are agitated when things don't come up to technical perfection. Most technical viewers have a kind of inbuilt graticule which detects the slightest non-linearity. Such matters nag the technician-viewer and since reality always falls far short of the ideal leads to a condition which could be (or should be) known medically as Technician's Twitch.

If only the setmakers would produce some truly hi-fi receivers, salvation would be at hand. Those afflicted could then follow the lead of the audio enthusiasts who cannot enjoy listening to recorded music because of (a) the shortcomings of their equipment or (b) the imagined shortcomings of their equipment.

They could dispense with the aerial system, rig up a sweep generator and 'scope as permanent fixtures and spend their leisure hours enjoying the waveforms and adjusting L14. In the manner of the audiophile who loves his equipment but hates the noises it makes, the technical viewer could sit back and relax and at last get some enjoyment from watching the screen.

Moreover he would be spared from trying to find some enthusiasm for the programmes that are being produced these days!

W. N. STEVENS—*Editor*

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THE NEXT ISSUE DATED AUGUST WILL BE PUBLISHED ON JULY 19

TELETOPICS

BBC DEALER SURVEY

A SURVEY carried out by the BBC among TV suppliers throughout the country has confirmed that suppliers would like to see the Trade Test Transmissions in colour on BBC-2 extended. Suppliers who are involved in the rental business expressed concern at the lack of test transmissions on Sundays and Bank holidays, saying that when they provide a "round the clock" service, more test transmissions are essential.

BBC BOOST COLOUR TV

THE BBC are planning a big boost in promotional activities to keep demand up with the supply now that more colour receivers are coming on to the market. Included in the promotion are travelling displays and exhibitions at crowd-drawing displays and holiday camps.

At the same time, the BBC will continue their Service Information bulletins for the trade on BBC-2 and in collaboration with the RTEB (Radio Trades Examination Board) they will include news of colour TV training courses for service engineers.

From the middle of June, shops will be able to borrow a travelling display which has been produced by the BBC in collaboration with Kodak Ltd. The display features the story of colour TV from its birth to the present day.

FLEMING MEMORIAL LECTURE

THE 1968 Fleming Memorial Lecture was held at the Royal Institution, Albemarle Street, London, W.1 at 7 p.m. on Thursday, 18th April. These lectures are held annually by the Royal Television Society in memory of the late Sir Ambrose Fleming who was President of the Society from 1930 to 1945.

"Digital Methods in Television" was the subject of this year's lecture which was given by A. V. Lord, Head of Physics Group, Research Department, BBC. Mr. Lord outlined the advantages that can be gained by introducing digital methods into parts of the standard television transmission chain. Developments along these lines could lead to an increase in the consistency of picture quality and improve operating efficiency.

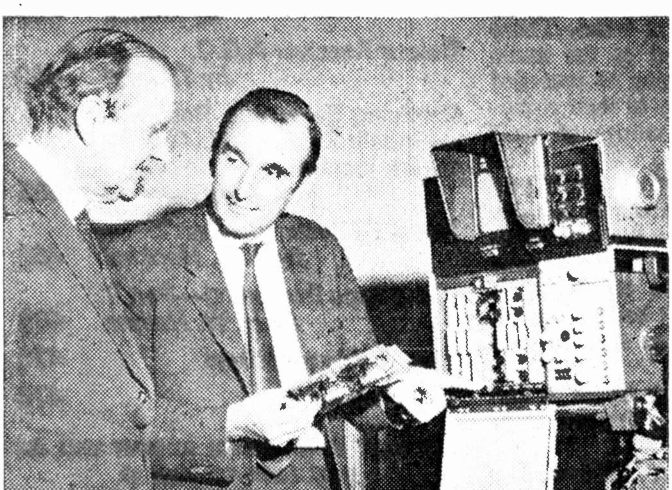
COLOUR TELEVISION FILM

ANOTHER film now available for hire or purchase from the Mullard Film Library is *Colour Television*.

The film is a general introduction to the subject and as such will be useful not only to engineers studying colour television but also to schools, clubs and other establishments. The film opens with a discussion on colour, colour mixing and the response of the eye, explaining how any shade can be simulated by mixing three primary colours. It goes on to discuss the colour television camera, the picture tube and the principles of colour television transmission and reception. It is in colour and lasts 16 minutes. The hire charge is £1 15s.

Further information on this film and many others can be obtained from the Mullard Film Library, 269 Kingston Road, Merton Park, London, S.W.19.

EMI GET COLOUR CAMERA ORDER



Picture shows Mr. W. R. Fletcher, Chief Engineer of London Weekend, and John Tucker, of EMI Electronics, with the Type 2001 *colour camera.*

EMI Electronics have received an order worth nearly £500,000 from London Weekend Television for colour television equipment. The order includes 22 of EMI's Type 2001 colour cameras for both studio and outside broadcast work.

London Weekend Television, who take over the ITA's London area contract on August 2nd, will initially operate from Rediffusion's Wembley studios. Regarding the choice of equipment, Mr. Bernard Marsden, Controller of Operations at London Weekend, stated that the final decision was taken only after stringent technical and running cost assessments of all available equipment. These were conducted on the Company's behalf by Mr. W. R. Fletcher, Chief Engineer and Mr. B. S. Pover, Head of Planning and Installation.

During the recent Olympic ice skating events at Grenoble and Geneva the Type 2001 was extensively used and the pictures were sent by satellite direct to the United States.

COLOUR CODING MAINS LEADS

A STANDARD agreed by the International Commission on Rules for the Approval of Electrical Equipment may soon be adopted for the colour coding of mains flexible leads in this country. The colours are: Live supply lead—BROWN. Neutral supply lead—LIGHT BLUE. Earth lead—GREEN or GREEN /YELLOW.

This was revealed at the BREMA annual meeting recently. The necessary legislation for the UK is believed to be on the way.

BBC-2 Relay Station for Salisbury

SALISBURY'S BBC-2 relay station began service recently for over 50,000 viewers in the town and surrounding areas including Wilton, Great Wishford, Porton, Bishopstone, Coombe Bissett and West Grimstead.

The service is on Channel 63 and vertically polarised. Aerials should be suitable for this channel as well as Channels 53, 57, 60 which have been assigned to this station for future u.h.f. services.

BBC'S SIDMOUTH TELEVISION RELAY STATION

THE BBC's television relay station at Sidmouth, Devon, was brought into service on 8 April. It transmits BBC-1 on Channel 4, horizontally polarised.

The Sidmouth relay station is situated in Salcombe Hill Road, east of the town centre and it will provide improved reception for some 12,000 people in Sidmouth, Sidbury and Sidford, especially at times when interference from foreign television stations is prevalent.

PAL PIONEER GETS HON FELLOWSHIP

THE pioneer of the PAL colour television system, Dr. Walter Bruch, has been awarded an Honorary Fellowship of the Royal Television Society.

Dr. Bruch is Director of advance development in the television field at AEG Telefunken, Hanover, West Germany.

PYE to build ITA Colour Stations

THE Independent Television authority has signed with Pye TVT Limited of Cambridge the largest single contract that it has ever placed.

This contract, which is worth over £2 million, is for 25 sets of transmitting equipment for the Authority's forthcoming duplicated 625-line u.h.f. service. Installation will begin in January 1969 and the first three stations to be equipped under this contract will start monochrome transmissions in the late summer of 1969, going over to colour as soon as possible. The remaining 22 stations will be brought into service successively up to the end of 1971. All this equipment will be used for the transmission of the ITA colour service, which is planned to open early in 1970.

These transmitters will be automatically controlled and unmanned. For maximum reliability transmitters will be installed in pairs connected in parallel.

The contract covers twelve pairs of 25 kilowatt transmitters, ten pairs of ten kilowatt output and three pairs rated at six and a quarter kilowatts.

The 50 transmitters covered by the contract will be of the most sophisticated design and the award of the contract to Pye TVT follows other major u.h.f. contracts for this type of equipment. The Company has recently completed the installation of a u.h.f. television station on Mount Rigi, near Zurich, for the Swiss PTT.

SATELLITES FOR EDUCATIONAL TV

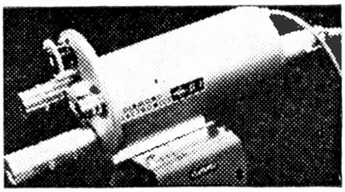
A SATELLITE communications system that could carry educational television to millions of people all over the world, from large cities to remote villages, at a cost of only pennies per year per person was described by the Hughes Aircraft Company at the Hanover Air Show recently.

Hughes developed the Early Bird satellite which in April registered its third anniversary in space and provides a communications and television link between Europe, North America and the Far East.

CCTV KEEPS A WATCHFUL EYE ON YOUR PINT

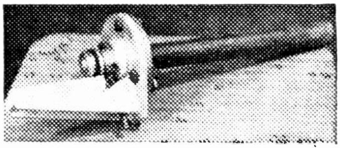
CLOSED-CIRCUIT television was as good an excuse as any for our reporter to visit the International Brewing, Bottling and Allied Trades Exhibition held recently in London.

Diamond Power Speciality Ltd. were giving the first public demonstration of their closed-circuit television system, which is designed to meet the specifications required by the brewing trade.



The ST-1 camera shown fitted with a special turret containing four lenses.

Model ST-1, an all-silicon transistor camera, together with its monitor and control accessories was demonstrated. This camera has a 650-line horizontal resolution and can operate from 0°C to 60°C within 10 per cent degradation spec.



The special lens fitting that enables pictures to be taken in very hot conditions.

Also shown on the stand was a special lens which is air-cooled and fixes on to the front of the camera so that pictures of the inside of working furnaces and vats can be seen.

Model ST-1 is a very compact camera measuring 12in. × 6in., is unaffected by vibration and enclosed in a splash and dust-resistant case. The price is around £600 if you're thinking of buying one together with monitor, and further details may be obtained from Diamond Power Speciality Ltd., Assay House, 28 Greville Street, London, E.C.1.

Pulse and Pattern generator

by J. E. KASSER

AN EXPERIMENTAL UNIT FOR INVESTIGATING PULSE TECHNIQUES

THIS unit was built whilst conducting an investigation into pulse techniques as applied to television. The line and field sync pulse generators were built into the unit as pulse sources to drive the remainder of the equipment. The unit is built in sections and is complete with its own built-in mains power supply. In most positions n-p-n switching transistors type BSY27 were used, OC42 or ASZ21s being used in the p-n-p positions. The type of transistor used is not critical, though it must be able to switch, and there are many alternatives available. N-P-N transistors were used for most of the circuitry because a negative earth was required as it was intended to use integrated circuits in one of the subsections. This negative earth and positive h.t. system did introduce problems when it came to adding negative-going sync pulses to a positive-going video signal.

There are four main features of the equipment: (1) mains power pack; (2) sync pulse generators; (3) video pattern generators; (4) sync adders and outputs. All outputs are at 75Ω impedance, the video being 1V peak and the sync 2V negative-going, i.e. conforming to usual standards. The timing is arranged for 625 lines. Most people at present use 405 lines, but as future plans envisage

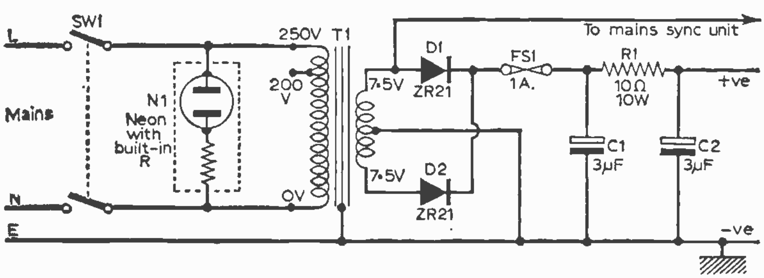


Fig. 1 (left): The power supply circuit. One of the 7·5V a.c. phases is taken to the mains lock circuit to synchronise the field generator.

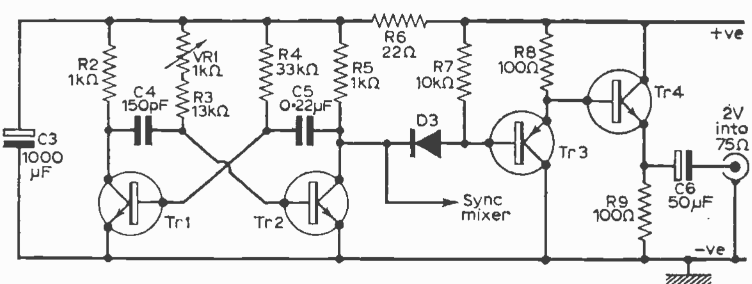


Fig. 2 (right): The line generator circuit. This consists of a standard free-running multivibrator circuit feeding a compound emitter-follower pair. VR1 enables the circuit to be set to 15,625 c/s (625 lines).

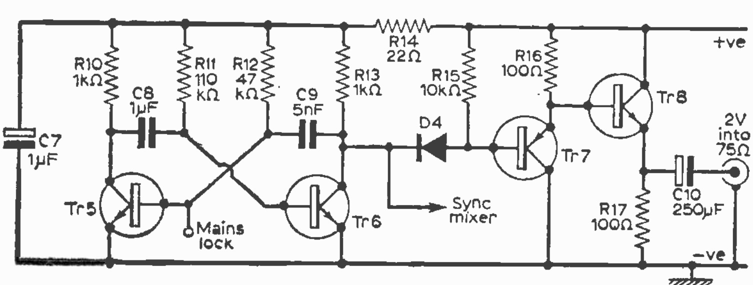


Fig. 3 (left): The fielo generator circuit. Apart from the time-constants of the multivibrator this is identical to the line generator. Tr5 base is synchronised to the mains frequency via the mains lock circuit.

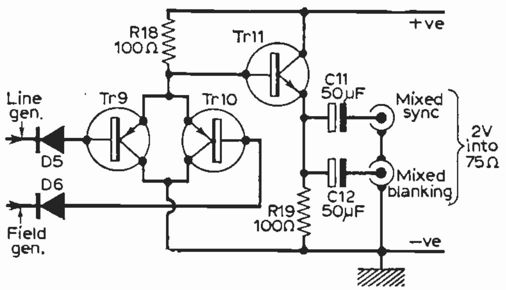


Fig. 4: The sync mixer. Tr9 and Tr10 form an or gate which drives the emitter-follower output stage Tr11.

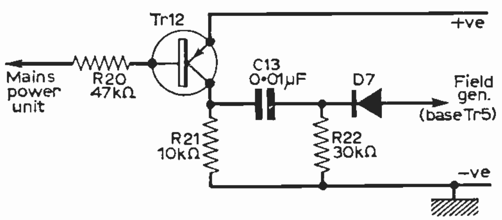


Fig. 5: The mains lock circuit. The 50 c/s sinewave input is applied to the base of Tr12 via the limiting resistor R20. The resulting square wave is differentiated by C13 and R22, clipped by D7 and used to synchronise the multivibrator Tr5, Tr6.

a switch to 625 it was decided to start now with a 625-line system. The pattern signals provided are: (1) sawtooth (this is non-pulse but useful); (2) half-line; (3) half-field; (4) checkerboard (with bars if required).

We shall describe each section in turn, giving only circuit details since layout is not really critical provided that the usual care is taken in the construction. The prototype was built up on perforated board using fixing pins to hold the components in position. The unit was built in two parts, one the pulse and pattern generator circuits and the other the power unit.

Mains Power Unit

Any power unit capable of providing 8-9V d.c. at 200mA can be used. Figure 1 shows the circuit adopted, using biphase half-wave rectification. This gives a 100c/s hum component which is easier to filter, a simple *RC* filter circuit being used. One of the 7·5V a.c. phases is taken to the mains lock circuit.

Sync Pulse Source

Both line and field generators (Figs. 2 and 3) use a standard free-running multivibrator circuit with the time-constants calculated to give the correct pulse widths for the synchronising signals. Each pulse generator is followed by a compound emitter-follower set to give 2V into 75Ω out. The pulse mixer (Fig. 4) is a transistor or gate comprising Tr9 and Tr10 feeding an emitter-follower Tr11. This is only a simple pulse generator and there is no interlace or separate blanking pulses, so the sync pulses are used for both. If an interlaced generator is available it should of course be used and this section neglected. 50c/s (mains) pulses are applied to the base of Tr5 in order to lock the field sync pulses to the mains. This ensures that any hum present in the unit is stationary and no annoying hum bars are seen on the screen. Figure 5 shows the simple mains lock circuit. A 50c/s sinewave is applied to the base of Tr12 via the 47kΩ limiting resistor R20. The resulting square wave is differentiated and then clipped by D7 and the pulses are then applied to the base of Tr5 locking the field pulses to the mains. The line pulses are free running and the preset variable resistor VR1 in the base circuit of Tr2 is used to set the line speed to 15,625c/s for 625 lines.

The pulse outputs from the emitter-followers are looped round all the electronic generators before arriving at the sockets on the front panel into which the 75Ω load resistor is plugged. These sockets are also used to apply sync pulses to other equipment when used in conjunction with these electronic patterns.

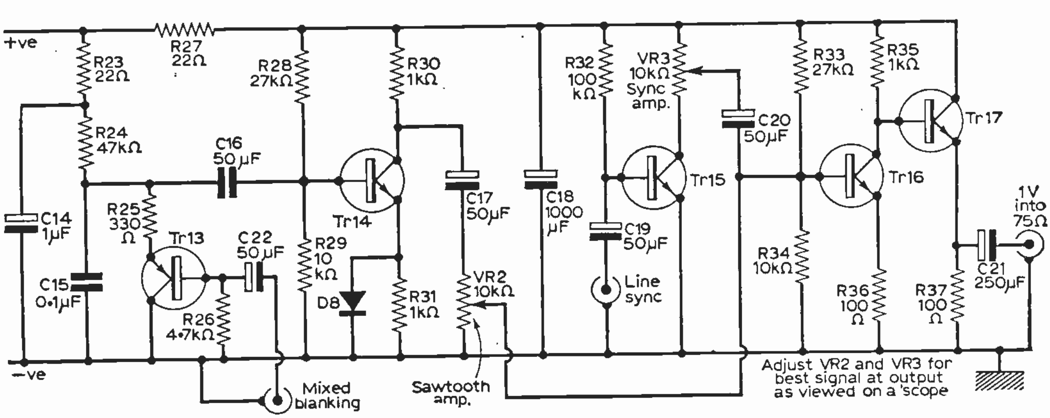


Fig. 6: The sawtooth pattern generator. The sawtooth waveform is generated by C15 charging exponentially via R24 and discharging when shorted by Tr13 being switched hard on. Tr14 acts as a linear amplifier.

COMPONENTS LIST

Resistors:

R1	10Ω 10W	R31	1kΩ	R60	1kΩ
R2	1kΩ	R32	100kΩ	R61	3·9kΩ
R3	13kΩ	R33	27kΩ	R62	390Ω
R4	33kΩ	R34	10kΩ	R63	100kΩ
R5	1kΩ	R35	1kΩ	R64	10kΩ
R6	22Ω	R36	100Ω	R65	1kΩ
R7	10kΩ	R37	100Ω	R66	150Ω
R8	100Ω	R38	100kΩ	R67	22Ω
R9	100Ω	R39	1kΩ	R68	100kΩ
R10	1kΩ	R40	20kΩ	R69	1kΩ
R11	110kΩ	R41	1kΩ	R70	1kΩ
R12	47kΩ	R42	1kΩ	R71	100kΩ
R13	1kΩ	R43	1·2kΩ	R72	100kΩ
R14	22Ω	R44	1kΩ	R73	1kΩ
R15	10kΩ	R45	3·9kΩ	R74	100Ω
R16	100Ω	R46	390Ω	R75	100kΩ
R17	100Ω	R47	100kΩ	R76	1kΩ
R18	100Ω	R48	10kΩ	R77	1kΩ
R19	100Ω	R49	1kΩ	R78	100kΩ
R20	47kΩ	R50	100Ω	R79	100kΩ
R21	10kΩ	R51	22Ω	R80	1kΩ
R22	30kΩ	R52	100kΩ	R81	52kΩ
R23	22Ω	R53	1kΩ	R82	10kΩ
R24	47kΩ	R54	100kΩ	R83	1kΩ
R25	330Ω	R55	1kΩ	R84	43kΩ
R26	4·7kΩ	R56	20kΩ	R85	100Ω
R27	22Ω	R57	1kΩ	R86	470Ω
R28	27kΩ	R58	1kΩ	R87	39Ω
R29	10kΩ	R59	1·2kΩ	R88	39Ω
R30	1kΩ				

All ½W, 10% miniature carbon unless otherwise stated

Variable Resistors:

VR1	1kΩ	VR3	10kΩ
VR2	10kΩ	VR4	1kΩ

Diodes:

D1	ZR21	D13	OAZ208
D2	ZR21	D14	OAZ200
D3–D12	OA202		

Integrated Circuits:

μL900	2 off	μL923	2 off
μL914	2 off		

Miscellaneous:

FS1	1A fuse
N1	Miniature mains neon
T1	Mains transformer with 7·5–0–7·5V secondary
SW1	Double-pole on/off switch

Output sockets, perforated boards (4 each 4 x 4¾in.), etc.

Capacitors:

C1	3μF 12V electrolytic
C2	3μF 12V electrolytic
C3	1000μF 12V electrolytic
C4	150pF miniature
C5	0·22μF miniature
C6	50μF 6V electrolytic
C7	1μF 12V electrolytic
C8	1μF miniature
C9	5000pF miniature
C10	250μF 6V electrolytic
C11	50μF 6V electrolytic
C12	50μF 6V electrolytic
C13	0·01μF miniature
C14	1μF 12V electrolytic
C15	0·1μF miniature
C16	50μF 12V electrolytic
C17	50μF 12V electrolytic
C18	1000μF 12V electrolytic
C19	50μF 6V electrolytic
C20	50μF 12V electrolytic
C21	250μF 6V electrolytic
C22	50μF 6V electrolytic
C23	50μF 6V electrolytic
C24	120pF miniature
C25	3000pF miniature
C26	8μF 6V electrolytic
C28	1μF 12V electrolytic
C29	50μF 6V electrolytic
C30	50μF 6V electrolytic
C31	50μF 6V electrolytic
C32	3000pF miniature
C33	1μF miniature
C34	12μF 6V electrolytic
C35	250μF 6V electrolytic
C36	1μF 12V electrolytic
C37	50μF 6V electrolytic
C38	120pF miniature
C39	160pF miniature
C40	50μF 6V electrolytic
C41	50μF 12V electrolytic
C42	0·05μF miniature
C43	3000pF miniature
C44	50μF 6V electrolytic
C45	50μF 6V electrolytic
C46	250μF 6V electrolytic
C47	50μF 12V electrolytic

Transistors:

Tr1, Tr2, Tr4, Tr5, Tr6, Tr8, Tr11, Tr14–17, Tr 19–22, Tr24–27, Tr29–31 Tr33–35, Tr36, Tr38, Tr39. BSY27 or BFY18.

Tr3, Tr7, Tr9, Tr10, Tr12, Tr13, Tr18, Tr23, Tr23, Tr28, Tr32, Tr37. ASZ21 or OC42.

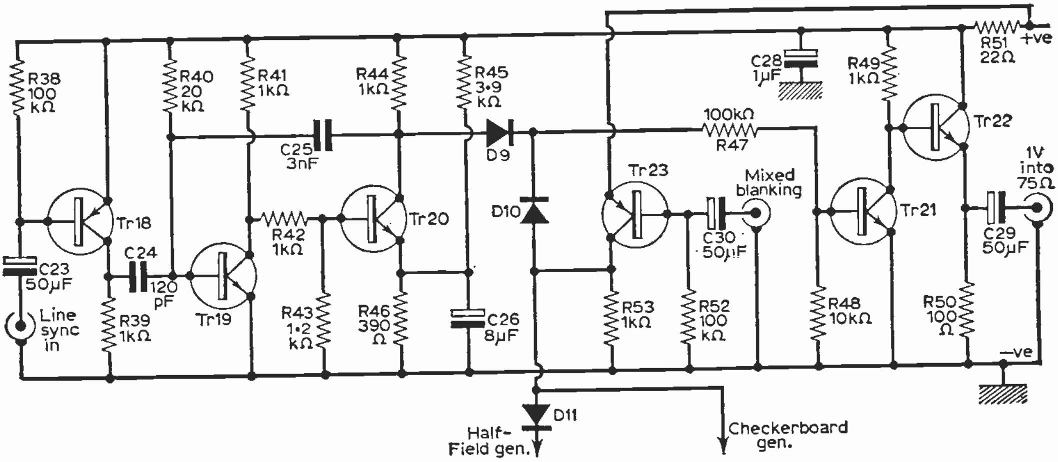


Fig. 7: The half-line generator. Tr18 inverts the input sync pulses which are used to trigger the monostable multivibrator Tr19, Tr20. The output is fed via D9 to the inverter Tr21 and emitter-follower output transistor Tr22, and via D10 to the checkerboard pattern generator to be described next month. The blanking pulses are also fed to the output to the checkerboard generator via Tr23.

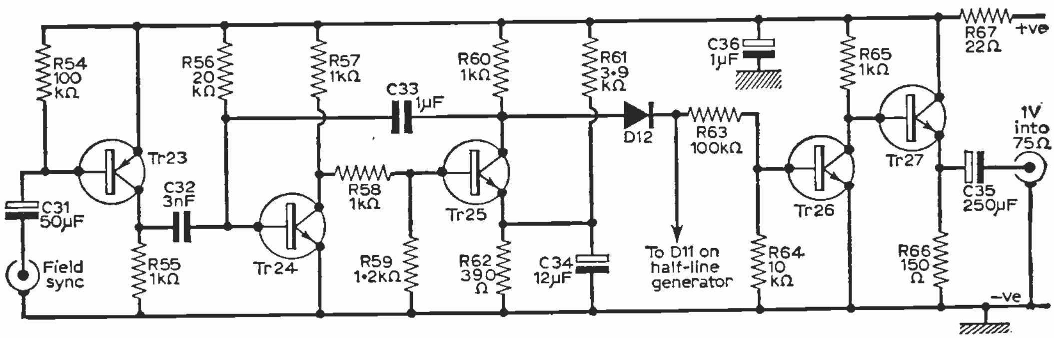


Fig. 8: The half-field generator. The same type of circuit as the half-line generator is used, with the value of the time-constant cross-coupling capacitor altered to give the required pulse repetition frequency.

Sawtooth Pattern Generator

Although this is not a pulse waveform a sawtooth is a very useful video test signal and so the generator was built into the equipment. The circuit is shown in Fig. 6. C15 charges up through R24 exponentially, and tries to charge up to the full supply voltage. However after it has charged for only a few microseconds a blanking pulse arrives at the base of Tr13; Tr13 then conducts shorting C15 to earth through the 330Ω resistor R25. Thus the potential across C15 falls to zero. When the blanking pulse has passed Tr13 switches off and C15 then begins to charge again through R24 and continues to do so until the next blanking pulse appears one line later. Mixed blanking is used so that there is no video signal present during both line and field blanking periods. The time-constant of R24 and C15 is arranged to be very long compared to the 64μS period of each line so that the rise in potential across C15 is linear.

The sawtooth waveform is coupled to Tr14 which acts as a linear amplifier. D8 is included in the emitter circuit to apply negative feedback which helps to keep the sawtooth linear. The remainder of the circuit comprises the sync adder and output stages and will be described later.

Half-Line and Half-Field Generators

The half-line and half-field generator circuits, Figs. 7 and 8, are almost identical. The waveform is called half-line or half-field but a truer description would be single bar, for in these circuits the input sync pulse (drive) triggers a monostable multivibrator which flips over when the pulse appears and flips back a short time later. The values of C25 and C33 are chosen to provide the required on time of the multivibrators: by varying the values of these components the duration of the black part as seen on the screen may be altered. The values given allow almost equal on-off times, hence half-line or half-field.

In the half-line generator Tr18 inverts the negative-going sync input pulse which is then used to trigger the monostable multivibrator Tr19 and Tr20. Similarly in the half-field circuit. The sync adder and output stages will be discussed later.

TO BE CONTINUED

THE ABC OF Colour TV

PART 2

G. P. WESTLAND

CONJUGATE SIGNALS

This is best described by reference to Fig. 8. On line one a particular hue represented by vector H is obtained from positive contributions from both R—Y and B—Y. On line two the + (R—Y) component is switched to − (R—Y), (i.e. inverted, equivalent to a phase change of 180 deg.) but the B—Y component is transmitted unchanged. The vector H is therefore swung down into the lower right quadrant, as shown H′. H′ is the conjugate of H, or in more simple terms it is the mirror image of H seen about the B—Y axis.

The word conjugate crops up quite frequently in the literature of colour TV, so it may come in useful.

CONVERGENCE

The process of converging consists of making the three coloured images coincide as accurately as possible over the whole screen of the c.r.t. Misconvergence shows up as coloured fringing on picture outlines, and as patches of apparent impurity in areas of otherwise even colouring.

Static convergence is carried out by means of permanent magnets fitted to the pole pieces of the convergence yoke, and is used to operate on the centre of the picture only.

Dynamic convergence is obtained by adjusting the shape of the line and field frequency currents in the convergence yoke coils to get accurate registration in all areas other than the centre of the picture. To begin with, only the vertical and horizontal centre lines are converged. Then, if necessary, a slight compromise can be made to improve the convergence in other parts of the picture in order to achieve the best overall effect. Note that there are no controls for adjusting convergence in the corners, as such. It can only be done at the expense of other parts of the picture.

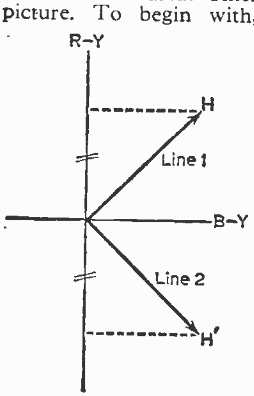


Fig. 8: Conjugate signals.

Perfect convergence is impossible. However, in a typical receiver the errors will be barely perceptible at a normal viewing distance. Another point: any adjustment of purity will probably upset the convergence, so always do the purity first.

CROSS COLOUR

If luminance information near the chroma subcarrier frequency gets into the decoder it will be processed with the chrominance signal to give small areas of spurious colour on the picture. This is *cross colour*. Any colour test pattern, with monochrome frequency gratings between 4·0 and 5·0Mc/s, such as Test Card F, will show this effect quite clearly. Similarly any fast transition on a picture, corresponding to fine detail, will also produce cross colour to some extent although in most cases it will not be easily visible because the high-frequency sideband components are of small amplitude. Harmonics of low-frequency luminance sideband components can also make their contribution to cross colour, and similar effects occur if the sound carrier at 6·0Mc/s beats with luminance sidebands of 1·6Mc/s to give spurious components at 6·0−1·6=4·4Mc/s. You can sometimes see this in the 1·5Mc/s gratings of Test Card F in the corners.

DECODER

Strictly speaking a decoder accepts the chrominance signal, processes it, and provides demodulated colour-difference outputs at a low level. In practice the term is often used to describe loosely the whole of the chrominance circuitry, but this is to be deprecated because several different types of decoding techniques can be used with some of the same auxiliary circuits. The best known decoding methods are Simple PAL or PAL_S; Standard PAL, with a delay line, usually termed PAL_D; and the chrominance locked oscillator.

DELAY LINES

Two different delay lines are used in colour receivers, one in the luminance channel and the other in the chrominance circuits. They serve different purposes. The need for the luminance delay line arises from the fact that signals passing through circuits of wide bandwidth such as the i.f. stages are delayed less than signals in circuits of narrow bandwidth such as the chrominance amplifiers. In the absence of any equalisation techniques the luminance information will appear on the c.r.t. screen before the colour information, and the misregistration will be sufficiently bad to degrade the picture.

In a typical colour receiver a delay of about 600nS has to be introduced after the luminance detector. The type of line which is commonly used consists of a single layer winding on top of a printed conducting pattern to give a distributed impedance. The characteristic input and output impedance is in the range 1–3kΩ, and this has to be accurately matched at both ends of the line, particularly the output, in order to prevent reflections which would be visible on the picture as ghost images.

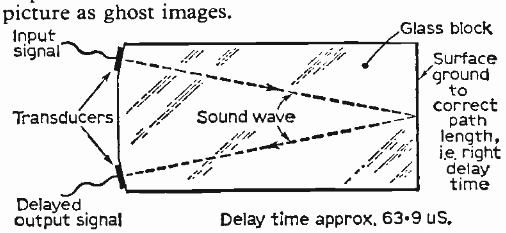


Fig. 9: The type of chrominance line-period delay line in general use in colour receivers.

The chrominance delay line is used for a completely different purpose, namely to store up the chrominance information for one line period so that information from two successive lines arrives at the matrix at precisely the same instant in time. A process of electronic averaging then takes place which enables subcarrier phase errors to be cancelled, and makes demodulation less critical.

The chrominance delay line is an electro-acoustical device, and the delay is governed by the path length and the type of material used. Most lines are made of glass and the required delay time is approximately 63·9μS. A typical line is illustrated in Fig. 9.

DEMODULATORS

The purpose of the demodulators is to extract the colour and burst information from the composite transmitted waveform, and so a typical decoder has

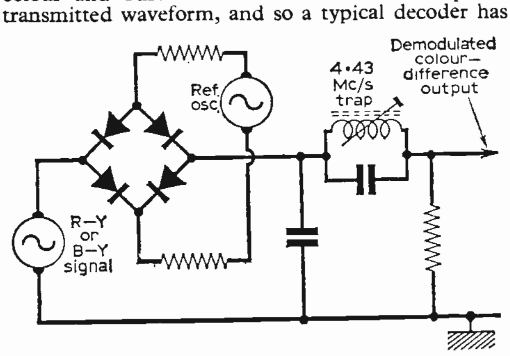


Fig. 10: A synchronous demodulator circuit in wide use. The series diode bridge detector.

three of them since there are two colour-difference signals (R-Y and B-Y) in addition to the burst signal.

The need for a special kind of detection process arises from the fact that the amplitude and phase of the chrominance subcarrier depend upon the colour content of the picture. If a simple a.m. detector is used, comprising a diode and *CR* load, the output is proportional only to the amplitude of the carrier and we get no information about the phase. The a.m. detector is therefore unable to distinguish between, say, +(R-Y) and −(R-Y) signal components represented by a subcarrier phase difference of 180°. The subcarrier is simply inverted, and the detector sees no difference.

In the case of the burst signal the amplitude is constant, but its phase changes from line to line between +45 deg. and −45 deg. about the −(B-Y) axis. An a.m. detector would give a train of rectangular pulses useful for a.c.c. purposes, but quite unable to control the a.p.c. loop or provide an ident signal output.

A colour demodulator differs from a.m. detection in that it is controlled by a reference carrier of constant phase obtained from the local reference oscillator. This reference carrier switches on the diodes at the tip of its sinewave excursions, and thus acts as an accurate timing device. The output is therefore dependent upon the amplitude of the chrominance signal at the instant when the diodes are opened. If the chrominance signal is going negative, a negative output is obtained; and conversely a positive output if the signal is positive going. If the demodulator output is to be proportional only to the signal, the reference carrier must be of constant amplitude and several times larger than the maximum excursion of the chrominance signal. A commonly used demodulator circuit, the diode bridge demodulator, is shown in Fig. 10.

DIFFERENTIAL-GAIN DISTORTION

An alternative name for this, which is self-descriptive, is "level-dependent gain". If the gain of a circuit changes as the signal amplitude changes, differential-gain distortion is introduced and so the output is non-linear. The output is not truly proportional to the input.

This distortion is not too obtrusive in areas of high saturation unless it is severe, but if it occurs at low-signal levels the pastel shades suffer and the results can be unpleasant.

DIFFERENTIAL-PHASE DISTORTION

Again a more descriptive term is "level-dependent phase". The hue of a picture element depends upon the phase of the chrominance subcarrier, and any distortion of the subcarrier phase will therefore cause a hue error. Differential-phase distortion means that the phase error depends upon the amplitude of the signal.

The two signal distortions just discussed can occur in the receiver and also in the transmission path—particularly in landlines and distribution cables. Repeater amplifiers and the like have to be carefully designed in order to minimise these effects, and signal correctors are used by the broadcasters to cancel out some of the errors. One of the virtues of PAL is that it is much less susceptible to these errors than most other colour TV systems.

DOT RECTIFICATION

The dot in this case is the interference pattern on the picture caused by the presence of the chrominance subcarrier in the luminance channel. Since the luminance bandwidth has to be 4·0Mc/s or more for good definition it is inevitable that the 4·4Mc/s subcarrier will appear at the c.r.t. (unless it is notched out) and cause patterning.

The c.r.t. is a non-linear device—its gamma of 2·2 tells you this—and so any subcarrier reaching it will be rectified to give an unwanted d.c. output. This is added to the signal voltage and distorts the picture. In practice the subcarrier amplitude is kept small in the luminance channel and so the distortion is quite small.

ENCODER

This is the opposite of the decoder used in a colour receiver, and is used in broadcasting studios and colour pattern generators. The R-Y and B-Y video signals are combined with the burst and the locally generated 4·4Mc/s carrier to give the complete chrominance signal ready for modulating on to the luminance signal. It is a sophisticated piece of equipment and must be designed and aligned with great accuracy.

E′u AND E′v SIGNALS

The luminance signal Y is obtained by adding together the R, G and B camera tube output voltages in the proportions $Y = 0{\cdot}3R + 0{\cdot}59G + 0{\cdot}11B$. The colour-difference signals are then derived in the form R-Y and B-Y by inverting the Y signal and adding it to the R and B signals. However the resulting colour-difference signals are too large for modulation on to the video signal and are reduced by "weighting" factors to 0·493(B-Y) and 0·877(R-Y). The relative proportions of R-Y and B-Y are restored in the receiver by adjusting the gain of one of the colour-difference channels.

For mathematical convenience 0·493(B-Y) is given the symbol E′u and 0·877(R-Y) the symbol E′v. When considering vector diagrams of PAL signals it is important to bear in mind that the angles representing particular hues will depend upon whether the diagram is expressed in terms of B-Y and R-Y or E′u and E′v.

GAMMA CORRECTION

This is a form of calculated predistortion introduced into the transmitted signal components to compensate for the input/output characteristics of a typical c.r.t., whether colour or monochrome. The light output of a colour c.r.t. is proportional to V^{γ}, where gamma = 2·2 and V is the drive voltage measured from cut-off, i.e. black level. The c.r.t. is therefore non-linear, and equal increments of input drive voltage do not produce equal increments of light output.

Gamma correction consists of compressing the signal so that it forms the inverse of the c.r.t. characteristic. No extra correction is needed in the receiver, and this saves the cost and complication of providing rather difficult non-linear circuits in every receiver.

GREY-SCALE TRACKING

Good grey-scale tracking is one of the most important attributes of a colour receiver if it is to have a good performance. It means simply that if a black-and-white picture is displayed on a colour c.r.t. already adjusted for correct purity and convergence all the tones from the darkest grey to the brightest highlight are of a neutral colour. There should be no suspicion that the picture is, in fact, obtained from mixing three primary colours. Furthermore this state of affairs must be maintained over a long period of time, and in spite of changes in mains voltage and customer brightness and contrast control settings.

If the grey-scale tracking is poor either the highlights or the darker tones will have a colour bias, and in bad examples all the tones may be distorted. In either case both colour and monochrome pictures will be seriously degraded.

Good grey-scale tracking in the dark tones is obtained by ensuring that all three guns cut off simultaneously at a drive voltage corresponding to signal black level. This is achieved by accurate adjustment of the d.c. potentials on the c.r.t. electrodes.

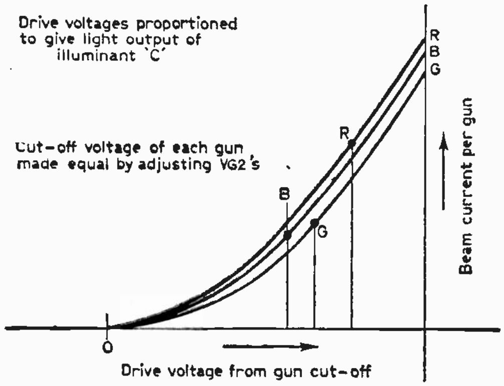


Fig. 11: Operating the c.r.t. for correct grey-scale tracking.

In highlight areas the luminance signal drive voltage must be proportioned between the three guns so that the correct amounts of red, green, and blue light are produced to give a white light of the right character. This is normally illuminant C. See Fig. 11.

HUE

The term "hue" refers to a particular colour, and does not specify how bright it is or how much white light has been added to it; i.e. whether it is desaturated or not. Thus we talk about a red hue, but this may be either bright or dim, and it may be desaturated so that it appears as a pale pink. It is still a red hue however.

Most hues can be obtained either from light of a particular dominant wavelength, or from a mixture of two or more hues of different wavelengths. The human eye cannot tell the difference. Hues in the magenta range, by way of exception, can only be obtained by mixing red and blue. See also *Saturation.*

IDENT

The R-Y component of the chrominance signal is inverted on a line-to-line basis before transmission in the PAL system, being +(R-Y) on one line and −(R-Y) on the next. Hence the name Phase Alternation Line. Identification, or "ident" for short, is the process of ensuring that the electronic switch in the receiver inverts the phase of the R-Y signal in sympathy with that of the transmission. If it does not, all colours other than that corresponding to pure B-Y will be distorted—in some cases grotesquely.

TO BE CONTINUED

DX-TV

A MONTHLY FEATURE FOR DX ENTHUSIASTS

by Charles Rafarel

THERE has been considerable improvement at last in Sp.E. reception and although most of us would have liked even better openings these may well have happened by the time you read these notes. During the current period there have been North-South openings. The earlier ones this year were almost exclusively East-West with practically no signals from Spain, Portugal, Italy etc. and only rare bursts from Scandinavia.

What is most encouraging is that the current openings have been of very much longer duration. Those of 4th, 8th and 19th May were all in excess of three hours, the last one being nearly for all the day. Here is my run-down of results for the period 19/4/68 to 19/5/68:

21/4/68 USSR R1.

22, 23 and 24/4/68 Czechoslovakia R1.

25/4/68 Czechoslovakia R1, Austria E2a.

1 and 2/5/68 Czechoslovakia R1.

4/5/68 Austria E2a, Spain E2 and E3 (excellent for Spain all afternoon).

5/5/68 Czechoslovakia R1, Sweden E2.

8/5/68 USSR R1 and R2, Poland R2, Czechoslovakia R1 (excellent for USSR).

12/5/68 Czechoslovakia R1.

15/5/68 USSR R1.

18/5/68 Portugal (Muro) E2.

19/5/68 USSR R1, Czechoslovakia R1, Poland R1 and R2, Switzerland E2 (very good), Norway E2, Italy IA, Yugoslavia E3, Spain E3 and E4.

NEWS and REPORTS

We have a completely up-to-date list of NRK Norway stations from E. Baker of Blyth:

Band I. Ch.E2, Melhus 100kW, Steigen 60kW, Greipstad 15kW, Gulen 8kW. Ch.E3, Gamlemsveten 60kW, Hemnes 60kW. Ch.E4, Kongsberg 100kW, Bremanger 30kW, Hadsel 10kW.

For optimists and East Coast DXers the Band III possibles are: Ch.E5 Nordhue 60kW, Ch.E6 Bjerkreim 7kW, Ch.E7 Hovdefjell 30kW, Ch.E8 Bokn, 100kW, Ch.E9 Bergen 140kW and Tron 30kW.

Incidentally E. Baker is off to Rio de Oro, W. Africa, on a DX amateur radio expedition in October next and hopes to be checking the DX/TV bands as well. His results should be most interesting since at those latitudes Band III ducting can cover over 2,000 miles and should include Central and South America.

The big news this month is once again F2 DX, alas not of reception in this country but our turn should eventually come. We have just had a letter from J. E. Brawn, C. S. Breiter, and W. Ruurds (ZS6UR) of Johannesburg. On 30/3/68 and 6/4/68, Ch.E2 TVE Spain Test Card identified, followed on 30/3/68 by Eurovision relay of the Boat Race and Grand National from 14.00 to 16.00 G.M.T. The reception on 6/4/68 was of a programme of about a half-hour duration; advertisements confirm that these signals were of Spanish origin and the characteristic "smearing" was present. This excellent reception was obtained on a Siera 23in. multistandard receiver.

We have a number of test pattern photos from G. F. van de Wijngaart of Mierlo, Holland, of W. German origin and taken from tropospheric signals in Bands I/III and they appear to show conclusively that W. Germany is transmitting colour on v.h.f. as well as u.h.f.

Another Equatorial area report of unusual DX/TV comes from J. Eyre who has moved from Halifax to Ascension Island and taken his DX/TV set with him. His first result was probable reception of Recife, Brazil, Ch.A2, 525 lines, which makes a nice start, and with the Band III ducting noted above he is now erecting a Band III array on top of a mountain at 2,500ft. altitude.

Still with our more distant DX friends, A. Papaeftychiou of Cyprus is still doing very well with his F2 reception and the transequatorial skip has now brought him Ghana Ch.E3, confirmed by a station announcement, so his F2 log now includes Ghana, Nigeria, S. Rhodesia and possibly Kenya, apart from his mysterious Ceylon (?) signal. He is still awaiting confirmation from Ceylon that their TV service is operational and I will not be at all surprised if their reply confirms his reception of that country as well.

Nearer home our local DXers have been reporting on the improved Sp.E. conditions. D. Bowers of Saltash, Cornwall, reports earlier Sp.E. openings in his area than in most other parts of the country. As early as 21-22/3/68 he had Spain E3, W. Germany E4, E. Germany E4, Norway E3 and E4, Sweden E4 and very short skip Belgium E3. On 3/4/68 good signals were available from Norway E3 and E4, Sweden E4, W. Germany E4, Austria E4 and Italy IB as well as Belgium on E3 again. He mentions DDR Cottbus E4 as his star performer, with almost daily reception, and goes on to say of the RSGB predictions for F2 possible activity "F2 activity m.u.f. very high in winter during the day but very low at night, the difference between day and night activity being much lower in summer" that this means "in one sense it is still possible to get F2 reception very late at night in the summer as the nights are short".

J. Shaw of Westcliff, Essex reports good reception of Finland Tampere E2 on 19/4/68; this is a rare one these days. He noted considerable twist in the polarisation angle of its signal, so this is typical Sp.E. propagation.

ADDING COLOUR TO THE commercials

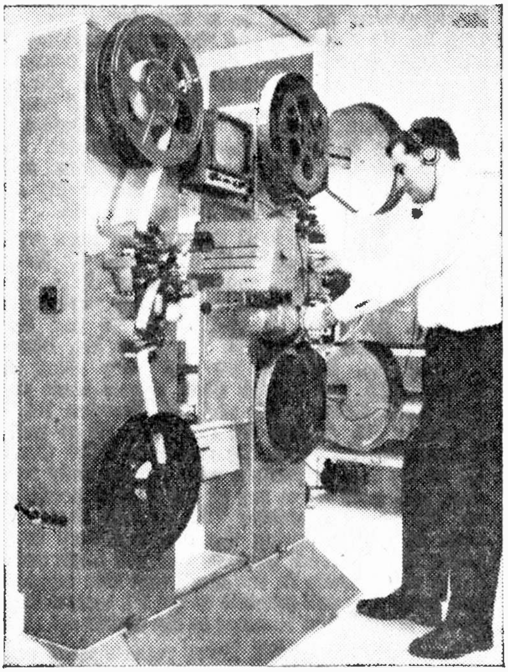
T I A

DAVID CAMERON

COMMERCIAL colour television may still seem a long way off (the ITA u.h.f. services are scheduled to start colour in 1970) but to those who will be involved in making the "commercials" time is all too short. Creating, scripting and shooting colour commercials is not simply a matter of loading the camera with colour stock instead of black-and-white.

Agencies handling television accounts have already been asking themselves many questions, and are in the process of finding most of the answers. The imponderables form an impressive list. Will colour commercials be more effective and if so how much more? How much more will they cost to produce and how long to make? How many people, and what type of people, will see them? How can colour commercials be made persuasive and what can psychology do to help? These are all basic questions, which in themselves contain the element of many subsidiary problems, all of which demand considerable research and experiment.

With regard to the viewing audience, American patterns show that the growth of colour TV is related to the number of transmission hours—whether the programmes are received by the viewer in colour or monochrome. Both the BBC and ITA should be radiating 40 hours a week in colour by the spring of 1970 and since all programmes will be broadcast simultaneously on 625 colour and 405 monochrome those still viewing in monochrome will be made fully aware that they can receive the programmes in colour if they have a suitable receiver.



Telecine Room: Lacing a double-head film on the Philips 35mm. telecine projector. This uses a Philips vidicon camera.

Opinion seems to harden on the fact that the number of colour sets will start climbing quite rapidly from early 1970 and will gather impetus by the end of 1972 when colour should be available to all regions.

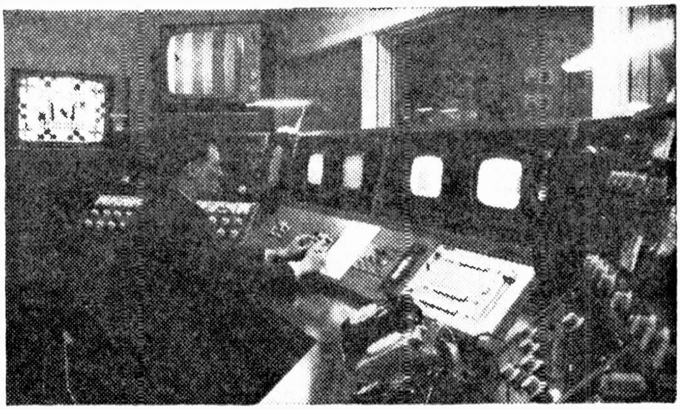
However, it is difficult to equate our own probable pattern to that experienced in the USA since most Americans buy their sets on h.p. whereas most UK viewers rent their sets. Although much depends on the ability of manufacturers to reduce the prices of receivers (which will be tied to production) and consequently for rental companies to bring down their charges, a well informed source estimates that by the end of 1970 something like 500,000 homes will be viewing in colour.

A complicating factor is that colour commercials will also be viewed by many households in monochrome and this will present many creative and technical problems for advertisers and agencies. They will be faced with having to produce monochrome commercials that a *minority* will view in *colour*. Later on they will have to produce colour commercials that *some* people will see in *monochrome*. Ultimately the full circle will be achieved and although the time is so far off it is fascinating to think that one day advertisers will find it worth while to produce a monochrome commercial to provide dramatic impact!

Colour commercials will obviously cost more to produce but since production costs form only a small proportion of the total budget on a major TV campaign, the 20-30% additional production cost will make little overall difference. The question is whether the small increases will be worth while in terms of impact, considering the low initial percentage of viewers who will actually see the commercial in colour.

The answers can only be found by the art directors. But the problems are quite considerable. For instance, a commercial designed and conceived as a colour production may be entirely successful as such but may be far inferior on monochrome to a commercial designed specifically for black-and-white. It will need skill to produce what will in effect be colour versions of monochrome commercials and to make them equally effective in either case. Generally, colour versions of monochrome productions *are* more effective but this is by no means an infallible rule.

During the initial years of commercial colour TV many advertisers will find it hard to decide whether or not to involve themselves in colour campaigns, particularly in view of the fact that the results of American researchers are far from decisive on the value of colour. [Posterity should preserve this gem from the USA—"women consider colour television 2½ times more *unique* than black-and-white"! (our italics).]



Telecine Control Room: In the foreground the audio test selector, tone generator and channel control panels. In front of the controller are the four video monitors, camera control units and mixing panels. Beyond the controller are the intercom waveform monitor and relay selector panels. Above these can be seen the R, G, B and black-and-white terminal monitors.

Perhaps an obvious point is that colour is particularly effective in advertising productions where colour plays an important role—or has been made to do so in marketing or packaging, etc. Also, of course, colour can be used to enhance the appeal of a product by playing up the background in which it is set; e.g. a hedge cutter itself would probably gain little by being shown in colour, but surrounding it with a background of hedges and gardens would be another story.

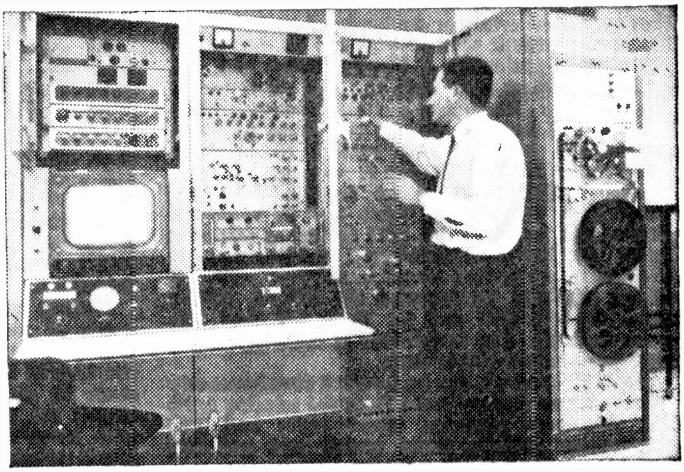
Researchers have often attempted to relate colours to psychology. Red is a *warm* colour, purple suggests *quality*, green is *restful*, etc. Others have concluded that colour commercials go down better because viewers like *colour* (otherwise they would not have bought a colour receiver). But what advertisers will have to keep firmly in mind is that any particular colour is related largely to its associations and that these can vary considerably—blue may suggest the comfort of warm summer skies to one viewer but may induce a different reaction to someone who is a poor sailor!

The technical aspects are daunting. Colour TV will not take extreme contrasts of light and shade, yet if suitable colours are not selected there may be inadequate contrast when viewed in monochrome. Colour film stock is often unsatisfactory due to variation in renderings yet video tape is unsuitable for location shots and is also expensive. Moreover what looks satisfactory on closed-circuit set-ups may not look so good on the average domestic receiver and because the colour saturation control will be within reach of the set owner it will not be possible to guarantee that the original material is reproduced on the home screen exactly as intended.

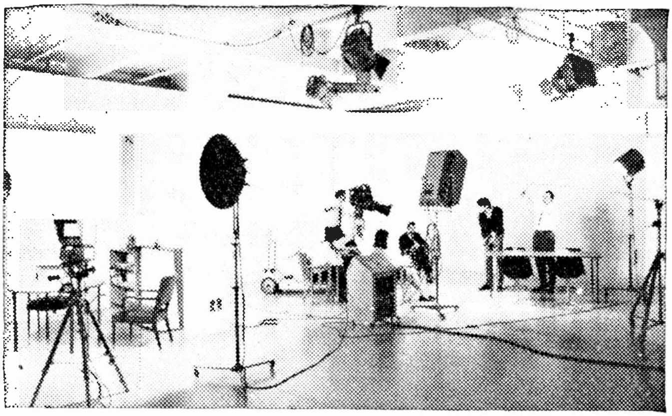
Benson's TV Centre

These are the sort of problems that TV advertising agents have faced since commercial colour TV looked like becoming a reality. One agency determined not to be caught on the hop is S. H. Benson Ltd. who have made prodigious preparations for colour commercials. During the past two years they have been assembling on the ground floor of their Kingsway, London, building an elaborate "television centre" aimed at providing the most comprehensive facilities for their TV clients in the colour age.

Occupying a floor area of 7,718 sq. ft. and involving a capital expenditure of almost £80,000 the set-up comprises viewing facilities, experimental film production facilities and supporting departments. Clients are able to see TV commercials, monochrome and colour, under actual television conditions at short notice. By installing separate colour and monochrome receivers clients can see both transmissions simultaneously on ordinary domestic receivers. Closed-circuit facilities are provided to enable both versions to be viewed in 30



Telecine Room: In the centre, the Rank Cintel-35mm. flying-spot scanner; on the right the Westrex 35mm. double-head playback machine; on the left the Goldring Lenco disc player (on the stand) and mounted in the cabinets, two Armstrong AM/FM radio tuners, a ¼-inch Ferrograph sound tape recorder and off-air television tuners, modulators and amplifiers.



Benson s Film and TV Studio: The Philips vidicon camera in use. The set is made up from modular flats using the theatrical principle of construction

offices and conference rooms throughout the building in addition to the 60-seat cinema.

The cinema

The cinema is equipped with a 35mm. Rank Westar projector for combined prints, or double-head material with optical or magnetic sound tracks (RCA sound system). Projection is for Wide Screen or Academy. There is also a 16mm. Hortson arc projector, capable of reverse run, using Hortson sound system and Academy screen size. Additional equipment includes Polaroid slide projection, 35mm. slide projection, outlets for ¼in. mono sound track (3¾, 7½ and 15in./sec.), disc turntable (78, 45 and 33⅓ r.p.m.) and radio (m.w., l.w. and f.m.).

Telecine room

The telecine room is packed with equipment. There is a Rank Cintel 35mm. flying-spot scanner for transmitting 35mm. colour or black-and-white film; combined prints or double-head material with optical or magnetic sound tracks can be run. It has two telecine projectors, a 35mm. Philips unit and a 16mm. Siemens unit. Both are used for transmitting over the closed-circuit chain black-and-white film material and can handle combined prints or double-head material with optical or magnetic sound tracks. Both can be run in reverse.

Other facilities include an Ampex video-tape recorder for transmitting video tape or combined double-head film material, with optical or magnetic tracks, that has been transferred to video tape, in addition to a standard mono sound tape recorder. Off-air receivers are installed for BBC-1, BBC-2 and ITA television and for m.w., l.w. and f.m. radio channels. The installation is completed by a four-speed record-player deck.

Up to 12 channels can be handled simultaneously—four picture transmissions from the telecine units and video-tape recorder, off-air radio and TV, gramophone records, mono sound tape and live transmission from the film studio.

Film studio

The film studio has a stage 40ft. long, 25ft. wide, 13ft. high, with a 50ft. cyclorama and adjoining scene dock. Cooker, refrigerator and sink units are installed. This experimental stage provides facilities for trying out new ideas and for making relatively simple and inexpensive try-outs of commercials which can be seen by the clients already on the spot. Thus a good deal of travelling time is avoided and pilot commercials can be evaluated at a relatively inexpensive stage. Full supporting facilities are available.

Permanent film equipment consists of 16/35mm. dual-gauge Camiflex with 7.5:1 zoom and fixed focal length lenses, a 16mm. Arriflex with 7.5:1 zoom and fixed lenses which can be blimped for sync sound shooting (fixed lenses only) in conjunction with a Nagra ¼in. sound tape recorder. An Edmonton camera velocilator is available.

The television facilities include a Philips vidicon camera chain (camera, control unit, monitor), a Marconi vidicon camera, an Ampex 7003 video-tape recorder and its monitor, a Sony video-tape recorder, camera and 9in. monitor. There is a push-button panel for cutting only. Mixing and over-laying of white on black titles may be done through a master mixer in the telecine room.

Sound recording room

A sound recording room has a built-in Revox tape recorder (3¾, 7½ and 15in./sec.) and a Sennheiser microphone. This room is designed so that additional recorders can be used in conjunction with the Revox for transferring or mixing sound tracks.

Supporting facilities

All these technical facilities are backed up by supporting services to check and despatch finished commercials to the programme contractors, for production costing and scheduling, the film and tape library, the casting section, etc. The casting department can interview a dozen or so artistes, make a test video tape in the studio and arrange for an edited tape to be replayed to a client over the closed-circuit system in one of the conference rooms in a matter of an hour or so—a considerable saving of time and cost over the conventional procedure.

Neither film nor video tape alone meets the needs of experimental commercial making. The great advantage of tape is speed—an elaborate commercial including titles, pack shots, etc. can be made in an hour or two and tested on closed circuit the same evening. But for location work with complicated cutting and optical effects film is still superior.

With the services and facilities provided at Benson's television centre there is no doubt that its flexibility and convenience will enable a company to look forward to the day when its first colour commercial is "in the can". And when a natural break *looks* natural. ■

fault finding FOCUS

PART 4

VISION I.F. STAGES

BY S.GEORGE

PROBABLY no section of the modern dual-standard receiver presents as many problems to the designer as does the vision i.f. circuits. The difficulties imposed stem from the fact that on v.h.f. the vision i.f. tuned circuits must have a response that attenuates the lower sidebands because on v.h.f. upper vestigial sideband transmission is used, the position of the sidebands being transposed because the local oscillator frequency is below the signal frequency, and centred on 34·65Mc/s, while on u.h.f. the i.f. response must be changed to centre on 39·5Mc/s, with a much broader bandwidth, and must attenuate the upper sidebands because lower vestigial sideband transmission is used for the u.h.f. transmissions. The overall space allocated to each channel, for both sound and vision, is 5Mc/s on v.h.f. and 8Mc/s on u.h.f. It is thus essential to include wavetraps in the vision i.f. circuits not only to shape the actual receiver response to the very precise requirements but also to prevent both sound and vision signals from neighbouring channels breaking through to the wanted channel.

In striking contrast the sound i.f. circuits, although handling a 38·15Mc/s signal on v.h.f. and a 6Mc/s f.m. signal on u.h.f., need no such elaborate circuitry, since the individual i.f. transformers, separately tuned to these v.h.f. and u.h.f. sound i.f. frequencies, can be simply series connected with no ancillary system switching since the disparity between the two frequencies is so great that they develop across their respective i.f. transformers with negligible signal loss across the complementary i.f. transformer. The only switch required is one to change from the sound i.f. input at 38·15Mc/s on v.h.f., which is either taken from the anode of the common i.f. amplifier where used or directly from the tuner, to the 6Mc/s u.h.f. sound take-off tuned circuit which is in the post-detector circuitry. The television sound i.f. circuits therefore quite closely resemble a conventional radio type of circuit with simple transformer coupling from one stage to another.

Vision i.f. stages in dual-standard models may well incorporate up to six wavetraps, however, and these may be of acceptor, rejector or bridged-T pattern, the actual choice of type depending on the degree of rejection required and the permissible bandwidth. Bridged-T types, although requiring more components than simple *LC* tuned filters, are more selective and have a greater attenuation of the unwanted signal. Typical wavetraps used in current models are shown in Fig. 11, while Fig. 12 shows a dual-standard vision i.f. channel (S.T.C.) incorporating several wavetraps.

To take v.h.f. first. As Fig. 13 shows, the vestigial vision signal extends right up to the h.f. end of the channel while the sound carrier, which is at the l.f. end of the channel, is only 0·25Mc/s from the h.f. end of the next lower vision channel. Therefore, while overall channel response must adequately respond to its co-sound signal, it must not be affected by the vision carrier so closely adjacent.

As the v.h.f. vision i.f. is now standardised on

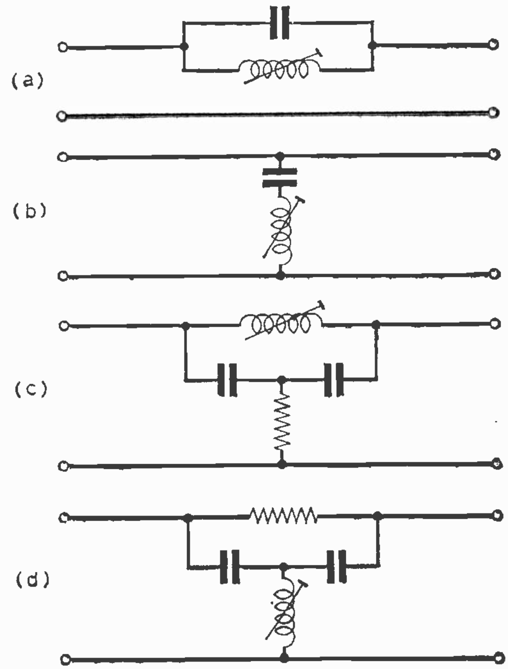
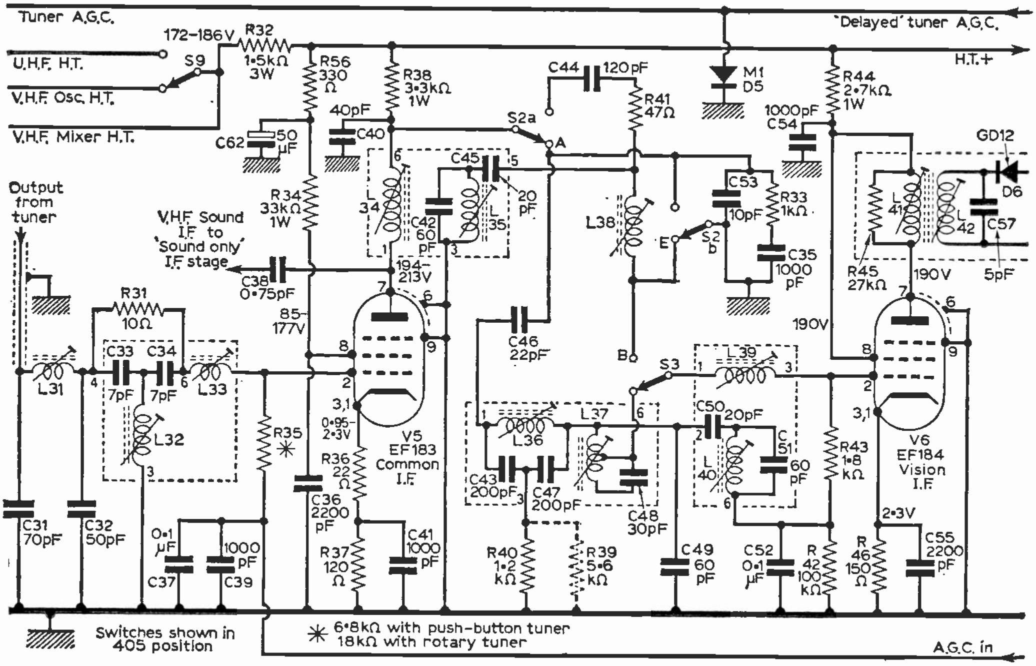


Fig. 11: Typical wavetraps used in television receiver i.f. circuits: (a) series rejector, (b) parallel acceptor, (c) and (d) bridged-T rejectors. Bridged-T filters give a much higher degree of attenuation and a more sharply tuned response than simple acceptor or rejector circuits.



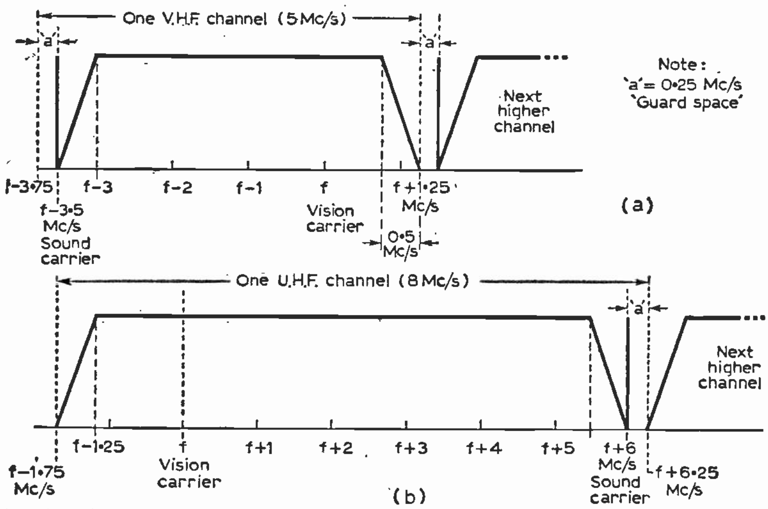


Fig. 12 (above): Typical dual-standard vision i.f. stages. On v.h.f. the traps are L36, C43, C47 38·15Mc/s (sound rejector), L37, C48 39·65Mc/s (adjacent vision) and L40, C50, C51 33·15Mc/s (adjacent sound); on u.h.f. the traps are L35, C42, C45 33·5Mc/s (sound i.f.) and L32, C33, C34 41·5Mc/s (adjacent sound). L41 and L42 are tuned to 37 Mc/s (midway between the v.h.f and u.h.f. vision i.f.s). Fig. 13 (left): Ideal v.h.f. and u.h.f. transmitter bandwidths. On v.h.f. there is upper sideband vestigial transmission with the sound carrier 3·5Mc/s below the vision carrier; on u.h.f. there is lower sideband vestigial transmission with the sound carrier 6Mc/s above the vision carrier.

34·65Mc/s with sound always 3·5Mc/s higher at 38·15Mc/s, most i.f. circuits incorporate four wavetraps as follows: (1) A wavetrap tuned to 33·15Mc/s to reject adjacent channel sound. (2) A wavetrap tuned to 39·65Mc/s to reject the adjacent vision channel. (Thus the overall v.h.f. channel response is buffered on either side by a protective wavetrap.) (3) A rejector tuned to the receiver's co-sound i.f. of 38·15Mc/s and placed late in the vision circuitry to remove any possible traces of sound-on-vision. (4) A rejector tuned to 3·5Mc/s and placed in the video circuit to remove possible dot interference due to the vision and sound carriers beating together to produce an intermediate signal at this frequency. The usual position of this tuned circuit is in the cathode lead of the video amplifier valve so that any signal at this frequency is attenuated by normal negative feedback action of the valve.

On u.h.f. there will usually be need for only two wavetraps, one each side of the channel, but due to the fact that the sound channel on u.h.f. is 6Mc/s above the vision carrier frequency instead of being 3·5Mc/s below the relative frequencies of the adjacent channel sound and vision rejectors will be transposed. The u.h.f. vision i.f. being generally 39·5Mc/s, there will probably be one wavetrap tuned to 31·5Mc/s to reject adjacent channel vision and another tuned to 41·5Mc/s to reject adjacent channel sound. As u.h.f. sound i.f. amplification takes place at 6Mc/s there is no need to include the type of sound-on-vision rejector usually found essential on v.h.f., or to include a "beat" rejector in the cathode lead of the video valve.

When the system switch is changed from v.h.f. to u.h.f. therefore, the following circuit changes occur: (1) The nominal i.f. frequency must be raised from 34·65Mc/s to 39·5Mc/s. (2) The response must be altered to suit lower instead of upper vestigial transmissions. (Note, however, that at i.f. the vestigial sidebands will be at the lower side of the channel on v.h.f. and the upper side of the channel at u.h.f.) (3) The response of the associated wavetraps must be altered, with the v.h.f. co-sound and dot rejectors being switched out. (4) The overall vision bandwidth must be raised from 3Mc/s to 5·5Mc/s. Furthermore the necessarily complicated design must require the minimum number of coils, while the actual switching mechanism, which must of necessity continue throughout the i.f. strip, must not introduce any instability or unwanted interstage coupling.

The detector output polarity must also be reversed on system change (this is really a video stage requirement) and unless an integrated tuner is used it will be necessary to switch power on and off to the relevant tuner, though as many receivers use one of the valves in the v.h.f. tuner to act as an additional i.f. amplifier on u.h.f. it will be necessary to maintain power to whichever valve is used. In the S.T.C. VC2 chassis shown in Fig. 12 the pentode section of the PCF801 mixer functions as the additional i.f. amplifier on u.h.f., so that power must be maintained to this valve when the set is switched to u.h.f. This practice of using a v.h.f. tuner valve as an additional i.f. amplifier on u.h.f. also has the advantage that there is only one i.f. output lead from the two tuners to the i.f. stages, thereby eliminating grid circuit switching.

Overall, then, to fulfil all these requirements, produce a reasonably flat-topped response free from ringing and with adequate sensitivity, and with complete freedom from sound-on-vision and vision-on-sound, represents a considerable design achievement.

But these tuning requirements are only half the problem. To accommodate the wide divergencies encountered in practice in aerial input strength, and to compensate for changes in signal level when changing from one system or channel to another, it becomes essential to include an automatic or partly automatic gain control system. This again brings associated problems for at the high i.f. frequencies used in television receivers variation of gain considerably alters the input impedance and capacitance of the valves employed so that mistuning of the controlled stage can occur as gain is varied unless steps are taken to offset the effect. And the need to maintain signal-to-noise ratio at a high level makes it essential that if the r.f. amplifier valve is also controlled the application of the control is held back or delayed till the input signal strength exceeds a predetermined value when the i.f. amplifier can no longer hold the signal at a low enough level.

The problem of gain control is further accentuated by the fact that the vision signal strength at the second i.f. stage, or the vision-only i.f. stage

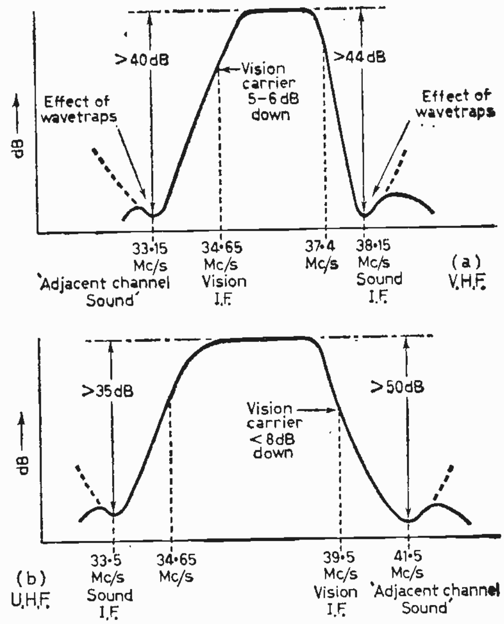


Fig. 14: Overall i.f. response curves for the circuits shown in Fig. 12, (a) on v.h.f. and (b) on u.h.f.

in sets using a common sound and vision stage, can reach a high value, and any variation of this valve's gain would cause distortion by operating the valve partly off the linear part of its characteristic. Control must therefore be confined to the first or common i.f. stage, augmented by control at a reduced or delayed level to the tuner r.f. amplifiers.

To offset variations of input capacitance caused by variations in grid bias to the i.f. valve it is standard practice to include a low-value resistor, 22Ω is a typical value, in series with the cathode lead and left unbypassed. The slight negative feedback developed across this resistor then largely removes the effect. However, this is not permissible in the r.f. amplifier stage as the effective loss in gm would be too great to tolerate. Fortunately the reduced level of a.g.c. control and the wider bandwidth of the stage minimise the effect.

It is standard practice therefore to have a preset sensitivity or preset gain control additional to the main contrast control, but arranged in similar fashion, that is shunted across the h.t. rail and chassis and designed to hold off the main a.g.c. rail potential till it exceeds a potential selected by the setting of this subsidiary control. In this way the r.f. amplifier is run at full gain, and therefore optimum signal-to-noise level, till excessive signal strength compels a reduction through the a.g.c. potential exceeding the delay voltage.

However in dual-standard models this is by no means the end of the story, for the mean-level a.g.c. systems employed almost universally today produce a voltage dependent on average picture content rather than carrier signal strength. With the negatively modulated u.h.f. transmissions this could lead to a condition known as a.g.c. blocking on very strong and dominantly dark scenes, when carrier amplitude is high. Oppositely to the v.h.f. transmission, the u.h.f. sync pulses extend from 77 to 100% of peak carrier power, with picture highlights occupying minimum carrier values. Predominantly dark scenes will therefore modulate the carrier to a high mean value, and the mean d.c. value from the vision detector will similarly be of high value. However—and this is the crux of the point—the grid feed to the sync separator valve, which develops the negative a.g.c. voltage, is a.c. via a capacitor from the video amplifier. Although the mean d.c. level from the detector is high, the variations, or the a.c. content, varying from the peaks of the sync pulses to the high average value of the dark video waveform, is only quite low, for being a mainly dark picture content the video waveform does not have a great amplitude excursion. If the a.c. signal applied to the sync separator is small so also will be the negative grid voltage developed as the a.g.c. potential, and we are then presented with the fact that on strong u.h.f. transmissions of mainly dark picture content the a.g.c. potential is at a minimum.

This low a.g.c. voltage can then accentuate the effect by permitting the controlled valves to operate at full gain and possibly overdrive the second i.f. valve to further reduce the disparity between sync pulse and picture content levels. This results in temporary complete overloading of the receiver and loss of a.g.c. action. However, in practice this may be averted by the employment of two simple but highly effective circuit arrangements, the use of an overload diode and self-bias of the second i.f. valve.

As indicated on u.h.f. mainly dark scenes produce a high value detector output. This, being of negative polarity, can serve to augment the mean-level a.g.c. voltage when it is low during such times. Accordingly, a diode is connected with its cathode to the u.h.f. detector output and its anode to the a.g.c. rail so that when the negative detector output exceeds the a.g.c. rail voltage conduction occurs through the diode and boosts the a.g.c. voltage. If only one diode is used for both u.h.f. and v.h.f. detection there will be no need to switch the overload diode out on v.h.f., as the positive output on this system would fail to cause conduction of the overload diode.

The other technique consists of self-bias to the second vision i.f. valve. Instead of returning the secondary of the i.f. transformer feeding the second vision valve to chassis and thus tying the valve grid directly to chassis, many designs feed the grid via a *CR* combination. With the valve correctly biased and with normal amplitude inputs this small circuit change produces negligible effect. Should the peak tips of the positive half-cycles during temporary overload drive the valve into grid current, however, a small negative voltage will be developed across the grid resistor by normal grid capacitor/grid leak action. This additional grid bias will then place the operating point of the valve closer to cut-off, reducing gain and restoring more normal operation. An example of this type of vision circuit overload protection as used in the Decca 122 series of receivers is shown in Fig. 15.

Of course the local oscillator section of radio and television frequency-changer valves and all line-output pentodes are always fully self-biased

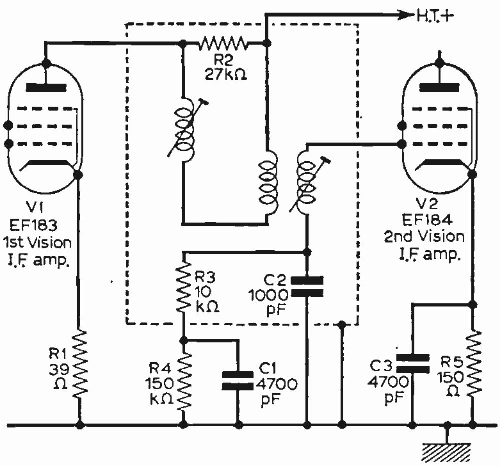


Fig. 15: Vision i.f. circuit overload protection. Should excessive inputs drive V2 into grid current R4, C1 develop additional self-bias to add to the bias provided by R5. V1 has a.g.c. applied to it R1 being left unbypassed to offset variations in input capacitance caused by a.g.c. variations.

using this system as, having no cathode resistor, even the smallest a.c. input can produce bias when the positive half-cycles cause grid current to flow. However, valves normally biased by a cathode resistor, as in the example shown, only produce additional grid circuit self-bias when input positive peaks exceed the standing cathode bias voltage. Normally such grid capacitor/grid leak combinations are connected directly to the valve grid, but in television i.f. amplifiers they are connected between the earthy end of the grid coil and chassis to minimise the capacitive loading of the components. However, their operation remains the same.

FAULTS AND SERVICING

The vision i.f. stages give little trouble in practice, the most common fault being complete failure to operate due to a valve having a short-circuit heater or internal electrode disconnection. Instability seldom occurs due to the comparatively low individual stage gains and use of stagger tuning but, when it does occur, is almost always due to an open-circuit or dry-jointed anode or screen decoupling capacitor. Sometimes these dry joints are in the capacitor itself where one of the lead-out wires fails to make contact with its associated plate and may only be held on by the exterior paint. In such cases, probing the component will usually show up any bad or intermittent contact.

Low gain, after valves have been eliminated, is also most often due to a defective valve decoupling capacitor, including this time the cathode resistor bypass. However, without calibrated test equipment and manufacturers' input/output gain figures it is impossible to test the overall sensitivity of an i.f. strip, and many cases of suspect low vision circuit gain are really due to tuner defects. When receiver sensitivity is low the best general indication as to where the fault lies is given by the degree of grain in the picture. The tuner

continued on page 472

LETTERS TO THE EDITOR

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

COAX PLUG ASSEMBLY

SIR,—On page 267 of the March 1968 issue of PRACTICAL TELEVISION is a diagram showing one method of assembling a coaxial plug. However it is not the best method. Its fault lies in the method of connecting to the outer conductor, using the collet clamp to grip the braiding. With this method the braiding easily works loose and causes poor contact.

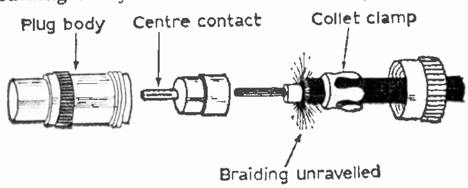


Fig. 1: Better way of fixing a coaxial plug

A better way is shown in Fig. 1. I make no claim for the originality of this method which was suggested in the Belling and Lee catalogue. As shown, a short length of the braiding is unravelled. When the plug is assembled, this braiding is gripped between the collet clamp and the body of the plug, thus making a firm contact. The clamp also grips the outer plastic covering of the cable, holding the plug firmly in position. The inner conductor should be soldered to the centre contact.

This method ensures that the connections are robust and will not work loose.—G. W. WATERS (Barry, Glamorgan).

ANY 30-LINE TELLYS?

SIR,—If by any chance a reader has one of the old 30-line mechanical television receivers from the 1930's, we would very much appreciate details, as we are forming a wireless museum in connection with our local Radio Society.

We would particularly like to obtain one of these vintage TV sets in time for our Exhibition of Old Wireless Receivers at our Mobile Rally which is to be held on the banks of the River Nene at Peterborough on September 2nd.—D. BYRNE, G3KPO (Hon. Sec., Peterborough Amateur Radio Society, Jersey House, Eye, Peterborough).

PROBLEMS SOLVED

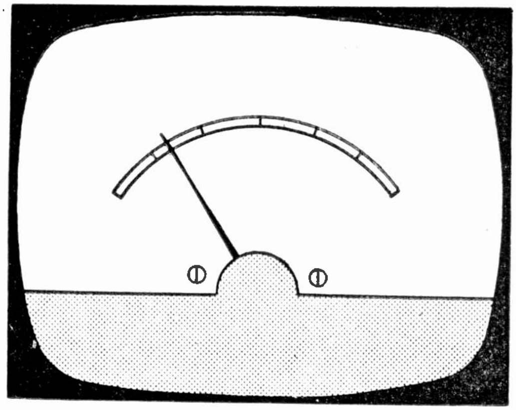
SIR,—Your reply to J. Humber of Pembroke Dock in Your Problems Solved (April issue) states that valves for a Murphy 240A (fine oscillator and discriminator) are 20L1 and 20D2. Surely this should read 20D1.

The only 20D2 value I have been able to trace is a triode hexode frequency changer with a standard British 7-pin base.—G. GEDGE (Aldeburgh, Suffolk).

We would like to thank Mr. Gedge. He is perfectly correct in his observations about the 20D1.—Editor.

TELEVISION RECEIVER TESTING

Part 3 by Gordon J. King



IN Part 2 we saw how overloading in the r.f. and i.f. stages can incite the symptom of sound-on-vision due to the sound signal actually modulating the vision signal because of the non-linearity of the overloaded stages. A perfectly linear stage has a transfer characteristic as shown in Fig. 1. Here it is clearly revealed that unit increase in input signal yields a corresponding linear increase in output signal over the whole of the signal range—called the dynamic range—from minimum to maximum and, indeed, anywhere within the range. As an amplifier provides amplification the input signal may be in units of a millivolt (or fractions thereof) while the output signal might be in tens or hundreds of millivolts, representing a gain or amplification of 10 or 100 times, corresponding to 20 and 40dB gain respectively.

Sadly, no amplifier has such a wonderfully straight transfer characteristic as shown in Fig. 1, Fig. 2 showing a more realistic characteristic. This will be seen to curve gradually at the lower signal levels and then more dramatically towards the top end of the signal range.

The result of the curvature is that the output signal no longer changes linearly in amplitude with that of the input signal. At the extreme end of the curve, for instance, an increase in input signal has virtually no influence on the output signal—which remains almost at the same amplitude. The point on the characteristic where the gentle curve changes into a more violent one signifies the onset of severe overloading. For most practical purposes, the gentle curvature within the working range is of no significance; it means, however, that no amplifier can be perfect.

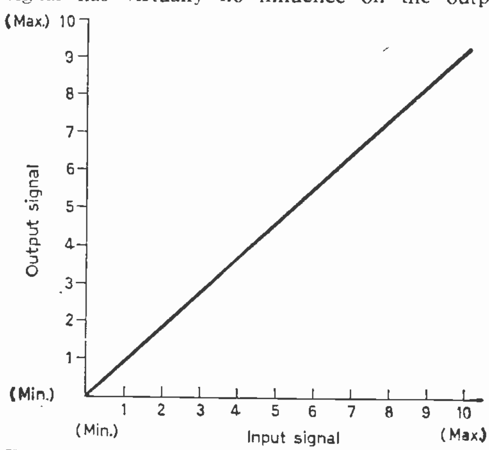


Fig. 1: The ideal transfer characteristic without non-linearity.

Non-linearity, no matter how mild, adds distortion to the amplified signal by introducing harmonic components of the "pure" input signal. Thus under these conditions if the input signal is totally free of harmonics and the output signal is channelled through a very sharply tuned filter —called a "notch filter"—of exceptionally high attenuation tuned to the fundamental input signal a residual signal would remain composed of harmonics of the pure fundamental input signal. This is harmonic distortion, and the greater the curvature of the transfer characteristic the greater the amplitude of the harmonic components. While such distortion is likely to be very low (often well below 1%) up to the overload point, it rises very rapidly when the signal operates in the overload region due essentially to the greater curvature of the characteristic and the resulting increase in non-linearity.

In addition to this, non-linearity has an effect on two or more signals passing through the same non-linear channel (or amplifier) rather like that of a modulator. That is, the signals intermodulate each other, resulting in a complex signal through the channel. With television receivers and amplifiers this is an embarrassing state of affairs because some of the amplifier stages carry both the vision and sound signals simultaneously. Thus non-linearity results in their intermodulation.

We must now divert just for a minute and consider the sound and vision channels in a typical television set—405-line standard sets for a start. The r.f. amplifier and frequency changer of the tuner carry both sound and vision signals, as also does the common i.f. amplifier, which is that into which the tuner output signals are fed. The sound signal is then extracted from the common stage by means of filters accurately tuned to the sound i.f., while the vision i.f. signal continues on its way to the vision detector through the vision i.f. stages.

Included in the vision i.f. channel is a filter sharply tuned to the sound i.f. and designed greatly to attenuate any sound i.f. signal in the vision channel. This is the sound rejector. If mistuned the sound signals in the vision channel will fail to be attenuated and will arrive at the vision detector along with the vision signals. Since the vision detector is a non-linear device, the sound signals here modulate on the vision signals so that the video amplifier and picture tube are presented with vision signals—giving the picture—and also sound signals which are responsible for the sound-on-vision interference (see Fig. 3, Part 2).

Sound-on-vision resulting from this cause is easy to clear simply by correctly tuning the sound rejector in the vision channel. However, and this is the important point, if the intermodulation takes place due to non-linearity in a stage common to both sound and vision signals the rejector will have no effect at all on it. Many enthusiasts—and some service technicians—have been known to locate the sound rejector in the vision i.f. channel and tune over its range in an endeavour to clear a bad symptom of sound-on-vision, yet ending up with the symptom worse than ever! This is because overloading was responsible—not misalignment.

Thus before attempting to clear sound-on-vision interference by realignment, a test should first be made for possible overloading. This simply involves interposing an attenuator in series with the aerial downlead. If the symptom disappears when the signal strength to the set is cut by two or four times (6 or 12dB) without there being an increase in the background grain (picture noise) then overloading is almost certainly responsible. Most sets should be able to handle a signal some ten times (20 dB) stronger than that required for a noise-free picture through normal a.g.c. action. Overloading of more recent models could thus be caused by trouble in the a.g.c. system as considered last month.

At this point it is worth mentioning that some of the earlier transistorised sets had an overload performance somewhat below that of their valved counterparts due to the fact that some of the earlier r.f. and i.f. transistors went into non-linearity at relatively lower signal levels than valves doing the same job. Moreover, transistor a.g.c. was less efficient than valve a.g.c. Modern transistors and associated a.g.c. techniques have resolved most of these problems though, but even so valves still have the edge on transistors so far as overloading is concerned.

Having now seen how to test for sound-on-vision due to overloading it will be instructive to see if there is any way of telling whether the symptom is resulting from misalignment or an incorrectly tuned rejector—or, indeed, from any other cause.

Operating the fine tuning control on 405-line sets (and dual-standard sets in the 405-line position using the v.h.f. tuner) can give a fair idea as to how well the sound rejector is adjusted. Test Card "D" should be used to assess the performance, and the idea is to adjust the fine tuning control (or oscillator tuning slug in the case of sets with no manual control or adjustable press-button) with the vision turned off—by turning the brightness control right down and leaving the contrast control in its normal, correct position—very carefully for maximum sound. Take some time over this to get the absolute sound peak.

When you are wholly satisfied with this adjustment, leave it so set and restore the picture to the correct contrast ratio by turning up the brightness control. Theoretically, the picture should now be perfectly clear of sound disturbances, and the 2·75Mc/s frequency gratings (the lower ones of the column of three on the left-hand side of the contrast wedge) should also be reasonably well defined. Some particularly good and well adjusted sets will also display the 3·0Mc/s gratings (the lower of the three on the right-hand side of the contrast wedge). In practice, though, it may be necessary to readjust the fine tuner very, very slightly to secure the optimum definition of the 2·75Mc/s gratings—but sound should still be absent from the picture.

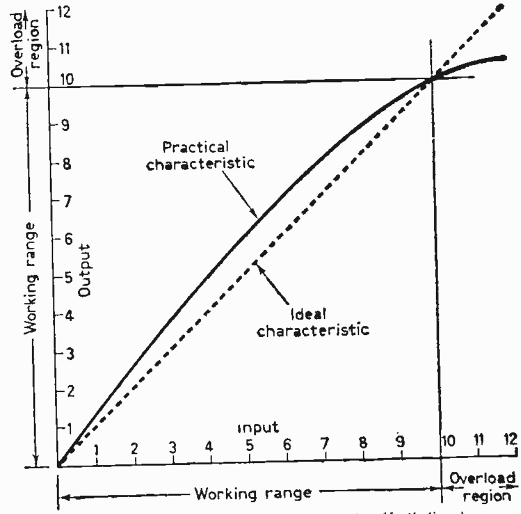


Fig. 2: Practical transfer characteristic (full line) compared with the ideal (broken line). Note increase in curvature outside the limits of the working range.

If it is impossible to secure these conditions and it is found that sound-on-vision occurs when the tuner is adjusted for the best definition of the higher frequency gratings, it is probable that the sound rejector is somewhat off tune; if maximum sound fails to coincide with the best definition when the fine tuning is adjusted, the sound i.f. transformers may also require a retune.

If the sound rejector is badly off tune a dip will occur in the vision i.f. response at a frequency removed from the sound i.f. This will let sound into the vision channel, as already explained, and will also attenuate the sidebands of the vision signal, showing on Test Card "D" as bad definition of the gratings corresponding to the affected frequency or frequencies. For this sort of test it is necessary to wait until the sound modulation is switched off during a Test Card "D" transmission—this happens at irregular intervals during the transmission.

It is not intended in this article to delve deeply into servicing procedures but one or two words about rejector tuning might not be amiss. It must be emphasised at the outset however that it is not possible fully to align a television receiver without the use of (a) a service manual or service sheet for the set, (b) a signal generator covering

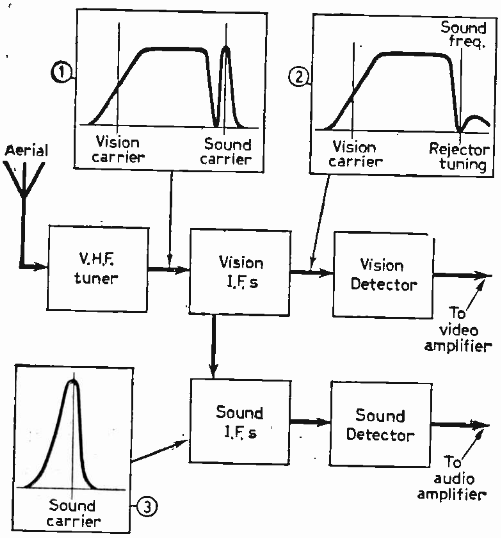


Fig. 3: Simple block diagram of a 405-line standard receiver, showing responses and signals.

the v.h.f. and i.f. bands and (c) a voltmeter or other similar instrument for recording sound and video signals at the outputs of the sound and vision channels.

Nevertheless, some adjustment of the rejector is possible—once it has been accurately located on the chassis or printed circuit board—on a transmission. The best plan is to set up everything ready for a tone transmission during a session of Test Card "D". This is done by giving the set time to warm up properly, by adjusting the fine tuning for maximum sound and slipping the line lock so that a dark, vertical bar appears on the picture, dividing it into two halves, called the condition of false line lock. Under this condition the display is most sensitive to sound breakthrough, which shows as ripple on the vertical edges of the picture either side of the dark, vertical bar.

Make sure that a core adjusting tool (non-metallic) is ready for tuning the rejector core. When a test tone comes on the sound channel, distinct waves will be seen on the edges of the picture, as just mentioned, and the exercise is then to adjust the rejector core very carefully until the waves disappear completely. This is the correct tuning point. One problem of this simple method of adjusting is that the sound breakthrough is not always sufficiently severe to give an accurate indication of the null point of the rejector's tuning. It is also most important to ensure that the fine tuning is adjusted for maximum sound before tuning the rejector.

If, on the other hand, it is found that the sound fails to coincide with the best picture definition on the fine tuning control, an attempt should be made to bring the sound i.f. tuning into correct alignment *before* making any adjustment to the rejector. This is fairly easily done by first adjusting the fine tuning control for optimum definition as shown by the test card frequency gratings, and then carefully adjusting the cores of the sound i.f. transformers to bring the sound up to maximum without touching the fine tuning control. After this, the rejector can be adjusted as already explained. A point to note here is that it is not particularly desirable to peak the sound i.f.s for two reasons: (a) oscillator drift is emphasised, and (b) the sound noise limiter performance is impaired. Thus after peaking the transformers it is a good idea slightly to detune the cores to flatten the tuning a little.

So far we have assumed that sound-on-vision is occurring at all levels of the volume control—even when the volume is turned all the way down. The symptom however sometimes occurs due to effects in the field timebase. A microphonic valve for example or bad decoupling or filtering in an h.t. supply circuit common to both the sound and field timebase sections can incite the effect. Microphony in the field timebase valve can modulate the field scan due to sound vibrations from the speaker activating the microphony shortcomings of the valve. This can be proved by turning down the sound. If the sound breakthrough now ceases, it is caused by one or other of the two possibilities just mentioned.

The best test for valve microphony is by tapping the suspect with the handle of a screwdriver with the volume control fully retarded while observing the picture. If this action "shatters" the picture with dark, horizontal lines, the valve is responsible. Otherwise decoupling should be suspected, which usually turns out to be a low-value or open-circuit electrolytic capacitor somewhere on the h.t. supply feeding both the sound output stage and the field timebase—an electolytic open-circuit on the screen grid of the sound output pentode has been known to cause the trouble.

Overloading of the signal-carrying stages, giving rise to severe non-linearity, can also be responsible for vision-on-sound, and this can be tested by attenuating the signal as explained for sound-on-vision. Vision-on-sound shows up as a rough buzz accompanying the sound, the strength and pitch of which tends to change as the content or make-up of the picture alters. If the picture brightens due to an increase in level of the picture signal, the buzz characteristically becomes louder. This is vision-on-sound.

It must not be confused with mains hum, which remains when the aerial is removed from the set; nor with field timebase breakthrough into the sound channel, which can be tested by removing the aerial, turning the volume control to maximum and then adjusting the vertical hold control. If this action alters the pitch of the buzz, the trouble is field timebase breakthrough, which is another story.

On the 405-line standard, the prime cause of vision-on-sound—excepting overloading—is incorrect alignment of the sound i.f. transformers. Figure 3 gives an elementary block diagram of the pertinent sections of a 405-line standard set. The v.h.f. tuner, it will be recalled, delivers both sound and vision signals at i.f., the sound signals are rejected in the vision i.f. channel and the vision signals are kept out of the sound i.f. channel by the sharpness of the sound i.f. tuning. These three factors are shown at (1), (2) and (3) in Fig. 3.

If incorrect tuning of the sound i.f. transformers shifts the response from the sound carrier towards the vision carrier (see (1)) the sound channel will receive a weakened (detuned) sound signal *plus* some sideband components of the vision signals, which are the cause of all the trouble. The break-through disturbance is also emphasised because the weakened sound signal proper reduces the signal-to-interference ratio, so that to restore the sound to its correct level the volume control has to be advanced well beyond its normal setting.

The trouble can be cleared by retuning the sound i.f. transformers, and the method outlined above can be adopted if alignment instruments are not available.

On the 625-line standard, misalignment of the intercarrier sound channel can produce the symptom, but owing to the manner in which the circuits work it is generally referred to as *intercarrier buzz*. The corresponding block diagram (somewhat simplified) of the scheme is shown in Fig. 4. Here it will be seen that both the vision and the sound signals are purposely arranged to pass through the main i.f. stages and arrive together at the vision detector. This is possible because on this standard frequency-modulated sound is adopted, to which the vision detector is effectively insensitive. However, the detector does serve to intermodulate, so to speak, the sound and vision signals—modulating one upon the other—resulting in a new signal which has a frequency equal to the difference between the sound and vision signals. This difference is 6Mc/s, as shown in (1) on the diagram.

A 6Mc/s filter in the vision channel delivers the 6Mc/s signal, called the intercarrier signal for obvious reasons, to the intercarrier sound stages which are tuned to 6Mc/s, from whence it goes to the f.m. sound detector.

To secure the correct "signal balance" at the vision detector the sound carrier is set at a level considerably below that of the maximum vision response amplitude (see (1) on the diagram). Moreover the intercarrier signal will never deviate from 6Mc/s no matter how the fine tuning is altered within the bounds of the television channel because it is set at the transmitter by the frequency difference between the two carriers. However, trouble can arise if the tuning of the intercarrier sound stages differs from 6Mc/s. In this event the intercarrier sound signal itself will fail to coincide with the response peak of the intercarrier sound stages; it will fall on the slope side of the response curve, as shown at (2) in the diagram. This causes the sound to be weak and demands an abnormally high setting of the volume control with a consequent impairment of signal-to-intercarrier buzz ratio.

Thus so far we have two main causes of intercarrier buzz: (1) incorrect level of the sound carrier in the vision i.f. channel and (2) misalignment of the intercarrier sound stages and associated tuned circuits and filters. There is a further cause (3) which is unbalance of the f.m. sound detector, resulting in the detection of residual sidebands of the vision signal. This happens because when out-of-balance an f.m. detector will tend to respond to residual a.m. signal.

We can test for (1) by adjusting the u.h.f. tuning and listening for any change in the level

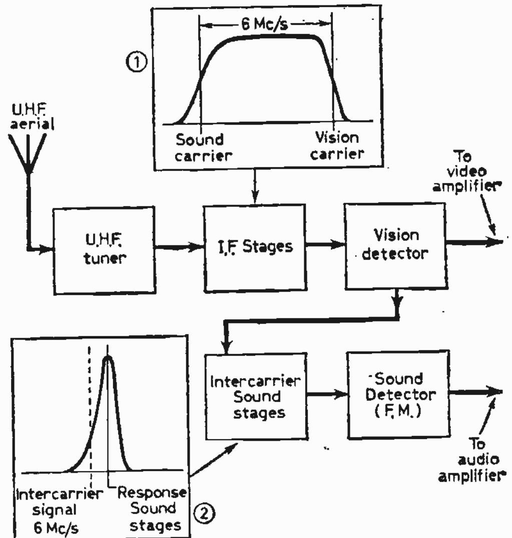


Fig. 4: Simple block diagram of a 625-line standard receiver, showing responses and signals.

of the buzz. If there is a substantial change, misalignment of the i.f. stages is likely. This is because tuning the oscillator will change the position of the carriers along the overall i.f. response curve, and thus alter their relative levels.

Cause (2) generally gives rise to abnormally high levels of sound background, containing buzz, hum and interference crackles due to the required high setting of the volume control.

The best test for cause (3) is to carefully adjust the small preset control associated with the f.m. detector. When the detector is correctly balanced by means of this preset the buzz will fall to a low level. If the level starts to fall when the control is turned to one extreme of its range, then one of the diodes in the sound detector could be defective or the ratio detector transformer could be misaligned.

Finally, a word or two about testing for vision bandwidth. Without elaborate test instruments the test cards are the best way of checking this. On the 405-line standard, the 2·75Mc/s frequency gratings of Test Card "D" should be reasonably well defined when the fine tuning control is critically adjusted for maximum sound, consistent with minimum sound-on-vision. When it is tuned beyond that critical point the 3Mc/s gratings might just about become visible, but then the picture is likely to be affected by the sound signal. Adjusting the tuning in the opposite direction should progressively reduce the definition frequency and ultimately cause smearing from the right-hand side of the black rectangle in the white background at the top of the card when the vision i.f. stages are correctly aligned.

Test Card "C" on the 625-line standard actually gives the values of the frequency gratings and optimum definition should occur when the tuning is for maximum sound. Misalignment symptoms on this standard have already been considered.

TO BE CONTINUED

PART ONE

X-RAY RADIATION

MARTIN L. MICHAELIS M.A.

FOLLOWING the X-ray radiation meter constructional feature in the May and June issues of PRACTICAL TV, this short series of articles will explain the nature of and conditions for the production of X-rays with particular reference to television receivers and other high-voltage equipment.

Electromagnetic Radiation

X-rays are electromagnetic waves obeying the same physical laws as other more familiar forms such as the carrier waves of TV picture and sound transmissions. They are propagated at the same speed as radio waves, light, and other forms of electromagnetic radiation. Their wavelength is so short that it is convenient to use the *Ångström* (Å) unit: one Å is equal to 10^{-10} meters. The wavelength of X-rays produced by sudden stoppage of electrons when they reach an anode plate after acceleration through 25kV (typical e.h.t. voltage for colour TV receivers) is 0·48Å. The corresponding frequency is $6{\cdot}25\times 10^{12}$Mc/s, an immense figure.

Electromagnetic radiation is produced or absorbed by the deceleration or acceleration of electric charges, i.e. by *changing* the total energy (kinetic and/or potential) of electric charges. The larger the energy change involved the higher the resulting frequency and thus the shorter the associated wavelength. The electrons flowing up and down a transmitting or receiving aerial *individually* suffer only extremely small energy changes, but huge numbers of electrons contribute to the radiated or picked-up power. The associated wavelengths are thus very long, i.e. many centimetres or metres, in TV and radio broadcasting. The energy changes of *individual* electrons amount to only 0·2μV acceleration or deceleration for absorption or emission of 50Mc/s electromagnetic radiation. On the other hand in the shunt stabiliser triode of a colour TV receiver we are accelerating electrons from rest up to 25kV then suddenly stopping them when they strike the anode. Most of the kinetic energy of the electrons is converted to heat, but some of the electrons radiate their entire kinetic energy loss as electromagnetic radiation of correspondingly immense frequency, i.e. as X-rays.

Quantum Theory

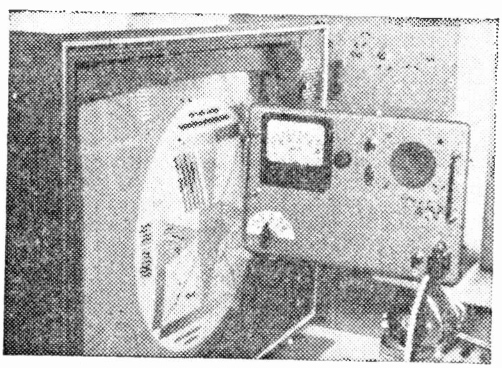
Thus the frequency of an electromagnetic radiation is directly proportional to the magnitude of the "energy jump" of the charged particle responsible for the radiation. This is known as *Planck's Quantum Law of Electromagnetic Radiation:*

$$E=h\times f$$

here E is the energy jump of the charged particle, f is the frequency of the resulting electromagnetic radiation in c/s, and h is the constant of proportionality, known as *Planck's Universal Constant of Action*, or simply *Planck's Constant*. The numerical value of h depends on the units in which we express the energy E. For our purposes it is convenient to express E in electron-volts (eV). One eV is the kinetic energy acquired by an electron when it is drawn through a potential difference of one volt. If we express E in electron-volts the value of h is $6{\cdot}62\times 10^{-34}$ Volt-Ampere-Seconds^2 (Joule-Seconds).

50Mc/s TV Transmitter

Using this value for h and $f=50$Mc/s we obtain a value of $3{\cdot}31\times 10^{-27}$ Joules for the associated energy E. Thus *every individual* electron in the transmitting aerial must lose *exactly* this amount of energy in single or successive steps if the resulting radiation is to be at 50Mc/s as set by the transmitter driving the aerial. If the electrical dimensions of the aerial do not happen to be such that electrons confined in it prefer to make energy jumps of this and not some



The author's X-ray radiation meter being used to check radiation from the screen of a colour television receiver. Reading 25μr/h, i.e. no significant level above cosmic background.

other magnitude, then the aerial is unable to accept and radiate the power presented to it. Large fractions of the power are then sent back into the transmitter unconverted to electromagnetic radiation. Only when the electrical dimensions of the aerial match the transmitter frequency can the electrons make energy jumps in unison of the correct magnitude for radiating the presented bulk energy as electromagnetic radiation at the transmitter frequency.

Resonance

This throws a rather important new light on the nature of the familar phenomenon of resonance, and interpretation in this sense is essential for proper understanding of X-rays when we move on to consider the corresponding larger energy jumps. The important principle which must be stressed here is that the "preferred energy jumps" are in some general way inversely proportional to the physical dimensions of the radiating system. It is a familiar fact that the dimensions of a transmitting or receiving aerial should be a multiple of a quarter wavelength (or a single quarterwave) of the intended frequency if optimum efficiency is to be obtained. Accordingly if we wish to produce the immense frequencies of X-rays with corresponding tiny wavelengths the associated "aerials" must be similarly tiny, i.e. of sub-atomic dimensions. In other words the electrons which are to lose energy in large single steps of around 25keV must do so by getting caught-up in the structure of *single atoms* of the target anode which thus functions as countless X-ray transmitting aerials.

If we have a piece of wire or a metal rod 150cm. long (quarterwave radiator for 50Mc/s) the possible energy states of electrons confined in this rod as a whole are separated by only 0·2μeV. This energy quantum corresponds to 50Mc/s electromagnetic radiation, according to Planck's Law. If we make the rod smaller the possible energy levels for electrons confined in it move farther apart so that larger energy jumps are involved corresponding to higher frequencies. The shorter rod thus has a higher resonant frequency, as will be familiar to most readers. Now imagine this shortening process continued until we are left with just a single atom. The resonant frequency has now moved right up to visible light and X-rays.

Atomic Structure

A metal rod or wire resonates at the frequency at which its length is a quarter wavelength and at any multiple of this fundamental resonant frequency. The frequencies which can be radiated or absorbed by the electrons in this rod thus constitute a simple harmonic series. The structure of atoms, i.e. the disposition of the electrons within a single atom, is rather more complicated, so that the resonant frequencies of an atom are irregularly spaced and no longer constitute a harmonic series. Nevertheless this does not alter the basic principles. It is convenient to consider the possible energy jumps of electrons in an atom in terms of more or less distinct groups according to the distance of the electron from the nucleus. The *outermost* electrons, i.e. those farthest away from the nucleus of the atom, have a relatively large region of space at their disposal so that they amount to a fairly large "aerial" with correspondingly small energy jumps and long wavelengths of associated radiation. The wavelengths involved here amount to about 5,000Å. Electromagnetic radiation of about this wavelength is visible light which is produced by energy jumps of the outermost electrons in atoms and never by any other means. The associated energy jumps amount to about 2·5eV.

The innermost electrons of an atom, those closest to the nucleus, are confined to a much smaller region of space and thus represent still smaller "aerials" than the outermost electrons which produce visible light. The actual constriction and thus the energy levels of the innermost electrons depends on the total number of electrons which the particular atom possesses. The heavier the type of atom the greater the number of outer electrons constricting the inner ones and thus the larger the energy jumps for electromagnetic interactions of the innermost electrons. Table 1 gives a few typical values for the characteristic energy jumps of the innermost electron in atoms of various elements likely to be used for the construction of television cathode-ray tubes, e.h.t. valves, etc. Electromagnetic radiation of corresponding quantum energy can be excited if electrons strike targets (valve anodes, c.r.t. screen, glass, etc.) containing these elements after electric acceleration through at least the respective specified voltage.

Emission and Absorption of X-rays

When an electron with sufficient kinetic energy strikes an atom in the anode or other target material it can knock an innermost electron of that atom right out of the atom. This step is analogous to the passage of electric energy from the tank coil of a transmitter into the aerial wire. The aerial wire, or our target atom, is now in the *excited* state. In either case the electron soon drops back to its former state, or the vacancy captures a different roving electron which amounts to the same thing. The energy thereby radiated is a quantum of electromagnetic radiation of the characteristic frequency and wavelength corresponding to the energy jump. In the transmitter this is the actual radiation energy which the excited aerial releases as electromagnetic waves into space.

We may next consider what happens to radiated X-rays. It is helpful again to think of the behaviour of the much longer radio wavelengths. These proceed through space until they meet some system capable of resonance, i.e. capable of picking up the electromagnetic energy and converting it to energy of charged particles in the system. Any matter will gradually absorb electromagnetic radiation in a random manner in this way, but properly tuned resonators are much more effective.

Thus wireless waves can travel great distances even if the medium is far from a proper vacuum, because diffuse matter (air, etc.) is far from resonance to these low frequencies unless it is ionised (ionospheric absorption). Conditions are different for the much higher frequencies and shorter wavelengths of X-rays. We mentioned earlier that the resonant frequencies of an atom never form a simple harmonic sequence but rather an intricate irregular set of groups. Thus whatever the actual type of atom concerned there will always be one or many resonances close to the actual frequency of an incident X-ray radiation and for this reason X-rays are absorbed much more heavily by matter than are the longer wavelengths used in radio and TV.

Various absorption mechanisms can operate, and details are very complicated. However we can note a few simple facts. The shorter the wavelengths, i.e. the "harder" the X-rays are, the better are they able to penetrate matter. Thus the 5·41keV chromium X-rays suffer about 80% absorption in passing through quarter of a millimetre of glass. Consequently there is little chance of low-energy X-rays generated by atoms of elements below chromium in Table 1 being able to penetrate the glass envelope of a valve or c.r.t. even if they are generated internally.

These elements below chromium are the major chemical constituents of glass and of the screen of a picture tube. The electrons accelerated inside the picture tube are fired at this screen and glass material. The resulting internal X-rays are unable to penetrate the substantial thickness of glass in front of the screen, quite apart from the fact that geometry considerations cause most of them to be emitted backwards anyway. A properly constructed monochrome or colour c.r.t. would thus not be expected to produce significant X-ray radiation, and practical measurements confirm this theoretical conclusion.

Colour picture tubes employ a metallic shadow-mask and it is important to use as light a metal as possible. If the mask was made of copper, or even molybdenum or tungsten or an alloy containing these heavy metals, we would be introducing atomic resonances capable of exciting hard X-ray emissions with the 25keV electron beam. These hard X-rays are able to penetrate the glass envelope of the picture tube with significant intensities. On the other hand the aluminium backing of modern monochrome picture tube screens is harmless. The K-line resonance for aluminium is only 1·49keV and such soft X-ray radiation is unable to penetrate the thick glass front of the tube. The K-line resonance is always the highest possible frequency. Thus all other possible resonances are of lower frequency and energy and even less able to penetrate the glass.

High-power valves must be provided with heavy metal anodes made of tungsten, molybdenum or special alloys most of which possess hard X-ray resonances. Lighter elements lead to unduly short service life whilst on the the other hand it is not possible to make the glass bulb thick enough to absorb the hard X-ray produced by the heavy metal anodes when e.h.t. accelerated electrons strike them. High levels of X-ray radiation through the envelope of these valves is thus more or less inevitable, and external shielding must be provided where necessary. This applies for any valve run at voltages above 5 to 10kV at considerable anode current, thus in particular to many types of commercial transmitter power valves.

In television receiving equipment projection picture tubes have long been the only important case but the shunt stabiliser triode in colour TV receivers is a recent addition to receiver X-ray sources. The e.h.t. rectifier is a potential source of X-rays under *fault* conditions. Under normal conditions the voltage across the e.h.t. rectifier when drawing current is too low for significant X-ray generation. A high inverse voltage, or a high voltage applied to a cut-off tube, produces no X-rays since it is not voltage alone but *electrons* accelerated through a high voltage that produce X-rays.

We have now covered the nature and origin of X-rays. Next month before proceeding to describe the measurement of X-rays we must go further into the quantum nature of electromagnetic radiation. A proper understanding of quantum emission, known as *photons* in the case of electromagnetic radiation, is quite essential before we can fully appreciate the use of an ambient radiation meter for measuring X-ray intensities.

TO BE CONTINUED

TABLE 1

K-LINE QUANTUM ENERGIES FOR X-RAYS (approximate values) AND WAVELENGTHS

Element	*Energy*	*Wavelength*
Carbon	282eV	43Å
Nitrogen	392eV	31Å
Oxygen	523eV	23Å
Neon	851eV	14Å
Sodium	1·04keV	11·5Å
Magnesium	1·25keV	9·6Å
Aluminium	1·49keV	8·1Å
Silicon	1·74keV	6·9Å
Argon	2·96keV	4·1Å
Potassium	3·31keV	3·6Å
Calcium	3·69keV	3·25Å
Titanium	4·51keV	2·66Å
Chromium	5·41keV	2·22Å
Iron	6·40keV	1·88Å
Cobalt	6·93keV	1·73Å
Nickel	7·48keV	1·60Å
Copper	8·05keV	1·49Å
Molybdenum	17·48keV	0·69Å
Tungsten	59·31keV	0·20Å
Uranium	about 100keV	0·12Å

AT the recent Brighton Arts Festival there was an ambitious and varied programme in which the British Film Institute organised an exhibition and two-day conference about the future of films for the cinema and for television. Stanley Reed, Director of B.F.I., and his executives had planned an event which attracted delegates from all parts of the film and television industries, with Sir Michael Balcon in the chair. Following some constructive addresses there were lively debates: in all it was a courageous undertaking that will be long remembered in Brighton.

The exhibition of early historic motion picture apparatus was splendid, with photographs and relics of the 1900-1906 vintage days of film making in Brighton and Hove. For it was here that the first Hollywood-type film colony set itself up under the benevolent American despot Charles Urban.

During 1900 to 1910 London suffered badly in the winter months from thick fogs, intensified by the millions of smoky chimneys, which was why Charles Urban encouraged film production in Brighton. He even promoted the manufacture of motion-picture cameras in the town when Alfred Darling, a photographic instrument maker, was able to supply him with the heavy wooden film camera. Urban sold these in all parts of the world, even penetrating the Edison Trust territory of the USA. Williamson's started making their own film cameras, in Brighton, too! Then in about 1903 there were no less than six makes of professional motion-picture cameras being made and sold in England: Prestwich, Moy, Williamson, Darling, Wrench, Newman. Hundreds were exported. Now in 1968 there are no 35mm. motion picture cameras being made in England!

Little has been done in the world development, manufacture and sale of *new* types of 35mm. motion picture cameras since about 1932. Any improvements that have been introduced have been minor refinements. The most obvious and important improvements have always seemed to concern the photographic lens and electronic aids. These are skillfully patched on to motion picture cameras which, in some cases, were being designed and on the drawing-board more than thirty years ago.

Now that the Central Unit for Scientific Photography (CUSP) has been created research facilities will become available for film camera manufacturers to start afresh on a completely new concept, avoiding the noisy gears which are so difficult to silence by introducing crystal-controlled motors; and more efficient camera drive by using torque motor for film take-up instead of mechanical spring belts. All these things and many others could bring the professional motion picture camera up to date. Variations of the same camera could be used for telerecording pictures on to 16mm. or 35mm. film (for educational purposes) by photographing good quality video-taped pictures off the face of a TV monitor. In educational usage this would overcome the restrictions of the interchange of helical-scan videotape for which a standard has not yet been adopted. In any case, there are already 23 such standards in use. The only type which is used by all is 16mm. or 35mm. film—that is, the same as applies in world television entertainment.

The fact that the Film Production Association and the British Kinematograph Sound and Television Society propose in principle to collaborate with CUSP should make this possible.

DEVELOPMENTS

At the commencement of television in Britain the BBC took over existing buildings and adapted them from theatres, concert halls, film studios and warehouses. Equipment from film studios was introduced. Now the boot is on the other foot. Film studios are imitating many of the techniques, technical facilities and equipments of television studios. The new dual-purpose stages at Pinewood and Elstree have paved the way.

After considerable independent research both these studio managements preferred to use bricks with steel framework for the buildings rather than concrete. This was one of the big steps forward which helped to remove structure-born noise and at the same time looked in every way pleasanter than the concrete jungle. It turned out to be a less expensive method of building, too.

A great step forward has just been made with a new light source, a much improved version of the incandescent lamp previously known as the tungsten iodide lamp but now called the tungsten halogen lamp. This is a very much smaller lamp the glass bulb of which doesn't blacken and the life of which is longer. At present it is fitted with the standard type bipost for fitting into existing old-type lampholders in old-type spotlights.

This new development has been carried out in both England and America and British Lighting Industries Ltd. were the first in London to give a demonstration. This will result in a new series of lightweight spotlights, flood lights and reflector lights which will benefit film and television studios, especially colour television.

Iconos

Colour Receiver A.G.C.

T. John

AMONG the sections of the receiver where we are going to have to get used to new techniques with the advent of colour sets is the a.g.c. circuitry. From the commencement of dual-standard operation the use of mean-level a.g.c. has been the general rule because of the complications that arise with a dual-standard gated system operating on the two different sets of parameters. The disadvantage of the mean-level technique is well known: the a.g.c. potential varies with changes in average picture content as well as with changes in signal strength so that the black level, the "reference point" in the television signal waveform, is lost, resulting in a picture that lacks good black-and-white contrast. On 405-line operation, for example, a predominantly dark scene will lead to a reduction in the a.g.c. potential so that the gain of the receiver increases and the picture is brightened. On 625 lines with negative picture modulation the opposite effect occurs, so that a dark picture becomes darker still.

In practice this disadvantage of the mean-level system has been found to be not too objectionable by viewers. With colour, however, the problem is aggravated since the drawback of the mean-level system here in addition affects the intensity of colour reproduction. Thus for colour reception it is desirable to use a system that samples the received signal at some definite level.

The gated systems used in many fringe-area 405-only receivers sampled the signal during the back porch period when the signal is at black level. Because, however, of the use of negative modulation on 625 lines a simple alternative with this system is to sample the signal during the sync pulse period, since the sync pulse represents maximum signal amplitude. This technique, in fact, called *sync-tip a.g.c.*, is used on all current colour receivers in the 625-line mode. It is simple to achieve, since all that is required is a diode or transistor operating as a rectifier to provide "peak detection" of the tips of the sync pulses.

One widely used type of circuit, employing a transistor (Tr1) as the peak detector, is shown in Fig. 1 (the particular circuit is as used in the Pye colour chassis). Here on 625 lines the input from an emitter-follower stage in the luminance channel is applied direct to the base of Tr1. The potential divider R1, R2 in the emitter circuit biases the transistor so that it only conducts at maximum signal amplitude, i.e. the sync tips. As a result of this Tr1 provides an output that is dependent on the amplitude of the sync pulses in the received signal. This is smoothed by C1 and used to control the a.g.c. amplifier stage Tr2. C1 also prevents Tr1 bottoming, i.e. being driven into saturation, by the sync pulses. D.C. coupling to the amplifier stage is used, via a voltage-dependent resistor in this example. C2 provides the main a.g.c. system smoothing.

The colour receivers so far introduced all use transistors in the i.f. strip and, of course, the u.h.f. tuner unit (or integrated u.h.f./v.h.f. tuner unit) so that the forward a.g.c. technique as used in hybrid black-and-white receivers is employed. With this system the a.g.c. potential is used to increase the conduction of the controlled stage when the signal increases instead of reducing the current through the transistor with increase in signal strength as in the "normal" reverse a.g.c. system used in radio receivers and the sound i.f. strips of television receivers. With the forward a.g.c. system reduction of gain is achieved by incorporating a bypassed resistor in series with the collector of the controlled stage so that as the current through the transistor increases its collector voltage falls, i.e. stage gain is reduced. This technique has the advantage of keeping the controlled transistor on a more linear part of its characteristic, giving improved signal-handling performance.

A stage of amplification is necessary between the a.g.c. rectifier and the controlled stage(s), and the circuit is arranged so that this transistor, the a.g.c. amplifier (Tr2 in Fig. 1), is bottomed, i.e. fully conducting, under weak-signal conditions. In this condition, to take the example of an n-p-n

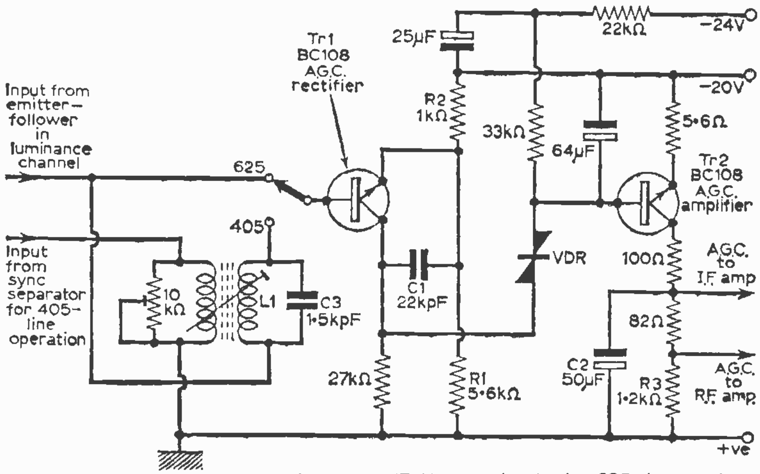


Fig. 1: A.G.C. circuit using a peak detector (Tr1) operating in the 625-line mode on the sync tips and an a.g.c. amplifier stage (Tr2).

a.g.c. amplifier controlling an n-p-n i.f. stage as is actually the case in Fig. 1, maximum voltage negative with respect to chassis is developed across the a.g.c. amplifier load resistor R3. On increase in signal strength the a.g.c. rectifier output reduces the conduction of the a.g.c. amplifier so that the voltage across the load resistor decreases, i.e. becomes less negative. This is equivalent to applying an increased positive bias to the base of the controlled stage, and since with an n-p-n transistor a positive-going drive is required at the base to increase the current flowing through the transistor the stage then passes a greater current. As a result its collector voltage falls giving forward a.g.c. action.

The above conditions apply when silicon n-p-n transistors are used in the i.f. strip, as they are in most of the colour receiver chassis, and in this case a silicon n-p-n transistor is used for the a.g.c. amplifier. The exception to this state of affairs is the Bush-Murphy colour chassis in which germanium p-n-p transistors are used up to the final vision i.f. stage, with an OC45 p-n-p transistor a.g.c. amplifier. Here again the amplifier stage is operated in the bottomed condition on weak signal reception, but a negative-going control potential is required to increase the conduction of the controlled stages to provide forward a.g.c. action. The Bush-Murphy a.g.c. circuit, using a diode (D1) 625-line sync-tip peak detector, is shown in Fig. 2.

As in monochrome practice delay is generally incorporated in the a.g.c. circuit so that the gain of the r.f. stage is not reduced until the input signal reaches a high level, thereby obtaining optimum signal-to-noise performance on weak signals. At high input signal levels the a.g.c. needs to be applied to the r.f. amplifier in order to prevent overloading in the initial stages. A widely used delay system in colour receivers is shown in Fig. 3 and has the advantage of making the a.g.c. to the i.f. and r.f. stages largely independent.

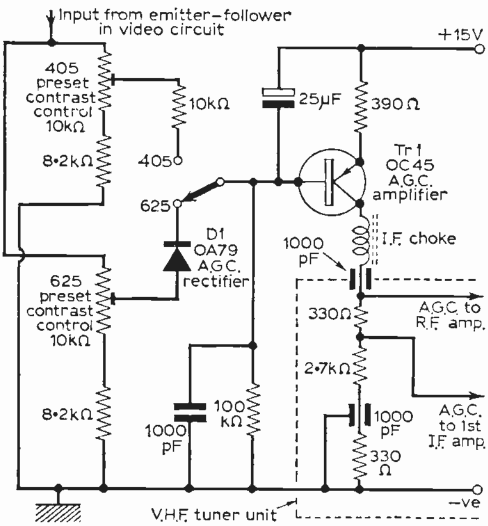


Fig. 2: A.G.C. circuit used in Bush-Murphy models with diode peak detector and p-n-p a.g.c. amplifier.

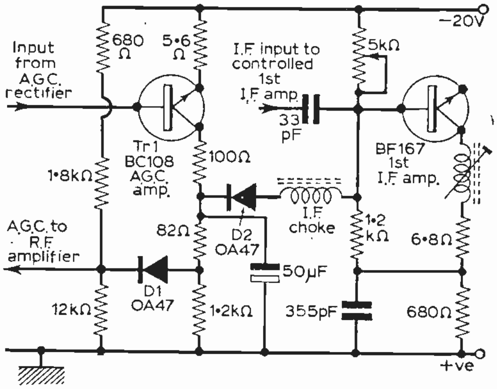


Fig. 3: Commonly used a.g.c. delay circuit providing independent control of the r.f. and i.f. stages.

When the a.g.c. amplifier is bottomed at low signal strength diode D2 is forward biased and diode D1 reverse biased so that a.g.c. is applied to the i.f. stage only, via D2. As signal strength increases and the voltage across the a.g.c. amplifier load resistor falls, however, the situation as determined by the bias networks on the anode side of D2 and the cathode side of D1 reverses, D1 then being forward biased so that the a.g.c. is applied to the r.f. stage and D2 reverse biased cutting off the a.g.c. to the i.f. stage.

The sync-tip system cannot be used on 405 lines since the sync tips then represent nil modulation. Thus some other technique must be used. In many chassis mean-level a.g.c. is reverted to on 405 lines. On other chassis, however, another new technique is used—the "sync ringing" system. This provides gated operation on 405 lines so that the black level, at the back porch of the television signal waveform, is the reference source for the a.g.c. system.

Reverting to Fig. 1, the input to the a.g.c. peak detector on 405 lines is taken via the ringing circuit L1, C3. This is coupled to a winding fed with pulses from the sync separator stage. These constant amplitude pulses are combined with the video signal to provide the gating action. The system is designed so that on the first positive overswing following the sync pulse the a.g.c. rectifier samples the signal. This point coincides with the back porch period of the television waveform, giving us a black-level reference.

The 625-line a.g.c. system previously described also provides mean-level action under certain circumstances i.e. when the receiver is not in tune and when system changing, in order to prevent lock-out.

In addition to a.g.c., a.f.c. is incorporated on some colour chassis. The Thorn/B.R.C. system was described by K. Royal in the January issue of PRACTICAL TELEVISION. That used in the Pye chassis operates on similar lines. It is also general practice to use automatic chrominance control (a.c.c.) in the decoder the usual system being to rectify and smooth the burst signal and use this output to control one of the chroma amplifier stages. ■

Servicing TELEVISION Receivers

No. 147 - SOBELL/G.E.C. 1000/2000 SERIES—*continued*

by L. Lawry-Johns

WE can now back-pedal a little and return to the line output stage. The e.h.t. rectifier often develops an open-circuited heater, this of course causing complete loss of screen illumination. The fault is fairly obvious since the line timebase whistle is still healthy on the 405 line standard but the DY86 (or DY87) does not light up. A DY86 or DY87 is specified and this is the valve to use for replacement. It's no earthly good trying an EY86 because it just won't work. An internally shorted DY86 will cause gross overloading of the output stage reducing the line whistle and perhaps causing the PY800 and/or PL500 to overheat.

Efficiency diode

This valve (PY800) can give some trouble at times. It can just go down (lose emission) or occasionally short inside, both resulting in loss of picture. Gradual loss of emission will give a reduced width effect particularly on the left side.

Line output valve

This valve (PL500) is the prime cause of loss of width where the unfilled margin each side gets wider each day. It also has the unpleasant habit of developing an intermittent internal short that damages its screen feed resistor (R122 on scanning panel). Unless one is prepared for this, the resistor can be replaced without the PL500 giving further trouble until the set has been returned to the customer when the same thing happens again much to the annoyance of all concerned. A PL504 can be used for replacement.

Intermittent loss of line hold

Sudden loss of line hold and equally sudden restoration is often the result of a poor soldered contact on the small scanning panel and erratic operation as the panel is moved provides proof of this. Usually the poor connection is around the P3/2D discriminator (flywheeel sync diodes). It doesn't take long to run around all these joints with a hot iron and some resin cored solder.

Line hold troubles need not be confined to the small scanning panel. The PCF802 contributes its quota of loss of line hold or no line oscillation troubles and this is a must to check.

Bottom compression

This is a very common fault on most makes of receiver and is usually due to a low emission field output valve, an open-circuit bias electrolytic or a leaky linearity capacitor. However on this series there is a very regular cause of this trouble which is not due to any of the factors just mentioned. The 100kΩ P5 overall linearity control

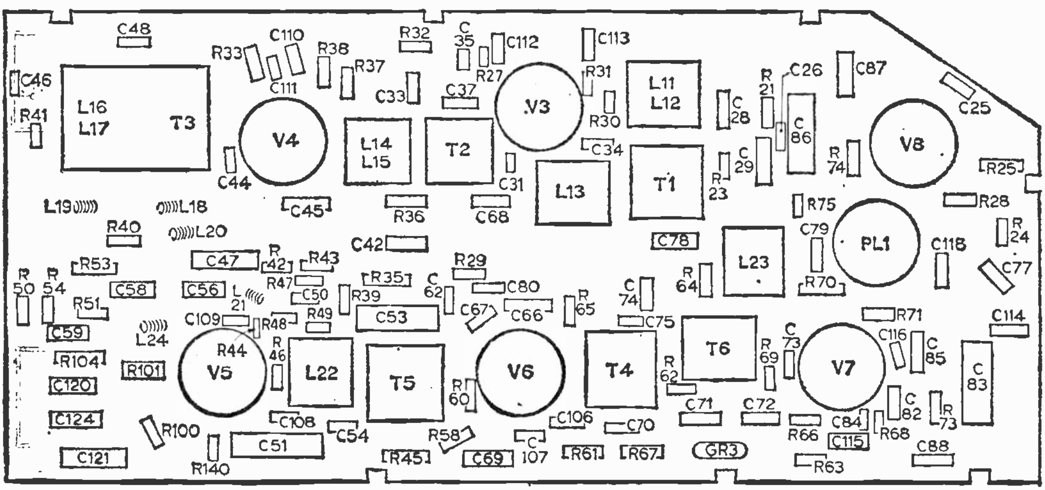


Fig. 3: Component layout of the i.f. printed board.

becomes defective; high resistance or open-circuit at one end of the track. If a preset is not to hand a fixed resistor of about 27kΩ will give (usually) quite even linearity. Having said this we must point out that the control may be innocent and the fault may lie in the PCL85, R88 or one of the capacitors C94 (0·01μF) and C97 (250μF). C92 can get leaky but this will cause bottom fold up and overheating of the PCL85 and R88 (330Ω). Overall lack of height i.e., a gap top and bottom, should direct attention to R127 1·2MΩ on the scanning panel, this being in the boost line feed to the height control.

White line across the centre

Complete non-operation of the field scanning should direct attention to the PCL85, again to the scanning panel, C140 (0·01μF) tending to short to chassis, and to the height control itself. This is, of course, P3 (1MΩ). Check voltages to pins 1, 6 and 7 to ascertain which are absent. For example, no voltage at pin 6 or 7 would trend to suggest that R90 (330Ω) is open-circuit. On the other hand, full h.t. at pin 7 with very low voltage at pin 6 would direct attention to the primary winding of TX1, the field output transformer.

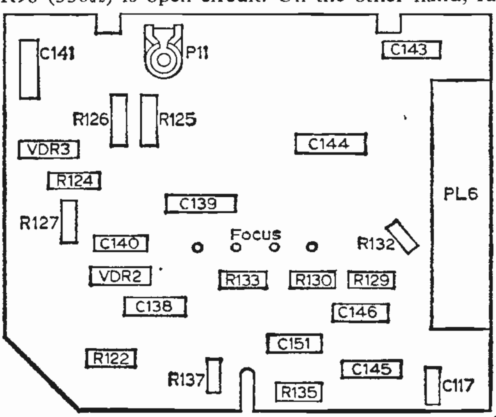


Fig. 4 (above): Scan panel layout.

Fig. 5 (right): Timebase panel layout.

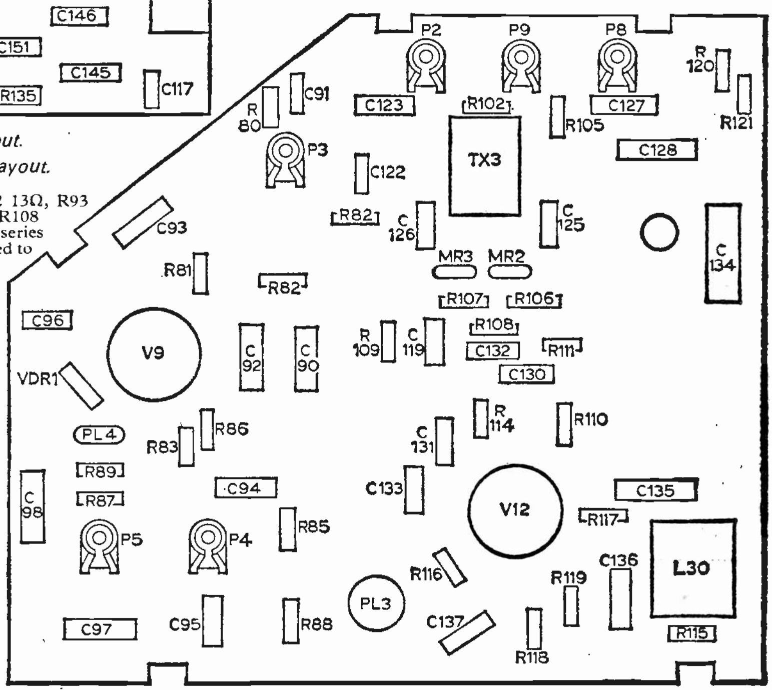
Modifications: C144 0·11μF, R92 13Ω, R93 17Ω, R94 17Ω R101 33kΩ, R108 560kΩ. 300pF capacitor added in series with C119, junction being connected to SW3-1 625-line position.

Video troubles

One persistent fault is the PFL200 running into grid current, although this doesn't occur on these models as much as it does on some others of different manufacture. The reason why it doesn't occur so often is that the grid leak total resistance is about half that used in some makes. It will be seen that R42 and R43 are, from a grid leak point of view, in parallel. Even so, the fault of increasing brightness when on u.h.f. is almost bound to be encountered sooner or later, BBC-1 and ITV apparently not being affected. A new PFL200 will put things right but it is quite in order to reduce the value of the grid leaks provided the ratio of the two values is maintained. Values of 330kΩ and 390kΩ can be used. The PFL200 can also be responsible for a variety of faults ranging from poor sync on either or both standards, the appearance of heavy shading (hum bars) across the screen, to nothing more than a buzz which affects u.h.f. sound only. An internally shorted PFL200 will not only damage the resistors associated with it but also damage the OA70 diode (GR1) if the receiver is switched to 405 when the fault occurs. When switched to 625 the detector diode is divorced from the video amplifier from a d.c. point of view by C47 (0·1μF).

Vision I.F.

Vision signal faults are not confined to the video stage. Whereas it used to be rare for an i.f. stage using EF80 valves to give trouble, it is by no



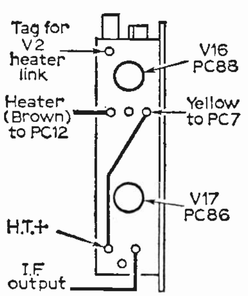


Fig. 6: Representative u.h.f. tuner unit wiring.

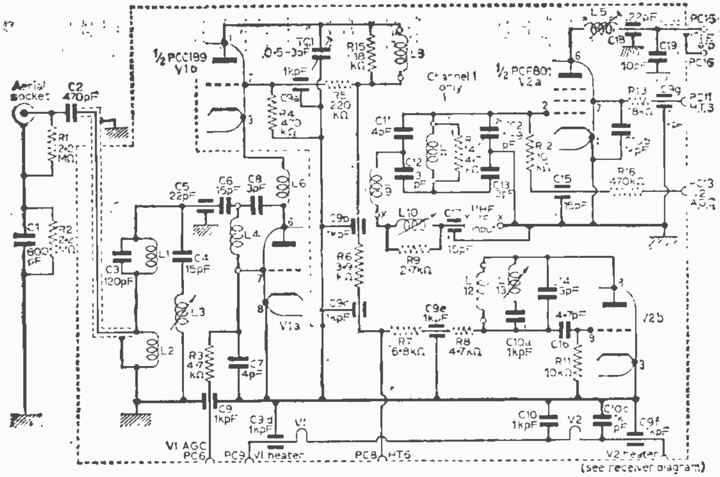


Fig. 7: Circuit diagram, v.h.f. tuner type P33041/1.

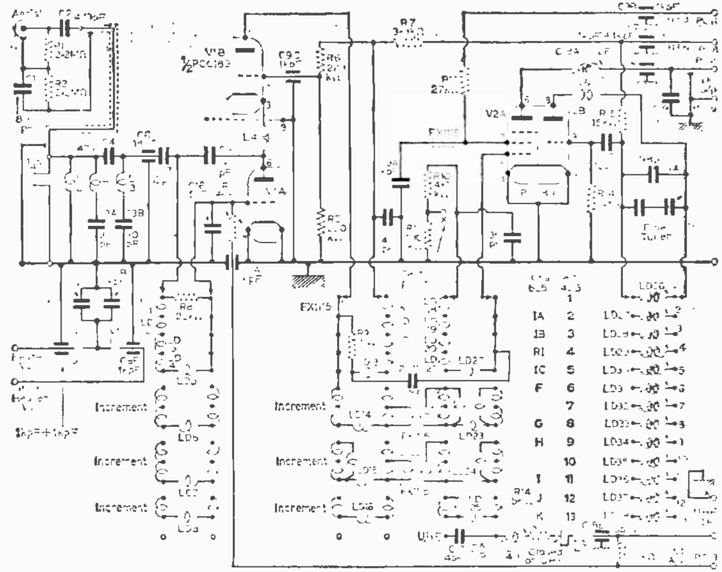


Fig. 8: Circuit diagram, v.h.f. tuner type M96512.

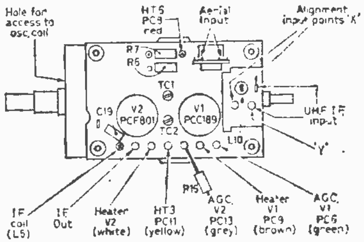


Fig. 9: P33041/1 v.h.f. tuner layout.

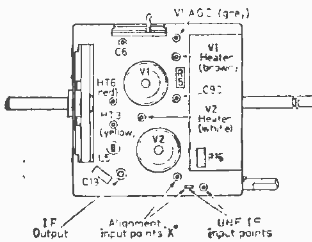


Fig. 10: M96512 v.h.f. tuner layout.

Valve		Anode volts 405	Anode volts 625	Screen volts 405	Screen volts 625	Cathode volts 405	Cathode volts 625	Cathode mA 405	Cathode mA 625
V3	EF183	180*	170*	45*	45*	1·7	1·5	15·5	13·8
V4	EF184	170*	165*	170*	165*	2·4	2·3	16	15·3
V5a	PFL200	130*	125*	170*	168*	4·1	5·8	26	29
V5b	PFL200	170*	170*	95*	95*	—	—	—	—
V6	EF80	170*	165*	170*	165*	1·9	1·9	12·7	12·7
V7	EH90	72	115	42	35	1·6	1·5	1·7	2·4
V8a	PCL84	217	210	227	220	3·1	3	2·6	2·5
V8b	PCL84	1·6	0·9	—	—	1·5	0·8	—	—
V9a	PCL85	200	192	215	206	17·5	17	53	51
V9b	PCL85	48	50	—	—	—	—	—	—
V12a	PCF802	107	100	—	—	—	—	—	—
V12b	PCF802	190	180	—	—	—	—	—	—
V13	PL500	—	—	218	210	—	—	115	140

* Obtained via 100k resistor in series with meter prod-clip. Picture tube first anode 480 volts cathode 110 volts. E.H.T. 16·5kV. Total h.t. current through CH1 300mA (405), 340mA (625). U.H.F. tuner h.t. current 23mA. Boost volts 770 (405), 820 (625). HT1 241V (405), 232V (625); HT2 231V (405), 221V (625); HT3 205V (405), 197V (625); HT4 215V (405), 206V (625).

means rare to find a faulty EF183 or EF184 causing various effects, due no doubt to the finer spacing of the electrodes. These effects can range from complete loss of signal to sound-on-vision, hum bars, vision buzz on sound etc.

Sound stages

The most frequent cause of trouble in the sound section is associated with the EH90 stage, where the two resistors, R73 18kΩ and R71 5·6kΩ give rise to faulty operation.

The usual effect is for R73 to change value and become overheated. R71 doesn't take kindly to this change of conditions and follows suit. Thus there is a low-resistance path from h.t. to chassis through R69 180Ω. This state of affairs usually attracts attention before R69 burns out and the appearance of R71 and R73 will immediately confirm the source of the overheating. As the colours will be indecipherable it is as well to make a note of the values and wattage in case one is caught without the circuit. R73 should be at least 2 watt and R71 at least 1 watt.

Crackling

An intermittent crackling noise unaffected by the position of the volume setting is invariably due to a faulty PCL84 audio-output valve. This is a noise very similar to that caused by leakage from an h.t. track to a grid track on a printed panel or across the pins of a valveholder. The writer once encountered this fault and promptly replaced the PCL84 only to hear a few days later that the fault was still present. Much time was given to checking tracks, valveholder etc. as the fault was intermittent only to find that the new PCL84 was the real culprit.

Persistent buzz on sound

If the fine tuner is not effective in clearing a vision-on-sound buzz, replace C51 32μF electrolytic which decouples R45 supply to V5A screen and V7.

Distortion

If distortion occurs only on a strong signal BBC-1 or ITV but does not affect the u.h.f., check R67 (4·7MΩ) as this resistor tends to go high leaving the diode to receive its bias from R66. Distortion on BBC-2 only should lead to a check of the EH90 and associated resistors, R73, R71, R69 and R68 in that order.

Most other faults which occur on the i.f. panel can usually be traced to poor switch contacts, these either being dirty or not travelling far enough (mechanical adjustment), or to dry joints on the printed panel.

Tuner units

The u.h.f. tuner employs two valves; a PC88 and a PC86. If the tuner is inclined to drift, change the PC86. If the reception is noisy or tends to fade after a few minutes change the PC88 and then check the PC86. If the fault persists check the switching and then check the u.h.f. tuner for dry joints. Quite often an end wire of a resistor may never have been properly soldered but may have functioned well until the wire becomes tarnished. A visual inspection may reveal this without much ado.

The v.h.f. tuner may be one of two types. On either type the contacts must be kept clean to ensure positive switching. A low-emission PCC189 will give rise to a noisy picture as indeed will a faulty PCF801 but the PCC189 should be checked first. If the valves are not at fault check the small 18kΩ resistor R13 (turret tuner) which sometimes goes high. If the u.h.f. signal is strong and clear but one or both of the v.h.f. channels is absent check not only the tuner valves but also the PCF801 oscillator section resistors. In the turret tuner there are two, a 6·8kΩ and a 4·7kΩ in series (the 6·8kΩ tends to go high) and in the other (semi-incremental inductance M96512) there is one 15kΩ.

Remember that the i.f. output of the u.h.f. tuner is fed to the v.h.f. tuner for amplification by the PCF801 mixer section.

Voltage and current data

The readings given in the table on the opposite page were measured with a mains input of 245V a.c. using a 20,000 ohms/volt meter. V3-V8 readings were taken with no signal and the contrast control at maximum, other valve voltages with normal signal applied and then attenuated to just lock the timebases and the controls set to give a normal picture.

Piped systems

In many blocks of flats the u.h.f. signals are changed to v.h.f. on one of the Band I channels so that all signals can be distributed on one system. In this case the u.h.f. biscuit is removed from the v.h.f. turret and replaced by the channel biscuit required so that although the system switch is actuated to change the switching on the i.f. panel to the 625 standard, the v.h.f. tuner is still receiving a Band I channel. At the same time, the h.t. switching is linked across at SW2-9 to maintain the h.t. to the v.h.f. tuner at all times. The u.h.f. tuner is then unused. When, as on earlier models, a separate 405/625 switch is fitted, it is only necessary to maintain the h.t. to the v.h.f. tuner and switch this to the required channel.

Servicing the chassis

Most of the work necessary can be carried out merely by removing the rear cover. However when inspection or resoldering is necessary, the panels can be upended quite easily once the switch linkage is released. To do this release the clips, not the screws, and remove the pivot and cable complete. If the screw is released the correct setting may not be regained when replacing. To release the panel, slacken the two spring-loaded screws at the rear and lift the rear edge clear. Disengage the front lugs from the chassis holes, upend, and locate the front lugs in the rear slots on the main chassis.

Spot limiter

This is an extra unit which may not be fitted. If it is not fitted, the plugs can be seen protruding from the right side of the i.f. panel, on to which the unit can be fitted if necessary.

NEXT MONTH: THORN 900 CHASSIS

Novel TV Systems

PART 2 A. O. HOPKINS

BY the late 1920s, with a choice of efficient optical rotors and excellent photoelectric cells, discharge lamps and light-control cells, a universally acceptable TV system seemed much nearer. The c.r.t. was not accepted as the inevitable display device because of its cost, dangerously high voltage and complex circuitry. What would have been thought of today's compatible colour TV set costing £300, generating 25kV, and with triplicated circuitry?

Early Colour and Stereo TV

In 1928 Baird demonstrated the first colour TV employing a disc with three spirals of apertures, each spiral being covered by a red, green or blue filter through which the coloured rays swept over the subject for reflection to a bank of photoelectric cells. A similar three-spiral disc formed a coloured image with red light from a neon lamp, and green and blue from a mercury-vapour and helium lamp, the two lamps switching on alternately. The colour was described in *Nature* as vivid and natural.

Following Baird's lead colour filters were added to old and new optical rotors, raising pictorial definition beyond the mere line total of these mechanical systems. This principle of easy, cheap conversion to colour TV was lost when the c.r.t. shot definition up to 405 monochrome lines.

In 1928 Baird also demonstrated the first stereoscopic TV pictures, using two separate circuits and double-spiral discs. At the receiver the two scans were viewed by normal stereoscope.

Mosaic of Lamps

In 1930 Baird put the early "mosaic" idea into striking effect; he built a screen of 2,100 flashlamp bulbs (30 rows of 70), and fed the picture signal to each lamp in turn via the sweeping contacts of a large commutator. Among those whose faces were seen on the brilliant screen by a large audience at the London Coliseum was popular Bombardier Billy Wells. Baird's lamp screen was later seen by audiences in Berlin, Paris and Stockholm.

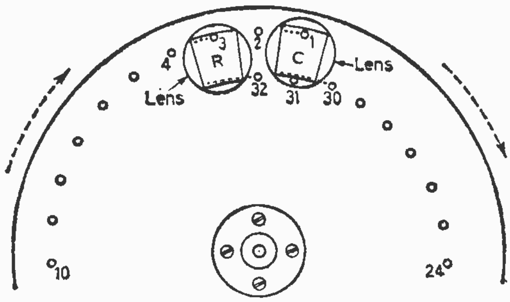


Fig. 8: Camera-receiver disc. Two lenses and two frames: for camera C, for receiver R. For 30-lines: 32 apertures.

Zones for More Lines

In Part 1 I explained how the 12½ pictures of 30 lines, believed to contain 26,000 elements and to need a 13kc/s channel, were broadcast within a 9kc/s bandwidth (of 18,000 scan units). No more lines could be transmitted in one m.w. channel.

Baird realised in 1925 that many more lines than the original 30 would be required, as is proved by his patent of that year describing picture division into zones. Eventually, in 1930, he transmitted 90-line pictures on three separate "zone" circuits. Figure 7 compares the single 30-line zone with the complete picture. Aspect ratio of the complete scan became 9 : 7, which the "black band" sync pulsations reduced to the 4 : 3 ratio of the standard film frame as shown.

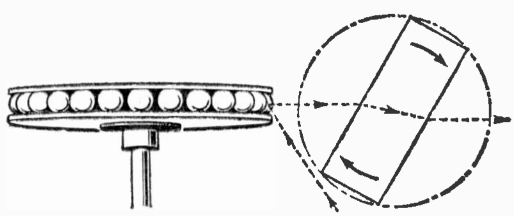


Fig. 9: Ball-bearing scanner. Line traced by reflection from each ball. Rotating glass block deflects in frame direction.

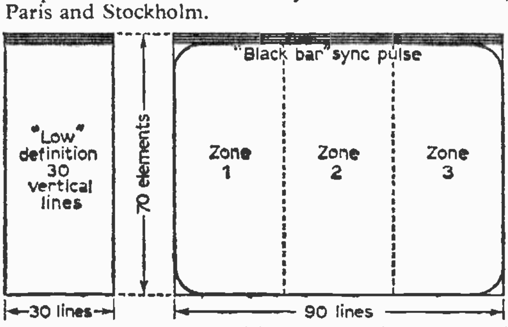


Fig. 7: Scanning zones. Raising the definition from "low" by three simultaneous transmissions of 30-line scanning.

In 1930 the HMV Company transmitted a 5-zone picture from film, using a large lens-wheel for the whole scan, in 5 channels. The zones were reassembled for projection as a picture with 4 : 3 ratio by a mirror-drum receiver.

In Europe and the USA obscure experimenters, the real "backroom boys", and large radio companies competed to be first with *the* system for world-wide television. Old ideas for optical analysis were revived, and modern techniques applied to make them work, some by hybrid combinations of mechanical analysis and c.r.t. reception.

The "mirror screw" was a compact scanner in which a spiral stack of metal plates with polished edges deflected the light beam at progressively changing angles to trace a raster.

Brighter and Larger Pictures

However bright one spot of light, its rapid movement along the line left a weak impression, weaker as the spot decreased in size for each increase in line-total. The Scophony Company projected a large picture to the screen by showing a whole line of scanning instead of only one spot. Walton converted the whole scene progressively to a single line, a "stixograph", for one simple sweep of the scanning point; starting with a stack of flat lenses, stepped into "echelon" formation, he later devised a special lens with stepped facets to revolve, presenting a succession of whole lines to the scanner. Originally reception was by similar apparatus.

In the "big screen" Scophony projector a brilliant line of light illuminated a "diffraction cell", a glass tube containing liquid to which supersonic vibration was applied by piezo-electric crystal. The picture signals travelling along the tube set up patterns of varying darkness, which modulated the light along the line, which was immobilised in position on the screen by a mirror-drum. The lines were increased into the hundreds.

In another system, to avoid high-speed rotation of a mirror-drum the sweeping rays from each reflector were intercepted by a wall of prisms, each presenting a line to the scanner and so multiplying the line total. Double reflection from a small double-sided reflector rotating on the optical axis of a stationary circle of mirrors was another successful line multiplier.

Camera—Receiver Disc

For amateur experimenters it was important to be able to check results on simple apparatus. The easiest way was to make an optical rotor (disc, lens-wheel, etc.), act as both camera and receiver, with no synchronising problem; the photoelectric cell and discharge lamp, placed at opposite edges of the disc, covered equal frame areas but each used only half the apertures or lenses.

I used all 30 lines of a disc for both purposes by bringing "camera" and "receiver" together as in Fig. 8. I added 2 apertures to the usual 30, giving enough separation (over 4 inches with a 24-inch diameter disc) for the two lenses, "camera" and "viewing". Two masks enclosed the scan by lines 1 to 30, and 3 to 32, respectively.

Cheap Receivers

There was agreement that receivers for the "low definition" broadcast must be inexpensive. Disc Televisors were sold for use with the domestic radio, and later mirror-drum projectors needing 400 volts to "strike" the discharge lamp and a well-amplified input from the BBC broadcast from a m.w. station. The essential components of both types were also sold for assembly at home; the low price of these may surprise readers: aluminium disc with mounting bush, 30 square holes, from 7s. 6d.; neon flat-plate lamp, from 12s. 6d.; motor (750 r.p.m.), from 30s. 0d.; sync control (phonic wheel, poles, coils, pedestal mount), 25s. 6d.; sync transformer (peaking at 375c/s), 12s. 6d.

Even cheaper motors would do: some sold for construction toys, or a good one from a vacuum-cleaner, for 10s. or less. Aluminium sheet for a disc cost about a shilling; the spiral of holes could be drilled to overlap the lines slightly, softening the join between them. Cheap "magnifying" glasses were sold, and "breadboard" construction with wooden mounts and cardboard screening kept the cost low.

The mirror-drum receiver called for assembly to a more "professional" standard, but the accurately machined components were reasonably priced: a 6in. drum with 30 optical quality mirrors, £2 15s.; a "crater" lamp (30mA), £1 17s. 6d.; for polarised light two Nicol prisms, £1 10s.; and a grid cell (light control), £2 2s.

Ball-Bearing Scanner

A compact projection scanner for home-assembly was that outlined in Fig. 9. Two circular metal plates, with grooves near the edge gripping a packed circle of steel ball-bearings, were mounted on the spindle of a motor. A narrow beam of modulated light from the crater lamp or grid cell was intercepted by the reflecting edge of the rotor, each ball tracing a line. The "frame" sweep was by refraction through a block of glass mounted to rotate at half the picture speed, geared down from the motor spindle.

Cone Reflector, Light Circle

In order to escape the rigid structure of all one-way scanning, vertical or horizontal, I formed a "light circle" for sweeping the analysis at numerous angles in succession. In Fig. 10 a tubular discharge-lamp is fixed on the axis of a truncated cone reflector. The annular projection of light (seen in section) can be traversed by a series of apertures or lenses in one or more optical rotors turning on the common axis. A glass plate is bushed at the centre to admit an extended motor spindle, and to support the rotor(s) turned by it. Three lenses are spaced around the axis.

Scanning in a few successively changing directions, or many, can be superimposed to show a structure-free picture, of primary importance for experiments in colour for television.

Rotating the Rays

An amusing effect, first seen on the cinema screen, and occasionally as a telecine switch between scenes in a TV comedy, is the unexpected rotation of the picture about its centre; a pattern of concentric circles appears as picture details link up into rings of different brightness. One method is to rotate a lateral-inversion prism about its long axis as in Fig. 11 (a), close to the cine camera lens. The prism is fixed within a metal tube which has a circle of teeth about it engaging a gear-wheel on the motor spindle.

Employed for television, rotating the rays allows multidirectional analysis, and also spiral scanning, with a suitable optical rotor. In order to simplify the drive, and to admit more light, I mounted two plane reflectors for lateral inversion as at (b). The reflector at 45deg. to the rotational axis receives light rays by reflection, and passes them outward to the second reflector which returns them, inverted, to focus where both axes coincide. Optical rotation occurs at twice the motor speed.

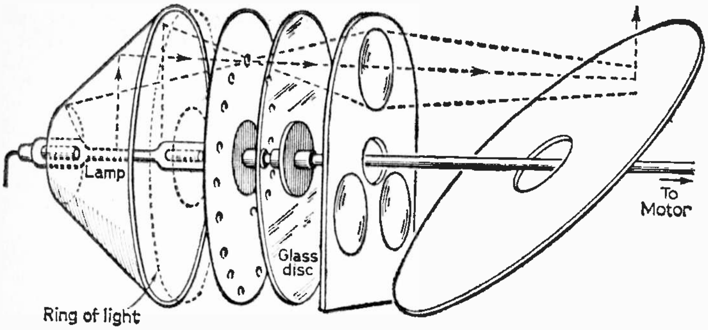


Fig. 10: Cone reflector for multi-scan: annular projection with apertured disc, bushed glass plate and circle of lenses.

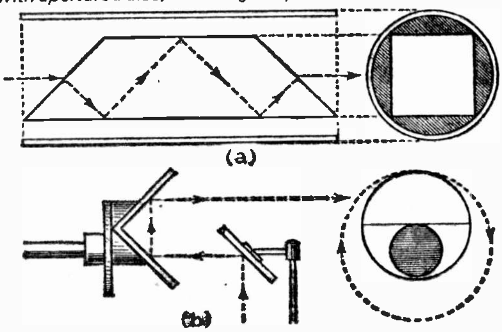


Fig. 11: Rotating the rays: (a) by inversion prism, (b) by inverting reflections.

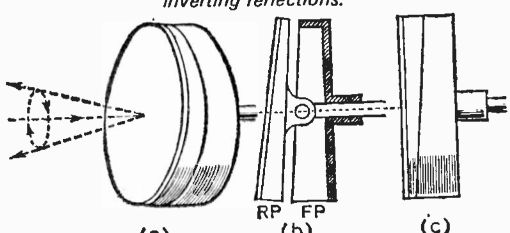


Fig. 12: Spiral scanner: (a) scanning ray sweeps widely to trace outer curve of spiral; (b) reflector plate RP separated from flange plate FP (section); (c) ray returned to centre of screen on completion of spiral trace.

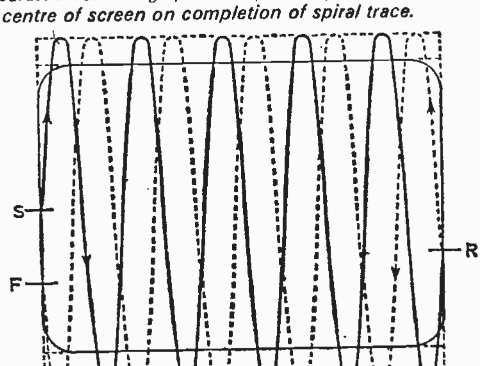


Fig. 13: Sinewave scan. This multiple interlace starts at S and then returns from R to finish at F. Continuing, the trace fills the screen without flicker or visible "structure".

Spiral Scan

My own effort to reduce the "spiral" scanner to its simplest form, directly driven, is outlined in Fig. 12. The small plane reflector is fixed to plate RP mounted to rock slightly upon the motor spindle. The back of RP is inclined to the reflectors, and is pressed by the inclined flange of the plate FP by a spring (not shown). Both plates turn independently in the same direction but at slightly different speeds, with FP sliding slightly along the spindle to maintain pressure. At (a) the two inclinations combine to thrust the reflector to its extreme angle, sweeping the axial ray widely, as shown. At (b), in section, the plates are separated to show how RP rocks, and FP slides, on the spindle. At (c) the inclinations have cancelled out, returning the reflected ray along the axis. The changing reflection angle sweeps a pencil of light from the centre in widening circles and back again, tracing a spiral.

Sinewave Scan

Originally the high voltage-peak generated by the line flyback in sawtooth timebases was a danger and caused component breakdown. A "safe voltage" method of scanning by c.r.t. was developed, as an alternative to "parallel line", in which the vertical deflection was sinusoidal and the horizontal was pyramidal. The "straight" part of the sinewaves carried the picture modulation, with the curves at top and bottom hidden by the screen surround as shown in Fig. 13. Two lateral scans are shown, with only 5 cycles in each and the return traversal in broken line for clarity. By starting at S and finishing at F the scan will continue by tracing lines to the right of those previously traced, until the screen is covered by a self-concealing cross-hatch of lines. This was really an efficient multiple-interlacing scan in two directions, in which the faults of present-day twin-interlaced scanning (line pairing and visible structure) could not occur.

The Ultimate System?

Television started with a mosaic. Is the present-day triad-colour mosaic in the shadowmask tube the ultimate system? Is the expensive intricacy of "compatible" colour too great to allow the simplification essential to make it available to the majority of viewers?

The sister art of the cinema has been overtaken by television despite the superior definition on wider screens; the colour tube has too coarse a grain to compete in quality or size. Progress demands that all picture presentation be of highest quality, eventually linked for home or public viewing. The complex circuitry imposed by "compatibility" seems to render any NTSC-based colour system too inflexible to encourage the necessary inventive effort. ■

VIDEO TAPE RECORDING

PART 9

H. W. HELLYER

THEORETICALLY it should be possible to construct a recording and replay machine along the lines described in previous articles to operate on any line system. In practice the complications raised by different standards make it necessary to use extra circuitry. But more important, the development of video tape recorders during the past couple of years has embraced more than a change in standards. Some of the limitations of the earlier models have been overcome; and some desirable features have been added.

We have been taking a close look at the Sony system, this being the first to become available at a low price to industry, commerce and the domestic user. It is fitting that we should continue to use their machine as an example for the introduction to 625-line video tape recording work, even though there are now rivals creeping into world markets. (It would be tactful, but hardly honest, to omit to mention that this is also the range of equipment with which the author is most familiar!)

The version in which we are interested at present is the Sony CV2100CE. This is a dual-standard model, 405-line or 625-line horizontal scanning (and, for that matter, taking in the French 819-line system —a factor which the Concorde engineers have not failed to use to their advantage). Vertical scanning is again 25 fields, with 2:1 interlace. The horizontal resolution is better than 240 lines at 625-line recording and the video signal-to-noise ratio can be brought to 40dB with the normal field adjustments and is considerably better than this when set up correctly on the bench. Tape speed is 11½in./sec., giving a recording time of approximately 40 minutes with the ½in. tape at present in use.

As with the previously described model, sync is negative-going, and a composite video signal of from 1 to 3 volts is the line standard (using the term line here in its accepted audio sense). Any normal 50 field camera can thus be employed. But the monitor must be compatible with the standards in use off-air. Three monitors are provided by Sony for the Western European (French, etc. C.C.I.R.), Italian C.C.I.R. and British standards, and large-screen monitors which are based on Pye and Rediffusion television receivers are available to agents in this country.

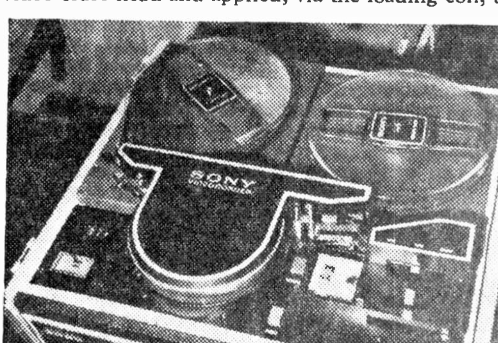
So much for the bare bones: what about the differences? The 2100 can be used for dubbing, editing, displaying a still picture and recording automatically—all features that were rapidly found to be desirable when clients outlined the purposes to which their prospective new toy was to be put. Additional controls now fitted will give some idea of these functions.

First the sound dub and edit buttons, which are together beneath a small sliding panel near the function control. These permit the insertion of new material and with a little practice quite good insertion from the camera can be obtained, although there is still a definable break at the start and finish of editing during playback, this showing as stripes for about a second as the synchronism locks to the new signal. As the tape is being replayed, with the camera connected and the TV/camera switch set to camera, the edit button is pressed, then the record button. The new recording from the camera begins when the record button locks. To unlock it is necessary to press the edit button again, a couple of seconds before the end of the new section, then flick the function control to stop. The new picture is then inserted on the pre-recorded tape.

To add sound the edit button is again used, but this time in conjunction with the dub button. Once again the tape is replayed, the edit button pressed and then the dub button; the function selector is again used to close the insertion, this time without the need for neutralising by again pressing the edit button. An extra feature here that is very handy is a separate light in the level meter which comes on when the dub button locks and warns the operator that new recording is taking place over the playback. Connection of the monitor during these operations allows a close watch to be kept on timing. Here is the answer to absolute lip-sync.

As with many other complicated functions this operation when analysed turns out to be quite simple. It is done by switching the bias and erase oscillator for either sound only or sound and vision powering while the main circuits are still in the play mode; then, by action of the normal record button, inserting the new material to be dubbed. Almost like a superimposition on a normal domestic tape recorder.

Almost, but not quite, as we can see from Fig. 31 where the oscillator circuit is drawn together with the associated switching which has been simplified to omit such refinements as the dubbing light and the power line to the synchronising circuits which for our purposes can be taken for granted. When the dub button is pressed the oscillator current is diverted from the video erase head and applied, via the loading coil, to



Top deck view of the Sony CV2100 recorder. The edit and dub buttons are next to the record button.

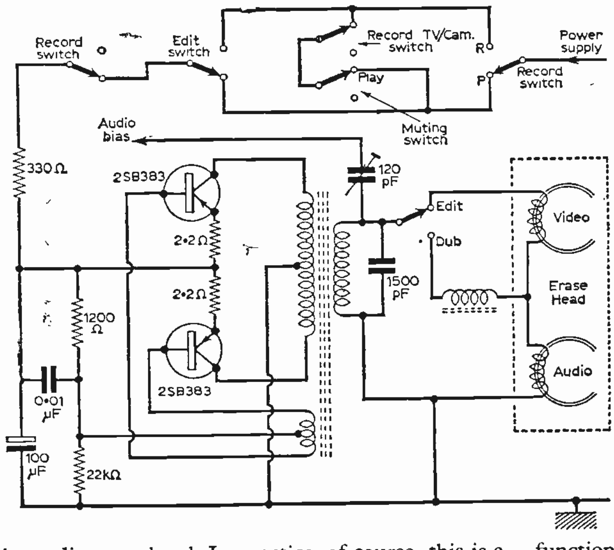


Fig. 31 (left): Additional switching is incorporated in the power supply circuits and in the erase head section of the latest machines to enable editing and dubbing of vision and sound to be carried out. Note that while editing, i.e. insertion of new video material, causes erasure of both vision and sound, dubbing switches in the sound erase winding only via a loading coil.

the audio erase head. In practice, of course, this is a single construction head, with dual windings and gaps appropriately positioned. (Easily said, but the problem of adjacent, interacting magnetic fields posed some ticklish engineering problems before this EF69-2102 head was brought into production, I am told.)

The edit switch is also in the power line, virtually in series with the section of the record switch as shown in Fig. 31, and simply allows preparation of the oscillator while playback is still in operation, and the powering of the sync amplifier. By some clever parallel switching through sections of the record and muting switch circuits it also kills the oscillator preparatory to ending the dubbing. Space considerations preclude our showing the whole switch assembly, but the foregoing explanation should be sufficient for an understanding of this added function.

Switching is again the secret of the standby operation. This is the process that enables the operator to view a still picture, and is basically a method of rotating the heads while keeping the standard tape drive circuits in a neutral position, i.e. leaving the tape stationary, but able to be moved by hand. In practice it does not give an absolutely clear single field, nor can it be kept on indefinitely. Five minutes is about the maximum time limit before the constant traverse of the heads begins to affect the tape (and, when you stop to think about it, this is pretty good for a 1500 r.p.m. assembly with the two heads whipping past the oxide coating: no wonder that elaborate video tape recorder designs such as the Ampex have had to incorporate refinements such as air pumps to keep the tape an infinitesimal distance from the heads).

The standby switch is the upper one of the three at the right-hand side of the machine, and is pulled out to retain the power to the head rotor assembly. When the main function selector is then moved to stop the tape halts and the heads traverse a single field which is—if you recall previous articles—a diagonal line of recorded magnetic impulses on the tape. Because of the changeover pulse and the lack of servo information the subjective effect of this is a band of apparent interference an inch or more wide across the screen. By moving the spools by hand until the head traverse just coincides with a recorded scan this band can be taken to the top or bottom of the monitor screen where it will not interfere with the information. Primitive though this may sound, in operation it is extremely easy to perform and a very good still picture is obtainable with full interlace.

The switching is arranged so that three sections are in parallel, any one of the three energising the motor when closed. The first switch is the normal energising section of the function selector switch, the second is part of the record button assembly so that the motor runs as soon as the record button is pressed, and the third is the standby switch. All the mechanical coupling is via the function selector so that the tape does not move until this switch is engaged in any of the various functions.

The third innovation is the manual/auto facility which operates on the video and audio circuits together using a five-pole two-way switch to select the circuitry and to couple the indicator light and meter to its appropriate source. In Fig. 32 only the relevant circuit sections of this switch are shown and the circuitry is drawn in simplified form to highlight the principle rather than delve into great detail. For manual recording the video input is taken via the video level control straight to the modulator. But when auto is selected the full video input is applied to an additional five-stage amplifier, the output from this becoming the source for the modulator.

This video (a.g.c.) amplifier has a preset level control at the input, a clamp with its own voltage control for preset regulation, and the succeeding stages are arranged to handle signals within the selected limits and present a constant signal to the modulator. The video output control at the output of the a.g.c. amplifier is an additional precaution to ensure that the early stages operate at their full gain on a low signal, but bias back to regulate gain on a large signal, to preserve the best signal-to-noise ratio. No signal can be better than the incoming source, and it is important that this is not spoiled by the use of the automatic function, so setting up needs a little care. Readers who are familiar with various methods of obtaining automatic contrast control on television receiver circuits will recognise the principles, and should need no further details.

Audio circuits have received a lot of attention from designers and a great number of clever circuits for automatic control of recording level have been incorporated into domestic tape recorders, especially the smaller types. Just as a complete new section is needed to regulate the gain of the video signal—simple back-biasing methods leading to high noise figures on low-level signals and distortion on high ones—so the audio circuits require extra care. The method chosen by Sony is not the most complicated but as it is presumed that audio is an ancillary to video tape recording and not its prime function the basic circuit of Fig. 33 is quite sufficient. It consists of a

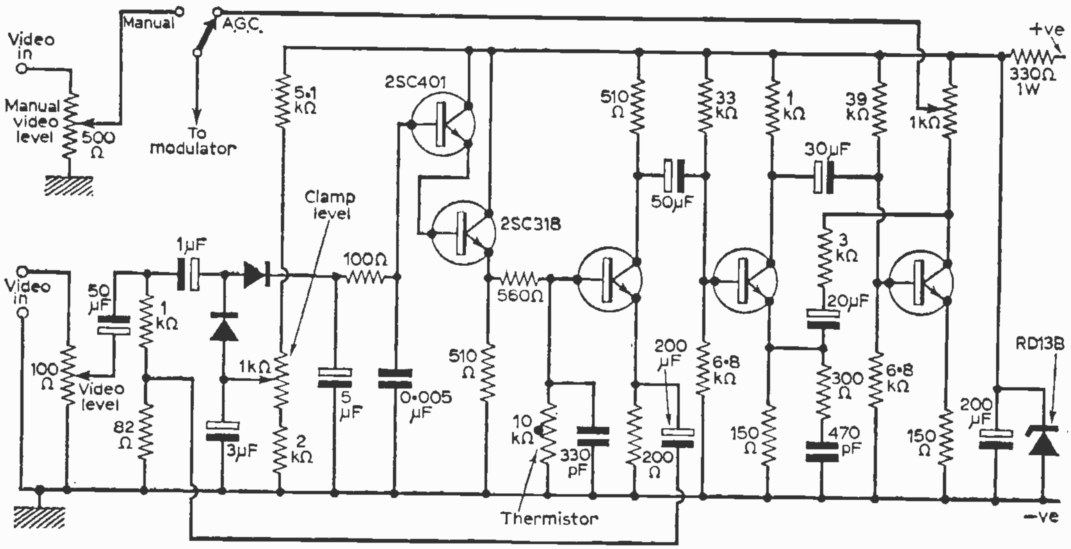


Fig. 32: The video manual/auto circuits.

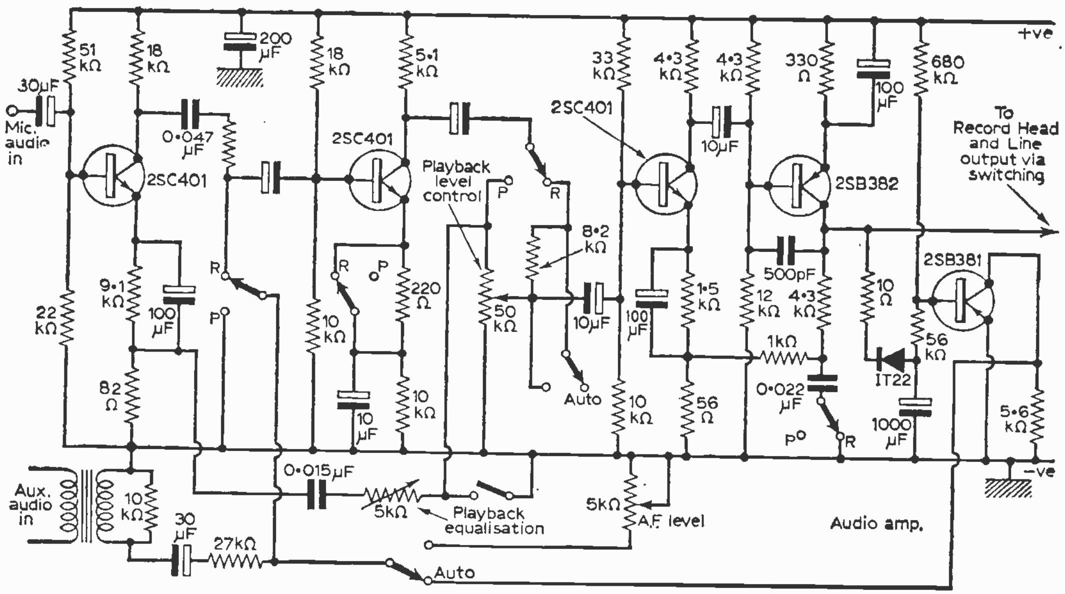
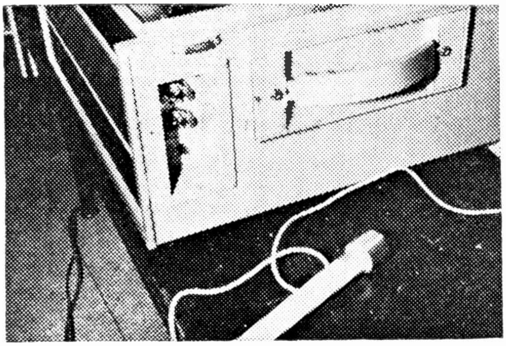


Fig. 33: The audio manual/auto circuits.

sampling stage which rectifies part of the signal from the output stage of the amplifier and feeds this varying d.c. via an amplifier, which also acts as a delay device, so that the resultant voltage can control the base of the second stage. At the same time part of the series feed to the third stage is changed to allow this transistor to "follow" the gain level slowly. For such a simple circuit it is remarkably effective. It should be mentioned that the first stage of this audio amplifier is only employed as a preamplifier for the small head signals during playback, and does not come within the automatic control circuit at all.

The addition of a.g.c. helps to make possible another facility which has been requested on several occasions, the duplication of tapes. This is particularly useful for industrial and educational users. By connecting a master video tape recorder and a similar machine as a slave, coupling these to a camera and a monitor and using a link unit which is supplied as an extra to the basic video tape recorder assembly, three separate functions can be added. A pre-recorded tape can be copied directly with no greater adjustment than checking the audio level (because playback of audio is controllable on the master machine, whereas video is at constant level). A TV signal can be recorded on the master and fed directly from the master circuits to



The standby switch with other selectors is sited in a recessed panel at the right-hand side of the recorder.

the slave machine, giving effective duplication. And a camera signal can be recorded simultaneously on the two machines.

By quite simple matching arrangements a number of monitors can be linked into the assembly, and a number of cameras hooked up and switched as required. The use of a.g.c. permits the minimum of operator adjustments once the preliminary setting for best conditions has been made. As an inveterate knob-twiddler who likes to feel he is driving the tape recorder, this writer has been somewhat lukewarm toward automatic recording circuits, but certainly experience has shown the great advantage of this function for video tape recording and closed-circuit television links and one can only applaud the ingenuity of the Sony designers.

A further facility that will be welcomed by those who experienced some difficulty in rigging up r.f. modulator circuits to convert the video signal to a modulated r.f. signal for direct application to the aerial terminals of a television receiver is the addition of a three-way switching system to the CV2100 camera. This consists of a VTR/video/r.f. switch, with the following functions: VTR, camera coupled to the video tape recorder in the normal way; video, line monitoring, the video output being taken directly to a line monitor, i.e. adapted TV receiver, bypassing the video tape recorder; r.f., direct display of the camera shot on a conventional 625-line television receiver, tuned to channels 3 or 4, by connection of the camera to the aerial socket. Note that it is always advisable to fit the conventional television receiver with a 1:1 isolating transformer when coupling it to any other piece of equipment. This is of course a general tule, sadly ignored by many who want to make tape recordings (audio) of their favourite programmes. It is a wonder there are not more accidents reported. Presumably anyone investing in the relatively high capital cost of video tape recording will not begrudge the couple of pounds extra that an isolating transformer would set them back!

Some interest has been shown by readers in the modifications to the original video tape recorder to enable direct coupling of the camera for closed-circuit work, and in the rather makeshift r.f. modulator that was the first attempt to enlarge the scope of this machine. In the final article of this series we should find space to discuss this and to give the relevant circuits as well as to take a general look at the rapidly growing field of video tape recording and "shoestring" closed-circuit television techniques.

TO BE CONTINUED

FAULT FINDING FOCUS

continued from page 450

mixer valve contributes most of the noise in the valve line-up, so that any evidence of above-normal grain with adequate aerial input suggests that the fault lies in the r.f. stage failing to provide sufficient signal amplification to swamp the mixer valve noise. When the tuner is up to standard, and with a good aerial input, no matter how weak the picture may be due to an i.f. circuit fault it should be completely free from grain.

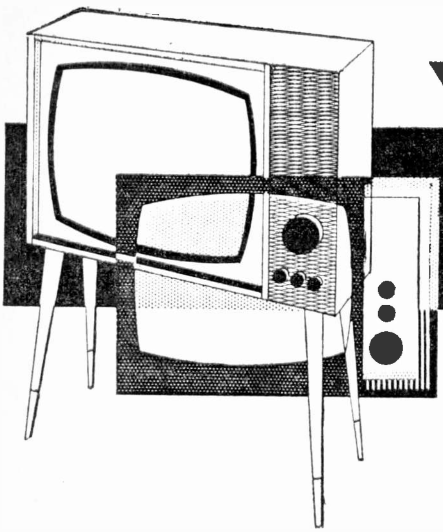
Instances of excessive sensitivity on the other hand usually indicate a complete or partial failure of a.g.c. control. The commonest cause is an over-advanced preset gain control but quite often a slightly soft controlled valve can feed sufficient positive grid current into the a.g.c. rail to offset the negative control bias. If the r.f. amplifier is at fault, this usually shows up as cross-modulation producing sound-on-vision and vision-on-sound on strong signals.

When the excessive contrast is completely uncontrollable. the commonest cause is a short-circuit across the a.g.c. rail to chassis or a break in a high-value feed resistor. In printed panel receivers, short circuits across the a.g.c. rail are most often caused by shorting solder blobs, but on occasion the a.g.c. clamp diode breaks down. While it is also possible for any of the a.g.c. decoupling capacitors to be at fault, due to the low voltages employed this possibility is very remote.

To check if the a.g.c. system is operating, short the rail to chassis on a weak signal and there should be very slight increase in gain. Short the rail to chassis when a strong signal is being received and gain should very markedly increase. For a more detailed test connect a high-resistance meter on a low-voltage range from the a.g.c. rail to chassis, and the negative control voltage should be seen to vary as different strength channels are selected, reducing to zero as the contrast control is advanced.

In those Ekco/Pye models that use high-level contrast control this test will not apply, as the actual contrast potentiometer is paralleled across the video load resistor and does not directly affect the a.g.c. potential. In these models the small panel-mounted 405 and 625 sensitivity presets regulate how much of the a.g.c. voltage is offset by an opposing small positive voltage.

TO BE CONTINUED



Your Problems Solved

Whilst we are always pleased to assist readers with their technical difficulties, we regret that we are unable to supply diagrams or provide instructions for modifying surplus equipment. We cannot supply alternative details for constructional articles which appear in these pages. WE CANNOT UNDERTAKE TO ANSWER QUERIES OVER THE TELEPHONE. The coupon from page 476 must be attached to all Queries, and a stamped and addressed envelope must be enclosed.

MURPHY V250

This set has no picture and no raster. All the valves light up and the sound is not affected. I suspect failure of the e.h.t. transformer as there is no spark obtainable from the 2nd anode (e.h.t. cap) or at the base end of the tube. I am told that the type of transformer fitted in this set is not now obtainable, so if this is at fault, can you advise what other type of transformer would be suitable?

There is no line whistle to be heard, either with the aerial connected or disconnected, and operation of the line hold control either way fails to produce one.—J. Edwards (Brighton, Sussex).

A faulty line output transformer could produce your symptoms, as could almost any other fault in the line output stage. You are correct in assuming that the e.h.t. rectifier is within the transformer, sealed in, and that the chances of obtaining a new one are very remote. It is necessary to withdraw the chassis from the cabinet to service the transformer, but this is simply done by removing the front knobs, two screws at the back of the chassis, and sliding the whole receiver out of the cabinet.

MURPHY V430

The defect on this receiver is loss of contrast—the picture being very dim and weak and the contrast control being effective only for about one-eighth of its range. The picture obtained is correct in focus and form.

BBC-1 cannot be tuned for good sound and vision together.—E. Dunster (Abingdon, Berkshire).

We advise you to proceed by checking the 30C1 mixer valve, and common i.f. stage 30F5 adjacent to the tuner. A frequent cause of trouble is defective decoupling, particularly in the tuner itself, and this can be located by bridging each of the small decoupling capacitors in turn with a known good one held with an insulated clip such as a plastic clothes peg.

PYE V7CDL

I have replaced the c.r.t. in this set. A fair picture can be obtained but when the brightness is turned up the picture expands and becomes progressively dimmer until it disappears altogether. In addition the flyback lines are visible.

I have replaced the e.h.t. rectifier also both h.t. rectifiers, the efficiency diode and the line and field output and oscillator valves.—J. Rowe (Exeter, Devon).

Your trouble could possibly be due to a faulty or displaced ion trap magnet. These items are relatively inexpensive, and you should be able to check by substitution. If your fault is accompanied by shading on one side, check the 25μF electrolytic capacitor which decouples the cathode of the PL81 to chassis.

SOBELL TS17

The fault on this set is recurring very weak picture, so I obtained another c.r.t. (MW43-64) and fitted it, taking care of the position of the ion trap magnet etc. When I tried the set with this new tube, the picture appeared but it was very dark and could only be viewed in a dark room. I then changed the PL81, PY81, EY51 and the tuner valves but all to no avail.—W. Tait (County Durham).

If the picture is correctly focused (with the scanning lines clearly defined), the tube first and final anode voltages are correct and also the focusing magnet, it is possible that the ion trap magnet has reduced in field strength, making it impossible fully to illuminate the screen. However, if the raster cannot be resolved in full brightness with the brightness control at maximum, and the picture appears over-contrasted normally, there could be an alteration in value of a resistor in the brightness control circuit. The video amplifier valve may be low and there could also be trouble in the vision detector and/or interference limiting circuits of the vision channel. Check these possibilities.

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Twin Panel Types: A47-13W, A59-16W, A59-13W

MAZDA
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Twin Panel Types: CME1906, CME2306

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1S4	4/9	12AU6	4/9	DF91	2/9	ECL86	8/3	PCF82	6/-	U47	13/6
1S5	4/3	12AU7	4/9	DF96	6/-	EF39	3/9	PCF86	9/9	U49	13/6
1T4	2/9	12AX7	4/9	DH77	4/-	EF41	9/6	PCF800	11/6	U52	4/6
3A5	8/6	12K8GT	7/6	DH81	12/6	EF80	4/9	PCF801	7/3	U78	3/6
3S4	5/9	20F2	10/6	DK32	7/9	EF85	5/6	PCF802	9/6	U191	11/-
3V4	5/9	20L1	16/9	DK91	5/6	EF86	6/3	PCF805	9/-	U301	13/6
5U4G	4/6	20P3	14/9	DK92	9/3	EF89	5/3	PCF806	11/6	U801	18/9
5V4G	8/-	20P4	18/6	DK96	7/-	EF91	3/6	PCF808	12/6	UABC80	6/3
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ULTRA V1775

When this receiver is switched on from cold, the bottom of the picture is cramped, there being about three inches of black at the bottom of the screen. This slowly expands and after about 15 minutes a full picture appears. The picture seems to be a little too wide but this does not alter at all.

It is possible to adjust the height control to obtain a full picture when the set is first switched on, but after about 15 minutes the picture is far too elongated.—A. Fitch (Ruislip, Middlesex).

If the field timebase valves are definitely well up to standard (and low emission is usually responsible for the trouble mentioned), suspect increase in value of a resistor associated with the field timebase, which gradually restores to normal value while it is passing current. Also check the h.t. rectifier and make sure the mains tapping closely corresponds to your household input voltage.

PETO SCOTT 1724

This set is giving trouble mainly in the line output transformer which was replaced recently. Everything is perfect until the e.h.t. comes through the anode lead halfway between the top cap of the e.h.t. rectifier and the e.h.t. winding and then the raster disappears.

I have insulated the e.h.t. lead but this burns through after a while.—G. Burton (Lincolnshire).

We presume the e.h.t. lead is fractured at the point of the discharge. Renew the lead carefully, leaving no wire ends or sharp edges. Insulate with good plastic and keep away from any chassis members.

HMV 1842

This set appears to be producing excessive e.h.t. from the line output transformer. I have recently fitted a re-gunned tube type E17/70 in place of the original 5/3 tube and this appeared to work satisfactorily for a number of months. Whilst investigating vision-on-sound and sound-on-vision problems, the set was given a prolonged run of about four hours when the e.h.t. collapsed.

The e.h.t. fault was traced to breakdown of capacitor C57. Substitution with a 0·05μF capacitor restored e.h.t. but flashover occurred at the focus control. I then carried out the modification calling for the deletion of the focus pot. and associated components and this resulted in flashing over of the PY81.

I have substituted the EY51 in the e.h.t. transformer, the PY81 and the PL81 with the result that the picture is perfect but the internal flashover in the PY81 still persists with one flash about every three seconds, the time increasing with increase in tube current.

I therefore presume that some method of damping is required to protect the PY81.—D. Coombe (St. Albans, Hertfordshire).

Check the capacitors associated with the line scanning coils or, if necessary, damp the coils with a parallel capacitor of, say, 100pF at 5kV rating. It could be that the drive waveform from the line oscillator is distorted or of incorrect amplitude due to alteration in value of a coupling component.

STELLA ST1011U46

The picture collapsed to about 3in. height. V14 (PCL82) was found to be faulty and replaced, but the picture still did not fill the screen fully at the top and bottom. V15 and V16 were checked and found to be in order.

By reducing R98 (1MΩ) to 680kΩ and adjusting R100, the picture just about filled the screen but after about half an hour, a 1in. gap top and bottom appeared.—G. Billows (Backwell, Nr. Bristol).

We presume you have checked the 100μF cathode bypass capacitor of the field output stage, and mention this only to remind you—its principal effect is on the bottom of the picture.

Your description of the fault would indicate that the field oscillator is not receiving its correct h.t. The feed is from the boost line, and a common cause of loss here is the 2·2MΩ focus control, a slider preset resistor mounted across the base of the c.r.t. Check by disconnecting, when the picture should brighten and the field fill—indeed, probably overfill, subsequent upon your adjustments to try to gain height previously.

REGENTONE 10-5

The picture on the above-mentioned set is marred by a loss of height, the height control being at its maximum. I have changed the field output valve PCL82 and also the h.t. valve PY32 but substitution made little difference other than curing a tendency to field roll when first switching on. It appears that service sheets for this particular model are hard to come by and I would very much appreciate your help in pin-pointing the possible cause of this annoying fault. Perhaps I should also mention that the black band top and bottom of the picture is approximately 1½in. wide.—F. Tabb (Hayes, Middlesex).

We would advise you to check the 1·2M resistor (R64) to pin 9 of the PCL82 (V12). Also check C57 (0·05μF) boost line decoupler to the h.t. line if R64 is not at fault.

A service sheet on the Ten 4 or Ten 12 holds good for the Ten 5.

SOBELL TPS147

This set suffers from severe sound-on-vision on Channel 5 (BBC-1). Channel 8, ITA, is quite normal. I have tried retuning the oscillator coils in the tuner without success and the only way to obtain a stable picture is to tune on the vision signal and reject the sound.

I have checked the aerial and replaced by substitution the r.f. amplifier and mixer-oscillator valves without any improvement being made to the picture quality.—R. Wilson (Consett, Co. Durham).

This trouble—if not caused by tuner oscillator misadjustment or overloading due to a too strong BBC-1 aerial signal—is almost certainly caused by misalignment in the sound/vision i.f. strips. Your best plan would be to have the set completely re-aligned. However, we are not clear on this, since you say it can be cured by tuning to the vision and then rejecting on sound. This would imply misaligned sound rejectors in the vision i.f. channel.

INVICTA 138

Sometimes when this receiver is first switched on the sound is cut out by a loud hum upon which the volume control has no effect. After switching off and on once or twice the sound returns and will function correctly for about an hour or two, after which the loud hum will return. The picture in the meantime is very good and all the controls are functioning correctly. I have replaced the following: C39, C40, C41, C56, C58, C80, C93, C28, C57, C86, C59, C60 and C61 together with R81, R82, R83, R84, R85 and R86 and two EF80s and PCL83. These however did not remedy the fault.—R. Dodgson (Workington, Cumberland).

It would appear that you have checked all the probable causes of the hum. We would suggest that you check the valve bases for intermittent contact between heater pins and others due to blobs of solder or bent contacts etc. Then check the printed panel for similar faults.

DECCA DM45

I get a perfect picture on both channels and the sound is very good, but there is one very odd intermittent fault. When there is a film being televised on either channel all goes well until there is a distant or long shot when the field slips until the camera comes back to close-ups when it holds and locks perfectly.

When this fault occurs and I try to eliminate it by careful adjustment of the field hold control no improvement in picture is noted. The strange thing is that this fault only appears when a film is being shown: when any "live" programmes are televised the set behaves perfectly normally.

I have changed the field valves but no change has resulted.—F. Marsh (Newcastle, Staffordshire).

This seems to us something like a fault in the field interlace filter or sync separator section. Try the sync separator valve with another if possible. If the valve is O.K., check the components on its control grid (R and C). Sometimes misalignment in the vision i.f. channel or a defect in the video amplifier valve can upset the sync on picture changes. Check the components in this valve's cathode circuit.

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PRACTICAL TELEVISION, JULY, 1968

TEST CASE -68

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

? *Symptoms on a Murphy V350 indicated excessive drift of the local oscillator frequency. When the set was first switched on from cold, retuning the oscillators associated with the BBC-1 and ITV channels would give good pictures and sound on both channels, but these progressively deteriorated as the set warmed up, accompanied by severe sound-on-vision interference. The trouble could be cleared by again retuning the oscillators but then after the set had been switched off for some time the effects would return on switching on from cold, calling for further readjustment.*

Replacing the tuner valves failed to cure the trouble, and it was still present after the small ceramic capacitors associated with the local oscillator section had been replaced. It was noticed, however, that the sound had a tendency to tune rather peaky on the oscillator and that there was slight patterning on the pictures.

Apart from the oscillator/tuner, what could have been responsible for 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 67
Page 428 (last month)

Checking the voltage at the grid of the video output valve with respect to chassis with a valve voltmeter showed a positive potential of several volts with and without the aerial connected. The feed from the vision detector to this grid was temporarily disconnected, and the positive voltage then collapsed to zero. Further testing revealed that the positive voltage was present across the video detector load as long as the set was switched on, and this was later proved to be caused by oscillation developed in the vision i.f. amplifier being rectified by the detector diode. The oscillation was so severe that it was completely blocking the i.f. channel, and influencing the picture in the way described last month.

The trouble was cured by replacing several decoupling capacitors in the vision i.f. stages. Most of the trouble was cleared by replacing the 0·001μF capacitor on the screen grid of the final vision i.f. amplifier valve, but one or two similar capacitors needed replacement to achieve optimum stability.

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