TELEVISION

SERVICING · CONSTRUCTION · COLOUR · DEVELOPMENTS

20p

OCTOBER 1971

20MHz (IC) PULSE SCALER/SIGNAL GENERATOR

ALSO: TROUBLE-TRACING CHART

SECRETS OF THE SONY COLOUR RECEIVER

405 SOUND IF AND GATED AGC CIRCUITS FOR THE CONSTRUCTOR

The world's greatest news stories of our time!

No.1 OUT NOW!

The headlines that were front-page sensations

HEADLINES is the new and exciting publication for every man and woman who wants to read again the thrilling and true front-page stories of just how and when it happened.

THE R101 — the fantastic story of the airship that ended in disaster and death . . .

JACK JOHNSON — the amazing career of the negro world champ that nobody loved . . .

RUTH ELLIS — who gunned down her lover and was the last woman to hang. The case that gnawed the conscience of Britain.

MANCHESTER UNITED — the famous football team that died in their fatal flight to Munich . . .

THE TITANIC — the appalling disaster of the ship they said was unsinkable . . .

ALCOCK AND BROWN — in nightmare over the Atlantic. Their incredible non-stop flight in a tiny biplane . . .

ROGER BANNISTER — and the four-minute mile sensation. Great athletes said it was impossible but he proved them wrong . . .

NEVILLE HEATH — with the mind of a compulsive killer. Young, handsome, charming, and an officer in the RAF. But he was a psychopathic murderer . . .

THESE AND OTHER GREAT FRONT-PAGE STORIES OF THE TWENTIETH CENTURY ARE ALL IN NO. 1 ISSUE — NOW!

New . . . thrilling . . . exciting, HEADLINES features more than 40,000 words of absorbing reading with vivid and dramatic pictures.

Only 15p— *from your paper shop.*

TELEVISION

SERVICING·CONSTRUCTION·COLOUR·DEVELOPMENTS

VOL 21 No 12
ISSUE 252

OCTOBER 1971

BROKEN BANDWAGON

Only a few years ago certain sections of the electronics industry were rubbing their corporate hands together as the sight of an apparently new Eldorado ascended over the skyline. Heralding the new prosperity was the growing demand for semiconductors in general and i.c.s in particular. Unfortunately this has now turned out to be the old, old story of enthusiasm clouding commercial judgement, with too many companies throughout the world setting up far too much production capacity for a market which for a fleeting moment seemed to be inexhaustible but which vanished into thin air like a Will o' the Wisp.

The hard fact is that the industry has vastly over-produced for customers who just aren't there. The result of this can be seen in the catastrophic fall in the prices of semiconductor devices—standard i.c.s particularly—to a level such that the UK division of GEC for example say that it costs them more for raw materials alone than the price at which they can sell a device! The gravity of the situation is underlined by the decision of GEC to withdraw from the market in standard mass-produced i.c.s and to close down two of its semiconductor plants, while last year Mullard report that they lost £1·4 million on integrated circuits.

A graphic illustration of the state of the market can be seen from the way in which the price level of dual-quad gates fell from £3 in 1967 to 75p in 1968-9 to around 30p at the end of 1969 and to 5p in 1970 (in the UK) and only 3p in the USA! This amounts to dumping. In the first quarter of this year the price of standard TTL-logic i.c.s fell by 50% while over the last 18 months prices in some cases have dropped to a *tenth* of their previous levels. We've seen all this happen before in other fields of course, with too many companies jumping on the bandwagon of a newly developing market. But the consequences are serious for the future development of the electronics industry.

Television is only a small part of the world of electronics and is at the moment shielded from the cold economic winds howling throughout the industry as a whole. But from our own experience of the ups and downs over the years we can perhaps be allowed to say that the present situation should never have got to its present out-of-hand condition: something must be done to restore sanity and rationalisation to the industry.

W. N. STEVENS, *Editor*

THIS MONTH

THE NEXT ISSUE DATED NOVEMBER WILL BE PUBLISHED OCTOBER 22

TELETOPICS

CHANCELLOR'S GREEN LIGHT

The recent mini-budget certainly came at the right time so far as the TV trade is concerned—just as the rise in colour set deliveries was beginning to level out and the decline in monochrome set deliveries was leading to talk of redundancies and short-time working. There had in June, however, just before the budget, been a slight upturn again in colour set deliveries at 47,000 for the month. Now all seems plain sailing, with the 18% cut in purchase tax from 36¾% to 30% and the abolition of HP, rental and credit agreement controls. Dealers should be wearing smiles on their faces, but possibly not just yet: there is reputed to be £250 million worth of tax-paid goods in the electrical shops, and there is no rebate on stocks held. We imagine, however, that the growing interest in colour and the easier terms will soon get us back to the set shortage condition again.

TROUBLES IN THE IC FIELD

The cheer on the domestic front is not reflected elsewhere though. GEC's decision to stop making standard i.c.s emphasises the extraordinary mess that has developed in the semiconductor field, with the present prices of many standard i.c.s not even covering the cost of the raw materials used. Figures given in the House of Commons by Mr. B. Harrison M.P. of the fall in the price quoted for a standard quad-gate i.c. illustrate the situation: in 1967 these were quoted at £3 each; by 1968/9 the price had dropped to 15/- while in December 1969 the price was 5/6d; at the end of 1970 prices of 1/- in the UK and 7½d in the US were being quoted. The market collapsed following cutbacks in the US space and defence programmes, but even so there seem to have been too many firms trying to get on to a bandwaggon that just wasn't big enough. It is sad on this side of the Atlantic to reflect that while the UK was in the forefront of the early development of radio, the thermionic valve, radar, television and the electronic computer we have never really been in the picture at all with the technology that produced the most far-reaching revolution in electronics of all, semiconductor technology. One wonders whether we are destined now to take a perpetual back seat.

SENDING DIAGRAMS OVER THE PHONE

RCA Global Communications Inc. have introduced a new system, called the Videovoice, to enable diagrams, charts, etc. to be transmitted over ordinary voice-frequency telephone lines. In addition to the telephone itself each end of the link has a TV camera, monitor and control unit. The document to be transmitted is viewed by the camera and can be displayed for several minutes or a new view can be transmitted at 30 second intervals. A single frame from a moving scene can be sent by operation of a freeze button. Conversation is discontinued while the picture is being transmitted but if duplex working is used discussion and picture exchange can take place simultaneously. The picture is stored by an RCA silicon-target storage tube which enables it to be scanned at a relatively slow speed: in this way it is possible to transmit picture information within a bandwidth 0.001 of that required for normal TV.

'SCOPE BANDWIDTH EXTENDED

We can now it seems think of 'scope bandwidths extending into the GHz range! This is the achievement of two Philips' engineers, C. Loty and G. Clement, who by mounting a channel-plate electron multiplier just behind the phosphor screen of the tube have obtained bandwidths of 2 and 3·3GHz at deflection sensitivities of 20mm/V and 5mm/V respectively. The channel plate (see *Teletopics*, April 1971) amplifies the beam current so that the potential across the tube can be substantially reduced—to about 400V—thereby much increasing the deflection sensitivity while still giving sufficient trace brightness. A travelling-wave deflection system is used consisting of an open helix which is wrapped around the axis of the gun current.

SET AND TRADE NEWS

On the import side **Telefunken** have reduced the price of their colour sets and **Hitachi** the price of their monochrome portable, in both cases by about 10%. We've noticed considerable price cutting of imported set prices in the shops. **Teleton** have introduced a "go-anywhere" 12in. dual-standard portable, the TA12DU, which can be operated from a 12V battery or the mains. The weight is 20lb and the recommended price £89·75.

Maggs of Bristol are importing a 26in. colour model from Finland. This is available to the trade with discounts. The set features two loudspeakers, tone and tint controls and a varicap tuner. It is on sale to the public at their branches in Bristol and South Wales at £375 which includes the first year's service free—this they say is worth £20.

SGS have introduced three new i.c.s for the sound sections of TV receivers. Most noteworthy is the TBA631 which in addition to carrying out the usual intercarrier sound channel functions also incorporates a driver and audio power output stage. The output is 2·6-3W into 16Ω, depending on the distortion level. The TBA581 and TBA591 are intercarrier sound i.c.s, the former suitable for driving a class AB complementary power output stage and the latter for driving high-voltage class A transistors or valves.

The latest BREMA set delivery figures give the first six months' totals for the year: 278,000 colour sets and 666,000 monochrome. In comparison with the first six months of 1970, colour deliveries are up 46% and monochrome deliveries down 16%.

IMPROVING THE SHADOWMASK TUBE

A good example of the steady technical development that goes on, often unnoticed, is the work that has been put into improving the shadowmask tube since the start of colour broadcasting in the UK in the summer of 1967. This work was reported to the Royal Television Society recently by W. W. Wright, Chief Engineer of Thorn Colour Tubes Ltd., and the paper appears in the July/August issue of the Society's Journal. Over the period the brightness level of the white field obtained at 800μA has been increased by over 118%. This increase has been brought about in several ways: new phosphors are being used, and improvements have been made to the screen printing procedure, increasing the screen efficiency and giving closer control of beam landing so that a slight increase in mask transmittance is obtained. Other improvements to the tube have made setting up easier and increased the operating stability. Temperature-compensated masks—the use of a bimetal support system to provide axial movement of the mask-frame assembly to compensate for radial changes in register—have minimised warm-up registration drift, improvements to the gun focusing have resulted in better resolution and less variation with beam current and deflection angle, while convergence stability has been increased by taking various measures which reduce the beam diameter as it passes through the convergence assembly. Further developments are being worked on.

TRANSMITTERS IN OPERATION

The BBC-2 service from **Carmel** (Carmarthenshire) has started on channel 63 with horizontal polarisation (receiving aerial group C). BBC-1 u.h.f. transmissions have started from **Bromsgrove** relay (Worcestershire) on channel 31 (vertical polarisation, receiving aerial group A—note that channel 21 was originally allocated for BBC-1 from this station), **Lark Stoke** relay (Gloucestershire) on channel 33 (vertical polarisation, receiving aerial group A) and **Craigkelly** (Fife) on channel 31 (horizontal polarisation, receiving aerial group A). Both BBC-1 and BBC-2 transmissions have started from **Haslington** (Lancs) relay, BBC-1 on channel 33 and BBC-2 on channel 26 (vertical polarisation, receiving aerial group A). BBC-1 test transmissions from **Fenton** (Stoke-on-Trent) have started on channel 31 (vertical polarisation receiving aerial group A).

FOR THE SERVICE ENGINEER

First, soldering and desoldering. Henri Picard and Frere (34-5 Furnival Street, London EC4) have introduced a new desoldering gun called the Soldavac. This is a modified version of the tool recently commented upon in our *TV Test Report* series (see July issue, page 392). Steadying rests are provided for the fore and middle finger, with a large trigger for thumb operation to bring the tool into action. Light Soldering Devices Ltd. (28 Sydenham Road, Croydon CR9 2LI) have introduced a dry desoldering wick, known as the Bradewick, for removing solder from all kinds of solder joints. The wick has a high solder absorption capacity as a result of the way in which it is impregnated with dry resin flux. From Orientation Ltd., Mayfield, Coverack, Cornwall, come two soldering bits designed for the removal of components whose leads are in T formation: they are said to be particularly suitable for soldering and unsoldering transistors in printed-circuit boards and will fit any standard soldering instrument.

Among a new range of Hameg 'scopes released by Echo Metrix Ltd. (113-5 The Broadway, Leigh-on-Sea, Essex SS9 1PG) are the HM312 which is suitable for colour TV work and the HM207 compact model designed for field servicing or production line applications. The HM312 has a d.c. to 10MHz bandwidth, maximum sensitivity of 50mV/cm. and 8 × 10cm. screen size. The HM207 has a d.c.-coupled 7MHz amplifier and 12-step input attenuator allowing measurements of signals up to 150V: the maximum bandwidth of d.c. to 12MHz is obtained with a 2cm. deflection.

Pye have introduced at £155 (to dealers) a colour TV service jig. This consists of a complete colour receiver in a rigid open frame with all panels plugged in. It can be stood on any side for easy access to components when servicing. Faulty panels from any Pye single-standard colour set can be plugged in.

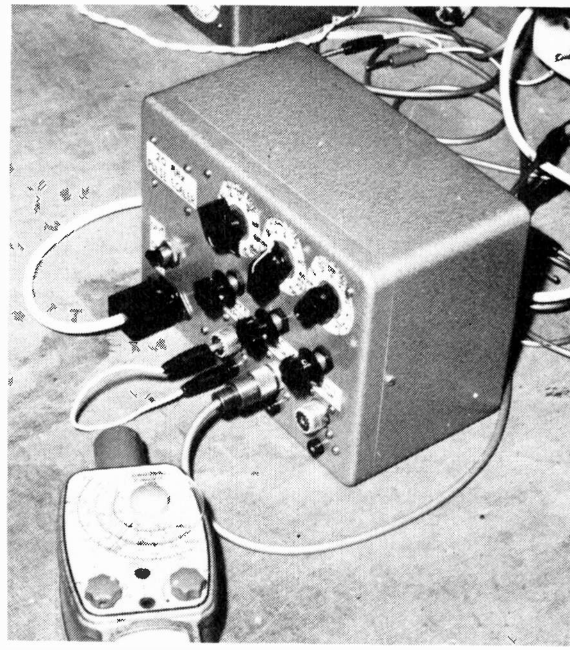
Lastly a useful tip from "Squarewave" writing in *Electrical and Electronic Trader* recently. He points out that the i.c.s now widely used in TV intercarrier sound channels normally produce very little background noise but produce a loud high-gain hiss with no signal input. This hiss can easily be mistaken for front-end noise! So it doesn't mean that the earlier stages are operating at high gain if you turn up the volume control and get a loud hiss from the loudspeaker.

MULTIPLE HOLOGRAMS STORED IN CRYSTAL CUBE

Scientists at the RCA Princeton Laboratories New Jersey have developed a system of storing a number of separate three-dimensional holographic images in a crystal the size of a cube of sugar. This information storage system has a theoretical capacity of a trillion bits per cubic centimetre of crystal. The different holograms are formed in the crystal by using a different recording beam angle for each one. Subsequently only a minute change in the angle at which the read-out laser beam strikes the crystal makes it possible to select one hologram from another. The holograms are stored as a charge pattern in the doped crystal which is heated to 100°C to stabilise the pattern. The material used is said to be 500 times more sensitive to light than any previously used so that it is no longer necessary to use a very powerful laser to write in and read out the hologram, while the holograms are not destroyed in the read-out process.

It seems that smallness equals advance just now in the world of electronics. RCA have also come up with a device capable of storing a complete TV frame in an area of 1 sq. cm. A vidicon is used to record on to a coplanar grid of silicon storage elements. The storage capacity is 600,000 bits of TV or the equivalent digital information. The system can perform a variety of operations including zooming in on any portion of the stored frame, erasure and alteration, etc.

THIS versatile instrument can be used on its own as a self-excited or externally-triggered wide-range pulse generator but has been specially designed to serve as a front-end adaptor for our recently published digital frequency meter. Used with this it extends the frequency range up to 20MHz on direct counting. The pulse scaler employs an aperiodic input amplifier which will handle signal frequencies up to 20MHz with a nominal counting trigger sensitivity of 10mV r.m.s. A single-turn loop of flexible wire (length about 4 to 6in.) connected between the input and a chassis socket will pick up sufficient signal voltage to trigger the counter system from the probe coil of a grid-dip meter, from oscillating tuned circuits in running



20MHz

PULSE SCALER/SIGNAL GENERATOR

MARTIN L. MICHAELIS M.A.

equipment or from any other source of localised r.f.

The accompanying photo shows how loose the coupling may be: the coupling loop, a piece of flexible insulated wire looped between two banana plugs connected to the input, is at a considerable distance from the probe coil of a grid-dip meter (Grundig Resonance Meter 1). This distance is roughly the maximum usable to still give reliable triggering of the frequency counting system for any frequency from 100kHz to 20MHz. Similar or smaller coupling loops consisting of one or a few turns may be connected to one end of a length of coaxial cable plugged into the scaler input to form a suitable probe for sampling active circuits in running equipment. The probe will not disturb the circuits in any way because the inductive coupling need only be extremely loose. Alternatively signals can be injected directly or capacitively from signal generators or other equipment with r.f. output sockets.

The waveform fed to the scaler is immaterial for all frequencies above 10kHz—sinewaves, distorted sinewaves or any other regular pulsed or rounded waveforms give equally secure triggering. Inputs below 10kHz should be pulsed, i.e. at least one peak-to-peak transition should occur at least every 50msec. If this condition is not satisfied loss of trigger sensitivity is the only consequence—the scaler will trigger even on sinewaves of 20Hz provided the amplitude is sufficient. Since however frequencies up to 100kHz can be fed directly to the digital frequency meter this limitation is not important. Using the digital frequency meter intermittent-counting mode to count for exactly 10sec the resolution of the digital frequency reading is ± 1kHz at 20MHz. A resolution of ± 10kHz at 20MHz is obtained in a single counting second in the intermittent mode.

Pulse Generator Functions

The instrument can be operated in two modes, self-excited or scaling/triggered. In the self-excited mode it produces accurate square output pulses continuously adjustable in amplitude from zero to 10V peak. Positive and negative output polarities are available simultaneously with separately adjustable amplitudes. The outputs are d.c. restored to approximately chassis potential so that between pulses there is nominally no voltage present at the output. The pulse and space times are independently adjustable with the respective selector switches, providing a wide range of combinations corresponding to pulse repetition frequencies from a fraction of the television field frequency to well above the television line frequency.

In the scaling/triggered mode the instrument requires an input signal and adjustment of the trigger level control according to the amplitude of this input signal. The minimum input required is 10mV r.m.s. (or 30mV peak-to-peak for an arbitrary waveform) and the maximum is about 1.5V r.m.s. (5V peak-to-peak). Larger inputs may lead to erratic triggering and should be avoided by turning down the output level control of the signal source, loosening the coupling or using some other form of attenuation.

A third selector switch provides ten logarithmically graded digital scaling factors (frequency division ratios) from 1 to 1,000. The scaled down outputs are the same pulses as in the self-excited mode. The pulse time selector and output amplitude controls are

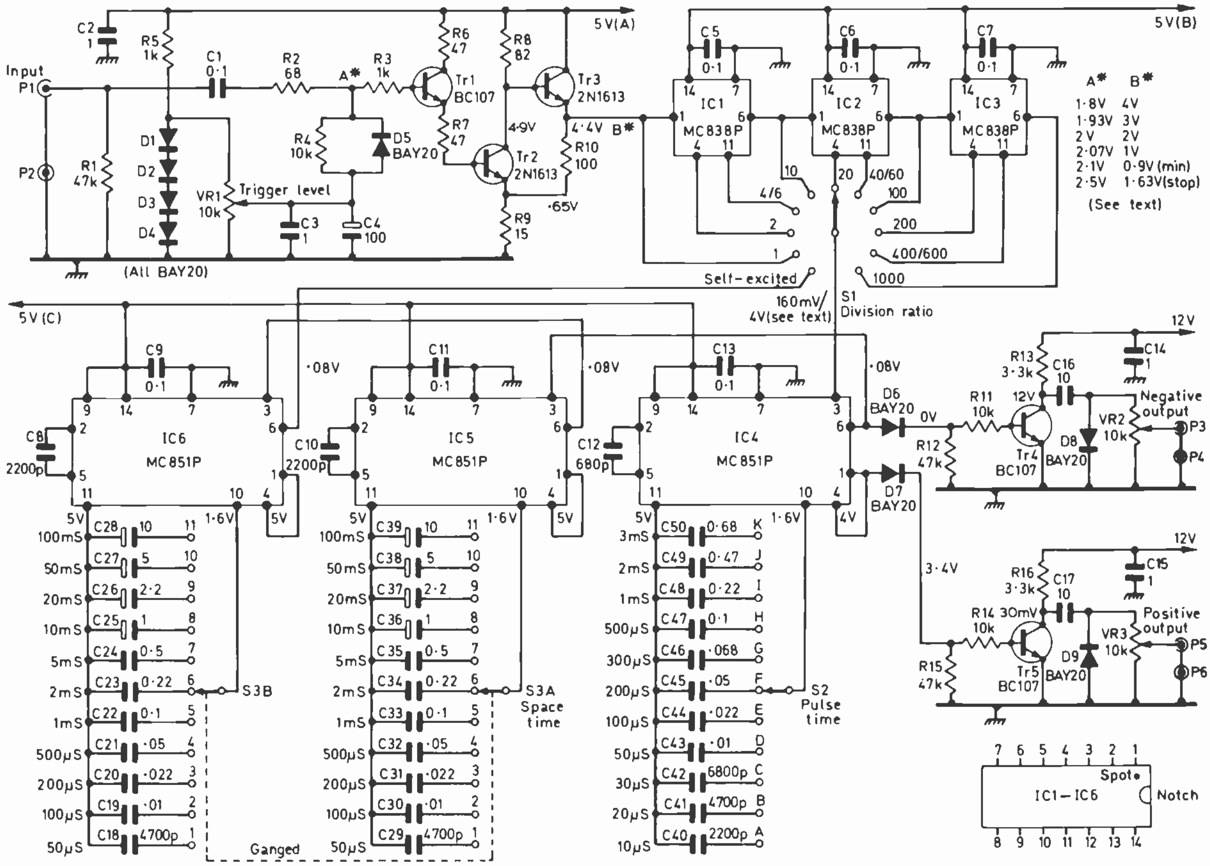


Fig. 1: Circuit diagram of the 20MHz pulse scaler. The power circuitry will be given next month. Stages IC4-IC6 with the output amplifiers Tr4 and Tr5 form an independent pulse signal generator which will operate in the self-oscillating mode or triggered via the input amplifier and scaling stages.

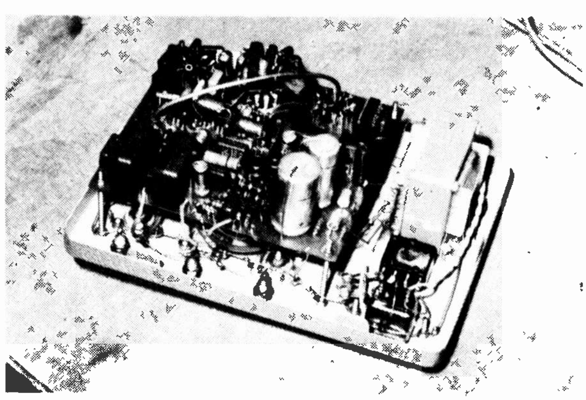
effective as previously but the space time switch is of course out of circuit since the time between successive pulses is determined by the input frequency divided by the selected scaling ratio. With the latter at the highest setting (1,000) an input at 20MHz produces an ouput at 20kHz which is of course suitable for the frequency meter. A convenient pulse time is 20μsec and the resulting pulses should be fed to the pulse input of the meter: since this has its own d.c. restorer it is quite immaterial whether the positive or negative pulse outputs are used. A pulse amplitude of a few volts is required by the frequency meter for secure triggering and this is much less than the output available from the scaler.

Generating VLF Pulses

In designing electronic equipment pulses of short or medium duration but very low repetition frequencies are often required so that the secondary effects produced in the circuits by such pulses can be observed. These secondary effects may have a duration which is extremely long compared to the pulse time. Most conventional sine, square or pulse audio signal generators do not tune below about 20Hz. The scaler can be used to extend the frequency range of such generators downwards by a factor of up to 1,000. This does not alter the pulse amplitudes, times and polarities but merely extends the intervals between successive pulses. The input waveform should preferably be pulsed if the frequency is below 10kHz but it is quite immaterial whether the waveform be a symmetrical squarewave, a highly asymmetrical squarewave, a sawtooth or anything else provided there is at least one very rapid peak-to-peak transition.

Flutter Scaling

The available scaling factors of 1, 2, 5, 10, 20, 50, 100, 200, 500 and 1,000 are all produced from binary powers of two as the scaling stages are essentially binary dividers which pass an output pulse to the next



Internal view showing method of construction.

★ components list

Resistors:

R1	47kΩ	R6	47Ω	R11	10kΩ	R16	3·3kΩ
R2	68Ω	R7	47Ω	R12	47kΩ	R17	100Ω 1W
R3	1kΩ	R8	82Ω	R13	3·3kΩ	R18	68Ω 2W
R4	10kΩ	R9	15Ω	R14	10kΩ	R19	220Ω 1W
R5	1kΩ	R10	100Ω	R15	47kΩ	R20	470Ω

½W, 10% carbon unless otherwise specified.

Potentiometers:

VR1 10kΩ lin. VR2 10kΩ log. VR3 10kΩ log.

Capacitors:

C1	0·1μF	C15	1μF	C29	4700pF	C43	0·01μF
C2	1μF	C16	10μF	C30	0·01μF	C44	0·022μF
C3	1μF	C17	10μF	C31	0·022μF	C45	0·05μF
C4	100μF El	C18	4700pF	C32	0·05μF	C46	0·068μF
C5	0·1μF	C19	0·01μF	C33	0·1μF	C47	0·1μF
C6	0·1μF	C20	0·022μF	C34	0·22μF	C48	0·22μF
C7	0·1μF	C21	0·05μF	C35	0·5μF	C49	0·47μF
C8	2200pF	C22	0·1 μF	C36	1μF El	C50	0·68μF
C9	0·1μF	C23	0·22μF	C37	2·2μF El	C51	2200μF El
C10	2200pF	C24	0·5μF	C38	5μF El	C52	1000μF El
C11	0·1μF	C25	1μF El	C39	10μF El	C53	100μF El
C12	680pF	C26	2·2μF El	C40	2200pF	C54	100μF El
C13	0·1μF	C27	5μF El	C41	4700pF	C55	100μF El
C14	1μF	C28	10μF El	C42	6800pF		

El, 25V electrolytic, all others plastic film or ceramic 100-500 V. Select smallest possible types. C18-C50 change values in linear proportion if other times desired. C16, C17 may be tantalum electrolytics.

Semiconductors:

Tr1	BC107	D6-9	Any silicon signal diode	IC1-3	MC838P Motorola decade counters
Tr2	2N1613				
Tr3	2N1613	D10-11	Silicon 0·5A l.t. rectifiers	IC4-5	MC851P Motorola pulse univibrators
Tr4	BC107				
Tr5	BC107	D12-14	5V, 100mA zener diodes (tolerance +0·5V.)		
D1-4	Any silicon diode				
D5	Any r.f. diode				

Miscellaneous:

P1, 3, 5	Coaxial sockets	S3	2 pole 11-way rotary
P2, 4, 6	Chassis sockets	S4	2 pole on/off toggle
P7	Mains input	T1	220V, 10-0-10V approximately 0·5A
F1	1A fuse		
S1, 2	1 pole 11-way rotary		

Cabinet, printed circuit board, etc.

stage for every second input pulse they receive. The scaler chain consists of three i.c.s in cascade each of which scales by ten with four binary dividers. Now four binary dividers on their own will divide by 16, not 10. Thus each i.c. also contains feedback logic elements which sense when the ninth of the sixteen states occurs, thereupon introducing a feedback loop which makes the tenth input pulse reset the chain of four stages in the i.c. to zero and then switches the feedback path off again.

The i.c.s have separate pins giving access to the outputs of the four binary dividers in each. An output scaled down by 2 is obtained from the first and is regular and unaffected by the logic feedback that establishes the count of 10 instead of 16. The output scaled down by 5 is obtained from the second divider. In the absence of the decimal feedback logic this output should be scaled down by 4 rather than 5. It would thus produce output pulses on the fourth, eighth, twelfth and sixteenth input pulse without the feedback. With the decimal feedback the fourth and eighth pulses appear undisturbed but the twelfth and sixteenth are missing because the feedback resets the i.c. to zero on the tenth input pulse. Thus the fourth and eighth input pulse of every set of ten produce an output pulse at the divide by 5 output which functions correctly so far as digital counting is concerned because we get exactly two output pulses for every ten input pulses. But the output pulses are not in regular sequence. The interval between the fourth and eighth pulse in every 10 is four input periods but the next output pulse interval, from the eighth in one set of 10 to the fourth in the next set of 10, is six input periods. This train of output pulses thus contains pulse intervals which are alternately 20% longer and 20% shorter than the average interval.

Measuring Dead Times

This makes no difference so far as digital counting is concerned and the scaling factor of 5 can be treated as if it is a regular 5 instead of alternating between 4 and 6. The scaling factors of 2 and 10 are regular, the former for the reason already explained and the latter because the decimal feedback in the i.c. ensures this regularity. Similarly the scaling factors that are decimal multiples of 2 and 10 are regular but the decimal multiples of 5 all show this *flutter* between 4 and 6.

There are two kinds of i.c. on the market for scaling down by 10. The first is the kind operating as just outlined. The second contains three stages with a binary capacity of 8, reduced to 5 by feedback, and a fourth independent stage in cascade to produce the division by 10. This type produces the 5 as well as the 2 without flutter. We have decided to use the type with fluttering 5 however because the waveform produced when scaling down from a conventional pulse generator is very useful in measuring *dead times* while the fluttering 5 is in no way inferior to a regular 5 so far as frequency metering is concerned.

All pulse circuits without exception possess a dead time, that is the minimum time which must elapse after one pulse before the circuit can respond correctly to the next pulse. This is sometimes loosely called the recovery time. It is often necessary in designing TV equipment to have a simple method of measuring the dead time and in particular to test whether drive frequencies close to the dead-time limit provoke any subtle forms of instability which could have a disastrous effect on the picture performance. Economical designs often drive circuits close to their dead-time limits, but not too close.

To investigate the dead-time characteristics of a circuit select one of the flutter scaling factors (5, 50 or 500) and trigger the scaler with the output of a conventional variable frequency pulse generator. Feed the fluttering output pulse train from the scaler to the equipment on test and observe the response on an oscilloscope. The train of pulses with 4-6 spacing is easily synchronised and observed. Next increase the pulse generator frequency gradually until the oscilloscope display becomes erratic. If the circuit's dead time is well defined and free from secondary instabilities—as it should be—only the set of pulses at the end of the 4-period intervals will vanish completely or erratically on the display while the set of pulses at the end of the 6-period intervals will remain unaffected. If both sets of pulses start to become erratic together the circuit on test has instability too near its dead-time limit. If there is no instability and the dead time is sharp the 4-interval pulse set vanishes within a very small frequency increase of the driving pulse generator and the 6-interval pulse set then persists until the pulse frequency has been increased by about 50% when the 6-period interval has also become equal to the sharp dead time so that the scope display then vanishes completely. If there is no instability but the dead time is diffuse the 4-interval set of pulses will vanish progressively in an erratic manner over a corresponding range of frequency increase of the driving pulse generator. The time scatter of the dead time obviously exceeds about 50% if the 6-interval pulse set commences to vanish too before the last remnants of the 4-interval pulse set have completely disappeared.

When making dead-time observations synchronise the scope externally with one of the scaler outputs, feeding the circuit on test from the other scaler output. It is then possible to note the positions on the screen corresponding to members of each pulse set

21cm x 15cm

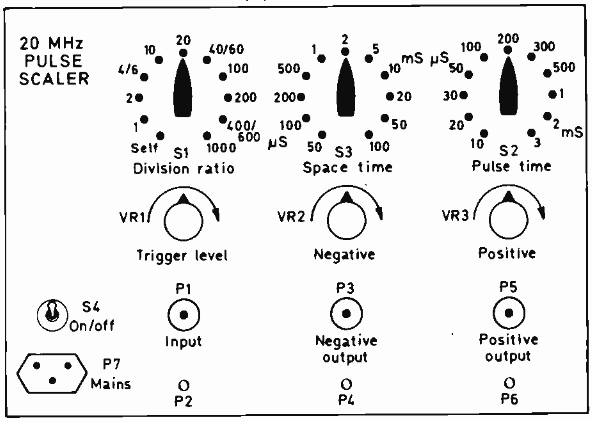


Fig. 2: Front panel layout.

and thus to see clearly which set commences to flicker and when. External sync also makes independent variation of the drive amplitude applied to the circuit on test possible. Drive amplitude has a profound effect on dead-time behaviour in many circuits.

Circuit Description

The complete circuit (except for the power supply) of the 20MHz pulse scaler is shown in Fig. 1. It employs only five transistors and six integrated circuits. The three transistors Tr1 to Tr3 form a special trigger amplifier which is a modified Schmitt circuit with insufficient gain in this case to produce a true threshold trip. The inevitable finite hysteresis associated with such a response was found to be embarrassing for smooth toggling of the first decade counter IC1 at very high frequencies. Performance was poor above 2MHz with insufficient gain to give a trip but becomes very smooth up to at least 20MHz when the gain is reduced with R8 to the point where it is just insufficient for a trip yet still produces heavy positive feedback for good input sensitivity.

The functions of the three cascaded scaler decades IC1-IC3 and the associated division ratio selector switch S1 will by now be apparent. The selected scaled down output from the scaler chain drives the univibrator i.c. IC4. This rests with a logical 0 at output pin 6 and a logical 1 at output pin 1. Each transition from a 1 to a 0 applied to the input pin 3 causes the states at the output pins 6 and 1 to change over for the pulse duration determined by the pulse timing capacitor selected by S2. The opposite polarity output pulses from IC4 are amplified by the output stages Tr4 and Tr5 and fed to the respective output sockets. C16, D8 and C17, D9 provide d.c. restoration so that the negative pulses are entirely negative-going from the resting potential and the positive pulses are entirely positive-going from the resting potential regardless of the duty cycle (pulse/space time ratio).

The trigger amplifier Tr1-Tr3 and the scaler chain IC1-IC3 are out of circuit when S1 is in the self-excited position. IC4 then functions in the same manner as previously but is driven by IC6 which with IC5 and IC4 then form a closed pulse ring. The output pulse from IC4 triggers IC5 which triggers IC6 which then triggers IC4 so that the ring oscillates continuously.

CONTINUED NEXT MONTH

PART 2 **K. T. WILSON**

THE TAA700 JUNGLE CIRCUIT

THERE are limitations with integrated circuits which prevent the appearance of the "all-integrated" TV receiver. One important limitation is of voltage, which prevents the use of integrated circuits in high-voltage stages such as the video output stage. Another limitation is of power dissipation because of the small size of the silicon chip. This limitation prevents i.c.s being found in the line output stage though i.c. audio and field output stages are possible. A third difficulty is that inductors, or capacitors having values of more than a few tens of picofarads, cannot be economically produced in present silicon integrated circuits. R.F. or i.f. amplifiers using integrated circuits therefore take the form of an integrated amplifier block used in conjunction with discrete inductors and capacitors to achieve the desired gain and selectivity.

The stages that lend themselves most readily to integration are those which use pulse or other untuned signals at low amplitudes. This description fits perfectly the circuits used for video preamplification, a.g.c., sync separation and flywheel sync—a set of circuits often nowadays referred to as the "jungle stages."

Block Diagram

The Mullard TAA700 is a 16-lead integrated circuit in a rectangular 22×7×4mm. case which carries out the functions of the jungle stages in monochrome or colour receivers. It is used in the Pye 169 single-standard monochrome chassis and the Philips G8 single-standard colour chassis. The block diagram is shown in Fig. 1 and indicates the circuit tasks carried out by it and also the required inputs and the outputs obtained.

Video Section

The video preamplifier section can be driven directly from the video detector diode which will also be the take-off point for the intercarrier sound and often in colour receivers for the chroma signal as well. Any filters needed must be included between the video detector diode and the TAA700. The video output of the i.c. is at low impedance (from an emitter-follower stage, with the load resistor connected externally to minimise power dissipation in the i.c.) and can be used in a monochrome receiver to drive a video output stage of the BF178 type or in a colour receiver taken to the luminance delay line and thence to a buffer stage driving the RGB video amplifiers.

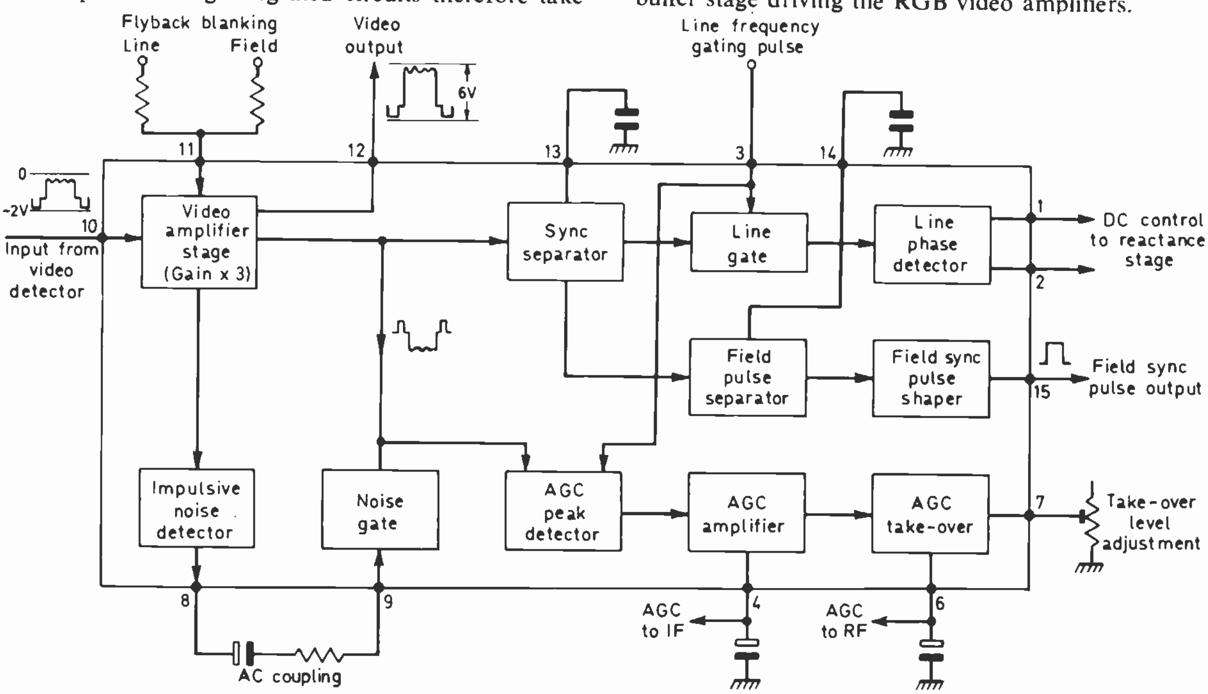


Fig. 1: Block diagram of the TAA700. The video output at pin 12 is positive-going with black at approximately 5V and peak white at approximately 9V. The output stage bias must take into account the positive sit-up of the video output from the TAA700. A 1-5V blanking pulse at pin 11 removes the video signal from the output.

The input includes an integrated resistor of 2·7kΩ and no d.c. bias is required here. The video input should be 2V peak which in a monochrome receiver can be readily obtained from the detector diode. For colour sets improved linearity can be obtained by operating the detector diode at a higher level: a potential divider must then be used as the detector load with the input to the i.c. taken from the junction of the resistors. This approach may also be used where a higher sound signal level is required.

The video output signal has a peak-to-peak amplitude of about 6V with the black level at +5V and a black-to-white signal amplitude of 3·8V. This is suitable for driving a video output transistor such as the BF178. Line and field flyback blanking pulses can be fed in at pin 11 when the i.c. is used in a monochrome receiver. In a colour television receiver where a.c. coupling and d.c. level clamping of the luminance signal is used flyback blanking cannot be carried out in the TAA700: it must be done elsewhere. In this case pin 11 must be connected to chassis.

AGC System

The a.g.c. system built into the i.c. detects the amplitude of the sync pulse tips and is gated by line pulses to minimise the disturbance to the a.g.c. potential that would otherwise occur during the field sync pulse group. This enables a short time-constant to be used for the a.g.c. circuit, minimising picture flutter. The line gating pulse fed to pin 3 should have an amplitude of +1 to +5V peak. The a.g.c. output is positive and is intended for forward a.g.c.—where an increase in the emitter current of the controlled stage results in decreased gain. Two outputs are available, one for the i.f. amplifier and the other for the r.f. stage. A reservoir capacitor is necessary at each output and should be mounted close to the i.c. Decoupling at the controlled stages is important.

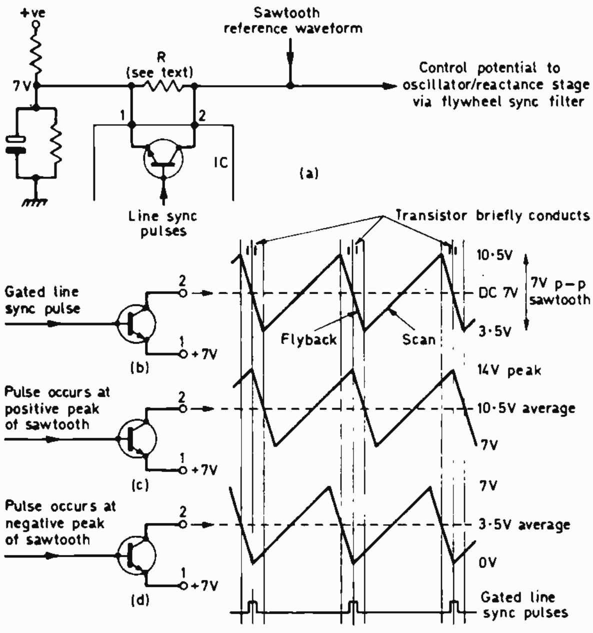


Fig. 2: Operation of the flywheel line sync discriminator. R is 10kΩ with a transistor line oscillator, 220kΩ with a PCF802 line oscillator.

In a.g.c. systems generally it is best for the control to operate on only the i.f. amplifier at lower signal voltages, transferring to the r.f. amplifier stage at higher signal levels. This ensures that the best signal-to-noise ratio is obtained with small amplitude signals where noise is most noticeable. The voltage at which control shifts from i.f. to r.f. control is determined by an external preset potentiometer connected to pin 7.

Sync Separation

Separate line and field sync separator stages are used in the i.c. The line sync separator stage is of the conducting-on-peaks variety and uses an external charge-storage capacitor since the 220nF required is too large to be built into the i.c. A low-pass filter is incorporated so that high-frequency noise and the colour bursts are removed before sync separation. The line sync pulses are then used internally in the line flywheel phase discriminator circuit to be described later. The field sync separator circuit requires a 47nF integrating capacitor connected to pin 14. The 10V rectangular field pulse output at pin 15 is best connected to the field oscillator through a d.c. blocking capacitor of about 1nF. The internal circuit of the TAA700 includes protection diodes to avoid damage to the field sync separator caused by pulses fed back from the oscillator.

Noise Gating

It is important that the a.g.c. and sync systems are protected from impulsive noise. This is done by detecting noise pulses of amplitude greater than the video signal and using them to gate the a.g.c. and sync channels internally. To prevent lock-out causing loss of signal, a.c. coupling is introduced into the noise protection system via pins 8 and 9.

Flywheel Line Sync

Pins 1 and 2 on the TAA700 are connected internally to the emitter and collector of a transistor which acts—instead of the conventional pair of diodes—as the flywheel sync phase detector. This transistor will conduct in either direction. A d.c. bias voltage is applied to pin 1 and the reference sawtooth waveform (derived by integrating flyback pulses from the line output stage) is applied to pin 2. Because of voltage restrictions within the i.c. the voltages applied to these pins must be kept within limits of +14V and chassis potential: a typical case would be a +7V steady voltage applied to pin 1 and a 7V peak-to-peak sawtooth applied to pin 2.

The principle of operation of the phase detector is outlined in Fig. 2 where (a) indicates the basic circuit arrangement. The 7V standing bias at pin 1 is applied to the oscillator via the transistor in the i.c. and the usual externally-connected flywheel filter circuit. The sawtooth waveform is applied to the collector of the phase detector transistor and the sync pulses to its base. Fig. 2(b) shows the effect when the reference waveform and the sync pulses are in sync: the transistor conducts briefly at the centre of the sawtooth flyback and the control potential remains at 7V. If now the line sync pulse applied to the base of the transistor causes it to conduct on the positive peak of the reference waveform (oscillator slow) the rectified signal at pin 2 is at a d.c. level of 7V+3·5V=10·5V.

If on the other hand the transistor conducts on the negative sawtooth peaks (oscillator fast) the d.c. level at pin 2 is 7V−3·5V=3·5V.

This maximum available output swing of ±3·5V corresponds to the width of the line flyback pulse. Such a large phase error is outside the range of useful working and a more typical value of error might be around one third of this value which would lead to a discriminator output of ±1V. This value of phase shift might typically build up as a result of a 500Hz difference between the sync and the line oscillator frequencies, in which case an oscillator with a frequency control sensitivity of 500Hz/V would be able to correct the deviation. This sensitivity is easily obtained with either valve or transistor oscillators. Many line oscillators in fact have a sensitivity to voltage control which is greater than this and lower values of steady bias and sawtooth voltage can be applied to the TAA700 to suit such circuits.

The values of the resistors used in the bias network which supplies the steady voltage to pin 1 should be low so that a low impedance is presented to pin 1. The reason for this is that the base current of the discriminator transistor within the TAA700 flows via pin 1 and this base current is cut off when no video signal is present since the base is driven by the line sync pulses. If the bias network had a high impedance there would be a change of voltage at pin 1 and the line oscillator would change frequency: this would occur for example during channel switching. The maximum impedance of pin 1 to earth should be around 300Ω. In addition to this a resistor should be connected between pins 1 and 2 to avoid the output to the line oscillator reactance stage becoming open-circuit during loss of video signal: with this resistor present the oscillator is locked to a frequency set by the steady voltage on pin 1.

Sync Gating

Line flyback pulses are applied to pin 3 to gate the line phase detector so that the circuit is operative only during the line flyback pulse period. This has several advantages: the noise immunity of the line synchronisation is improved, the disturbance in the line flywheel action due to the group of half-line and broad field pulses in the sync waveform is very much reduced, and also the phase detector is given the behaviour of a frequency discriminator in the out-of-sync condition thus effectively widening the pull-in range of the flywheel system.

Surrounding Circuitry

Figure 3 shows the circuits which will typically be used in the region of the TAA700. The video input is obtained from an OA90 video detector diode and is attenuated by R1, R2 before being fed to pin 10. A 9V pulse (positive) from the line output stage is applied to pin 3 through an 8·2kΩ resistor (R3) to gate the line sync and the a.g.c. circuits. No other signal inputs are needed. The d.c. inputs are the main supply voltage, +12V well smoothed, at pin 5; the r.f. a.g.c. delay voltage (0-12V) at pin 7; and the flywheel sync bias voltage at pin 1. Pin 16 is the chassis connection. The a.c. coupling for the noise gating system is connected between pins 8 and 9.

The outputs comprise the a.g.c. voltage for the r.f. stage from pin 6, the a.g.c. for the i.f. stages from pin 4 and the field sync pulse from pin 15. The video

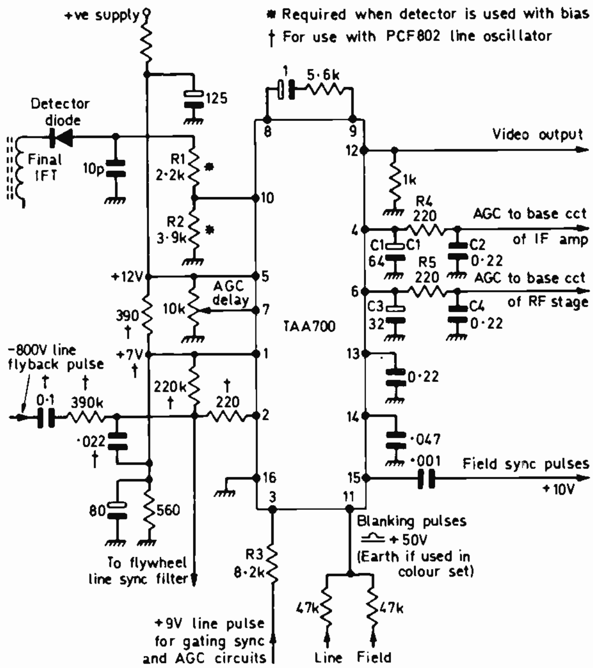


Fig. 3: Typical external circuitry for the TAA700. C1 and C3 are a.g.c. reservoir capacitors, R4, C2 and R5, C4 provide decoupling at the controlled stages.

signal appears at pin 12 and the line phase correction voltage at pin 2. The connections to pins 13 and 14 (sync circuits) and 11 (flyback blanking) were mentioned earlier.

Postscript

Not all receiver manufacturers are agreed about the extent to which the signal stages should be integrated. Some argue that the straightforward transistor circuitry involved (particularly since noise and sync gating is not used in conventional circuits) is hardly worth the trouble of replacing. Another argument which is used is that the large number of connections to a single device make the layout around the i.c. very much more critical than if conventional circuity is used. A third point which is raised is that there are other ways of splitting up the circuitry: some designers for example might wish to include the sync separator along with the line and field oscillators (and possibly later the field output stage) in one i.c. and the video and a.g.c. stages in another. Other combinations are possible and we may see some diversity in design arising here, in contrast to the view once held that the use of i.c.s would cause complete uniformity of design.

The TAA700 is now supplied for replacement purposes only, having been superseded by the basically similar but improved type TBA550Q which will be described in a later article.

Acknowledgment

The author wishes to acknowledge gratefully the help given by Mullard Ltd. in the preparation of this article. The original report on the use of the TAA700, by M. C. Gander of the Mullard Central Application Laboratory, appeared in the January 1970 issue of *Mullard Technical Communications*.

TO BE CONTINUED

TELEGENIC

THE TELEVISION trouble-shooting chart

THIS list of symptoms and the possible causes of television receiver faults is not a complete servicing guide but is intended to provide useful guide-lines for those new to television or servicing. In compiling this guide nearly all types of receiver—single- or dual-standard, valved, transistorised or hybrid—have been taken into account. Some checks must be ignored if they are not applicable to the type of receiver at fault.

Blank Screen, No Sound

(1) *Heaters dead.* Check mains fuse; heater dropper resistor; mains tapping panel or connections; open-circuit valve or c.r.t. heater; open-circuit power plug to tuner or other subchassis; heater chain thermistor; heater chain rectifier.
(2) *No h.t.* Check h.t. fuse; h.t. mains dropper resistor; h.t. rectifier.
Check for an h.t. short-circuit if the h.t. fuse is blown.

Blank Screen, Sound Normal

(1) *No e.h.t.* Check e.h.t. rectifier or e.h.t. multiplier; efficiency (boost) diode; line output valve or transistor; line oscillator valve or transistor or driver transistor; line blocking or sinewave oscillator transformer; flywheel sync diodes; drive to line timebase (negative voltage at grid of output valve); boost reservoir capacitor; other timebase components; line output transformer.
(2) *C.R.T. biasing.* Check first anode voltage; c.r.t. grid and cathode potentials; grid and cathode biasing and decoupling components including v.d.r. in brilliance circuit if fitted; video amplifier if direct coupled.
(3) *C.R.T.* Check for open-circuit heater; low emission; ion trap missing or mispositioned; poisoned cathode (ionised).

Raster OK, No or Poor Picture, 405 Sound OK, 625 Poor or No Sound

(1) *Video amplifier.* Check valve or transistor(s); video detector; video amplifier components.
(2) *Vision i.f. strip.* Check valves or transistors; power supply to strip including dropper resistor to transistorised strip; components in strip.

Raster OK, No or Poor Picture, No or Poor Sound on both Systems

(1) *Common i.f. stage.* Check valve or transistor; interconnecting coaxial lead from tuner to i.f. strip; other components in common stage.
(2) *Tuner.* Check r.f. amplifier and oscillator/mixer valves or transistors; switch contacts; other components.
(3) *Aerial.* Check coaxial plug to receiver; aerial connections; aerial location; receiver input components.
(4) *Low h.t. to tuner.* Check h.t. rectifier; dropper resistor in feed to tuner(s).

Picture OK, No or Poor Sound

(1) *Audio amplifier and output stage.* Check for open-circuit loudspeaker leads; valves or transistors; other components.
(2) *Sound i.f. and demodulator.* Check demodulator diode(s); valves or transistors in strip; other components in strip.
If noise is heard on turning up the volume control the circuits following the control are in order.

Intermittent Sound or Vision

(1) *I.F. circuits, video or audio output circuits.* Check joints on chassis or printed board; printed circuit board for hairline cracks; cracked or overheating resistors; chassis contacts of screening cans; coaxial cable connections between tuner(s) and i.f. strip; dirty valvebases or pins.
(2) *Tuner.* Check for badly aligned turret contacts or poor tension; locating cam loose or broken; mechanical rigidity; poor aerial socket contact.
(3) *Aerial.* Check connections; mechanical stability; shorting along feeder length caused by cable grip or feeder rubbing on sharp edge.

Uncontrollable Brightness

(1) *C.R.T. biasing.* Check grid and cathode bias components; video amplifier valve or transistor(s); d.c. restoration diode.
(2) *C.R.T.* Check for open-circuit electrode or inter-electrode short.

Varying Width and Height

(1) *E.H.T. generation.* Check e.h.t. rectifier; efficiency diode; boost reservoir capacitor; line output transformer.
(2) *C.R.T.* Check for varying tube capacitances by replacement.

Lack of Height

(1) *Field output stage.* Check valve or transistor(s); cathode (emitter) bypass electrolytic and bias resistor; adequate h.t.; linearity circuit; leaky coupler; output transformer and damping components across primary.
(2) *Field oscillator.* Check valve or transistor; check boost supply to valve (high-value feed resistor, faulty height control, boost reservoir capacitor, also possibility of interelectrode leak in tube); charging capa-

citor from anode of oscillator to chassis or cathode of output valve.
(3) *Field deflection coils.* Check for possible shorted turns; coil damping resistors; insulation to chassis; thermistor in coil circuit.

Top or Bottom Compression

(1) *Field output stage.* Check output valve or transistor(s); cathode bypass electrolytic and value of bias resistor; field charging capacitor; leaky coupler; components in linearity circuit; damping across output transformer and output transformer for shorted turns (these last two affect the top of the picture).
(2) *Field deflection coils.* Check for possible shorted turns.

Lack of Width

(1) *Line output stage.* Check line output valve or transistor(s); boost diode; preset width control(s); e.h.t. stabilisation circuit; h.t. voltage; line output valve screen resistor; adequate line drive; S-correction capacitor(s); line output transformer.
(2) *Line deflection coils, width or linearity coil.* Check for possible shorted turns; insulation to chassis; core of width or linearity coil secure; width or linearity coil damping resistors.

Different 405, 625 Widths

Line output stage. Check S-correction capacitors; width/stability control setting; stabilisation circuit.

Poor Line and/or Field Hold

(1) *Sync separator.* Check valve or transistor; anode or screen resistors; grid leak or base bias resistors; heater rectifier in some Bush-Murphy models.
(2) *Video amplifier.* Check valve; screen decoupling; cathode bypass capacitor.
(3) *Sync coupling.* Check coupling components between sync separator and timebases including interlace diode in case of poor field hold.
(4) *Flywheel sync circuit.* Check discriminator diodes; flyback pulse coupling components; d.c. amplifier if incorporated.
(5) *Line oscillator.* Check valve or transistor(s); operation of hold control and its series resistors; oscillator stage components.
(6) *Field oscillator.* Check valve or transistor; hold control and associated components; leaky coupling capacitors in stage; interlace diode; heater chain rectifier in some models where the field output stage bias is derived from the heater chain; boost reservoir capacitor; interlace control if fitted.

Horizontal Line Moving Vertically

(1) *Hum.* Check h.t. smoothing components; stage decoupling capacitors.
(2) *Valves.* Check for heater-cathode breakdown.

Picture not Central

(1) *Shift magnets or deflection coils.* Check setting and position.
(2) *Field deflection coils.* Check for d.c. through coils due to output transformer insulation breakdown.
(3) *Line deflection coils.* Check for d.c. through coils due to output transformer insulation or capacitor breakdown.

(4) *Line oscillator.* Check line hold control setting on receivers with large pull-in range.

Line Ringing

(1) *Third or spurious harmonic ringing.* Check width and linearity coils and damping resistors; line deflection coil inductance; line output stage tuning capacitors; line output transformer.
(2) *Spurious oscillations.* Check chokes at top caps of line output valve and efficiency diode; line output valve screen decoupling.

Picture Ringing

(1) *Excessive video h.f. response.* Check h.f. peaking components in video amplifier and detector circuits and detector compensating network.
(2) *Tuner.* Check oscillator setting and level.
(3) *Aerial.* Check for feeder mismatching at array and receiver; receiver aerial input circuit; ghosting.
(4) *A.G.C. circuit.* Check a.g.c. circuit decoupling components.
(5) *Vision i.f. strip.* Check alignment.

Poor Definition

(1) *Poor video h.f. response.* Check h.f. peaking components in video amplifier and detector circuits and detector compensating network.
(2) *Vision i.f. strip.* Check alignment.
(3) *Lack of signal.* Check aerial and siting.
(4) *Video signal level low.* Check tuner and i.f. valves or transistors.
(5) *Aerial.* Check for feeder mismatches on short cable run.

Poor Focusing

(1) *C.R.T.* Check first anode and focus potential; ion trap (if fitted) position; focus control circuit.
(2) *H.T.* Check h.t. rectifier; boost reservoir capacitor.

Arcing and Corona Discharge

Check e.h.t. lead; e.h.t. voltage tripler; e.h.t. rectifier heater; internal arcing in efficiency diode; line output transformer.

Picture Distortions

(1) *Line pulling.* Check for weak signal; poor aerial; low gain
(2) *R.F. patterning.* Check for foreign or co-channel interference; cross-modulation caused by excessive signal (check sensitivity preset); heater chain decoupling; radiating video amplifier; poor i.f. screening can chassis connections; oscillator setting; 4·43MHz rejector setting (625).
(3) *Pincushion distortion.* Check c.r.t. correction magnets; line linearity control setting.
(4) *Line non-linearity.* Check line linearity sleeve setting on c.r.t. neck; width control setting; efficiency diode (left-hand edge non-linearity); line output valve or transistor (right-hand edge non-linearity); line output valve screen voltage; S-correction capacitors

(centre non-linearity); cathode or emitter circuit of line output stage (centre non-linearity).
(5) *Ghosting*. Check aerial matching; aerial position; multipath reception.

Negative Picture

(1) *Vision interference limiter or black spotter*. Check setting of preset control; diode; bias components.
(2) *Low e.h.t.* Check e.h.t. rectifier; line output valve; efficiency diode; boost reservoir capacitor; h.t.; line output transformer.
(3) *C.R.T.* Check for low emission; low heater current.
(4) *Signal overloading*. Check preset sensitivity control setting; a.g.c. circuit; try inserting an aerial attenuator.
(5) *Ion trap*. Check position.

Sound-on-Vision

(1) *I.F. and video amplifiers*. Check 3·5MHz trap setting (405); 6MHz trap setting (625); sensitivity preset control setting; overloading—a.g.c. circuit; sound trap.
(2) *Tuner*. Check oscillator tuning.
(3) *Microphony (increases with volume)*. Check for microphonous valves (particularly in tuner); microphonous c.r.t.
(4) *H.T. feedback*. Check smoothing components; decoupling capacitors.

Vision-on-Sound

(1) *Sound i.f.* Check first i.f. transformer (405); 6MHz take-off coil tuning (625).
(2) *H.T. feedback*. Check smoothing components; decoupling capacitors.
(3) *Radiating video amplifier*. Check for "soft" valve; heater decoupling.
(4) *Microphony*. Check for microphonous valves.
(5) *Field buzz*. Check field oscillator stage decoupling.
(6) *Hum*. Check h.t. smoothing components; valve heater-cathode leakage.

Sound Distortion

(1) *Hum*. Check h.t. smoothing components; decoupling capacitors; valves for heater-cathode leakage.
(2) *Field buzz*. See vision-on-sound above.
(3) *6MHz buzz* (625). Check a.m. rejector control in ratio detector circuit; detector diodes; 6MHz take-off coil tuning; alignment of 6MHz tuned circuits.

General Safety Precautions

(1) Nearly all receivers use a.c./d.c. techniques: thus the receiver chassis may be *live*. For safety always check the chassis potential and reverse the mains connections if necessary.
(2) Never assume that the receiver mains switch is functioning correctly.
(3) Ensure discharge of the c.r.t. final anode cavity before removing tube.
(4) Do not dispose of old c.r.t.s in public places or in dustbins. Do not attempt to destroy them unless the space they are within is well sealed.
(5) Never overtighten c.r.t. clamps.
(6) Never carry a c.r.t. by its neck.
(7) Always replace implosion screens where they were originally fitted.
(8) Never attempt to use a multimeter at the anode of the line output valve or transistor or efficiency diode cathode—nor on the line output transformer windings.
(9) Never check for e.h.t. sparks in the line output stage if transistors are employed. ■

LETTERS . . . .

SYNCHRONOUS DETECTORS

In your interesting article on Synchronous Detectors in the January issue there is an error: like the other three circuits shown in Fig. 4 the first one also switches on just once each reference signal cycle. On the half cycle when the anodes of diodes 1 and 2 are positive with respect to the cathodes of diodes 3 and 4 all the diodes conduct: on the following half cycle all the diodes are cut off.—**T. John** (*London*).

Mr. John is quite correct: our apologies for this slip.—*Technical Editor*.

MULTI-CHANNEL UHF RECEPTION

I reported in June 1970 on the channels which could be regularly received in Bands I and III here at Leeds. As a follow-up readers might be interested in the stations now receivable here using an eleven-element rotatable Group B u.h.f. aerial at 30ft.

Ch. 22	BBC-1	Belmont (Lincs)	Excellent
Ch. 24	ITV	Sandy Heath (Bedford)	Extremely weak
Ch. 25	ITV	Belmont Anglia TV	Excellent
Ch. 26	BBC-2	Bilsdale (N. Yorks)	Excellent
Ch. 28	BBC-2	Belmont	Excellent
Ch. 29	ITV	Bilsdale Tyne Tees TV	Excellent
Ch. 33	BBC-1	Bilsdale	Excellent
Ch. 44	BBC-1	Emley Moor Local	Excellent
Ch. 47	ITV	Emley Moor Local Yorks TV	Excellent
Ch. 51	BBC-2	Emley Moor Local	Excellent
Ch. 55	BBC-1	Winter Hill (Lancs)	Good, slightly grainy
Ch. 58	BBC-1	Waltham (Leics)	Fair, grainy
Ch. 59	ITV	Winter Hill Granada TV	Good
Ch. 61	ITV	Waltham ATV	Fair
Ch. 62	BBC-2	Winter Hill	Good
Ch. 64	BBC-2	Waltham	Fair

The pictures from Belmont and Bilsdale are equally as good as the local transmitter Emley Moor which can be seen on a clear day. The pictures from Waltham are fairly good but the grain is more prominent. The picture is however watchable. The Sandy Heath signals are extremely weak with heavy fading.

The u.h.f. tuner is transistorised, using two BF180 transistors, and is almost noise free.

The pictures from Winter Hill and Waltham are better when received on a 6 over 6 Yagi for 2 metres (Ham Band) which is at 40ft. and clears rooftops that the u.h.f. aerial does not.

The only trouble with having all these channels available is that it doesn't leave many free channels for the reception of Continental stations during Trops! I have received Holland, France and E. and W. Germany on u.h.f. but as yet no Belgium. I wonder why?—**C. Morton (G8EMS)** (*Leeds*).

LONG-DISTANCE TELEVISION

ROGER BUNNEY

CONDITIONS have remained reasonably active throughout July though there has been a slight drop in the number and intensity of Sporadic E openings. At the time of writing, however, there is every reason to suppose that we can look forward to continued Sp.E openings into August. Thanks to the prolonged hot spell during the first half of July, tropospherics were active for many enthusiasts in favourable positions. Indeed, we have received a number of letters telling of enhanced tropospheric reception, mainly on u.h.f. from West Germany and the Low Countries. One particularly interesting letter came from C. Dalziel giving news of his West German u.h.f. reception on an extremely long North Sea path at his home in Aberdeen. My own log for the period under review is as follows:

2/7/71	TVE (Spain) E2, E3, E4; RAI (Italy) 1A; ORF (Austria) E2a; plus unidentified signals.
3/7/71	USSR R1; TVP (Poland) R1, R2; MT (Hungary) R1; Switzerland E2; CT (Czechoslovakia) R1.
4/7/71	USSR R1, R2; TVR (Rumania) R2; MT R1; TVP R1; RAI 1A; TVE E2; SR (Sweden) E2.
5/7/71	USSR R1; JRT (Yugoslavia) E3, E4; Switzerland E2, E3.
6/7/71	RAI 1A.
7/7/71	TVE E2, E3, E4.
9/7/71	TVE E2, E3, E4; RTP (Portugal) E2, E3.
10/7/71	USSR R1; ORF E2a; TVE E2.
11/7/71	TVE E3; RTP E3.
13/7/71	TVE E2, E3, E4; RTP E3; RAI 1A, 1B.
14/7/71	TVE E2, E3; RTP E2, E3; RAI 1A, 1B.
16/7/71	NRK (Norway) E2, E3, E4; SR E3, E4; RAI 1A; USSR R1, R2; TVP R1.
17/7/71	USSR R1, R2; NRK E2, E3 twice, E4; Iceland E4 (first time this year!).
19/7/71	USSR R1; NRK E3; SR E2.
20/7/71	USSR R1; TVE E3, E4.
22/7/71	NRK E2; Iceland E4; plus unidentified signals.
24/7/71	TVP R1, R2; MT R1; CT R1; RAI 1A, 1B; JRT E3, E4; SR E2; plus unidentified signals.
25/7/71	RAI 1A.
27/7/71	CT R1; MT R1; RAI 1A; JRT E3, E4.
28/7/71	TVE E2, E4.

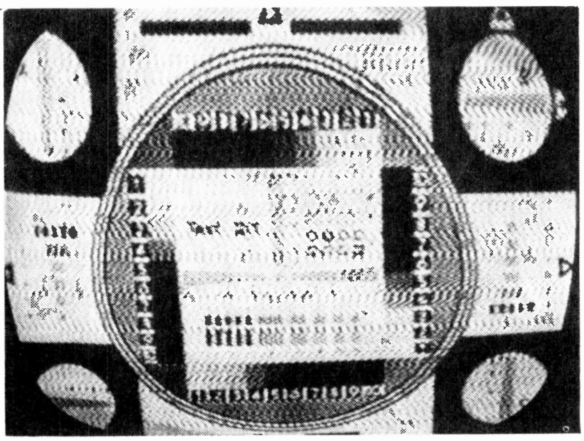
As before, I have included only Sp.E loggings in order to keep the log down to a reasonable size for the column. Sufficient to relate that during the first two weeks of July the various Northern French v.h.f. and u.h.f. transmitters were received at reasonable strengths during the enhanced tropospheric conditions at that time. It is interesting to note that at this particular location the south and south-east still seem to be favoured, with repeated reception of both TVE, RAI and JRT. One mystery signal was noted on 27/7/71. At 16.45 BST I noted on ch.E3 a cartoon film which faded into the noise to be replaced with a weak Telefunken-type test card. Both above and below the central circle on the edge of the frame were three widely spaced white letters. The card appeared at 16.52 and faded at 17.05. Direction seemed to be ESE, suggesting JRT. I wonder if anybody noted this test card? Frank Smales (Pontefract) has noted TVE to carry an identification on the main test card, from the ch.E4 transmitter at Guadalcanal, the name appearing just under "TVE", stating the transmission site "Guadalcanal".

News

Yugoslavia: We gather that the official inauguration of the first colour transmissions will be on New Year's Eve from a 1,000kW e.r.p. u.h.f. transmitter serving RTV Belgrade. Other high-power transmitters are also planned, taking their programmes from each Studio Centre of the six Republics of Yugoslavia. The various centres are being enlarged for the second service programming and production and a fairly rapid coverage of the six regions is expected although initially colour transmissions (PAL) will be of material received on Eurovision/Intervision exchanges.

France: We understand that ORTF-1 (French 1st Chain on 819 lines v.h.f.) are now testing on 625 lines with positive video each Tuesday from 09.00-12.00 BST. At 12.00 transmissions change to the normal 819-line service. Various patterns are radiated on 625 lines including the 2nd Chain test card. Sound transmissions remain unaffected throughout this time. There is no official word at present on the reason for these tests.

Albania: We have been making further enquiries as to the television situation here and now have some definite news. Via our friend Michele Dolci in Bergamo, we

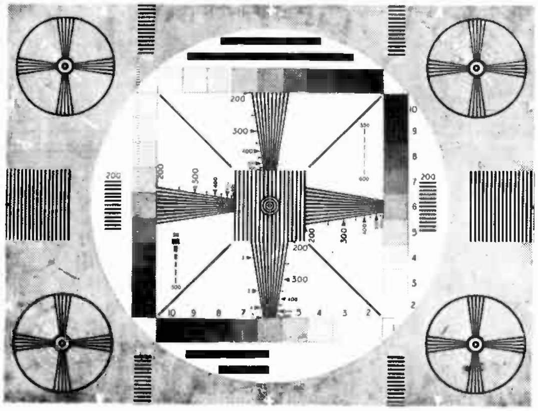


Albanian test card

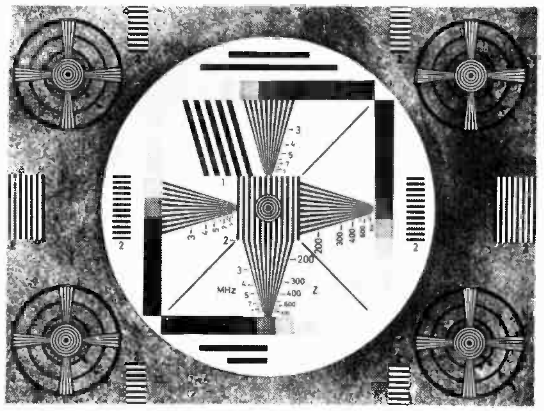
Albanian station identification slide

DATA PANEL 3—2nd series

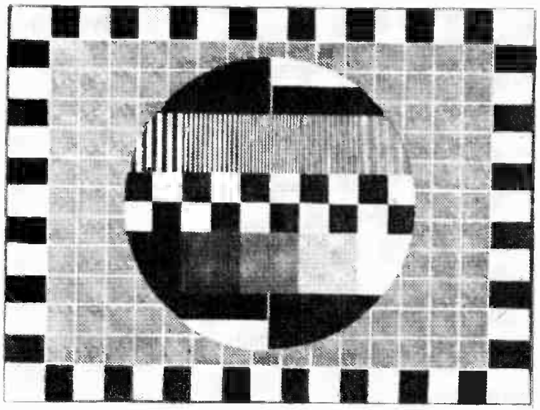
STANDARD PATTERNS



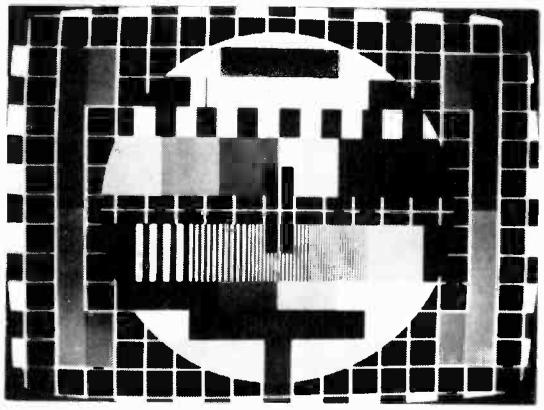
RMA Test Card



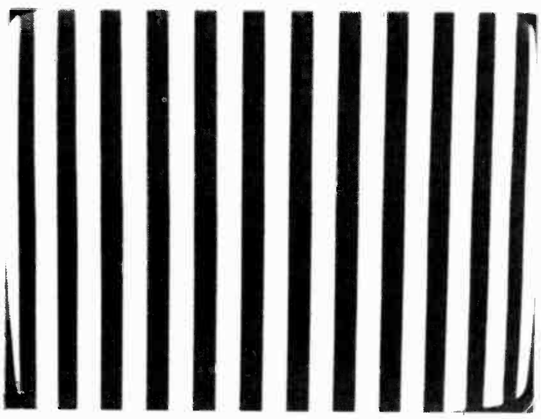
Telefunken Test Card



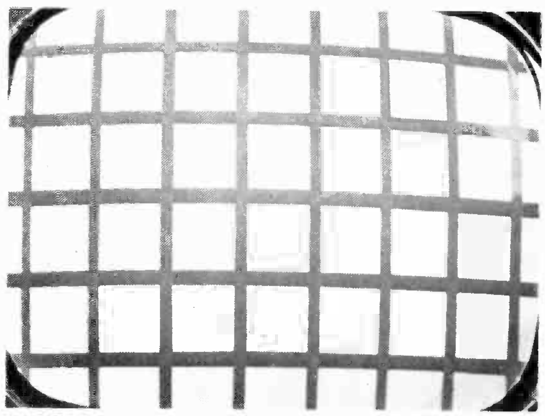
Philips PM5540 Electronic Test Card



ORF PM5544 Electronic Test Card



Vertical Bars Pattern



Test Grid

understand that a fellow enthusiast in Brindisi has been receiving signals which are now reported as ch.R7. These transmissions, however, do not come from the Tirana area but from an area in the south of the country. Both test transmissions and programmes are being radiated and we are most fortunate to be able to show the test card and the station identification slide this month. These were actual off-air photographs and consequently are not up to our usual standard, but in view of their importance we feel that they must be shown. The vertical test bars pattern is also radiated, as shown in our Standard Patterns this month. The 50W transmitter is still the only one listed for Albania—at Tirana. We have received no reports of its reception and, indeed, do not not know if it is still operative—on ch.R2. We have found difficulty in obtaining information regarding Albanian TV so if anyone can assist with further information it will be most gratefully received.

Sunspots: Predictions of smoothed monthly counts: July 58, August 56, September 54, October 52, November 50, December 48. The increasing fall in sunspots is reflected in the above numbers; indeed, the actual mean value for June 1971 was 47·1, somewhat below the actual prediction. Courtesy Swiss Solar Observatory.

From our Correspondents

A long letter has arrived from Hugh Cocks (Mayfield, Sussex). Hugh uses a Sony transistor television receiver containing coils for the American channels A2-6. Consequently Hugh is at present unable to receive ch.E2 but he certainly makes up for this with excellent coverage of the various Band II (TV) channels. Among the stations he has received in Band II has been the transmitter at Zielona Gora ch.R3 200kW in Poland. Hugh has also been very active with tropospherics during the periods noted above and has presented a fine record of various West German, Dutch and Belgian u.h.f. stations. In his letter Hugh mentions reception of various radio stations on frequencies around 70MHz, apparently of East European origin. Well, there is in Czechoslovakia an extensive f.m. radio network transmitting in a band between 66·32MHz-72·50MHz. This is apparently a countrywide network with transmitters ranging in power up to 10kW and radiating programmes for the whole day, from approximately 04.30 to 24.00 BST. Consequently if you hear East European signals whilst tuning for Band II TV signals it is almost certain that the Czechoslovakian f.m. radio service is being received. I hope that answers Hugh's query and also to have covered a possibly rather little-known transmission band.

A letter from Hal Moorshead (Wanstead, North-East London) reports excellent colour DX signals (CDX) on his KB 22in. colour receiver. Living in a most favourable position by all accounts, with no high ground between Hal and the sea, signals from West German, Dutch, Belgian and French transmitters were received (the latter with reversed video). Hal in particular notes excellent colour from the Goes, Holland, transmitter on ch.E29. A 10-element group A aerial is the only one in use so we can see that long-distance reception is possible on relatively simple equipment.

R. Finch (Birmingham) has sent in a most impressive log detailing the various days of Sp.E reception in his area. Signals seem to have been received from most countries, including the new Czechoslovakian test pattern on several occasions. A rather alarming comment at the end of his letter tells that during the last season (1970) his DX aerial mast was struck by lightning. Although, apparently, lightning never strikes in the same place twice, he is taking no chances and has rebuilt his Band I aerial on a rotator in the loft!

In Remembrance

It is with considerable regret that I heard the news that our old friend Doug Bowers (Saltash) had pased away on July 11th, 1971. Doug was a long-established DX enthusiast and despite being disabled for the past 11 years had been very active. He will be particularly remembered for his tropospheric reception of Spain on various occasions, on both v.h.f. and u.h.f. We would like to pass our sincere condolences to Mrs Bowers and her son in their sad and unexpected loss.

BACK NUMBERS

We regret that owing to the closure by the Company of the department concerned it is no longer possible to supply back numbers of TELEVISION. To ensure that readers get TELEVISION regularly we strongly recommend that a regular order is placed with a local newsagent or that an annual postal subscription (£2·65 including postage for one year to any part of the world) is taken out. Reference to past issues is possible at some public libraries which hold bound volumes and we understand that some offer a photostat service.

SECRETS OF THE SONY COLOUR RECEIVER

K. ROYAL

THIS is the colour receiver which has been the subject of a number of press reports in recent months: it is the one designed to operate on the PAL system but without infringing the Telefunken patents. There is no doubt that it is a remarkable set which has been very carefully and cleverly evolved by the Sony engineers. It is also a very sensitive set which I personally can vouch works extremely well in fringe areas.

Display Tube

The display device is not the usual shadowmask tube but a tube called the Trinitron which, instead of using diminutive clusters of red, green and blue glowing dots, is based on vertical red, green and blue glowing stripes. Moreover it uses a single electron-gun assembly (but with three beams) as distinct from the three guns of the shadowmask tube. These features significantly reduce the complexity of convergence both in circuitry and adjustment. However, the screen size is currently smaller than that of shadowmask tubes, being 13in. in the KV1320UB. Our main purpose in this article though is to examine the chroma and decoder departments to see how Sony have exploited the PAL signal without getting into trouble with Telefunken.

The Trinitron tube requires primary-colour drive and the block diagram (Fig. 1) shows that the colouring section concludes with a matrix taking the three colour-difference signals and the Y signal and delivering the red, green and blue signals to the Trinitron

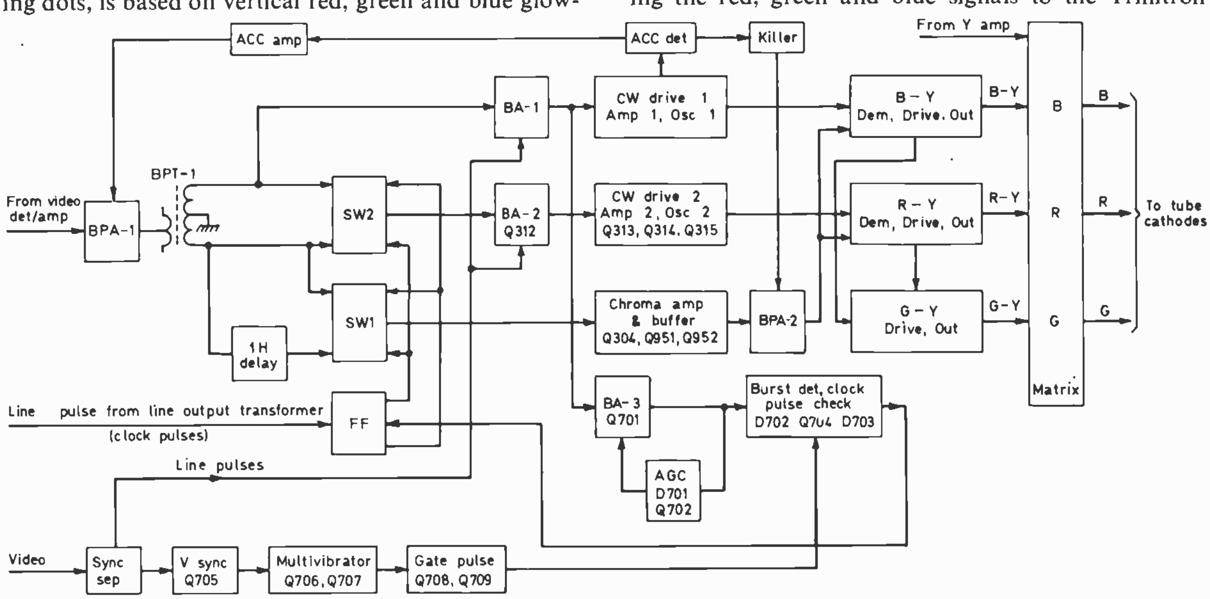


Fig. 1: Block diagram of the Sony decoder and tube-drive system.

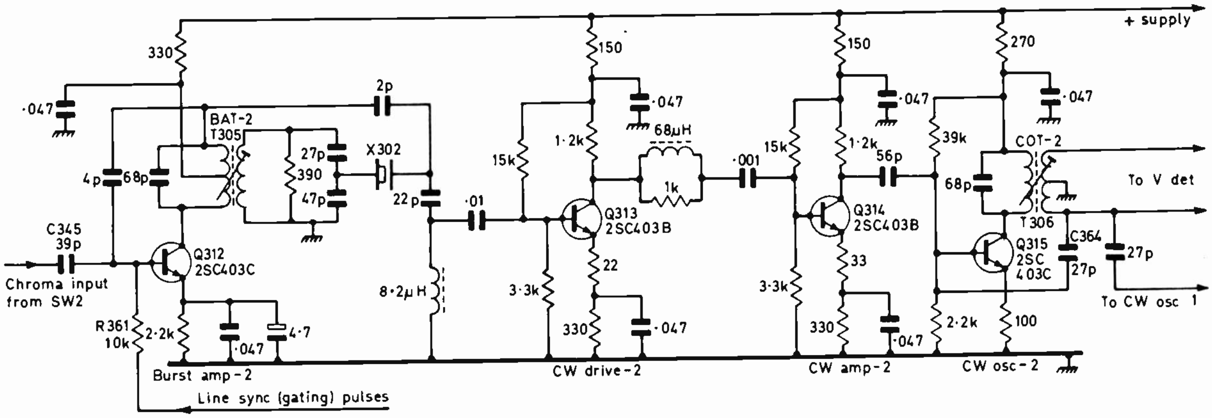


Fig. 2: Circuit of the V reference signal channel.

cathodes: this section of the set is reasonably conventional.

Reference Signal Generators

The R−Y (V) and B−Y (U) synchronous detectors produce the two transmitted colour-difference signals in the usual way, but instead of there being just one reference signal generator there are two of them, denoted *CW drive 1* and *CW drive 2* in Fig. 1. For proper quadrature demodulation we need of course two reference signals with a 90-degree phase displacement between them. Ordinary PAL sets accomplish this by including a 90-degree phase shifter in the reference signal feed to one of the synchronous detectors: Sony do it differently as we shall see.

Each reference signal channel starts with a 4·43MHz crystal which is stimulated, and thus caused to oscillate, by colour bursts applied to it from the burst amplifier. Again there are two of these, one in each channel, denoted *BA—1* and *BA—2* in Fig. 1. The circuit of one channel (the other is just the same), including the burst section, is shown in Fig. 2.

The amplifiers receive chroma signal from the chroma channel *BPA—1* (Fig. 1) via transformer *BPT—1*. Amplifier *BA—1* in the B−Y channel is fed direct from *BPT—1* but the feed to *BA—2* in the R−Y channel is via *SW2* which introduces a 180-degree inversion on alternate lines. This can be appreciated better from Fig. 3. *SW2* itself is operated by line-by-line pulses (from block *FF* in Fig. 1) and thus switches between positions A and B line-by-line (*FF* is a "flip-flop", see later). Thus with *SW2* in position A the chroma signal is fed direct to both *BA—1* and *BA—2* while in position B the chroma signal applied to *BA—2* is changed 180 degrees in phase by the inverter. (In practice inversion is carried out by the centre-tapped secondary winding of *BPT—1*.)

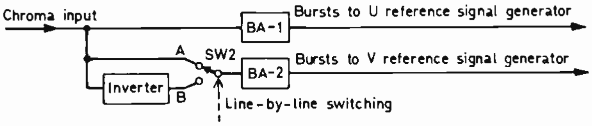


Fig. 3: Simplified block diagram showing how SW2 inverts the signal fed to BA-2 on alternate lines.

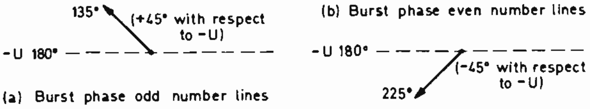


Fig. 4: The phase of the PAL bursts, (a) on odd lines, (b) on even lines.

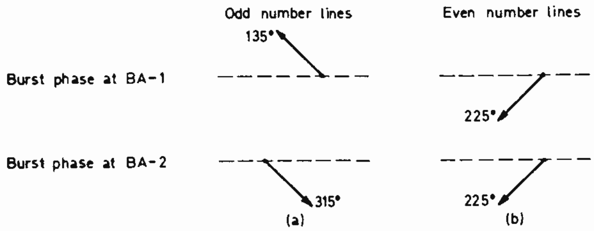


Fig. 5: Phase of the burst signals fed to BA-1 and BA-2 on odd lines (a) and even lines (b).

PAL Swinging Bursts

What is the significance of this? First let's recap on the PAL chroma signal and recall to start with that the phase of the bursts swings 45 degrees about the −U chroma axis (see Fig. 4) so that on one line they are +45 degrees and on the next line −45 degrees. It is convenient to consider lines of chroma signal in consecutive number (1, 2, 3, 4, etc.) and that the bursts swing from 135 degrees on one line to 225 degrees on the next consecutive line (this is because the −U chroma axis is regarded as 180 degrees). On this basis then the PAL signal is transmitted so that the bursts on odd number lines (1, 3, 5, 7, etc.) are at a phase of 135 degrees while those on even number lines (2, 4, 6, 8, etc.) are at a phase of 225 degrees as shown in Fig. 4.

Action of SW2

Now let us see what happens when these line-by-line bursts are switched by *SW2* and processed by the inverter in Fig. 3. If the chroma line is say an odd number and *SW2* is at position B then the bursts fed to *BA—2* will have a phase of 315 degrees (since they are shifted 180 degrees by the inverter) while those fed to *BA—1* will have the transmitted 135-degree phase. These conditions are shown at (a) in Fig. 5. On the next consecutive line, which will be an even number one, the bursts will have a phase at *BA—2* of 225 degrees, since now *SW2* is at position A—in other words the phase will coincide with that transmitted as shown at (b) in Fig. 4—while the phase of the bursts at *BA—1* will also be at 225 degrees because the chroma input to *BA—1* is direct. These conditions are shown at (b) in Fig. 5.

The net result of all this is that *BA—2* driving the V reference signal channel is fed with bursts swing-

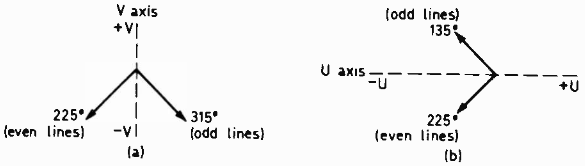


Fig. 6: The average phase of the reference signal fed to the V detector is coincident with the V chroma axis (a) while that of the reference signal fed to the U detector is coincident with the U chroma axis (b).

ing ±45 degrees relative to the V chroma axis while *BA—1* driving the U reference signal channel is fed with bursts swinging ±45 degrees relative to the U chroma axis, as shown respectively at (a) and (b) in Fig. 6.

The burst amplifiers *BA—1* and *BA—2* drive the 4·43 MHz crystal tuned circuits and because of the high *Q* of these and the time-constants involved the average phase of the signal generated in the *CW drive 1* channel lines up with the U axis while the average phase of the signal generated in the *CW drive 2* channel lines up with the V chroma axis. Moreover the intervals between the bursts are effectively deleted so that each synchronous detector receives a c.w. signal at 4·43MHz with a 90-degree displacement between the two signals as required for correct quadrature demodulation. That is, the phase of the signal applied to the V detector is along the V axis and that of the signal applied to the U detector along the U axis.

When we commenced investigating the action of switch *SW2* and the inverter in Fig. 3 we assumed that *SW2* was at position B during odd number lines. We could have started the discussion by assuming the switch to be in position A during odd number lines. Exactly the same net results would have been achieved, but instead of the average phase of the bursts fed to *BA—2* lining up with the −V chroma axis the phase would have lined up with the +V chroma axis. That is the phasors in Fig. 6(a) would have been pointing upwards instead of downwards as shown. The 90-degree phase difference between the reference signals going to the V and U detectors would thus still have been maintained.

From this aspect therefore it matters not in the least whether *SW2* switches from A to B on odd or even lines. In fact the set works (with certain provisos) whichever line *SW2* latches on to. Nevertheless there is an identification (ident) system which synchronises the switching to one particular line mode, the even number lines. We shall see in a minute that such lines correspond to PAL lines of reversed V chroma phase—i.e. −V lines.

Reference Signal Channels

Transistor Q312 in Fig. 2—the *BA—2* burst amplifier—receives at its base the chroma signal via C345 and also line sync pulses through R361. The transistor is normally biased off but during the bursts it is biased

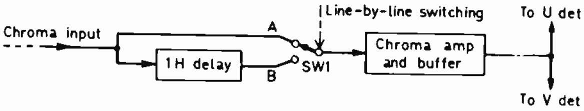


Fig. 7: Simplified block diagram showing how SW1 feeds the signal from the delay line to the chroma channel on alternate lines.

on by the line sync pulses. These are positive-going and about 6V p-p. They are taken from the sync separator through an *LC* circuit which adjusts their timing to correspond to the periods of the bursts. Q312 is thus a gated burst amplifier so that the bursts only arrive at the crystal X302 via transformer BAT—2 when Q312 briefly conducts during the burst period, i.e. the chroma information is deleted. The crystal produces the 4·43MHz c.w. signal which after amplification by Q313 and Q314 is fed to Q315. This transistor is under conditions of mild positive feedback (from transformer COT—2 in the collector via C364 to its base), ensuring that a steady 4·43MHz signal is fed to the V detector. The other channel is just the same but drives the U detector.

PAL V Chroma Phase Alternations

Going back to Fig. 1 we see that there is a second diode switch *SW1* which is associated with the delay *1H*. This switch feeds chroma signal from transformer *BPT—1* to the *chroma amplifier and buffer* (and thence through *BPA—2* to the V and U detectors) either direct or through the delay *1H*. Fig. 7 shows the relevant section in block diagram form. *SW1* is also switched line-by-line and as for *SW2* the switching source is *FF*. Thus *SW1* and *SW2* switch in synchronism line-by-line.

We must now look at the second parameter of the PAL signal, namely the line-by-line phase alternations of the V chroma signal. These 180-degree alternations accompany the swings of the bursts so that on odd number lines when the bursts are at 135 degrees the V chroma signal is positive (i.e. +V) while on even number lines when the bursts are at 225 degrees the V chroma signal is negative (i.e. −V). The action is clarified in Fig. 8. The U chroma signal of course has a constant phase axis on all lines.

Now let's see what *SW1* (Fig. 7) does to these alternations. If the line is say an odd number with +V chroma and *SW1* is at position A then the chroma signal is applied directly to the *chroma amplifier and buffer* and the conditions are as shown in Fig. 8(a). On the next line however when the transmitted signal is −V (an even number line) *SW1* will be at position B and chroma signal will pass to the chroma amplifier etc. through delay *1H*. The period of delay provided by *1H* is exactly equal to a line period (64μS). Thus with *SW1* in position B the chroma amplifier etc. will receive a signal corresponding to the previous line, an odd number one carrying +V chroma. In this switching mode therefore the chroma amplifier will receive only those lines of chroma signal corresponding to +V. In other words it will not receive lines with −V chroma signal and instead will process the previous lines with +V chroma signal. If the switching mode is reversed only the −V chroma lines will be processed and since *SW1* is synchronised to *SW2* the reference signal phase would change to suit these lines. This then is

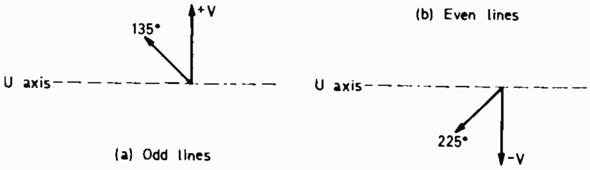


Fig. 8: PAL line-by-line V chroma 180-degree alternations; (a) during odd lines, (b) during even lines.

why it doesn't matter whether *SW1/SW2* switches from A to B on odd or even lines from the general theory of the system.

While all this is going on the lines of Y (luminance) information are being handled in the normal way. What the system does is to delete the phase alternations of the PAL signal at the expense of a rather insignificant reduction in the chroma information used owing to the +V (could be −V) lines being repeated during the times when −V chroma is being transmitted. Note carefully though that the Y information is not in any manner impaired since from this aspect the receiver works normally: and it's the Y signal of course that carries the picture detail.

Since the PAL parameters have been removed the receiver behaves like one designed for the American NTSC signal. The phase correction attribute of the PAL system is thus deleted. This is done because to retain it in any way would be an infringement against the Telefunken patents. In practical terms this means that the colours can change mildly with changes in chroma signal phase anywhere in the system (at the transmitter, in propagation or at the receiver).

Hue Control

Since there is no PAL "colour lock" the receiver is equipped with a hue control—as are American NTSC receivers—and the circuit of this is shown in Fig. 9. This can be tied up with the overall block diagram (Fig. 1). The chroma signal is fed to Q951 base from Q304, a buffer amplifier in the chroma channel, which is an emitter-follower. The signal is then passed to Q952 base through transformer T951 and thence from the emitter of this transistor via colour and subcolour controls to *BPA—2* which feeds the V and U detectors with chroma signal.

The network concerned with the hue control is related to the secondary of T951 and the components between this and Q952 base. The hue control proper (VR905) comes into this of course and owing to the capacitive reactance of C956/C957 working in conjunction with the network resistors relative to the centre-tap on T951 secondary the phase of the colour vector can be swung about ±20 degrees by the hue control. The transformer is tuned to provide the correct nominal phase when the hue control is at mid-setting, indicated by a "click" position.

Relative to the centre setting therefore the hue can be swung towards magenta one way and towards cyan the other and which direction of rotation gives the particular change depends on whether *SW1/SW2* are switching from A to B on odd or even lines. Assuming that T951 is accurately adjusted for exactly the correct hue when VR905 is at its centre "click" position, then random changes in the line-by-line switching mode have no effect at all on the colours. Since this condition would never exist in practice however (the hue control is there to adjust anyway!) random changes in line-by-line switching would tend to introduce colour error (the eye would average the colours produced by the two switching modes and discern the incorrect colours).

To avoid this *SW1/SW2* are switched from A to B on either odd number *or* even number lines and a unique ident circuit has been developed for this. It is understood that this is engineered so that the even number lines (those carrying −V chroma signal) are used for the chroma information. But the receiver would work equally as well—so far as I have been able to judge—by the use of odd number lines (those carrying +V chroma signal).

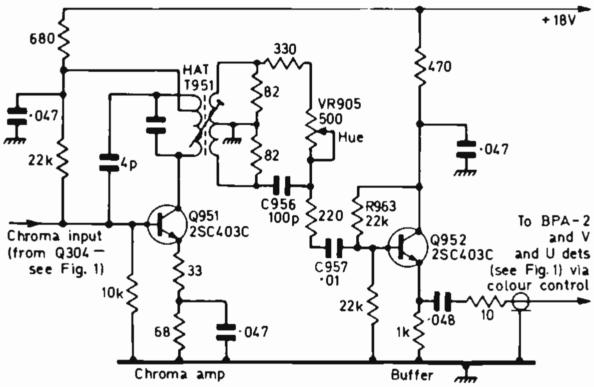


Fig. 9: The chroma amplifier and buffer circuits, showing the hue control arrangement.

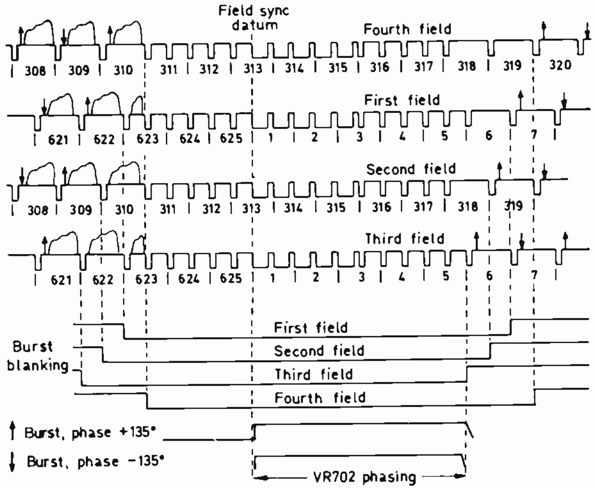


Fig. 10: The BBC's burst blanking sequence during the field sync periods, showing how this is related to the Sony "ident" switching system.

Sony Ident System

Although it has so far been assumed that line pulses directly switch *SW1/SW2* this is not strictly true: *FF* (Fig. 1) a bistable ("flip flop") circuit which is triggered line-by-line by pulses from the line output transformer actually controls *SW1/SW2*. The action is similar to the V detector bistable switching of ordinary PAL receivers.

Figure 1 shows that *FF* also receives an input from the *burst detector clock pulse check*. This is the ident section which produces pulses to set the *FF* switching to the selected lines of the chroma signal. Thus if *SW1/SW2* tend to switch in the incorrect mode the ident system yields a cancelling pulse—causing *FF* to miss a count—thereby restoring the correct (selected) switching mode. This action is again similar to that of V detector switching synchronisation in PAL receivers. While, however, PAL receivers obtain the V ident signal from the 7·8kHz "ripple" produced from the swinging bursts by the reference oscillator a.f.c. loop phase detector, the Sony receiver obtains the switching information from the special *burst*

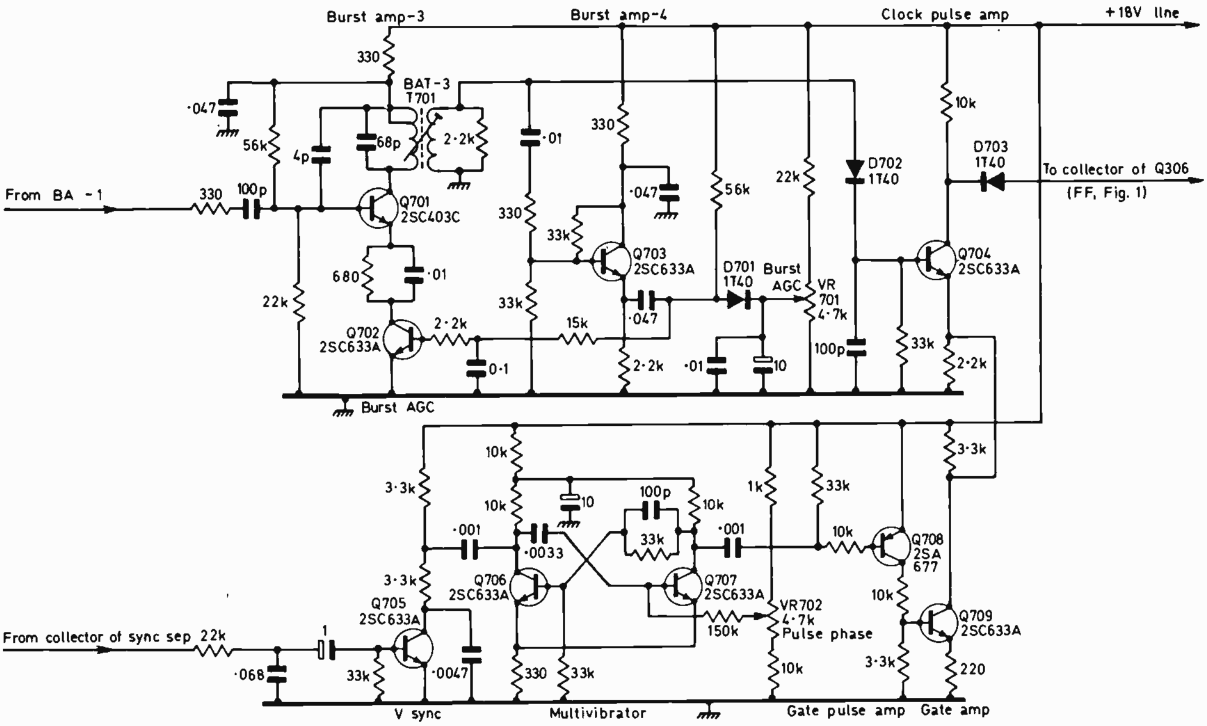


Fig. 11: Circuit of the Sony ident system.

blanking sequence of the PAL signal during the field blanking periods. To obtain the ident signal from the swinging bursts—as in PAL receivers—would seemingly infringe the Telefunken patents.

Burst Blanking Sequence

Figure 10 shows the video waveform of the PAL signal during the field blanking period: this reveals that the burst blanking is staggered over a four-field cycle to ensure that all the field scans start and finish with bursts of the same phase. At the commencement of PAL colour transmissions this staggering was not employed and as a result flickering occurred at the top of pictures carrying colours of high saturation. This was caused by the bursts being at one phase for fields 1 and 4 and at the opposite phase for fields 2 and 3. The BBC now use the sequence shown in Fig. 10 and it is from this that the Sony ident signal is obtained.

dent Circuit

The circuit of the system is shown in Fig. 11. Bursts from the gated burst amplifier *BA-1* (Fig. 1) are applied to *BA-3* which is transistor Q701 in Fig. 11. Burst a.g.c. is applied to Q701 via Q702. Diode D701 rectifies the bursts at the emitter of the subsequent burst amplifier Q703 and the resulting d.c. is fed to Q702 base. A fairly long time-constant is employed here. The change in Q702 conduction thus regulates Q701 bias, and hence its gain, thereby keeping the burst level constant.

Q706 and Q707 comprise a monostable multivibrator; that is, the circuit is triggered into one mode of conduction and then automatically switches itself back to the other mode. Q705 processes the line sync pulses fed to it from the sync separator and the resulting integrated signal triggers the monostable. How soon this returns to its other mode depends on the setting of phase preset VR702.

Briefly, what happens is that a series of bursts arrives at D702 from T701 secondary. At D702 cathode they form 4V p-p pulses and since they are positive-going at Q704 base they tend to switch this transistor on. Negative-going pulses then appear at the collector and are passed through D703 to the first transistor of the flip-flop (block *FF* in Fig. 1). When the switching mode is correct the pulses aid the normal line-by-line switching; if it is incorrect they will restore the mode as previously explained by making *FF* stop for a "count."

Q704 conduction is under the control of the gate amplifier Q709 and this transistor is switched by the monostable output pulses via the gate pulse amplifier Q708. In effect therefore Q704 samples the bursts during the field blanking periods, a pulse being produced for ident purposes as soon as a field commencing with bursts of 135-degree phase occurs.

There are many other aspects of the circuit which we cannot go into for the present, but a better idea of the ident action might be gleaned from the waveforms shown below the video waveform in Fig. 10. The phasing preset VR702 merely alters the "positioning" of the ident pulse. ■

NEW ENGLISH ELECTRIC VIDICON

English Electric have introduced a 13mm. separate-mesh ruggedised vidicon with low-power (0·6W) heater which makes it suitable for use in battery-powered cameras. The small dimensions of the P888 enable cameras of minimal size to be produced. The tube has a spectral response similar to that of the human eye and because of the smaller target area there is a reduction in lag compared to larger tubes.

RAPID LINE TIMEBASE *Fault Diagnosis*

K.B.Whapples MSERT

In the author's opinion it is the speedy diagnosis of faults in the line timebase that causes the greatest difficulty to less experienced service technicians. The purpose of this article is to encourage the use of quick methods of diagnosis in the field—since it is in the field that rapid checks are essential if service calls are to be efficient. The basic idea put forward is that a flexible series of quick checks can often lead to the fault being corrected on the spot: only if these checks fail to reveal the cause of the trouble is it then necessary to bring the set in to the repairshop for conventional stage-by-stage testing and evaluation in logical sequence with the full complement of test gear.

Of paramount importance in the field is initial careful examination of the set: learn to look, listen, smell and if necessary touch parts as the set warms up. The procedure should become automatic as experience is gained. As an example of the importance of physical checks, it is hardly meritorious to find by methodical testing that low gain is due to low screen voltage in a stage if the offending feed resistor is all the while obviously and visibly burnt!

Sound Normal, No Raster

Consider then the typical domestic dual-standard receiver with the familiar symptoms of sound normal, no raster. In 80-90% of such cases the cause is a line timebase fault. The important steps are to confirm whether this is so and then to decide whether the repair can be made there and then. Assume then that the set is switched on and that our senses have revealed nothing unusual—initial sensory checks should of course include tube and valve heaters and any signs of overheating.

First ascertain the presence of e.h.t. If the a.c. side (anode top cap) of the rectifier is the most accessible point and the voltage here seems satisfactory, replace the rectifier and check that the heater of the new one is alight. If the set uses an e.h.t. multiplier disconnect this and confirm the presence of sufficient a.c. at the output from the line output transformer e.h.t. overwinding by means of a spark test. A faulty multiplier will almost always load the timebase to virtual standstill and the strong odour is immediately detectable and recognisable. Disconnecting a faulty multiplier will allow the timebase to burst into life which becomes immediately apparent. If now satisfied that there is sufficient e.h.t., check the c.r.t. for correct bias, first anode voltage, heater voltage or ion trap (if fitted) troubles. These points are readily accessible and if all's right here we know we have to concentrate on the line timebase.

The method I advocate and use myself in the field is next to set about eliminating possibilities, not in any logical order but in a sequence depending entirely on the accessibility of the components in the offending timebase. This approach relies on working through a list—given later—of possible failures. This should be done in such a way that information gathered from each preceding check is used in conjunction with the next most convenient move to make.

Check the operation on both systems, ensuring that the system switch moves to a positive mechanical position and that the contacts used in the timebase appear to be in good order—some receivers, particularly certain GEC and Thorn group models, are notorious for line faults due to poor switch contacts. Any valve which could possibly cause the symptoms should be checked by substitution as this is quickly done and puts our mind at rest before going on to more troublesome tests. Standard tests like lifting the top cap of the efficiency diode to check for a short-circuit boost capacitor are however easily done before getting around to valve changing.

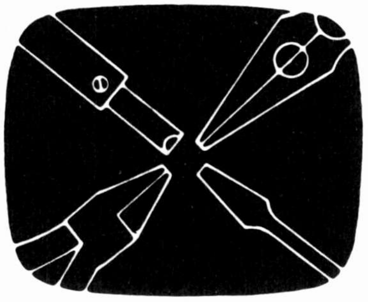
If there is no a.c. on the efficiency diode or e.h.t. rectifier top caps and a labouring output pentode one would suspect lack of drive from the line oscillator stage. A faulty e.h.t. multiplier, deflection coil assembly or perhaps an e.h.t. rectifier with short-circuit heater could, however, produce similar symptoms and all these can usually be eliminated by making disconnections and noting results in the time taken to locate the line output valve grid lead and make a measurement there. Width/set-boost controls are also worth checking by turning to show whether the track is faulty.

The approach suggested may appear random and undisciplined but I can assure readers that in my own experience it has proved its worth in so far as this method enables most line timebase faults to be detected and repaired in a shorter time than by using the classic stage-by-stage technique.

Possible Faults

Here then is the list of possibilities which can be rapidly worked through: **valves**—check all in the timebase if in doubt; **boost capacitor**—lift top cap off efficiency diode to see whether this produces some sort of results; **deflection coils**—often easily unplugged to note whether a short is loading the timebase; **video**—check that the tube bias varies as the brightness control is adjusted; **system switch**—check if not throwing and for bad contacts; **plugs**—check mating of any form of connections; **pulse capacitors** (connected across sections of the transformer)—examine for signs of distress and if necessary cut one lead and note effect; **width potentiometer**—check for bad track; **ion trap**—check for broken strap and/or maladjustment; check **line drive,** presence of **boost voltage,** tube and valve **heaters, e.h.t. multiplier,** line output valve **screen voltage** and the condition of the **linearity sleeve.**

In most sets all these things can be checked in a few minutes and a decision can then be made as to whether the receiver can be repaired on the spot. In conclusion, criticisms and suggestions will be received with great interest, bearing in mind that the aim of the approach outlined is to provide a rapid system of fault-finding which does not overlook too many possible causes of line timebase failure and is yet realistic and economical in this very competitive industry. ■



SERVICING television receivers

L. LAWRY-JOHNS

SOBELL ST282 SERIES—cont.

Field Timebase

There are several trouble spots which affect the height, shape and field hold. Now that these sets have had a good deal of use there are a few not so common faults which did not show up previously. For example an almost total collapse of the height need not be due to a fault in the timebase itself but to one in the h.t. line. If the main smoother loses capacitance (C92, 200μF) the only obvious symptom may be that the raster is only an inch or so high in the centre. Clipping a test electrolytic from Ch1 to chassis (convenient on the lower left) will prove whether this is so and may save a lot of time checking around the PCL85 stage.

This is not to say that faults do not often occur in the timebase itself. On the contrary there are many common fault conditions, mainly due to defective capacitors. It is our practice to replace all suspect paper types from C112 to C119. This is not expensive and can be done quite quickly. C115, C116 and C122 should be rated at 1kV for reliability. At the same time the electrolytic C117 should be replaced and the value of R118 checked. This resistor is often damaged by a faulty PCL85 and should not be left in circuit if it is discoloured.

It is not unusual for C117 to explode scattering bits of its inside over a wide area. This happens when the PCL85 shorts internally. The thing to do in this case is to replace the valve, R118 and C117.

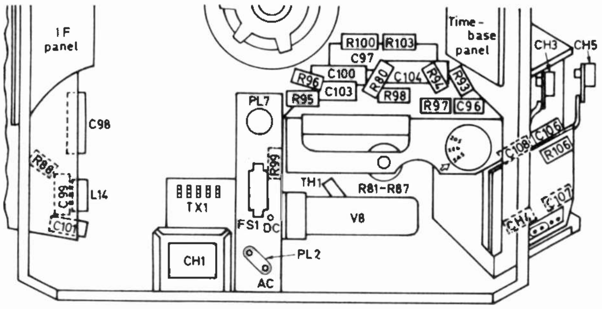


Fig. 2: Rear chassis view.

IF Stages

At the top of the panel there is a three-pin plug and socket. This is the connection to the volume control. It is a common complaint that the sound may suddenly blare out at full blast irrespective of the position of the control. The control itself is rarely at fault: it is the three-pin socket which is normally found to be responsible. The trouble is that the socket legs are not making proper contact with the print. Good contact must be made on both sides of the panel and all connections should be cleaned and re-soldered. This may not prove to be as easy as it sounds.

The nearby PCL84 valve is the audio output valve and is often responsible for low and distorted sound. Also check C76, C77 and C79. The first two are often leaky and the latter often open-circuit. A defective PCL84 may have damaged R76 which must also receive attention.

Sound distortion should also direct attention to R66 (4.7MΩ). This is the load resistor of the noise limiter MR3: its value sometimes goes high, clipping even normal signals. Also check C73 and C75.

In the sound i.f. stage V9, R60 may be found burnt out due to C65 shorting. The same thing occurs in the vision i.f. stage V4 where the resistor is R30 and

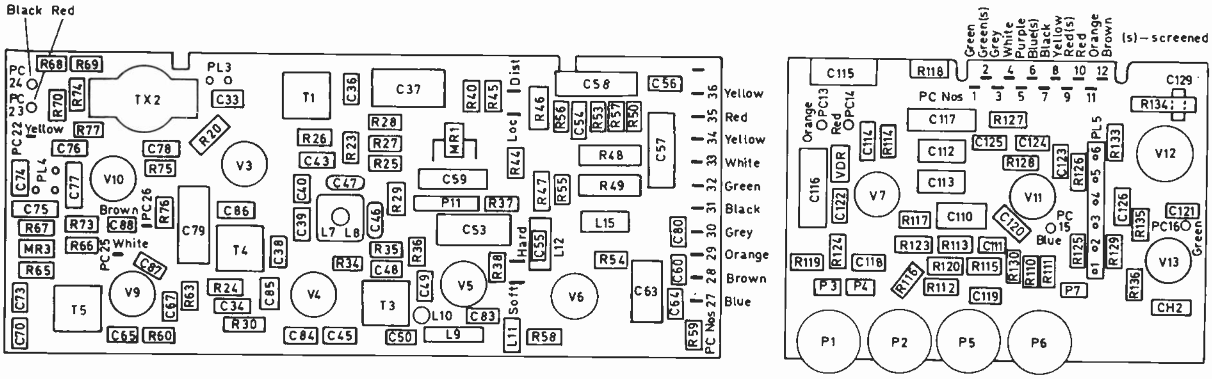


Fig. 3: Layout of the timebase and i.f. printed panels.

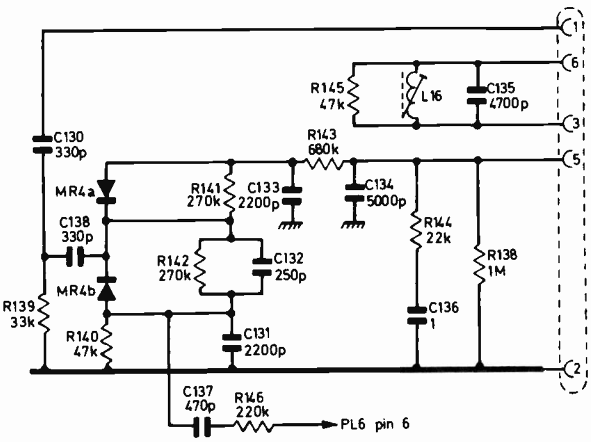


Fig. 4: Circuit of the optional plug-in flywheel sync unit fitted in some fringe area sets. In later flywheel units R138 is 680kΩ, R140 27kΩ, R143 1·5MΩ and R145 is omitted.

the capacitor C45. The panel itself is often damaged by this type of short and the consequent burning. Some careful cutting away of the affected parts with replacement wiring is often necessary to avoid replacing the complete panel.

Note also the h.t.-to-chassis path formed by the resistors R23, R25 and R27. If R23 is burnt but not R25 check the EF183 and C40. If both R23 and R25 are damaged change both as the trouble is more likely to have been caused by a change in value rather than a short elsewhere.

Video Stage

Changing the PCL84 video amplifier V6 can do wonders for the picture contrast and definition and a further improvement can be had by replacing C58. This capacitor also has a profound effect upon the field and line synchronization, being in the PCL84 cathode circuit: if it becomes open-circuit current feedback is introduced thereby reducing the gain of the stage particularly at the lower (sync) frequencies.

Tuner Units

The tuner found fitted may be of the push-button type or the standard Sobell rotary. Quite a bit of trouble has been experienced with the push-button type, mainly mechanical (broken or worn plastic members etc.). It is essential to set up any particular button in the first instance (channel selection) with the button *not* pushed in (remove outer cover to adjust). When the channel has been selected, the button may be depressed and the red fine tuner end adjusted for optimum results. If the plastic is worn this may not be possible.

The rotary tuner shares with the push-button type one common defect. This is the tendency of the oscillator load resistor to rise in value to a point where the local oscillator fails and the only signals received are those which break through at the i.f. The rotary tuner uses a 10kΩ 1W type in a fairly open position under the PCF806 valvebase. If the one fitted is discoloured cut it out and fit another. Even if this is not essential at the moment it can save trouble later.

The same cannot be said for the resistor used in the push-button tuner. A 12kΩ 1W type is used and a certain amount of dismantling must be done to gain access to it. Therefore, if the tuner is functioning leave it alone and merely check the valves and clean the contacts.

Conclusion

If one further word of advice may be offered it is to purchase several of these secondhand sets cheap and not in going order rather than to buy one at a higher price reputedly in good going order. This ensures the availability of spares and enables one to have the comfort of knowing that the finished set is not bodged in any way.

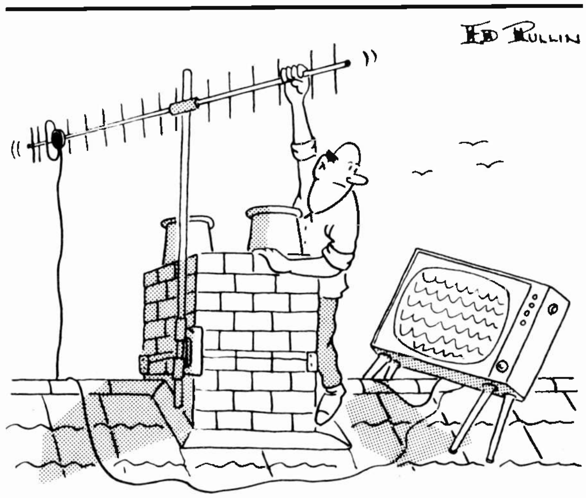
Editorial Note: We understand that these sets are available in "as-is" condition from RBTV, 82 North Lane, East Preston, Sussex at £16 plus £1·50 carriage.

NEXT MONTH: DEFIANT 9A50-9A52 SERIES

AERIAL NEWS

The aerial makers have been busy with new introductions and improvements to existing ranges. Maxview aerials have introduced a direct-to-chimney wall bracket which in conjunction with a new universal clamp is claimed to fix any aerial to any mast, making aerial orientation easier and reducing installation time. Details from Maxview Aerials Ltd., Maxview Works, Setch, King's Lynn, Norfolk. J Beam have made a number of improvements to the radiator (skeleton slot dipole) and reflector elements used in their Parabeam and Multibeam u.h.f. aerials. The junction box cable connections have also been modified. Rigidlock is incorporated in the radiator and reflector elements to prevent displacement by birds or high winds.

From Aerialite come the Constant, a set-top bisquare with two circular stainless steel elements at £1·80, the Selector, a smaller 9-element version of their Supreme fringe-area u.h.f. aerial with S-shaped directors and a pair of coplanar-mounted folded dipoles, and a new range of loft aerials, the 45/6/L 6-element aerial at £2·10 and the 45/10/L 10-element aerial at £2·50. These loft aerials are based on the Golden-Gain models but have an improved mounting arrangement for fitting to joists, roof beams or walls, providing a wide range of movement in all directions.



BASIC CIRCUITS FOR THE CONSTRUCTOR

4

THIS MONTH: 405-LINE SOUND IF STRIP AND GATED AGC CIRCUIT

J.W.THOMPSON

THE sound i.f. section is one of the least complicated parts of the receiver and should present few problems. The requirements for a 405 sound i.f. amplifier are that it should provide stable amplification at 38·15MHz with around 500kHz bandwidth, and also that the a.m. detector should produce a voltage which when used for the purpose of gain control will keep the audio output level reasonably constant with variations in signal strength. Without gain control the final i.f. transistor would go into limiting on all but the weakest signals, thus stripping the amplitude modulation from the i.f. carrier.

The circuit (Fig. 1) is very similar to that of the 405 vision i.f. channel described in the June issue, the only real difference being that the coils are designed to give a much narrower bandwidth. A 38·15MHz tuned circuit (L12, C14) in the vision i.f. (see Fig. 2, page 345, June issue) feeds a low-level signal to the base of Tr401. This transistor is reverse gain controlled by a negative voltage fed back from the sound detector D401. It is permissible to use reverse gain control in this application because we are not too worried about changes in i.f. response shape—a tilt of a few dB does not matter here while it would be undesirable in a vision i.f. strip.

After amplification by Tr401 the i.f. signal is developed across an undamped single tuned circuit L401, C406. Impedance matching into the next stage is achieved partly by the primary-secondary turns ratio of L401 and partly by the potential divider formed by C409 and the input capacitance of Tr402. The second stage of i.f. amplification employs an identical tuned circuit L402, C426 and additionally the stage is unilateralised by R409 and C414. The final stage is also unilateralised and uses a double-tuned circuit, L403a/b with C421 and C422, to couple the high-level signal to the sound detector D401. L404 and C424 filter residual i.f. from the detected audio signal and a negative a.g.c. voltage is developed across C423 and passed back to the base of Tr401 via suitable low-pass filtering (R412, C408).

Construction and Testing

The recommended layout for the sound i.f. strip is shown in Fig. 2 and is very similar to the layout of the 405 vision i.f. strip (circuit No. 1 in this series). The screened input cable connected to the base of Tr401 should be as short as possible: this can only be achieved if the 405 vision i.f. strip is laid out alongside the sound i.f. strip as indicated. Medium-loss v.h.f. coaxial cable, not microphone cable, should be used. If the length of cable differs greatly from 5cm. a change in the value of C14 may be necessary to permit the correct tuning of L12.

As a preliminary test measure the resistance across C427: a short-circuit indicates a fault in one of the feedthrough capacitors. Assuming that all is well connect a 15V supply to the strip. The transistor emitter voltages should be between 1·5 and 4·0V.

Disconnect one end of R412, thus disabling the a.g.c. Inject a 100mV 38·15MHz signal at the junction of C11 and C12 (Fig. 2, June issue) and detect with a voltmeter across C424 (positive side of the meter to chassis). Peak L12, L401, L402 and both sections of L403 for maximum meter indication, constantly reducing the signal generator output so that the meter reading does not exceed 2V. When all the coils are fully peaked at 38·15MHz, manually sweep the signal generator between 37 and 39MHz and note the response shape of the i.f. amplifier. The response should be similar to that shown in Fig. 3. If it is narrower it is possible to detune L401 and L402 so that the response is "spread" to the correct limits. R412 may then be reconnected and the i.f. amplifier tested on an off-air signal. The level of audio from the detector may be changed if necessary by altering resistors in the a.g.c. loop, in particular R402 and R412.

Line-gated AGC Circuit

It is quite difficult to derive a suitable source of a.g.c. for a 405-line vision i.f. strip. Many readers will be aware of the unpleasant effects caused by the "mean-level" a.g.c. system generally used: the i.f. gain is dependent on picture content and on night scenes the gain is turned right up with a resultant increase in picture noise. The use of a line-gated a.g.c. circuit easily repays the extra effort involved in its construction.

The circuit (Fig. 5) is conventional and employs three transistors. The 405-line video signal is fed to the base of Tr405 in the collector circuit of which the gating transistor Tr404 is connected. Tr404 allows current to flow through the two transistors during part of the line flyback period only. Thus regardless of the picture content the video signal returns to black level at the beginning and end of each line (these periods are known as the front and back porches). If the line flyback gating pulses fed to the base of Tr404 arrive at the right time the black level of the picture will be effectively sampled by the series combination of Tr404 and Tr405 and an a.g.c. voltage will build up across C431. The level of this voltage will be proportional to signal strength and completely independent of picture content. Tr406 amplifies the a.g.c. voltage which is then used to control the gain of Tr11 in the vision i.f. strip.

The layout of the a.g.c. circuit is not at all critical and it may be built most easily on paxolin pinboard. If the connection between D403 and C110 is particularly long screened cable should be used, but do not screen the video feed to Tr405.

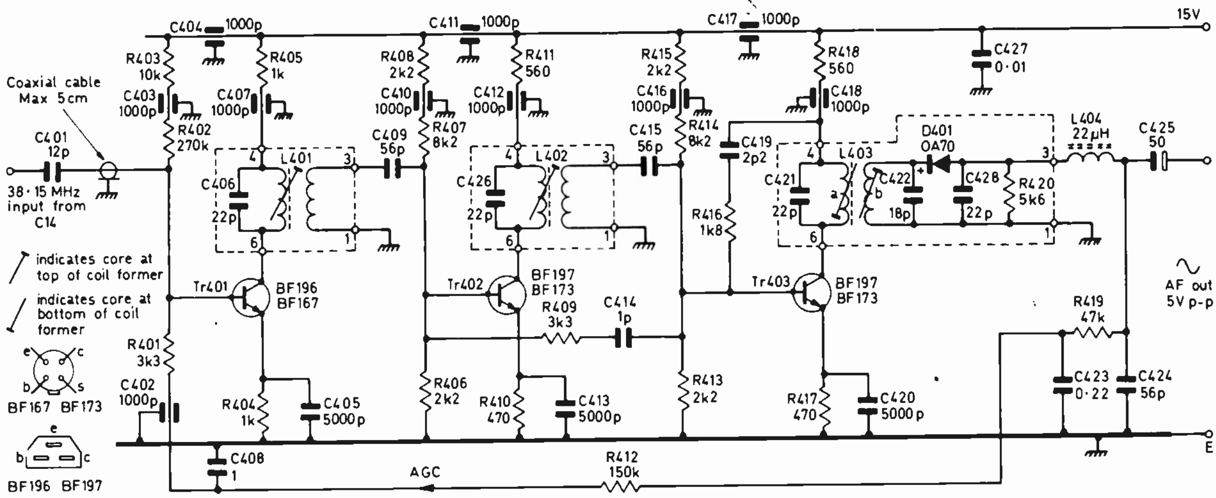


Fig. 1: Circuit diagram of the 405-line sound i.f. strip.

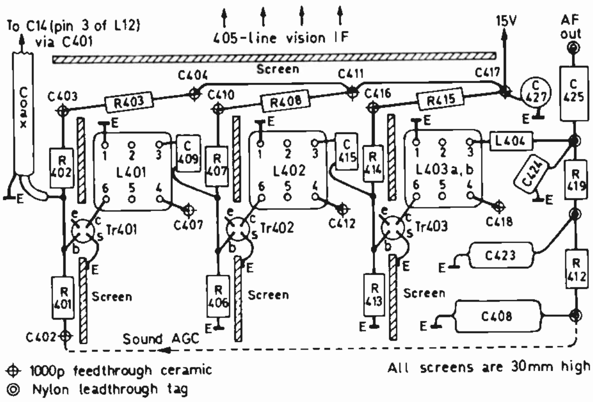
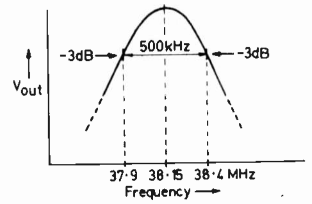
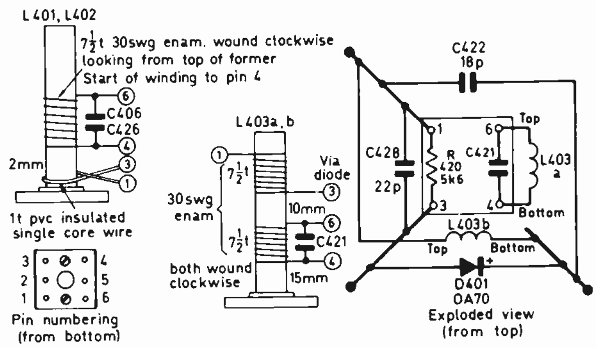


Fig. 2: Recommended layout (underside). For clarity the emitter resistors and capacitors, R405, R411 and R418 and the neutralising components have been omitted. The neutralising components should be connected in the same manner as those in the 405-line vision i.f. strip (see Fig. 4, page 347, June issue).

Fig. 3 (right): 405-line sound i.f. strip response curve.

Fig. 4 (below): Coil data for the sound i.f. strip.





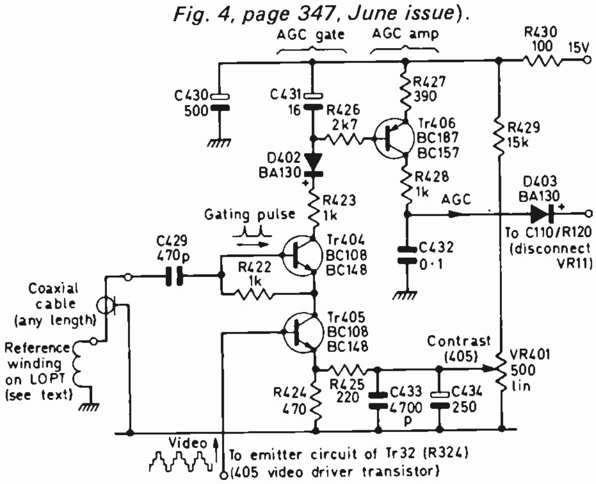


Fig. 5: Line-gated a.g.c. circuit for use with the 405-line vision i.f. strip. The BC157 has the same base as the BC148 and the BC187 the same base as the BC108, see Fig. 12, page 447, August issue. The gating pulse is obtained by winding four turns of e.h.t. cable on the line output transformer primary winding.

Installation of the a.g.c. unit in the receiver is straightforward. Disconnect VR11 completely and connect the lead which went to the slider of this control to D403. The contrast is then controlled by VR401. To obtain a suitable source of line gating pulses wind four turns of e.h.t. cable on to the primary winding of the line output transformer. One end of this reference winding is connected to chassis and the hot end to C429 through screened cable (see Fig. 5). The phasing of the winding may have to be reversed to obtain gating pulses of the correct polarity (positive-going). Note that the contrast will vary with the setting of the line hold control: the correct setting for this control will normally be near the centre of its lock-in range. More specific details of this will follow when the line timebase circuit is discussed.

ADDITIONAL NOTES ON CIRCUIT 2

Adding AFC

All tuners including varicap types suffer from oscillator drift with change in temperature. This drift may be as much as 500kHz for every 20°C rise in temperature. Drift can be minimised by mounting the tuner

★ components list

Resistors:

R401	3·3kΩ	R407	8·2kΩ	R413	2·2kΩ	R419	47kΩ	R426	2·7kΩ	All $\frac{1}{4}/\frac{1}{2}$W 5%
R402	270kΩ	R408	2·2kΩ	R414	8·2kΩ	R420	5·6kΩ	R427	390Ω	carbon film
R403	10kΩ	R409	3·3kΩ	R415	2·2kΩ	R422	1kΩ	R428	1kΩ	VR401 500Ω
R404	1kΩ	R410	470Ω	R416	1·8kΩ	R423	1kΩ	R429	15kΩ	Variable lin.
R405	1kΩ	R411	560Ω	R417	470Ω	R424	470Ω	R430	100Ω	
R406	2·2kΩ	R412	150kΩ	R418	560Ω	R425	220Ω			

Capacitors:

C401	12pF	SM	C411	1000pF	F	C421	22pF	SM	C431	16μF	E
C402	1000pF	F	C412	1000pF	F	C422	18pF	SM	C432	0·1μF	PE
C403	1000pF	F	C413	5000pF	DC	C423	0·22μF	PE	C433	4700pF	PE
C404	1000pF	F	C414	1pF	SM	C424	56pF	SM	C434	250μF	E
C405	5000pF	DC	C415	56pF	SM	C425	50μF	E	E	electrolytic 15V	
C406	22pF	SM	C416	1000pF	F	C426	22pF	SM	F	feedthrough	
C407	1000pF	F	C417	1000pF	F	C427	0·01μF	DC	SM	silver mica	
C408	1μF	PE	C418	1000pF	F	C428	22pF	SM	PE	polyester 160V	
C409	56pF	SM	C419	2·2pF	SM	C429	470pF	C	DC	disc ceramic	
C410	1000pF	F	C420	5000pF	DC	C430	500μF	E	C	ceramic	

Semiconductors:

Tr401	BF167	(BF196)	Tr404	BC108	(BC148)	Lockfit equivalents in brackets
Tr402	BF173	(BF197)	Tr405	BC108	(BC148)	D401 OA70
Tr403	BF173	(BF197)	Tr406	BC187	(BC157)	D402, D403 Any silicon diode, e.g. BA130, 1N914, etc.

Miscellaneous:

L404 22μH choke (Painton)
3 Aladdin coil formers $1\frac{7}{8} \times \frac{1}{4}$ in. (CR14)
3 Screening cans (CR15)
4 Hexagonal dust cores 6 × 12·7mm. (Z81A)
4 Nylon feedthrough tags (Z149)
Numbers in brackets from Home Radio catalogue.
30s.w.g. enamelled copper wire, etc.

in a cool part of the receiver but even this measure may not be necessary as even 500kHz drift is barely noticeable on a monchrome receiver. On a colour receiver however the tuning limits are much finer and the tolerable drift may be only 200kHz. In the writer's colour receiver (in which circuit No. 2 in this series is currently being used) the effects of drift were almost eliminated by sensible positioning of the tuner and the use of a very effective a.c.c. circuit in the decoder.

Drift can also be eliminated by the use of a.f.c. (automatic frequency control). T. Snowball's circuit given in the June issue can be modified for use with a varicap tuner and the details are given in Fig. 6.

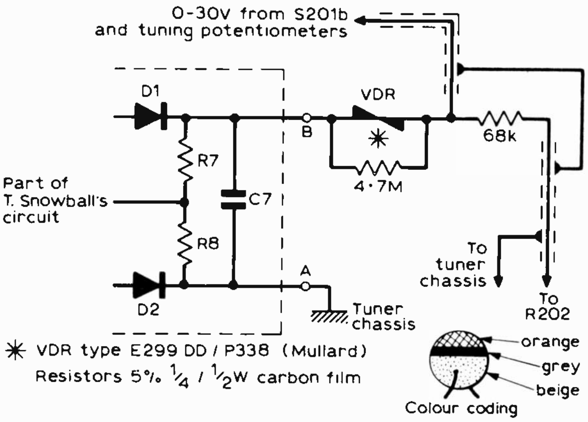


Fig. 6: Method of using the a.f.c. circuit given by T. Snowball in the June issue to provide a.f.c. for the varicap tuner used with the 625-line i.f. strip (Fig. 3, page 400, July issue).

Tr2 (see Fig. 4, page 361, June) and the associated components are omitted and the voltage from the a.f.c. discriminator (across points A and B in Fig. 6) is fed to the tuning voltage line of the varicap tuner via a resistance network incorporating a v.d.r. This device ensures that the a.f.c. loop gain is constant over Bands IV and V—it is a standard Mullard component (type E299DD/P338). Points A and B may need to be interchanged so that correct a.f.c. phasing is obtained.

The alignment procedure given in T. Snowball's article should of course be followed. Take the input for the base of Tr1 in the a.f.c. circuit from the junction of C244, C242 in the 625-line i.f. amplifier (Fig. 3, pages 400-1, July issue) via a 1pF capacitor. Realignment of L208/L209 will be necessary.

Extending the AGC Range

In certain locations the range of the a.g.c. circuit used in the 625-line i.f. strip may be found to be inadequate. The situation is likely to arise when signals are available from two or more u.h.f. transmitters, one of which might be about 10mV and another about 50μV. Changing the preset gain applied to Tr202 by selecting a suitable alternative value for R217 would in this case be inconvenient but it is possible to apply a.g.c. to Tr202 as follows. Change

—continued on page 565

COLOUR RECEIVER CIRCUITS

BASIC PAL CODING AND DECODING

GORDON J. KING

IN the last four articles we have considered in some detail the various circuits used with colour-difference and primary-colour picture tube drive, while the two articles prior to these investigated the circuits handling the video and luminance signals. We must next investigate the circuits which lead to the delivery of the two transmitted colour-difference signals, R−Y and B−Y, to the colour-difference preamplifiers. In this month's instalment however we shall, to set the scene, outline the basic features of the transmitted colour signals.

Encoding Summary

The signal path from the camera to the main modulator at the transmitter is shown in Fig. 1. The three pick-up tubes in the camera deliver R, G and B primary-colour signals in proportion to the colour in the scene present. These signals are applied to a matrixing system which produces three different signals. In one section of the matrix the R, G and B signals are added in the proportions of 30%, 59% and 11% respectively to obtain the Y (luminance) signal. In other sections of the matrix this new signal is subtracted from the R and B primary-colour signals to give R−Y and B−Y colour-difference signals. Thus at this stage there are three main signals: Y, R−Y and B−Y.

The Y signal constitutes the basic monochrome modulation and is applied to the u.h.f. carrier wave in more or less the normal way along with the sync and blanking pulses. This makes it possible for an ordinary black-and-white receiver to produce a monochrome picture from a colour transmission without undue complications: such a receiver does not of course respond to the colouring information in the composite signal.

PAL Signal Weighting

R−Y and B−Y signals in a PAL system transmitter are weighted and then applied to separate modulators. After weighting they are referred to as the V and U signals respectively. This weighting is introduced to avoid overmodulation of the composite vision carrier during peaks of the chroma signal. The values of the PAL weighting are such that V=0.877 (R−Y) and U=0.493 (B−Y).

At the U and V modulators the U and V signals are modulated on to a subcarrier with a frequency of exactly 4.43361875MHz—for convenience however this is generally given as 4.43MHz. The exact frequency is chosen to minimise the effect of the subcarrier on monochrome receiver picture displays and also allows the colouring information to be accommodated at the top end of the video spectrum within the normal 625-line monochrome channel bandwith.

Quadrature Modulation

The U and V modulators work with the same subcarrier frequency but the phase angle of the V subcarrier leads the U subcarrier by 90 degrees. The two modulators use double-sideband amplitude modulation with suppressed subcarrier and the two outputs are then added, the resultant signal multiplex being known as the *chrominance* (chroma for short) signal.

This technique of carrying two lots of different information on one carrier (or subcarrier) is known as *quadrature modulation,* because the phase of the carrier upon which one lot of information is carried differs by 90 degrees from that upon which the other lot of information is carried. In this way it is possible to carry two independent signals with minimal interaction on a common signal multiplex and subsequently to reclaim each signal separately and in isolation at the receiver.

Colour Bursts

A circuit in the receiver replaces the subcarriers suppressed at the transmitter, but since the demodulation in the receiver is possible only when the frequency and phase of the reintroduced subcarrier (generally called *reference signal*) match those at the transmitter the transmitted signal must carry information to enable this synchronism to be achieved accurately. For this purpose the colour burst signal,

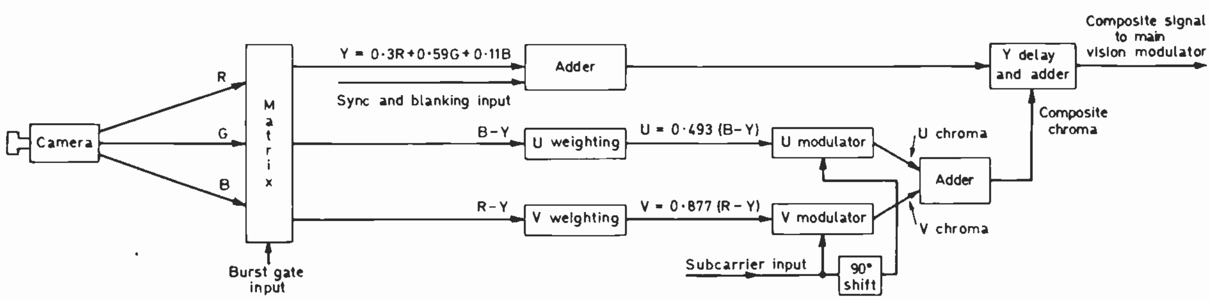


Fig. 1: Basic features of a colour transmitter (see also the PAL V switching shown in Fig. 8).

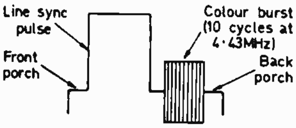


Fig. 2: The burst signal consists of 10 cycles of the subcarrier transmitted during the back porch period. (Not drawn to scale.)

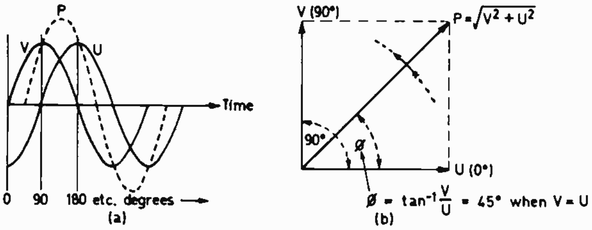
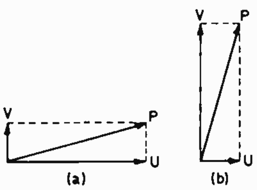


Fig. 3: V and U chroma signals with the resultant P obtained from their addition, (a) shown in sinewave form and (b) in vector form.



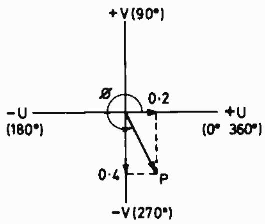


Fig. 4 (left): How the phase of the resultant P changes with differences in the relative amplitudes of V and U.

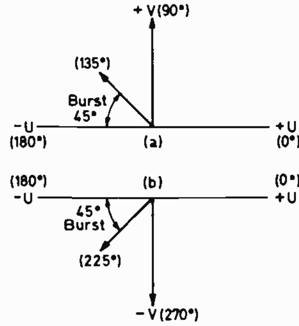
Fig. 5 (right): Chroma axes, showing the phasor P produced by −0·4V and 0·2U.

which consists of 10 cycles of subcarrier signal, is transmitted during the back porches of the line sync pulses as shown (not to scale) in Fig. 2. This signal is obtained from the subcarrier generator at the transmitter and so is of exactly the right frequency and phase to synchronise the reference oscillator used in a receiver. The receiver in effect processes these line-by-line bursts and changes them into a continuous signal for application to the chroma demodulators.

Modulators

The composite chroma signal is then added to the delayed Y signal and fed to the main vision modulator. Delay in the Y channel is necessary—as in the receivers themselves—to compensate for the narrower bandwidth of the chroma channel relative to the Y channel. Signals pass faster through the latter and so need to be delayed to secure time coincidence at the main modulator.

Fig. 6 (right): PAL V signal reference phase on odd lines (a) and even lines (b). The phase of the V component of the chroma signal is alternated through 180 degrees line-by-line. This gives rise to the swinging burst feature.



The V and U modulators delete the subcarrier signal, their outputs consisting of sideband energy only. This means that when the camera is scanning a colourless scene (i.e. one composed of white, through greys to black) there is no output from the modulators. Thus the modulators provide an output only when there *is* colour in the scene. The smaller the colour saturation the smaller the output from the modulators and the less risk there is of the chroma information causing dot interference on monochrome receivers.

The PAL System

Our basic block diagram (Fig. 1) has been simplified in order to give a clear overall picture of what goes on at the transmitter and does not show the PAL alternate line V switching. The V component of the chroma signal is transmitted with a 180° phase shift on alternate lines in the PAL system and among other things this means that the colour bursts swing in phase +45 degrees on one line and −45 degrees on the next line relative to the −U chroma axis as shown later (see Fig. 6).

Try to visualise the two components of the composite chroma signal first as ordinary sinewaves and then as vector equivalents. Fig. 3 shows at (a) V and U sinewaves of the same frequency but with a 90-degree phase displacement. The V wave is shown leading the U wave by 90 degrees. By adding the instantaneous values of the two waves we get the new

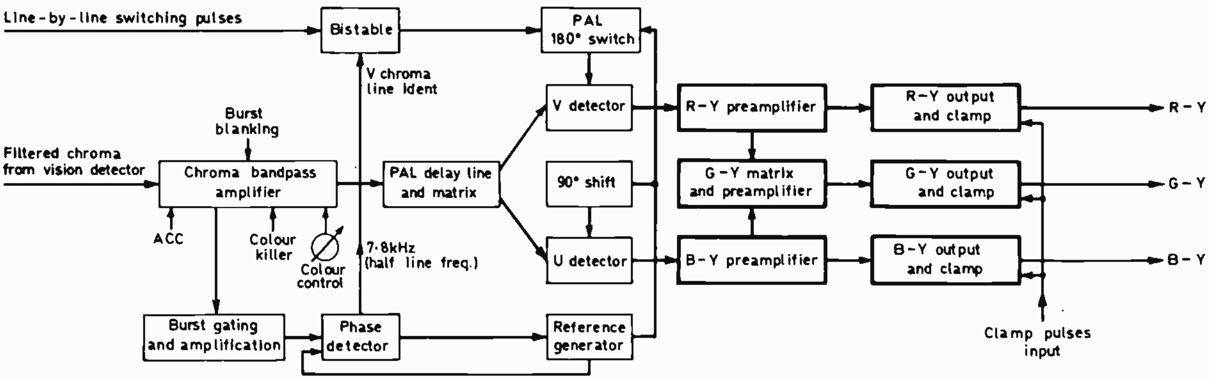


Fig. 7: Block diagram of the sections of a PAL-D receiver that deal with the colour signals. The sections shown in thick line (for colour-difference drive) have already been dealt with, those in thin line remain to be investigated in subsequent articles.

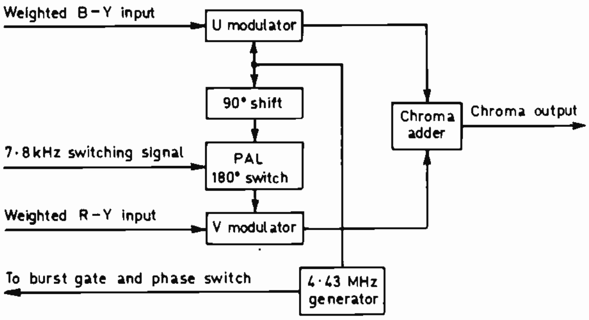


Fig. 8: Basic transmitter PAL switching system.

wave shown in broken line as P. Since waves V and U have the same amplitude and 90-degree displacement, the peak amplitude of the new wave P is equal to 1.4 times the peak of wave V *or* U. The vector equivalent at (b) reveals the function more clearly. The angle of the new wave P obtained from waves V and/or U depends on the relative amplitudes of the V and U waves. In colour TV parlance the U axis is regarded as the 0-degree datum so that V is at +90 degrees and with the V and U waves the same amplitude P is at +45 degrees. Fig. 4 shows what happens to P when the relative amplitudes of the U and V waves alter. Clearly the *angle* of P changes with relative changes in amplitudes of V and U; also the amplitude of P changes with changes in amplitude of V and U. In other words wave P contains information relating to both waves V and U!

Now the V and U signals can have either positive or negative values—depending on the chroma information—and because of this the sum or composite signal—P in Figs. 3 and 4—can fall anywhere within the four quadrants from 0 to 360 degrees shown in Fig. 5. Our P signal in fact indicates by its phase the hue and by its amplitude the saturation of the colour present. In Fig. 5 a −V signal of amplitude 0.4 and a +U signal of 0.2 amplitude are shown superimposed on the negative and positive V and U axes. The amplitude of the resultant P is 0.447 $\sqrt{(U^2+V^2)}$ while its angle is +296° 36′ ($\angle = -\tan^{-1}V/U$). The resultant P is known as the *phasor*, and for the conditions in Fig. 5 it represents a medium saturation blue-green hue.

Having got clear the fact that the phasor can take up any angle over 360 degrees and have any amplitude up to that corresponding to full saturation (limited by the PAL weighting) as determined by the phase and amplitudes of the V and U signals, we can next turn to the PAL parameters of the signal.

Figure 6 shows the PAL reference U and V axes and bursts on odd lines at (a) and on even lines at (b). The V phase is alternated through 180 degrees line-by-line and with this phase alternation the colour bursts swing in phase by ±45 degrees about the −U axis (hence the term "swinging bursts"). This is conveniently remembered in terms of odd and even lines, taking the line numbering consecutively, so that on odd lines (1, 3, 5, 7, etc.) the V chroma is along the 90-degrees axis, with the bursts simultaneously phased at 135 degrees, while on even lines (2, 4, 6, 8, etc.) the V chroma is along the 270-degree axis, with the bursts simultaneously phased at 225 degrees.

So far as the V chroma signal is concerned therefore a natural +V signal occurring during an odd line will be presented unaltered to the decoder in the receiver but the same signal occurring during an even line will appear at the decoder input as −V. We shall be seeing next month how this action helps to prevent the display of an incorrect hue even when there is a phase error somewhere in the overall system.

Decoder Block Diagram

To conclude this month's stage setting Fig. 7 shows the basic essentials of a PAL-D decoder. The composite chroma signal at the input is filtered from the complete signal present at the vision detector—this particular arrangement is often used in modern receivers. The chroma signal as a whole passes through a bandpass amplifier and thence to the PAL delay-line matrix circuit, where the PAL alternations just described are processed. This action effectively separates the V and U components of the signal, these then being fed separately to the V and U synchronous detectors which are so called because they must also receive a synchronised reference signal to replace the subcarrier signal which was suppressed at the transmitter. The outputs from the synchronous detectors are de-weighted and the resulting **R−Y** and B−Y signals used in the ways outlined in the last four instalments. The sections shown in thin line in Fig. 7 are those yet to be explored. As a concluding thought Fig. 8 shows the PAL switching at the transmitter. Next month we shall be making a start on the circuits proper.

TO BE CONTINUED

BASIC CIRCUITS FOR THE CONSTRUCTOR

— continued from page 562

the values of R217 to 10kΩ, R250 to 560Ω and C265 to 500μF. Connect a type OA90 diode between the collector of Tr206 and the junction of R215 and R217 with the cathode (marked positive) of the diode to Tr206 collector. Remember to disconnect this diode and also to change R217 back to 2·7kΩ during alignment.

Sync Performance and Crossmodulation

Under certain signal conditions sync pulses may leak on to the a.g.c. line thereby degrading the picture synchronising performance. To prevent this connect a 4·7μF 15V tantalum capacitor between Tr205 collector and chassis, observing correct capacitor polarity.

With aerial signals of greater than 10mV crossmodulation may occur in the r.f. stage in the tuner. The appearance of this effect on the picture is very similar to that of sound-on-vision as seen on 405-line receivers except that the pulsating bars on the picture are not synchronised with the sound. In extreme cases several pictures may be seen superimposed upon each other. The remedy is simple: fit a 12dB Belling-Lee coaxial attenuator in the aerial lead.

Corrections

A minor error occurred in the list of component values: the rating of R244 should be 1/10W and R246 ¼W. This does not in any way affect performance but it does make the layout more convenient. In Fig. 4(b) last month the transistor should have been numbered Tr34, not Tr35.

SERVICE NOTEBOOK

G. R. WILDING

No Focus Control Action

Poor focus was the complaint with a single-standard Philips colour receiver fitted with the G6 chassis and inspection showed that operating the focus control R5045 (see Fig. 1) produced no discernible effect. Tests on the tube base at focus pin 9 indicated almost 6kV irrespective of the setting of R5045 whereas optimum focus is usually obtained in the region of 4·2kV.

Seven megohm-value resistors plus R5045 (5MΩ) form a high-impedance potential-divider from the heater of the EY51 focus rectifier to chassis and it appeared that one of the resistors between R5045 and chassis was open-circuit. These seven resistors are mounted on a panel adjacent to the PY500 boost rectifier in the line output assembly and on testing along we found that almost all EY51's output was developed across R5049 which was clearly open-circuit.

Replacing this 3·3MΩ component restored the slight current drain through the chain and the proportional voltage drop across each resistor so that the focus control was able to vary the d.c. output in the usual manner.

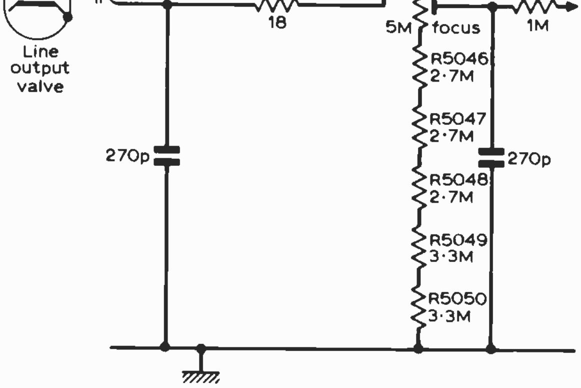


Fig. 1: Focus supply circuit used in the Philips G6 single-standard colour chassis.

No Raster

A 19 in. Defiant model had normal sound but no raster. The owner found however that when the brilliance control was turned to one end of its travel bright streaks would appear across the screen on rotating the channel selector. This clearly indicated adequate e.h.t. and an operational tube and it seemed that either the tube's cathode voltage was too high or its grid voltage too low.

Although in current designs the brilliance control may vary either the grid or cathode d.c. potential in many older models such as the Defiant model in question the video pentode is d.c. coupled to the c.r.t. cathode while the brilliance control varies the grid voltage. The most common cause of no raster in such receivers is failure of the video pentode to pass anode current. This will result in zero voltage drop across the video pentode load resistor so that its anode voltage and therefore the c.r.t. cathode voltage will be at nearly the full h.t. rail potential, cutting off the c.r.t. Zero video pentode current is usually caused by a burnt out screen feed or cathode resistor, often the result of an intermittent or complete interelectrode short in the valve. Component inspection around the video valveholder failed however to bring to light any signs of over-heating or even discoloration. All voltages were about normal and the small cathode potential showed that the anode/screen current was normal.

Turning our attention to the c.r.t. base we found that operating the brilliance control varied the grid voltage normally but that the screen flashes produced by channel selector rotation were obtained with the control at its *minimum position*. On then checking at the first anode pin we found zero voltage and a complete short from this point to chassis. Following through the chassis wiring we found the cause to be an 0·47μF decoupler and after replacing this we obtained a first class picture.

When investigating cases of no raster with the e.h.t. present remember that zero first anode voltage will always prevent beam current but the focus anode potential is immaterial. When the e.h.t. and first anode voltages are present temporarily shorting the tube's grid and cathode will by removing all bias always produce a full brilliance raster in an operational tube. If a raster fails to appear and the heater can be seen glowing then tapping the tube neck will often produce momentary screen flashes to prove that there is a tube defect.

Weak, Distorted Sound

An interesting sound fault was present on a GEC 2038 receiver and as the circuitry involved is contained in many other models the cause is well worth knowing. The symptoms were weak and distorted output on 405 (625 was locally unobtainable). The distortion clearly indicated an a.f. fault but replacing both the PCL84 output pentode and the EH90 preceding it failed to produce any improvement.

As the rear half of the receiver containing the PCL84 extended over the cabinet base we were able to make voltage checks on this valve without remov-

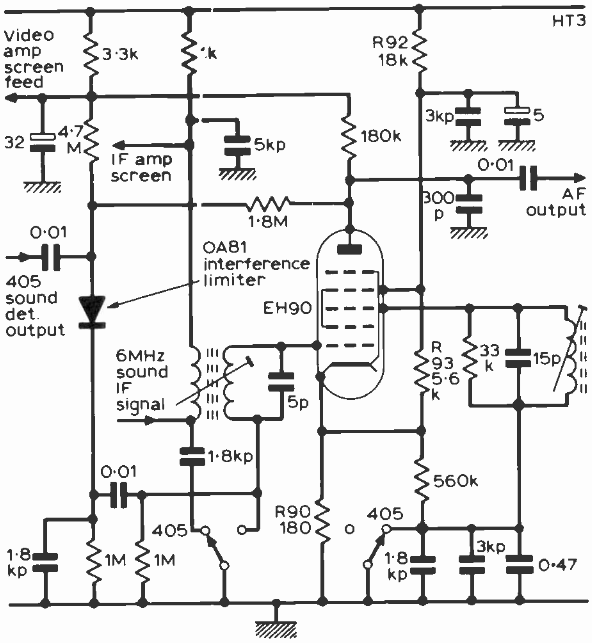


Fig. 2: EH90 625-line sound detector/405-line sound amplifier circuit used in GEC-Sobell dual-standard models. R92, R93 and R90 had all changed value.

ing the chassis. All proved normal. The EH90 stage (see Fig. 2) used in these and other models acts as f.m. discriminator on 625 and as a.f. amplifier only on 405. It seemed highly possible that grossly incorrect anode, screen or cathode voltages here might be the cause of the trouble. There was also the possibility that one of the high-value resistors associated with the a.m. noise limiter diode was open-circuit and as they were all conveniently mounted on top of the chassis we used the old dodge of connecting our meter on the 1,000V range across each suspect and noting the effect. There was no improvement and the diode itself was all right. The detector diode could be ruled out as although when high-resistance they cause great loss of volume they cannot introduce the high level of distortion present.

We next checked that the EH90 cathode resistor was 180Ω as specified and though it was markedly lower at 130Ω this could not be the cause of the present symptoms. On dusting off the surface dirt we then noticed that R93 a 5·6kΩ carbon resistor between the EH90's screen and cathode was discoloured and on checking its value found it to be just over 3kΩ. On replacing this component results improved enormously but were still not quite up to standard. Further tests showed that R92 an 18kΩ resistor from the h.t. rail to screen was also markedly reduced in value and after replacing this and the cathode resistor R90 the results were again first class.

Multiple resistor failures of this nature can be instigated by value reduction in any one of them but it shows once again how important it is to always look for visual evidence before making voltage checks. A discoloured resistor is certain to have altered value. This may be due to the long-term effects of running close to its maximum rating, to a leak in an associated capacitor or to excessive current consumption by a valve or transistor.

TO BE CONTINUED

YOUR PROBLEMS SOLVED

★ **Requests for advice in dealing with servicing problems must be accompanied by a 10p postal order (made out to IPC Magazines Ltd.), the query coupon from page 570 and a stamped, addressed envelope. We can deal with only one query at a time. We regret that we cannot supply service sheets or answer queries over the telephone.**

EKCO T407

A u.h.f. tuner has been added to this set to convert it for 625-line operation. The set has given very little trouble in the past but after conversion it is suffering from field slip—on 625 only, not on 405. I have checked the field timebase and the video and sync circuits without finding the source of the fault. The signal strength in this area is good.—G. Osborn (London).

This model usually has touchy field lock after conversion and a check with an oscilloscope around the PCL84 video amplifier stage should reveal the source of the trouble—pay particular attention to the 2μF screen decoupler. First of all however we suggest you try extra main smoothing. Check the front-to-back ratio of the field sync pulse shaper MR3.

PHILIPS 23TG170

On 625 lines the picture pulls to the left then goes back again and if the contrast control is turned back the fault seems to clear but the definition is lost. I have changed the PFL200 and its associated electrolytics and also the two ECC82 valves without improvement.—J. Lightfoot (Malvern).

The solution to this problem is to change the small clamping diode (X206, type BA115) in the a.g.c.-contrast circuit.

BUSH TV125U

When switched to u.h.f. the sound and picture fade off after about three minutes. The screen remains illuminated but the sound is a continuous hiss.—L. Kingsmoor (Ipswich).

We suggest you change both valves in the u.h.f. tuner unit, PC86 at the front and PC88 at the rear.

PHILIPS 1768U

The picture quality is very good but the sound is distorted. The audio valve and the sound i.f. and tuner unit valves have been replaced without curing the trouble.—C. Barker (Chalfont).

If the 150Ω bias resistor of the PCL83 audio output valve is in order then check the 2·7MΩ anode load resistor of the triode section of this valve (pin 1): the supply to this is derived from the boost rail.

PYE 11U

The vertical hold control is right at one end of the track and the height control (preset at the back of the set) has to be adjusted to get the picture to lock. The PCL85 field timebase valve has been replaced without improving matters.—T. Dowling (Three Bridges).

We suggest you replace the 1.2MΩ resistor R83 in series with the height control. This frequently changes value. Also check the PCL85 cathode decoupler C74, 200μF.

COSSOR CT1972A

The overall height of this set is reduced by about 20% at both top and bottom. The field timebase valves have been tested but found to be OK.—L. Cribbings (Cheadle).

The reduced height seems likely to be the result of insufficient boost voltage to the field generator stage. We suggest you check the two boost capacitors C415 and C416 (both 50kpF) and R438 in series with the height control. If these are OK check the h.t. voltage and the resistors (R108/R109) in series with the field scan coils.

HMV 2705

The fault on this colour set is crossmodulation. I understand that this could be due to an a.f.c. fault or faulty aerial orientation. The aerial has been repositioned but this does not get rid of the crossmodulation. The crossmodulation can be got rid of by adjusting the tuner button but doing this looses the colour as well. Adjustment of the local/distant r.f. gain preset does not improve matters at all.—C. Claymore (Bristol).

The a.f.c. circuit is a frequent cause of patterning on colour when the set is correctly tuned in. The circuit concerned is on the i.f. panel and a variable control (R141) is provided. Under no signal conditions you should be able to read 4·5V at the slider of this control. To set this control correctly first operate the set-white switch on the video board and disconnect the aerial. Then adjust R141 for 4·5V. Also check that the a.c.c. is set correctly by, if necessary, slight adjustment of R308.

PYE CT72

There is an intermittent fault on this set: when changing from one channel to another sometimes instead of getting the normal colour picture there is a black-and-white picture with horizontal colour bars about ½ to ¾ in. wide giving an effect rather like a coloured Venetian blind. By pushing the tuning button several times the fault will sometimes right itself.—T. Bride (Bath).

The reference oscillator on the decoder board needs readjustment. Simply turn RV10 the set a.p.c. bias control until good colour lock is obtained. RV10 is on the decoder board (the farthest in of the three boards on the bottom tray) and is on the left of the chroma delay line. It may be sealed with paint. Make sure that the oscillator link on the right of the delay line is not connecting intermittently.

BAIRD 673

There is at times partial line slip with parts of the picture waving from right to left about an inch or so. This cannot be cured by altering the line controls but can be stopped by reducing the contrast control setting. The line oscillator valve has been changed and this section of the receiver checked over generally.—T. Howorth (Leeds).

The fault could be in the PFL200 video amplifier section and this is the part of the set which should receive attention. Check the valve and its 4μF screen decoupler (pin 9). Also check the EF80 sync separator valve and its 8μF screen decoupler. A more thorough check of the a.g.c. circuit may be necessary.

HMV 2601

The fault with this set is no sound or vision though the raster is OK. The tuner valves and common vision and sound i.f. amplifier valve have been replaced.—A. Miller (Wirral).

It appears that the h.t. supply is not reaching the tuner. There are two feeds, one to the oscillator and the other to the r.f. amplifier, both via 5·6kΩ resistors (R51 and R52) on the right-hand side of the upper deck. Check for h.t. at both ends of these resistors.

PYE V510

The PCL82 sound output valve gets red hot with distorted sound which fades away. The valve has been replaced with the same results.—F. Douglas (Broadway).

There are two capacitors in the audio circuit which could cause this effect. They are the 0·022μF coupler C22 between the two halves of the valve and the feedback capacitor C21 100pF.

EKCO TC268

I have replaced the original CRM211 tube in this set with a CRM212 which is the same in all respects except for the tube deflection angle (90° instead of 70°) but I am unable to get it to display a picture.—A. Winfelt (Middlesbrough).

The bases of the two tubes are the same so you should be able to see a raster. Suspect a displaced ion trap magnet which would need moving along and around the tube neck for optimum results.

GEC 2028

Recently the line oscillator failed and a 560kΩ replacement resistor was necessary to restore working. Since this time there has been an intermittent fault—varying brilliance. Sometimes there is no change, at other times there are many alterations every few minutes. After the initial switch on the full picture scan builds up to normal brilliance only to fade quickly and then build up slowly again. At times there is blurring of the right-hand edges of images.—C. Major (Edinburgh).

Since this is an intermittent fault it might take a while to track it down. As it occurred following replacement of a resistor in the line oscillator stage it is possible that a socket or lead in the luminance circuit has been accidentally dislodged. Ensure that all connectors are tightly fitting and check that the system switch is on 625 correctly. The PL802 luminance amplifier valve may be faulty: if you have not got a replacement check the following base voltages (625), pin 7 175V, pins 6 and 8 240V, pin 1 1V. An unorthodox way of checking the PL802 is to lightly tap it to see whether the brilliance level changes. Also check the cathode circuitry of this valve, especially the components in coil T109 can. The luminance delay line connections can sometimes cause the brightness to alter. The beam current limiter should be set to 2·7V at the test point to the right-hand side of the set beam current control P507.

PYE CT78

This colour set gives an excellent picture but there is a hissing sound when words with an s, sh and sometimes c are spoken.—J. Arvin (Cheltenham).

The sibilance you are experiencing can be reduced by restoring R60, 10kΩ, if this is missing and by changing C59 to 10,000pF. These components with R59 form a combined detector load/de-emphasis network.

EKCO T417

The fault on this model is similar to line tearing but occurs only on 625 lines. It mostly takes the form of a band of about 2½ in. slowly moving down the screen and then repeating itself. The severity of the interference seems to be determined by the picture content. Test card reception is good, i.e. the resolution, frequency response etc. seem to be all right.—K. T. Smith (Grantham).

The problem appears to be hum in the u.h.f. tuner and we suggest you check the two valves in the tuner and the smoothing of the tuner h.t. supply.

KB CK402

There is a fault in the sound on this colour model, a grating sound being present almost all the time. The volume control has to be turned half-way round to get any reasonable results. The picture is excellent.—J. Tadworth (Preston).

Check the PCL86 audio valve. If a spare is not to hand wait until the fault occurs and see if the valve electrodes are glowing a dull red. If they are check the grid coupling capacitor Cf3 0·01μF to pin 8. If the valve does not glow check the other valve voltages —220V at pin 3, 200V at pin 6, 5·5V at pin 7 and 104V at pin 9. The loudspeaker could be at fault though this is unlikely as the fault is progressive.

MURPHY V310

The U26 e.h.t. rectifier has had to be replaced several times. I replaced it again recently, obtaining normal sound and a good picture, but the next time I switched on there was sound but no picture—the U26 had gone again. The line output transformer seems to be OK but I got a shock from the glass envelope of the U26.—R. Royle (Durham).

It is unusual for the U26 to keep blowing without the 30P4 line output valve suffering too. We suggest you check that the line output transformer has not at some time been replaced with one with a 6V e.h.t. rectifier heater winding intended for use with an EY86 type rectifier. Touching the U26 heater across a 2V battery will show you the U26 heater brightness when the valve is operating correctly.

EKCO T330F

The flywheel line sync discriminator diodes in this set need replacement. These comprise a single unit type D3-2-1YZ. Would two BA115 diodes do instead? I also wish to replace the interlace diode MR1 which is marked Q3/4. Would an OA81 suit here? Replacements for the originals seem hard to obtain. —C. Wells (Cheam).

The current BA115 or BA155 diodes will act as suitable replacements for the line and field sync diodes in your set. You could try an OA81 in the interlace diode position if you have one handy but the field synchronisation could be touchy with this.

EKCO CT103

The skin tones have become yellowish-brown. The colour-difference amplifier stages have been set up in accordance with the manual and the PCL84 colour-difference output valves changed but the skin tones are still the same.—T. Morton (Barnstaple).

We suggest you try adjusting RV26, the green colour-difference drive control on the colour-difference amplifier panel. Do this whilst watching the flesh tints on test card F.

PHILIPS 19TG175A

The picture and sound on u.h.f. are OK but on switching to v.h.f. the e.h.t. rectifier heater goes out and the line output valve overheats.—J. O'Brien (Barrow).

It appears that there is an open-circuit in either the 405-line hold control, the resistor in series with it or the system switch contacts which select the correct hold control.

TEST CASE

106

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

A colour receiver with primary-colour drive was being investigated for mild colour fringeing. The symptom was similar to horizontal misconvergence but with the difference that the fringeing occurred only on those parts of the picture corresponding to sharp changes in level of luminance or saturation. The effect was present on both colour and monochrome and close examination through a magnifying glass revealed that the horizontal colour displacement at the parts of the picture carrying highly defined vertical components was of the nature of yellow and blue.

The whole of the dynamic and static convergence procedures was run through but the trouble remained. The technician handling the repair was conversant with the symptom resulting from a fault in the luminance delay line, which also produces horizontal displacement, but generally in this case of the colour from the luminance information. It is the purpose of the luminance delay line to reduce the transient response of the Y channel so that it matches that of the chroma channel, thereby making the colour and luminance components of the picture coincide on the screen of the picture tube. Tests proved that the luminance delay line and associated circuits and components were in order however.

What section(s) of the receiver could have been responsible for this symptom and what would be the most likely components at fault? See next month's TELEVISION *for the solution to this problem and for a further Test Case item.*

SOLUTION TO TEST CASE 105

Page 523 (last month)

The incorrect colour-bar display detailed last month is a fair indication that the PAL V chroma switch has failed. Such trouble results in alternate lines of one field and alternate *pairs* of lines in a complete interlaced picture frame changing colour, this being responsible for the Hanover blind symptom. Similar trouble is caused when the PAL decoder delay-line circuit is out of balance.

In the case under consideration it was found that one of the switching transistors in the PAL switch bistable circuit had failed. The bistable circuit could therefore not be triggered by the line pulses and the R−Y signal phase alternation on alternate lines remained instead of being cancelled out by the PAL switch.

Published approximately on the 22nd of each month by IPC Magazines Limited, Fleetway House, Farringdon Street, London, EC4A 4AD. Printed in England by Fleetway Printers, Crede Hall Road, Gravesend. Sole Agents for Australia and New Zealand—Gordon and Gotch (A/sia) Ltd.; South Africa—Central News Agency Ltd., Rhodesia and Zambia—Kingstons Ltd.; East Africa—Stationery and Office Supplies Ltd. Subscription Rate (including postage): for one year to any part of the world, £2·65. "Television" is sold subject to the following conditions, namely, that it shall not, without the written consent of the Publishers first having been given, be lent, resold, hired out or otherwise disposed of by way of Trade at more than the recommended selling price shown on the cover, and that it shall not be lent, resold, hired out or otherwise disposed of in a mutilated condition or in any unauthorised cover by way of Trade, or affixed to or as part of any publication or advertising, literary or pictorial matter whatsoever.

TELEVISION CLASSIFIED ADVERTISEMENTS

The pre-paid rate for classified advertisements is 4p a word (minimum 12 words), box number 7½p extra. Semi-display setting £2·50 per single column inch. All cheques, postal orders, etc., to be made payable to TELEVISION and crossed "Lloyds Bank Ltd." Treasury notes should always be sent *registered post*. Advertisements, together with remittance, should be sent to the Classified Advertisement Manager, TELEVISION IPC Magazines Ltd., Fleetway House, Farringdon Street, London, EC4A 4AD, for insertion in the next available issue.

SERVICE SHEETS

SERVICE SHEETS & MANUALS

LARGE RANGE OF MODELS AVAILABLE FOR RADIO, TELEVISION, TAPE RECORDERS, ETC.
FROM 40p EACH - S.A.E. WITH ENQUIRIES PLEASE - 1971 INDEX LIST AVAILABLE 20p

MULLARD TRANSISTOR AUDIO AND RADIO CIRCUITS	PRICE £1.70p	
T.V. FAULT FINDING BOOK by DATA PUBLICATIONS LTD.	" 57p	
MULLARD VALVE & SEMI CONDUCTOR DATA BOOK	" 25p	POST
MAZDA VALVE & PICTURE TUBE DATA BOOKLET	" 25p	FREE
BRIMAR VALVES & TELE-TUBE DATA LIST	" 20p	
RESISTOR COLOUR CODE INDICATOR DISC	" 13p	

Large selection of Television Colour Manuals available - Prices on request.

BELL'S TELEVISION SERVICES
Albert Place, Harrogate, Yorkshire. Tel. 0423 - 86844

SERVICE SHEETS. Radio, TV, etc. 8,000 models. List 10p. S.A.E. enquiries. TELRAY, 11 Maudland Bank, Preston.

SERVICE SHEETS with Free Fault Finding Chart 35p, plus stamped addressed envelope. LESMAR, 15 Conholt Road, Andover, Hants.

RADIO, TELEVISION and Tape Recorders, 50 mixed odd sheets, 50p, also large stock of obsolete and current valves. John Gilbert Television, 1b Shepherds Bush Road, London, W.6. 01-743 8441. S.a.e. enquiries.

TRADER SERVICE SHEETS

40p each plus postage

We can supply Trader Service Sheets for most makes and types of Radios, Tape Recorders and Televisions—Manuals for some.

Cheques and open P.O.s returned if sheets not available.

OAKFIELD ENTERPRISES
LIMITED
29 CHURCH ROAD,
TUNBRIDGE WELLS, KENT

Make	*Model*	*Radio/TV*

1971 List now available at 10p plus postage

If list is required indicate with X

From ....

Address ....

....

enclose remittance of ....
(and a stamped addressed envelope)
s.a.e. with enquiries please
MAIL ORDER ONLY (May T)

LARGE SUPPLIER of SERVICE SHEETS

(TV, RADIO, TAPE RECORDERS, RECORD PLAYERS, TRANSISTORS, STEREOGRAMS, RADIOGRAMS, CAR RADIOS)

Only 25p each. Manuals from 50p

PLEASE ENCLOSE LARGE S.A.E. WITH ALL ENQUIRIES AND ORDERS. Otherwise cannot be attended to.

(Uncrossed P.O.'s please, original returned if service sheets not available.)

C. CARANNA
71 BEAUFORT PARK, LONDON, N.W.11

We have the largest supplies of Service Sheets (strictly by return of post). Please state make and model number alternative.
Free TV fault tracing chart or TV list on request with order.
MAIL ORDER ONLY

QUICK, EFFICIENT, UNIQUE SERVICE SHEET SERVICE

Very Large Stock
TVs, Radio, Amps, Test Gear.
Special Telephone Service available to Trade Customers.
Colour TV and Test Gear Circuits.
Exchange Service.
Full details with first Order.
List price 10p Post Free.
State Make and Model Number.
Large S.A.E. and 25p unfilled P.O.
Mail Order Only.

A.S.L., 21c Drydon Chambers, 119 Oxford Street, London, WIR 1PB

SERVICE SHEETS

(1925-1971) for Radios, Televisions, Transistors, Radiograms, Car Radios, Tape Recorders, Record Players, etc.
By return post with

FREE FAULT FINDING GUIDE

PRICES FROM 5p

Over 8,000 models available.
Catalogue 13p.

Please send stamped addressed envelope with all orders and enquiries.

Hamilton Radio
54 London Road, Bexhill, Sussex
Telephone Bexhill 7097

AERIALS

BAKER and BAINES for UHF Aerials

These aerials are suitable for both colour and black and white. Supplied with tilt clamp which will take up to a 2 in. mast. 10 ele £2·10, 12 ele £2·20, 14 ele £2·35, 18 ele £3·25, 22 ele £3·75.

Combined 405 aerials
Dipole and 5 £2·70, D and 8 £3·10, Loft Special D and 5 £2·10 complete with loft pole for ease of mounting in the loft space.
Lashing Kits—Co-ax—Diplexers and Triplexers—Clamps and couplers. UHF Pre-Amps, £3·75, p. & p. 12½p.
Please state channel numbers when ordering. Postage paid on all aerials inland. Accessories postage by weight.
S.A.E. will bring our full lists.

11 Dale Crescent, Tupton, Chesterfield

AERIALS

UHF: Set Tops £2·10, Outside: 9 ele £1·25, 10 ele £1·90, 11 ele £2·50, 12 ele £2·55, 18 ele £3·25, 20 ele £3·50. Multibeam 46 and Supremes £5·50.
All aerials supplied with clamps.
ANTIGHOST: Troubleshooters/Logbeams £5.
FM/VHF: H £2·25, 3 ele £3·25, 4 ele £3·75. Sterio 6 ele £6.
Motorized Units: Semi Auto £20, Auto £25.
All Aerials by leading makers.
ELECTRONICS, ACCESSORIES: Incl. Masts, Lashings, Plugs, Amps., Headphones, Meters, Stereo Cartridge Players, Cassettes, Tapes, etc., etc.
COAXIALE: Standard 100 Mtrs. £4·50. Low Costs £7, or per Mtr.
State channels for all TV Aerials/Amps. FM state wide band or channelized.
TERMS: CWO, COD, P & P 32½p. Send 2½p stamps for lists. Callers Welcome.
OVERSEAS customers welcome. Note New Zealand/Australia by sea, 7 weeks min. By Air quotations given.

JEFFRIES SERVICES
31 Hambrook St., Portsmouth. Tel. 28354

SETS & COMPONENTS

WITWORTH Transformers

Line out-put transformers
Manufacturers of the largest range in the country. All makes supplied. Free catalogue.

Modern
BAIRD, BUSH, GEC, PHILIPS.
Replacement types ex-stock.
For 'By-return' service, contact your nearest Depot:

London: 01-948 3702
Tidman Mail Order Ltd., Dept. PT.
236 Sandycombe Road,
Richmond, Surrey.

Birmingham: 021-643 2148
Hamond Components,
89 Meriden Street,
Birmingham 5.

Valves, Tubes, Condensers, Resistors. Rectifiers and Frame out-put Transformers also stocked.

TOP 20 TV Valves, 10p; PL504, PL36, PY33, 15p, P&P 4p per valve, over 12 valves post free. Guaranteed tested ex-equipment, individually boxed. Resistors and capacitors all values and sizes. Leading manufacturers components and hi-fi equipment, 10% or more off. 13A plugs, 12p. Mains fuses, 20p for 10. Tools, etc., P&P extra on all items. Trade enquiries welcomed, discount for quantity. S.A.E. for list. L & D Components Ltd., 71 Westbury Avenue, Wood Green, N.22. 01-888 2701.

VALVES, VALVES, VALVES

Any ten of your choice 72½p, post 5p. 100 £5·50, post paid.

EF85, EF80, EB91, EBF89, ECL80, EF183, EY86, PCF80, PCC84, PL36, PY81, PCL82, PCL83, PCC89, PY33, PY82, PY800, PY801, PY88, PCL84, 30F5, 6BW7, PY801.

BOB'S,
2 St. James Street, Rawtenstall
Rossendale, Lancs.
Mail order ONLY.

CHROMASONIC
ELECTRONICS
LOW NOISE HI-STABS

½ watt 5% all E24 values, 3 for **2p**, plus p & p **6p** for up to 50 resistors + **1p** for each additional 50
Skeleton Presets 0·1 watt **5p**, 0·25 watt **7p**.

5µF 64v; 16µF 40v, **6p.** 100µF 40v, **9p.** 640µF 25v, **18p. Polystyrenes 5p** each. **Silver Micas 7p** each up to 220pf. **C280,** 0·1µF 250v **3p. Feedthrough Ceramic** 1000pf **5p.**

BC107	**12p**	BC187	**27p**	OA90	**7p**
BC108	**11p**	BF194	**17p**	OA95	**7p**
BF167	**25p**	BF195	**17p**	2N1613	**22p**
BF173	**25p**	BF196		TAA700	**£2**
BF184	**25p**	(BF239)	**15p**		
BF180	**42p**	BF197	**15p**	AC128	**17p**

BU105 **£2·75**
BZY88 range **15p** each.
TTL Decade Counter 7490 **87p**

Coax Socket 8p. Switch 2 pole 3 way 25p

FREE CATALOGUE P & P 3p.

P & P on all orders other than Resistors **6p**
Dept. 'T', 56 Fortis Green Rd., London, N10 3HN

PHILIP H. BEARMAN

A leading name in valves and Tubes!

(Mullard, Thorn, Telefunken, etc.)

NEW MOSTLY BVA VALVES! Huge range by post service well known to the trade. Brief list of television types herewith, full list S.A.E. All types ex stock!

DY86/7	43p	PCF86	63p	PY82	50p	20L1	95p
EB91	250	PCF801/2	62p	PY800/1	50p	20P4	£1·00
ECC82	42p	PCF805	87p	R19	85p	30C15	90p
ECL80	50p	PCF808	85p	U25	95p	30C17	95p
EF80	42p	PCL82	51p	U26	95p	30F5	95p
EF85	45p	PCL83(S)	60p	U37	75p	30FL1 & 2	65p
EF183/4	57p	PCL84	60p	U191	90p	30L15	95p
EH90	55p	PCL805/85	66p	U193	48p	30L17	90p
EY51	60p	PCL86	66p	U251	95p	30P12	95p
EY86/7	43p	PL36/8	87p	U301	90p	30PL1	90p
PC86 & 8	75p	PL81	80p	U801	£1·25	30P4MR	£1·25
PC97	45p	PL83	85p	6/30L2	90p	30P19	87p
PC900	55p	PL84	65p	6AT6	55p	30PL13	£1·00
PCC84	50p	PL500	90p	6BW7	82p	30PL14/5	£1·10
PCC89	62p	PL504	90p	6CD6G	95p	etc., etc.	
PCF80	52p	PY81	50p	6F23	95p	**Trade prices**	

POST FREE OVER £3·00. 2½p PER VALVE BELOW £3·00
LATEST NEW BY100/127 type silicon rectifier 15p. 33Ω res 5p!

Large bulb Imported PCF80 32p! Philips PCL805/85 57p!

Note. Ask for separate component and transistor lists.

6 POTTERS ROAD, NEW BARNET, HERTS.

(Adjacent to Post Office)

Tel, 01-449/1934 & 449/1935 (Robophone)

Special quantity terms, lists, s.a.e. GIRO 34.361.4006

(suppliers to H.M. Govt. etc.)

TELEVISION TUBE SHOP

BRAND NEW TUBES AT REDUCED PRICES

A28-14W (A28-13W)	£12·75
A31-18W	£12·50
A47-11W	£9·95
A47-13W	£12·50
A47-14W	£8·25
A47-26W	£10·75
A50-120WR	£12·50
A59-11W	£12·95
A59-13W	£13·50*
A59-15W	£9·95
A59-16W	£13·50*
A59-23W	£14·75
A61-120WR	£16·00
AW36-21, 36-80	£5·75
AW43-80	£6·95
AW43-88, 43-89	£6·75
AW47-90, 47-91	£7·50
AW53-80	£7·50*
AW53-88, 53-89	£8·25
AW59-90, 59-91	£9·00
C17LM, 17PM, 17SM	£6·50
CME1201	£12·50
CME1402	£5·75
CME1601	£10·50
CME1602	£12·00
CME1702, 1703	£6·75
CME1705	£7·75
CME1713/A44-120	£14·50
CME1901, 1903	£7·50
CME1906	£12·50
CME1908	£7·75
CME2013	£12·50
CME2101, 2104	£8·25
CME2301, 2302, 2303	£9·00
CME2305	£14·75
CME2306	£13·50*
CME2308	£9·95
CME2413R	£16·50
CRM93, 124	£5·50*
CRM141, CRM142	£5·50
CRM171, CRM172	£6·50
CRM211, CRM212	£7·50*
MW36-24, 36-44	£5·50
MW43-69	£6·75
MW43-80	£6·75
MW53-20, 53-80	£7·50
TSD217, TSD282	£14·00†
13BP4 (Crystal 13)	£14·00†
190AB4	£9·25
230DB4	£11·25

†Rebuilt tubes also, at £7·00 plus bulb

*These types are FULLY rebuilt.

ALL TUBES ARE TESTED AND GUARANTEED FOR A MINIMUM OF 12 MONTHS

ADD 75p FOR CARRIAGE AND INSURANCE

COLOUR TUBES

19 in. and 22 in. having slight marks or scratches at £35 each

TELEVISION TUBE SHOP

48 BATTERSEA BRIDGE ROAD, LONDON, S.W.11. 228 6859

WE GIVE GREEN SHIELD STAMPS

LARGE quantities of used TV spares for most models, 1952-64. Lopts, Tuners IF Strips, Time Base Panels Scan Coils, Frame Transformers, Knobs, cabinet Trim, etc. New manufacturers replacement parts, can be supplied, for more modern sets on receipt of an order deposit. S.A.E. for quotations. C.W.O. to TV Dismantlers, Foxhole, Whitstone, Holsworthy, Devon.

T.V. SPARES

OIL FILLED MURPHY LOPT's U26 type. Model number not known. **£1·25** each plus **25p** p.p.

BAIRD/FERGUSON V.H.F. TUNERS. Uses PC97 and 30C18 valves. Fits 620 to 650 series models, complete with all coils, supplied less valves, **£1·75** each plus **25p** p.p.

BRC 960 I.F. PANELS. Complete and unused, less valves. Dual standard V.H.F./U.H.F. 405/625. Absolute bargain at **£2·50** plus **25p** p.p.

FERGUSON/EKCO PLUG IN MAINS LEADS. Moulded two-pin connector type. 6 for **£1·50** plus **25p** p.p.

LATE G.E.C./SOBELL 625 405, etc. Dual Standard 405/625 I.F. Panels, complete with switching for direct replacement in this popular Radio and Allied receiver. **£1·75** plus **25p** p.p.

TIMEBASE PANELS to fit Sobell 195, 282, 283, 284, 285, 286, 287, 288 (and DS models), McMichael MT762, 763, 765, P40S. Complete and new for direct replacement, **£1·75** each plus **25p** p.p.

V.H.F. ROTARY TUNER UNITS to fit McMichael, Sobell, G.E.C. New and unused, **£1·75** each plus **25p** p.p.

FERGUSON 800/850 series TIMEBASE PANELS, complete and unused in original packing. **£2·25** each, plus **25p** p.p.

SCAN COILS, 110° type will fit most makes, after modification. Originally manufactured for Pye but we have used them in BRC, Philips, etc. with good results. **£1·50** plus **25p** p.p.

WILLOW VALE ELECTRONICS LTD.

4 & 5 The Broadway
Hanwell, London, W.7

Tel: 01-567 2971 and 5400
01-579 3582

Terms cash with order or C.O.D. 27½p extra
S.A.E. all enquiries. Catalogue 20p

120 NEW ASSORTED Capacitors, Electrolytic, Mica, etc., and Resistors, ½/20W, 85p, Post Free. Whitsam Electrical, 33 Drayton Green Road, London, W.13.

Brand New
HARTLEY OSCILLOSCOPES C.T.316

In original packing. Miniature valves.
Band width up to 5 Megs.
Mains supply.
£40, plus £1·50 post and packing.
C.W.O. Carriage charges mainland only.

A. H. THACKER
Radio Dept, High Street, Cheslyn Hay, Nr. Walsall, Staffs.

SOUTHERN VALVE COMPANY

44 Earls Court Road, London, W.8

SPECIALISTS IN QUALITY VALVES FROM TOP MANUFACTURERS; WE DO NOT CLAIM THE LOWEST PRICE, BUT GENUINE VALUE!

All new and boxed, some BVA. Send s.a.e. for list.

DY87	37p	PC868	50p	PCL805	45p	U193	35p	30L17	75p
DY802	45p	PC97	40p	PCL86	37p	U251	62p	30P12	70p
EB91	15p	PCF80	32p	PL36	52p	6/30L2	60p	30PL1	60p
ECC81	37p	PCF86	52p	PL81	46p	6BW7	60p	30P4MR	95p
ECC82	30p	PCF801	50p	PL84	55p	6CD6G	90p	30P19	70p
ECL80	40p	PCF802	50p	PL500/4	65p	6F23	75p	30PL13	75p
EF80	27p	PCF805	50p	PY81	35p	6F28	48p	30PL14	75p
EF183	37p	PCF808	60p	PY800	35p	20L1	85p	etc., etc.	
EF184	37p	PCL82	37p	PY801	35p	20P4	90p		
EH90	45p	PCL83(s)	50p	U25	65p	30C15	70p		
EY51	50p	PCL84	37p	U26	60p	30FL12	75p		
EY86/7	37p	PCL85	45p	U191	65p	30L15	75p		

NOTE
BY100/BY127 equiv only 20p with resistor.

POST FREE OVER £2, BELOW 2½p EACH.
MAIL ORDER ONLY.

TV COMPONENTS (send S.A.E. for list), e.g.: Resistors in packs of 5, all values supplied. Price per pack as follows: 1 watt—10p, 2 watt—19p, 10 watt wire wound—40p, BY127 Silicon Rectifiers—20p each, Thermistors TH1—10 p each. Instant Heat Soldering Gun, only £3·25. Orders despatched within 24 hours (stocks permitting). For urgent orders telephone Doncaster 49874. Please add 15p for P. & P. (orders of £5 or over P. & P. free). TRIDENT TELEVISION SERVICES, 29 Richmond Road, Scawsby, Doncaster. Yorks.

TV's TV's TV's

SPECIAL OFFER—LIMITED PERIOD ONLY

19" Slim Thorn 800 TV's 13 channel.
Good working order. Polished cabinets.
Only **£9·50** PLUS £1·50 Carr.

EX-RENTAL TV's (UNTESTED)

Complete with 13 channel tuners. Good cabinets.
Carriage £1·50 extra.

17" Semi Slim (90° Tube)	**£2·50**
17"/21" Slim (110° Tube)	**£4·50**
19" Slimline	**£6·50**
23" Slimline	**£8·50**
19" BBC2 Sets	**£14·50**

PERFECT SPEAKERS EX T.V.

Pm 3 ohm (minimum order two) 5 in. round, 8 in. by 2 in. rectangular—12½p each. Add 7½p per speaker p. & p.

VALVES EX EQUIPMENT

EB91	5p	30L15	12½p	PL36	22½p
EBF89	12½p	30P4	12½p	PL81	17½p
ECC82	12½p	PC97	17½p	PY81	15p
EC180	7½p	PCF86	17½p	PY800	15p
EF80	12½p	PC84	7½p	PY82	7½p
EF85	12½p	PCF80	7½p	PY33	22½p
EF183	12½p	PCC89	12½p	U191	17½p
EF184	12½p	PCL85	22½p	6F23	17½p
EY86	17½p	PCL82	17½p	30PL1	22½p
30PL13	20p	PCL86	17½p	30P12	20p
630LZ	12½p	PCL83	12½p	30F5	10p

Add 2½p per valve p. & p., orders over £1 p. & p. free

UHF TUNERS

For Ferguson 850 900 chassis. Adaptable for KB, EKCO, T415, 1084 Chassis **£2·50**, p. & p. 50p.

SLOT METERS—SPECIAL OFFER

Smiths Mk. 11 6d. Convertible to 5p. (Smiths Kit costs **35p** each £1 each inc. p. & pkg. or 10 for £5 inc. p. & pkg.
Please write with SAE for quotations on any spares.

TRADE DISPOSALS (Dept. T.S.)

Thornbury Roundabout, Leeds Rd., Bradford.
Telephone 665670

TOWERBY LTD

For Line Outputs and Deflector Coils

We have the Country's largest stock of Manufacturer's Original (or Authorised Replacement) Line Output Transformers for many "difficult" makes, including **Ambassador, Baird, Cossor, Decca, Dynatron, Ekco, Ferguson, G.E.C., H.M.V., K.B., Masteradio, Peto-Scott, Philips, Regentone, RGD, Sobell, Ultra,** etc. Also deflector coils output and oscillator transformers, inc. **Alba, Bush, Murphy.** Examples, L.O.P.T. **Murphy** 350/410/540/659/759, **£7·35**; **Bush,** TV80, TV95, TV96, **£7·35**; **Cossor** 950, **£3·87½**; **Ferguson** 306/308, **£3·97½**; **Philips** 1768U L.O.P.T. assembly, **£6·75**; **Ultra** 1984-200c, **£5·06.**
Rewind most L.O.P.T., **£4·50.**

SPECIAL OFFER

Ekco improved type for Models T221, 231, 310, all at **£2·25**; **Ferranti** 14T4 series inserts, **£1·25**; **Philco** 1019/1021, **£2·62½**. Terms: C.W.O. or C.O.D. (17½p), post-packing 30p; 2 or more L.O.P.T.s post/packing free.
All enquiries answered but regret no lists available. Same day delivery on most types.

TOWERBY LTD

MAIL ORDER DIVISION OF T.C.S. LTD.
70 STREATHAM HILL, LONDON, SW2
Tel.: 01-674 2185.

PORTABLE TELEVISIONS

Battery or Mains. We stock over eleven different models. BIG Money Saving Offers. Trade supplied with Full Trade Discounts. All enquiries with S.A.E. please.
Ross Electrics,
1 Church Street, Ainsworth, Bolton.
21408/51956.

R & R RADIO

51 Burnley Road, Rawtenstall
Rossendale, Lancs
Tel.: Rossendale 3152

TESTED VALVES—
3 MONTHS' GUARANTEE

EBF80	15p	PCC84	15p	PY800	17½p
EBF89	17½p	PCF80	15p	PY801	17½p
ECC82	15p	PCL82	20p	U191	22½p
ECL80	15p	PL36	25p	30C15	25p
EF80	10p	PY33	25p	PCF86	25p
EF85	15p	PY81	17½p	PCL85	25p
EY86	20p	PY82	15p	PCL84	25p

Copper Laminate Board, for etching, 1p per sq.in. Double sided 1½p per sq.in. Any size cut, min. order 50p plus 10% P. & P.

Postage on Valves: one valve 4p, up to 6 2½p over 6 post paid.

BENTLEY ACOUSTIC CORPORATION LTD.

38 CHALCOT ROAD, CHALK FARM, LONDON, N.W.1

THE VALVE SPECIALISTS *Telephone 01-722-9090*

OA2	0·30
OB2	0·30
OZ4	0·23
1A3	0·23
1A5	0·25
1A7GT	0·33
1B3GT	0·37
1D5	0·38
1D6	0·48
1FD1	0·33
1G6	0·30
1H5GT	0·33
1L4	0·13
1LD5	0·30
1LN5	0·40
1N5GT	0·37
1R5	0·27
1S4	0·22
1S5	0·20
1U4	0·29
1U5	0·48
2D21	0·35
3A4	0·20
3B7	0·25
3D6	0·19
3Q4	0·38
3Q5GT	0·35
3S4	0·27
3V4	0·32
5R4GY	0·53
5V4G	0·35
5Y3GT	0·26
5Z3	0·45
5Z4G	0·35
6/30L2	0·55
6A8G	0·33
6AC7	0·15
6AG5	0·25
6AK5	0·25
6AK6	0·30
6AM6	0·17
6AM8A	0·50
6AN8	0·49
6AQ5	0·22
6AR6	1·00
6AT6	0·18
6AU6	0·20
6AV6	0·30
6AW8A	0·54
6AX4	0·39
6B8G	0·13
6BA6	0·20
6BC8	0·50
6BE6	0·21
6BH6	0·43
6BJ6	0·39
6BQ5	0·22
6BQ7A	0·38
6BR7	0·79
6BR8	0·63
6BS7	1·25
6BW6	0·72
6BW7	0·55
6BZ6	0·31
6C6	0·19
6C9	0·73
6C17	0·63
6CB6A	0·26
6CD6G	1·08
6CG8A	0·50
6CH6	0·38
6CL6	0·43
6CL8A	0·50
6CU5	0·50
6CW4	0·63
6D6	0·15
6DE7	0·50
6DT6A	0·50
6EW6	0·55
6F1	0·59
6F6	0·63
6F6G	0·25
6F13	0·33
6F14	0·43
6F15	0·65
6F18	0·45
6F23	0·68
6F24	0·68
6F25	0·58
6F28	0·70
6F32	0·15
6GH8A	0·50
6GU7	0·50
6H6GT	0·15
6J5G	0·19
6J5GT	0·29
6J6	0·18
6J7G	0·24
6J7GT	0·38
6K7G	0·10
6K7GT	0·23
6K8G	0·16
6L1	0·98
6L6GT	0·39
6L7	0·63
6L18	0·45
6L19	1·38
6LD20	0·48
6N7GT	0·40
6P28	0·59
6Q7	0·43
6Q7G	0·27
6R7	0·55
6R7G	0·35
6SA7GT	·35
6SA7	0·35
6SC7GT	0·33
6SG7GT	·33
6SH7	0·53
6SJ7	0·35
6SK7GT	·23
6SQ7GT	·38
6U4GT	0·60
6U7G	0·53
6V6G	0·17
6V6GT	0·30
6X4	0·20
6X5GT	0·25
6Y6G	0·55
6Y7G	0·63
7B6	0·58
7B7	0·35
7C6	0·30
7F8	0·88
7H7	0·28
7R7	0·65
7V7	0·25
7Z4	0·50
9BW6	0·50
9D7	0·78
10C1	1·25
10C2	0·50
10DE7	0·50
10F9	0·45
10F18	0·35
10LD11	0·53
10P13	0·54
10P14	1·10
12A6	0·63
12AC6	0·40
12AD6	0·40
12AE6	0·48
12AT6	0·23
12AT7	0·16
12AU6	0·21
12AU7	0·19
12AV6	0·28
12AX7	0·22
12AY7	0·68
12BA6	0·30
12BE6	0·30
12BH7	0·27
12E1	0·85
12J7GT	0·33
12K5	0·50
12K7GT	·34
12Q7GT	0·28
12SA7GT	0·40
12SC7	0·35
12SG7	0·23
12SH7	0·15
12SJ7	0·23
12SK7	0·24
12SQ7GT	0·50
14H7	0·48
14S7	1·75
19AQ5	0·24
19G6	1·45
19H1	2·00
20D1	0·65
20D4	1·05
20F2	0·65
20L1	0·98
20P1	0·88
20P3	0·82
20P4	0·89
20P5	1·00
25A6G	0·29
25L6G	0·22
25Y5	0·38
25Y5G	0·43
25Z4G	0·30
25Z5	0·40
25Z6GT	·43
30C1	0·28
30C15	0·60
30C17	0·77
30C18	0·60
30F5	0·70
30FL1	0·60
30FL2	0·60
30FL12	0·70
30FL14	0·68
30L1	0·29
30L15	0·68
30L17	0·69
30P4MR	·95
30P12	0·69
30P16	0·30
30P19/30P4	0·58
30PL1	0·59
30PL13	0·75
30PL14	0·65
30PL15	0·87
35A3	0·50
35A5	0·75
35D5	0·70
35L6GT	0·42
35W4	0·23
35Z3	0·50
35Z4GT	0·24
35Z5GT	0·30
50B5	0·35
50C5	0·32
50CD6G	2·17
50EH5	0·55
50L6GT	0·45
72	0·33
85A2	0·43
85A3	0·40
90AG	3·38
90AV	3·38
90CG	1·70
90CV	1·68
90C1	0·59
150B2	0·58
301	1·00
302	0·83
303	0·75
305	0·83
306	0·65
807	0·59
1821	0·53
5702	0·80
5763	0·50
6060	0·30
7193	0·53
7475	0·70
A1834	1·00
A2134	0·98
A3042	0·75
ACO44	1·16
AC2/PEN	0·98
AC6PEN	·38
AC2/PEN/DD	0·98
AC/PEN(7)	0·98
AC/TH1	0·50
AC/TP	0·98
AL60	0·78
ARP3	0·35
ATP4	0·12
AZ1	0·40
AZ31	0·46
AZ41	0·53
B36	0·33
CL33	0·90
CV6	0·53
CY1C	0·53
CY31	0·31
D63	0·25
DAC32	0·33
DAF91	0·20
DAF96	0·33
DD4	0·53
DF33	0·37
DF91	0·14
DF96	0·33
DF97	0·63
DH63	0·27
DH76	0·28
DH77	0·18
DH81	0·58
DH107	0·90
DK32	0·33
DK40	0·55
DK91	0·27
DK92	0·38
DK96	0·35
DL33	0·35
DL92	0·27
DL94	0·32
DL96	0·35
DM70	0·30
DM71	0·38
DW4/500	0·38
DY87/6	0·25
DY802	0·37
E80F	1·20
E83F	1·20
E88CC	0·60
E92CC	0·40
E180F	0·90
E182CC	1·13
E1148	0·53
EA50	0·18
EA76	0·88
EABC80	·30
EAC91	0·38
EAF42	0·48
EB34	0·20
EB91	0·11
EBC41	0·48
EBC81	0·33
EBC90	0·18
EBC91	0·30
EBF80	0·30
EBF83	0·38
EBF89	0·27
EBL21	0·60
EC54	0·50
EC86	0·63
EC88	0·60
EC90	0·25
EC92	0·35
ECC32	1·50
ECC33	1·50
ECC40	0·60
ECC81	0·16
ECC82	0·19
ECC83	0·22
ECC84	0·28
ECC85	0·25
ECC86	0·40
ECC88	0·35
ECC189	0·48
ECC804	0·55
ECC807	1·70
ECF80	0·27
ECF82	0·27
ECF86	0·65
ECF804	2·10
ECH21	0·63
ECH42	0·61
ECH81	0·27
ECH83	0·39
ECH84	0·34
ECL80	0·30
ECL82	0·30
ECL83	0·52
ECL84	0·55
ECL85	0·55
ECL86	0·36
EE80	0·70
EF22	0·63
EF36	0·33
EF37A	0·45
EF39	0·40
EF40	0·50
EF41	0·58
EF42	0·33
EF54	0·98
EF73	0·75
EF80	0·22
EF83	0·48
EF85	0·26
EF86	0·30
EF89	0·23
EF91	0·17
EF92	0·35
EF97	0·55
EF98	0·65
EF183	0·27
EF184	0·29
EFP60	0·50
EH90	0·38
EL32	0·18
EL34	0·46
EL35	1·00
EL37	0·87
EL41	0·53
EL42	0·53
EL81	0·50
EL83	0·38
EL84	0·22
EL85	0·40
EL86	0·38
EL91	0·23
EL95	0·34
EM34	0·90
EM80	0·38
EM81	0·39
EM83	0·75
EM84	0·31
EM87	0·35
EY51	0·33
EY81	0·35
EY83	0·55
EY84	0·50
EY87/6	0·30
EY88	0·43
EY91	0·53
EZ35	0·25
EZ40	0·40
EZ41	0·42
EZ80	0·21
EZ81	0·22
EZ90	0·20
FW4/500	0·75
FW4/800	0·75
GZ30	0·35
GZ32	0·41
GZ33	0·70
GZ34	0·48
GZ37	0·75
HABC80	·45
HL23DD	0·40
HL41DD	0·98
HL42DD	0·50
HN309	1·40
HVR2	0·53
HVR2A	0·53
IW3	0·38
IW4/350	·38
IW4/500	·38
KT2	0·25
KT8	1·75
KT41	0·98
KT44	1·00
KT63	0·25
KT66	0·80
KT74	0·63
KT76	0·63
KT81	2·00
KTW61	0·63
KTW62	0·63
KTW63	0·50
M8162	0·63
ME1400	0·74
MHL4	0·75
N78	2·05
N108	1·40
N308	0·95
N339	0·44
N359	0·44
P61	0·48
PABC80	·33
PC86	0·48
PC88	0·48
PC95	0·53
PC97	0·36
PC900	0·34
PCC84	0·29
PCC85	0·28
PCC88	0·43
PCC89	0·45
PCC189	0·48
PCC805	0·58
PCC806	0·69
PCF80	0·28
PCF82	0·30
PCF84	0·40
PCF86	0·44
PCF87	0·77
PCF200	0·67
PCF800	0·60
PCF801	0·31
PCF802	0·40
PCF805	0·60
PCF806	0·58
PCF808	0·68
PCH200	0·62
PCL82	0·32
PCL83	0·58
PCL84	0·34
PCL805/85	0·41
PCL86	0·39
PCL88	0·65
PCL800	0·75
PCL801	0·59
PEN4DD	1·38
PEN45	0·35
PEN45DD	0·75
PEN46	0·20
PEN453DD	0·98
PENA4	0·98
PEN/DD/4020	0·88
PFL200	0·53
PL33	0·38
PL36	0·47
PL38	0·90
PL81	0·44
PL81A	0·50
PL82	0·30
PL83	0·33
PL84	0·30
PL302	0·58
PL504/500	0·63
PL505	1·30
PL508	0·90
PL509	1·30
PL802	0·75
PM84	0·35
PX4	1·16
PX25	1·16
PY33/2	0·50
PY80	0·33
PY81	0·25
PY82	0·25
PY83	0·26
PY88	0·33
PY301	0·58
PY500	0·95
PY800	0·33
PY801	0·33
PZ30	0·48
QQV03/10	1·20
QS75/20	0·63
QS95/10	0·49
QS150/15	0·63
QVO4/7	0·63
R10	0·75
R11	0·98
R16	1·75
R17	0·88
R18	0·50
R19	0·30
R20	0·56
R52	0·35
RG1/240A	1·98
RK34	0·38
SP42	0·75
SP61	0·33
TH4B	0·50
TH233	0·98
Tp2620	0·98
UABC80	0·30
UAF42	0·49
UBC41	0·45
UBC81	0·40
UBF80	0·29
UBF89	0·30
UBL21	0·55
UC92	0·35
UCC84	0·34
UCC85	0·34
UCF80	0·34
UCH21	0·60
UCH42	0·60
UCH81	0·30
UCL82	0·33
UCL83	0·48
UF41	0·50
UF42	0·60
UF80	0·35
UF85	0·34
UF86	0·63
UF89	0·27
UL41	0·54
UL46	0·88
UL84	0·31
UM80	0·33
UR1C	0·53
UU5	0·38
UU9	0·40
UU12	0·22
UY1N	0·50
UY21	0·55
UY41	0·38
UY85	0·25
U10	0·45
U12/14	0·38
U16	0·75
U17	0·35
U18/20	0·75
U19	1·73
U22	0·39
U25	0·65
U26	0·56
U31	0·30
U33	1·50
U35	0·83
U37	1·75
U45	0·78
U47	0·65
U49	0·56
U50	0·26
U76	0·24
U78	0·20
U107	0·92
U191	0·58
U251	0·68
U281	0·40
U282	0·40
U301	0·40
U403	0·33
U404	0·38
U801	0·93
U4020	0·38
VP13C	0·35
VP23	0·40
VP41	0·38
VR105	0·33
VT61A	0·35
VU111	0·44
VU120	0·60
VU120A	·60
VU133	0·35
W76	0·34
W107	0·50
W729	0·60
X41	0·05
X61M	0·60
X63	0·33
XE3	5·00
XH/1·5	·48
Z329	0·70
Z749	0·68

All valves are unused, boxed, and subject to the standard 90-day guarantee. Terms of business:—Cash or cheque with order only. Post/packing 0·03 per item, subject to a minimum of 0·09 per order. Orders over 5·00 post/packing free. Same day despatch by first class mail. Any parcel insured against damage in transit for only 0·03 extra per order. Complete catalogue with conditions of sale price 0·07 post paid. Business hours Mon.-Fri. 9-5.30 p.m. Sats. 9-1 p.m.

We do not handle seconds nor rejects, which are often described as "New and Tested" but have a limited and unreliable life. No enquiries answered unless S.A.E. is enclosed for a reply.

STEPHENS

ELECTRONICS

24 PARTON RD., AYLESBURY, BUCKS.
Tel: AYLESBURY 4300
SEND S.A.E. FOR LISTS. GUARANTEE
Satisfaction or money refunded

TELEVISIONS
ELIZABETHAN TW12LZ PORTABLE TV

12 in. screen model complete with loop aerial system. Operates on 230-240 v. AC or 12 v. DC battery or 12 v. DC car battery. All transistor covering UHF, BBC1, BBC2 and ITA Channels 21-70. Size 15 in. × 12½ in. × 12 in. Weight 16¼ lbs. List Price £75. OUR PRICE ONLY **£52·97**. Carr. £1. Also the 14 in. Elizabethan Television Model No. F.14 (L.2). OUR PRICE **£56·50**. Carr. £1.

MULTIMETERS AND OSCILLOSCOPES
TWO NEW OSCILLOSCOPES FROM RUSSIA
CI-5 SINGLE BEAM OSCILLOSCOPE

10 mc/s passband, triggered sweep from 1μ sec. to 3 millisec. Free running time base from 20 c/s to 200 kc/s. Built-in time marker and amplitude calibrator. 3-in. cathode ray tube with telescopic viewing hood. **£39·00**

CI-16 DOUBLE BEAM OSCILLOSCOPE

5 mc/s passband. Separate Y1 and Y2 amplifiers, rectangular 5 in. × 4 in. cathode ray tube. Calibrated triggered sweep from 0·2μ sec. to 100 millisec. per cm. Free running time base 50 c/s to 1 mc/s. Built-in time base calibration and amplitude calibrator. **£87·50**

Full details on request. Full servicing facilities and spares available.

T.V. TUBES **"VIDEOCHROME"** T.V. TUBES

FOR BRILLIANCE & DEFINITION

17" £5·00
19" £5·50
21" £7·00
23" £7·50

19" PANORAMA £6·25
23" PANORAMA £8·25

CASH OR CHEQUE WITH ORDER

TRADE SUPPLIED
ALL TUBES PRECISION REBUILT AT OUR OWN FACTORY BY SKILLED CRAFTSMEN ● EACH TUBE BENCH AND SET TESTED TO A VERY HIGH STANDARD BEFORE DESPATCH

2 YEARS GUARANTEE ● FREE DELIVERY ANYWHERE IN THE U.K.

VIDEOCHROME TUBES LTD.
25 BELLEVUE AVENUE
RAMSGATE, KENT. Tel. THANET 52914