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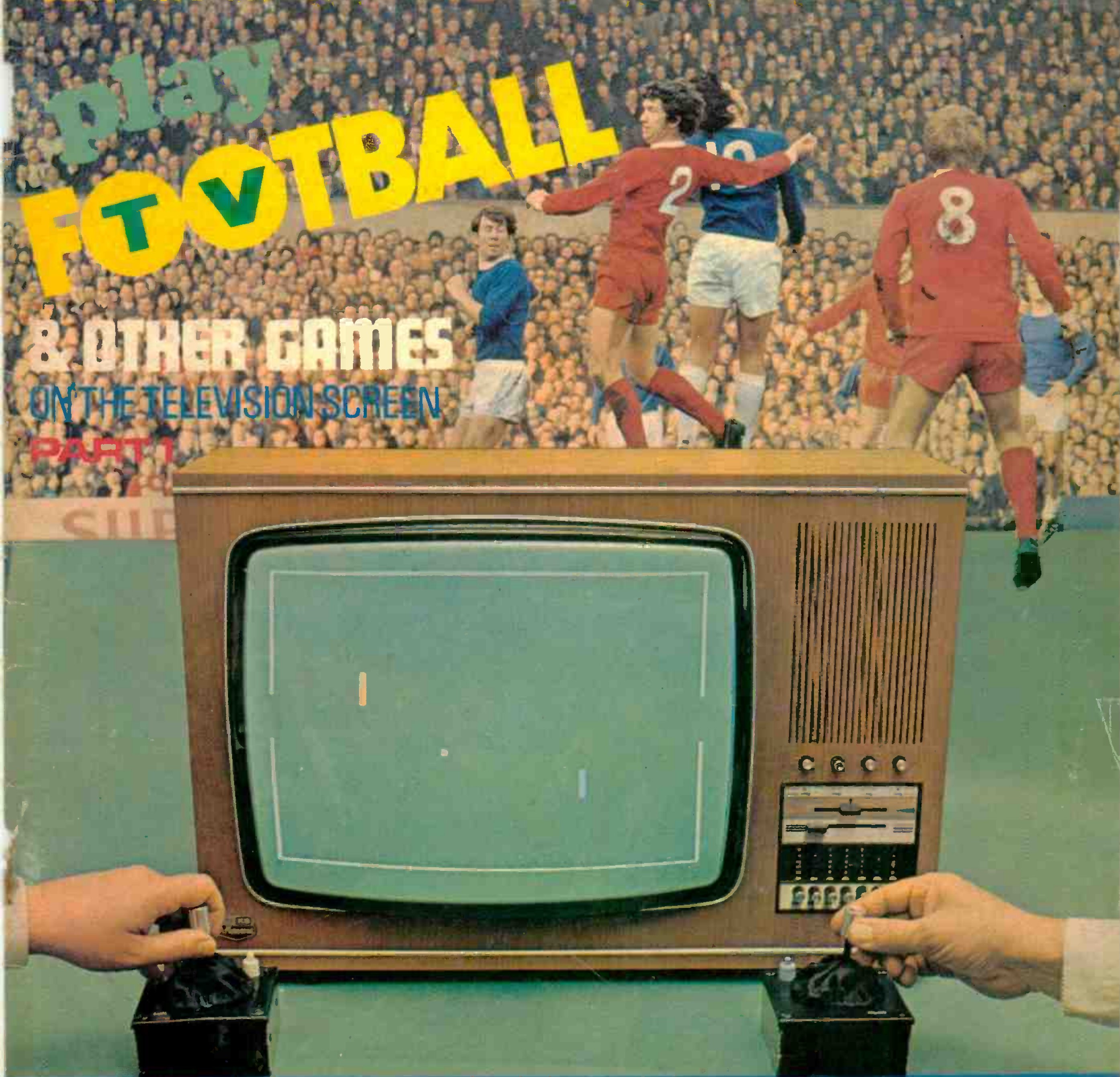

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6AK5	0·34	6F1	0·70	6X4	0·40	12SN7	0·60	35A3	0·65	AZ41	0·65
6AK6	0·60	6F6G	0·40	6X5GT	0·40	12SQ7GT	·65	35A5	0·80	BL63	2·00
6AM8A	0·55	6F13	0·55	6Y6G	0·75	14H7	0·55	35D5	0·75	CL33	1·50

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E92CC	1·00	ECH83	0·44	EY81	0·40	PC97	0·38	PL508	0·90	UCH81	0·38	VP23	0·75
E180CC	·95	ECH84	0·44	EY83	0·54	PC900	0·45	PL509	1·15	UCL82	0·38	VP41	0·75
E180F	1·00	ECL80	0·40	EY84	0·70	PCC84	0·40	PL802	0·95	UCL83	0·55	VT61A	0·35
E182CC	1·00	ECL82	0·34	EY87/6	·33	PCC85	0·44	PM84	0·60	UF41	0·70	VU111	0·44
E1148	0·53	ECL83	0·57	EY88	0·40	PCC88	0·60	PY33/2	·50	UF42	0·70	VU120	0·60
EA50	0·27	ECL84	0·60	EY91	0·58	PCC89	0·50	PY80	0·38	UF80	0·35	VU120A	·80
EA76	1·00	ECL85	0·60	EZ40	0·55	PCC189	0·53	PY81	0·31	UF85	0·44	VU133	0·35
EABC80	·38	ECL86	0·40	EZ41	0·75	PCC805	0·75	PY82	0·30	UF86	1·00	W107	1·00
EAC91	0·75	EF22	1·50	EZ80	0·28	PCC806	0·70	PY83	0·35	UF89	0·38	W729	1·00
EAF42	0·60	EF40	0·75	EZ81	0·27	PCF80	0·28	PY88	0·38	UL41	0·65	X41	1·00
EAF801	·75	EF41	0·70	FC4	1·00	PCF82	0·35	PY301	0·70	UL84	0·42	X63	1·25
EB34	0·25	EF42	0·55	FW4/500	1·00	PCF84	0·59	PY500	0·85	UM80	0·44	X66	1·25
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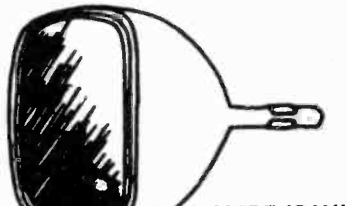

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TELEVISION

SERVICING·CONSTRUCTION·COLOUR·DEVELOPMENTS

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DEDICATED CONSTRUCTORS

One of the remarkable features of this magazine is that the majority of its readership is made up of a large number of dedicated people. The dedication is to the subject of course, presented in these pages by equally active and devoted television engineers. We are doubtful however of the logic of adhering strictly to coverage of one specialist subject to the exclusion of all else: hence the appearance recently of projects and features on related equipment.

When contemplating a major project—such as a colour receiver—a great deal has to be done to attempt to minimise the many and varied problems that could arise. Quality control such as that used in industry is impossible however and readers' own skills and expertise must be relied upon to some extent to make up for this.

In the present issue we are embarking on another quite complex project. Again it will be necessary to rely to some extent on the dedication and skills of individual constructors and because of this we are not going to lay down a "blueprint" that has to be rigidly followed. We have carried out considerable experimentation (and enjoyed doing so) and expect you to consider the project similarly—as an experimental exercise.

The TV Games project is a sophisticated version of the now popular slot machine idea. It does not involve such critical factors as a colour receiver but constructors who are interested in having a go are advised not to jump in too quickly and start buying all the components before assessing how far they feel they are likely to get. It is tempting to go all the way to colour display of the football game and there is much in favour of doing so in spite of the cost. We must warn readers at this early stage however that there are important factors to consider. Not the least of these is the restriction of not tampering with receivers on rental. Another is the complications arising from the wide variety of circuits in use in colour receivers. It is easier to start off in monochrome and is probably best to stay with this if your knowledge of colour set circuitry is limited. Details on conversion to colour will be given later in the series.

We urge all interested readers to follow the articles very carefully. If you prefer a less complicated version which can be connected direct to the aerial socket of a 625-line monochrome receiver the "Tele-Tennis" game project currently being published in *Practical Wireless* can be followed. Both projects are different and as far as we know are the first full television games designs to be published.

M. A. COLWELL—*Editor*

THIS MONTH

THE NEXT ISSUE DATED AUGUST WILL BE PUBLISHED ON JULY 15

TELETOPICS

AGREEMENT ON INSTANT TV NEWS

THE start of the proposed "instant news" television service which will enable viewers to display on their screens at the press of a button a selection of "pages" of news has taken a significant step forward with the announcement that the joint working party set up by the BBC, BREMA, IBA and the Ministry has come up with an agreed specification for the data signal transmission parameters required. The basic principle of the system is the transmission of news in coded data form on otherwise unused lines during the field flyback period. At the receiving end the data signal is extracted, stored and when required converted into alphanumeric form for display on the receiver's screen—either superimposed on the received vision signal or in place of the picture. A number of pages of different types of news could be stored and individually selected for display and the pages can be continually up-dated so that the latest news is available to viewers—in fact the BBC has already formed an editorial unit to fill the pages with up-to-the-minute information.

The BBC and IBA both developed and field tested such systems independently—the BBC's Ceefax system and IBA's Oracle. The parameters proposed by the joint working party differ significantly from the original Ceefax and Oracle characteristics, though they retain and extend some of the features of both. They also make possible a number of new features including several proposed by the receiver industry. The increased data transmission speed—a bit rate of some seven megabits a second—enables a 40 character row of letters to be transmitted on each of the lines used for the system. The use of lines 17 and 18 and 330 and 331 of successive fields makes it possible to provide up to 99 pages of information each with 40 letters per row and 24 rows per page. The complete series of pages can be transmitted in sequence in less than half a minute—faster than either of the original Ceefax or Oracle standards. Each page would include a header line providing the time accurate to the nearest second.

The new system could make use of the IBA developed graphics facility to enable simple line drawings such as weather forecast maps to be transmitted. The graphics information would be displayed by using a simple two by three dot matrix which increases the resolution of such information by a factor of six compared to the use of a full letter space to represent a graphics dot. The new proposals would also enable the text or graphics to be transmitted in six colours in addition to black and white.

The IBA has developed techniques of computer assembling and editing the pages of information and the Authority and Programme Companies have already given considerable thought as to the best way in which these arrangements can be used in the ITV system.

Experimental transmissions on the new standard are planned for the coming autumn and winter—as soon as a supply of prototype receivers has been produced by the industry for field testing.

The pages can be displayed on existing sets provided an adaptor is used to store and decode the data signals. Adaptors are expected to cost £50-£100. A cheaper and better alternative with new sets would be to incorporate the extra circuitry in the receiver—this could add as little as £20 to the cost of the set. Fig. 1 shows the basic elements of a Ceefax adaptor in block diagram form. The signal from the aerial is fed into the adaptor and the output from this is fed into the receiver at the u.h.f. aerial input socket. Within the adaptor there are two basic signal paths. The first is via the splitter, compensating amplifier and combiner to the receiver, giving normal programme reception. In the other path the signal passes through a tuner and i.f. strip after which it is demodulated and the coded data signal extracted and fed into the decoder and data store while the video part of the signal goes to the video switching section. The viewer press-button unit controls the page selector which extracts the data required from the store. This is converted into an alphanumeric display signal by the character generator and then passes to the video switch. The resultant signal—a page of information on its own or superimposed on the picture video—is then modulated on to an unused u.h.f. channel and fed via the combiner to the set..

Such a service would be a worthwhile extension to television broadcasting and could be introduced with little delay. We hope it will be. The only sour note is the to our mind unnecessary bitchiness of the BBC and IBA in making claims to have got in first with these developments. That apart, our congratulations to the engineers who have successfully developed and demonstrated the systems.

INTERNATIONAL TV TRADE SCENE

Some interesting figures have been released on the W. European colour set scene. Total distribution (i.e. sales, rentals etc.) in 1973 came to 6·4 million sets representing an increase of 40% over the previous year. Set distributions are expected to increase to an annual figure of 11·5 million over the next decade. The market penetration in W. Europe as a whole

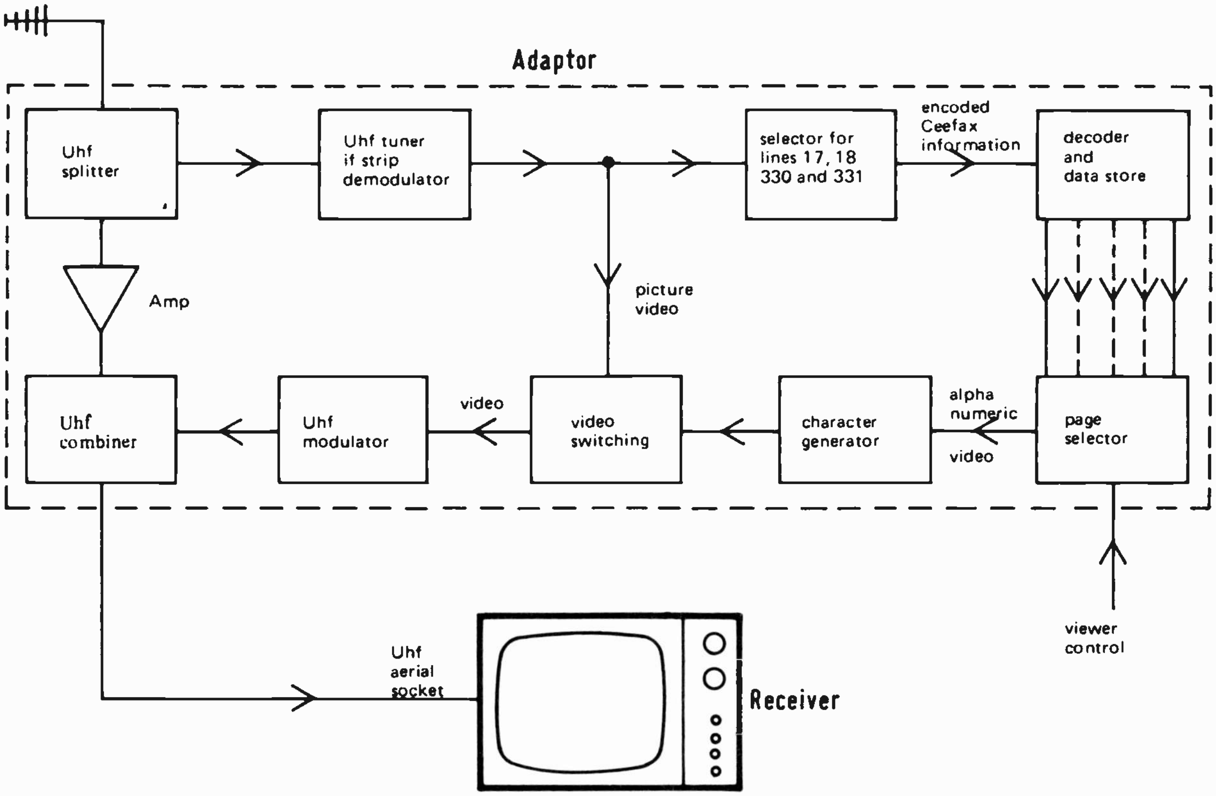


Fig. 1: Block diagram of a Ceefax adapter unit, courtesy BBC.

at the end of 1973 was 18%. The UK at 31% came second only to Sweden with a market penetration of 33% (but they had a few over for export!). By 1984 75% of W. European homes are expected to have colour sets.

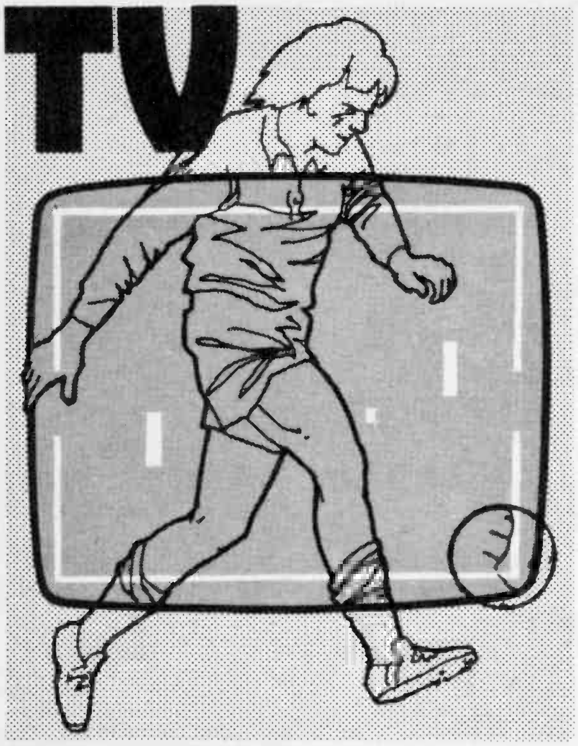
So far as the immediate UK scene is concerned however there is no doubt that the gloom has set in, with sales this year likely to be well below last year's record. The economic restrictions introduced by the previous Chancellor started the downturn to which BREMA, the setmakers' organisation, has responded recently with its £140,000 "finest consumer bargain in the country" British colour TV promotion campaign. It might have made more sense to aim this campaign at W. Europe as a whole where growth to date has been slower and the potential is much greater. There is an important difference however between the UK and W. European (i.e. continental) market: whereas in the UK rentals account for the great majority of sets distributed to the public, in W. Europe generally the emphasis is on individual sales. From the setmakers' point of view this means that whereas a standard, basic set will meet UK requirements the W. European market is keyed to sets featuring the latest developments (e.g. 110° tubes) and those rather tiresome luxury "extras" (e.g. remote control). The answer to this would seem to be that if Marks and Spencer can get themselves established in continental Europe it's about time DER and the rest of them did as well.

Against this background news has started to trickle through about the sets to be released at the annual trade shows. Of particular interest is the announcement from Pye that their latest colour models will incorporate facilities so that they can be operated in conjunction with videocassette machines.

A report issued by the Industrial Bank of Japan, one of Japan's leading financial institutions, forecasts that by 1975 the cost of producing radio and television sets in Japan will be higher—by some 2%—than in the US, a dramatic change from the situation only a few years ago when the Japanese domestic electronics industry was undercutting US and European manufacturers by substantial margins, and an insight into the efforts reported in this column recently of Japanese setmakers to establish plants in the US and elsewhere. It was only a few months ago that our own industry was so concerned about Japanese imports—but the problem even then was that of ability to supply rather than price. The report predicts that by next year the unit cost of producing radio and television sets in Japan will have increased by nearly 44% compared to 1970—the equivalent increase in the USA is expected to be only some 14%. Our own feeling is that the UK domestic electronics industry will shortly be very competitive indeed and we only hope that full advantage will be taken of this situation.

NEW AERIAL PREAMPLIFIER

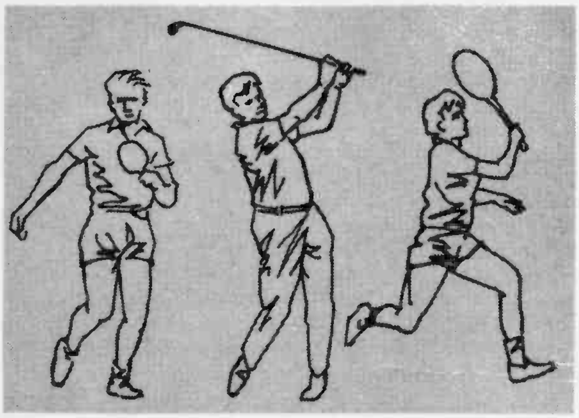
Labgear have introduced a new two-stage, high-gain aerial preamplifier (Model CM6030) which for best effect can be mounted at the masthead. The bandwidth is 40-860MHz (Bands I through to V), typical gain 22dB and typical noise figure 3.5dB.



TV FOOTBALL & other GAMES ON THE TELEVISION SCREEN

PART ONE

P. BUSBY* B Sc



*I PC SERVICES LTD.

THERE has been a great deal of interest in TV games in recent months, stimulated by the appearance from America of various games in public houses throughout the country. Most people will have seen examples of these where two 'men' (squares of modulation) and a 'ball' appear on the screen. The most popular appears to be tennis.

This series of articles is written for engineers interested in these games. Although only two distinct games are dealt with, the series concentrates on the principles used so that others may be made up. Many engineers will have friends running pubs, clubs and the like who cannot afford the very high prices of commercial equipment. Most games, including the complex football game described later, can be constructed from components costing less than £50. Thus an old monochrome television, a coin operated time switch and the games circuit can form a complete system for less than £70. This is a fraction of the cost of commercial installations. (Costs are based on March 1974 prices.)

It must be made quite clear from the outset that this project is suitable only for those conversant with TV circuitry. First because it is necessary to modify TV receiver circuits. Secondly because we shall describe in detail the interconnections to only one monochrome and one colour receiver. Other receivers, particularly colour, may require different connections, different drive circuits, different modifications. We cannot hope to cover all the possible variations that might occur and it will be up to the individual constructor to devise his own solutions to these problems.

We will show how the 'men' and the 'ball' are generated and controlled, also the methods used so that the ball bounces off a boundary line. Thus games of any degree of complexity can be devised, using several men, balls or boundaries as required. This is of course a constructional project and early in the series a simple ball game is described. This game has two men and a ball: each man can move anywhere on the screen and there are two boundaries which reflect the ball.

The main project later describes the more complex game illustrated on the front cover of this issue, where two men and a ball are used to play football. Each man in the football game can travel anywhere on the screen and can kick the ball in any direction. The ball's speed and direction are determined by the speed and direction of the man kicking it. The ball will also lose speed as it traverses the screen. On the front cover this game is shown wired to a colour TV receiver but there is no reason why a monochrome set should not be used.

In this first article the power supplies are described together with some of the circuits used in both the games. A list showing the semiconductors needed for both games is also given so that these may be purchased in bulk at the most advantageous prices.

The Basic System

The basic game system is shown in Fig. 1. Pulses are obtained from the TV line and field circuits to drive ramp generators. The ramp generators drive the men and ball circuits used to position them on the c.r.t. screen. The precise working of the men and ball circuits is described later. The game circuits control the men and ball so that the men can kick the ball; the ball direction and speed are determined together with its reflection from the boundaries. The degree of complexity in the game circuits is determined by the complexity of the game.

Signals from the men and ball modulate the television tube via the television drive circuits. These drive circuits will depend upon the actual receiver used, so constructors will have to devise their own circuits to suit their TV unless it happens to be similar to the set used in the equipment described for this project.

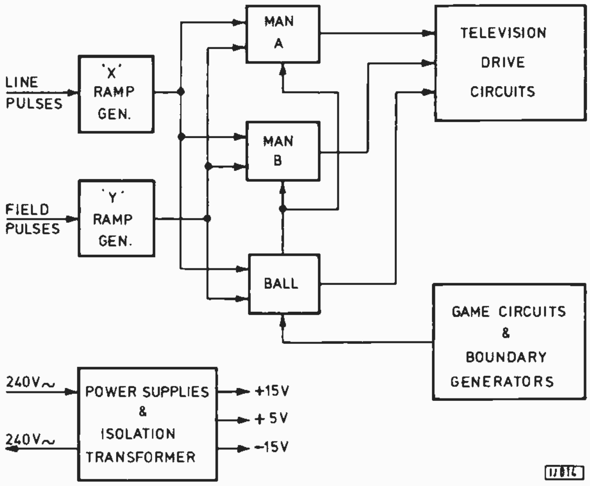


Fig. 1: Block diagram of the basic game system.

Power Supplies

The power supplies are common to whatever type of game is used. A mains isolation transformer for the TV set is also built into the power supply module. This is used to overcome difficulties arising from the connection of external circuits to a live-chassis receiver. It may be omitted where an isolated-chassis TV is used–but you won't find many of these! The power supply circuit is shown in Fig. 2. A transformer having two 19V 1A windings drives two bridge rectifiers. The d.c. from the rectifiers is smoothed by C1 and C2 giving approximately 27V. This is fed to three Fairchild precision voltage regulators to provide the +15V, +5V and −15V stabilised d.c. necessary to drive the game circuits.

The power transformer T1 and the isolation transformer T2 are mounted on a chassis as shown in Fig. 3. Also shown is the circuit board and the heat-sink holding the three 2N3055 power transistors. The precise layout of these components is unimportant so they may be mounted in any suitable case. Fig. 4 shows the layout of components on the power stabiliser board.

When the power supplies have been wired and checked they should be switched on and the outputs set to the correct voltages. Stabilisation should be

★ Semiconductor list

	PSU	Ramp Gens	TV Drive (Mono)	Man/Ball Circuits	Football Game	Simple Game	Football (Colour)	TOTALS Simple Game	TOTALS Football (Mono)	TOTALS Football (Colour)
Transistors										
BC182			1		2	6		7	3	2
BC184		8			4	1		9	12	12
BC212					2				2	2
BC214		2		4				6	6	6
TIS73					4				4	4
2N3055	3							3	3	3
2N3823					2				2	2
Diodes										
Bridge 2A 50V piv	2							2	2	2
BZY88-C10		1			2			1	3	3
IN914		1		6	12	3		10	19	19
Linear ICs										
µA723 (DIL 14)	3							3	3	3
741 (DIL 8)					12	4		4	12	12
Digital ICs										
7400				1	5	1		2	6	6
7401					2				2	2
7402					4	1		1	4	4
7404				1	2			1	3	3
7410							1	1		1
7413				2	3			2	5	5
74121		2		2	2			4	6	6

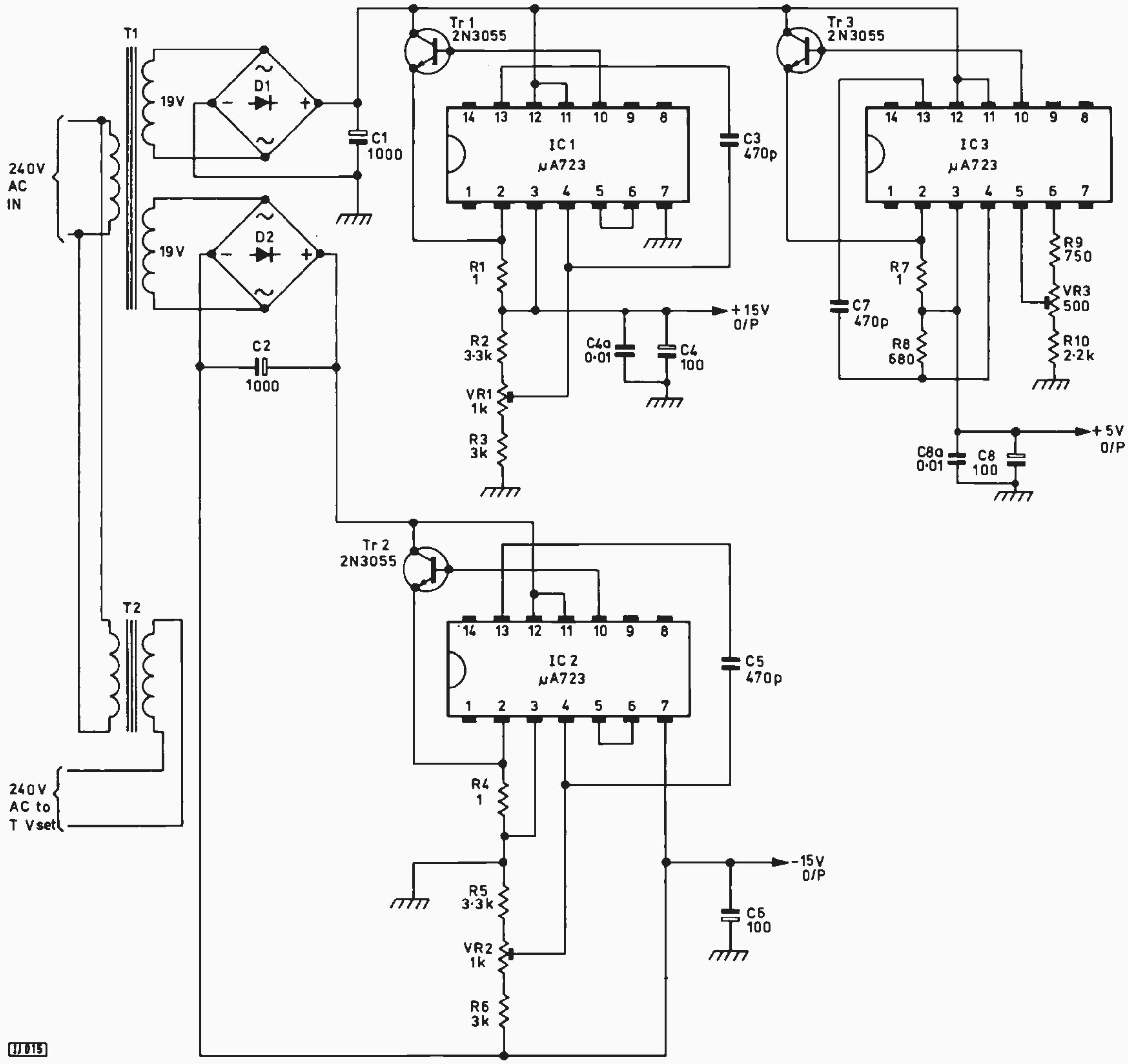


Fig. 2: Circuit of the power supply unit.

checked by momentarily connecting a load drawing 250mA to the supply whilst the voltage is monitored with a voltmeter. No appreciable change in voltage should occur as the load is connected and disconnected.

Man and Ball Circuits

Having completed the power supplies it is appropriate to construct the man and ball circuits. In next month's article the player control system is described. This together with the TV modifications will enable the men and ball to be displayed on a TV receiver. Fig. 5 shows the two man control circuits. Other men could quite easily be wired to another board if a more complex game is required. The meaning of the logic symbols will be given in the circuit description.

A man consists of Tr4, Tr5, IC5a, IC7, IC8b and IC9b. As the second man is identical it need not be described. Each man has a line ramp applied to IC5a which is a schmitt trigger circuit. The d.c. level of this ramp is controlled by VR4 and Tr4 so that the position along a line where the schmitt trigger switches is determined by the position of VR4. The output from the schmitt is inverted by IC8b to produce a positive signal for the remainder of the line. The leading edge of this pulse is differentiated by C18, R18 to give a short pulse whose position along each line is determined by VR4. If this pulse is used to modulate a c.r.t. it will produce on the screen a vertical bar as shown on Fig. 6. The vertical bar can be moved to any position across the screen by adjusting VR4. The width of the bar is controlled by the time constant of C18 x R18.

The field ramp is applied to a d.c. triggered monostable multivibrator IC7. The d.c. level of this ramp is controlled by VR5. Tr5 so that a pulse may be generated at any point in the field. If this pulse is displayed on a c.r.t. it will produce the horizontal bar

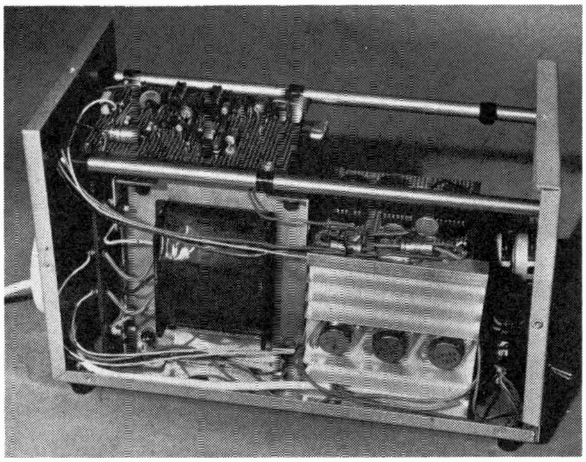


Fig. 3(a): This view of the prototype control unit during construction shows on the left the isolation transformer with the ramp generator board (to be described in Part 2) above it and on the right the power supply regulator board with its associated series stabiliser transistors. The mains transformer is beneath the regulator board.

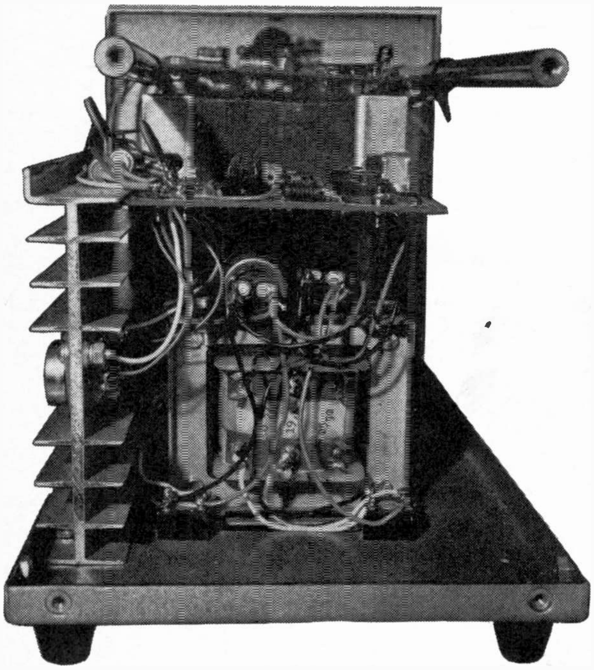


Fig. 3(b): View of the prototype control unit with the front panel removed to show the mains transformer, rectifiers and reservoir capacitors mounted under the regulator circuit board.

Fig. 4 (right): Layout of the power supply stabiliser board, which is built on strip-board.

shown in Fig. 6. This bar can be moved up and down to any position on the screen by adjusting VR5. The width of this bar is determined by the pulse width generated by IC7, in turn controlled by R26 and C19.
Capacitors C10 and C11 suppress noise generated by

★ Components list

POWER SUPPLY

Resistors: (all ±10%, ½W)

R1, R4, R7	1 Ω	R10	2.2k Ω
R8	680 Ω	R3, R6	3k Ω
R9	750 Ω	R2, R5	3.3k Ω

Preset Potentiometers: (all miniature carbon)

VR1, VR2	1k Ω	VR3	500 Ω

Capacitors:

C3, C5, C7	470pF	C4a, C8a	0.01µF
C1, C2	1000µF 40V	C4, C6, C8	100µF 25V

Semiconductors:
Tr1, Tr2, Tr3 2N3055
D1, D2 Bridge rectifier 1A 50V piv
IC1, IC2, IC3 µA723 Fairchild

Transformers:
T1 Pri.—240V, Sec. 1—19V 1A, Sec. 2—19V 1A
T2 Mains isolation, power rating to suit TV receiver used

MAN—BALL CONTROL CIRCUITS

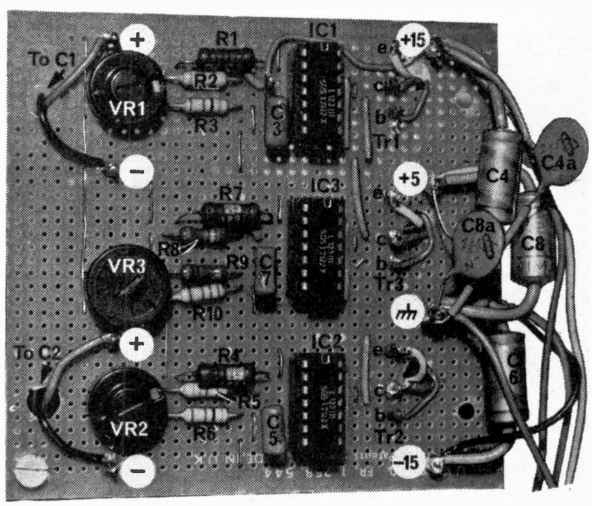
Resistors: (all ± 5%, ¼W)

R16, R20, R23, R27	220 Ω	R17, R21, R24, R28	510 Ω
R31, R33	330 Ω	R32, R34	1k Ω
R18, R25, R35, R36	390 Ω	R26, R30	10k Ω

Capacitors:
C14, C15, C16, C17, C18, C20, C22, C23, C24 — 1,000pF ceramic
C26, C27, C28, C29 — 0.1µF ceramic
C19, C21 0.22µF C25 0.5µF

Semiconductors:

Tr4, Tr5, Tr6, Tr7	BC214
D3, D4, D5, D6, D8, D9	1N914
IC4, IC5	7413
IC6, IC7	74121
IC8	7404
IC9	7400



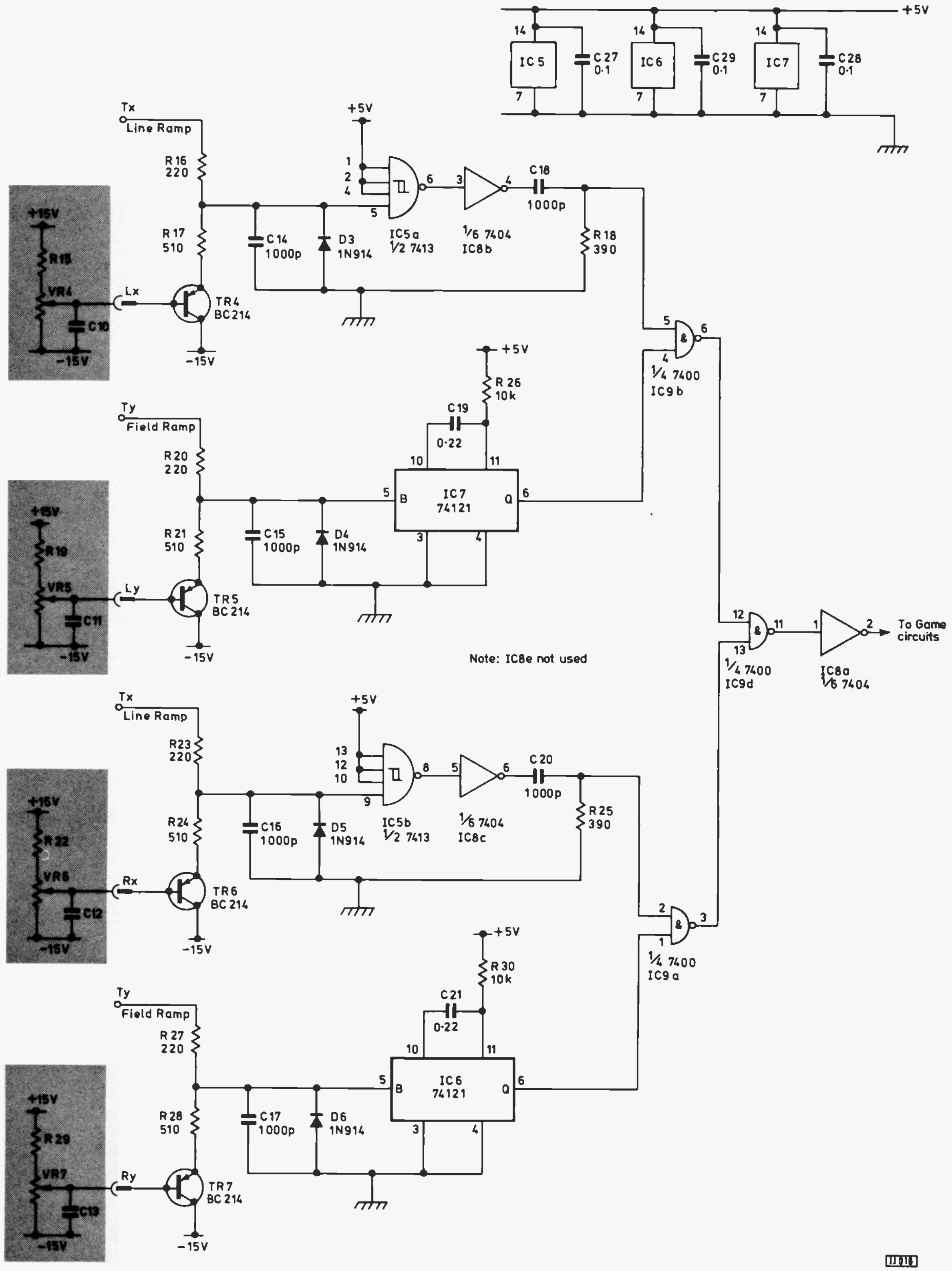


Fig. 5: Circuit of the left and right man control systems. The shaded circuitry is contained in the joy-stick controls to be described in Part 2.

the movement of VR4 and VR5. C14 and C15 suppress noise at the inputs to IC5a and IC7, whilst D3 and D4 ensure that no excessive negative signal is applied to the i.c. inputs.

The vertical and horizontal bars are not in fact displayed. The signals are taken to IC9b instead. This is a NAND gate. At one time it would have been called a coincidence gate because when two positive signals are applied its output will go to zero. Its output remains positive for all other conditions. Thus when the two signals are applied to IC9b its output will go to zero only when *both* signals are present. This is the crosshatched area shown in Fig. 6: it represents a man whose width is controlled by C18 x R18 and whose height is controlled by R26 x C19. The man's position in the "Y" direction on the screen is controlled by VR5 and in the "X" direction by VR4. In next month's issue a joy-stick control will be described linking VR4 and VR5 together so that the man can be moved to any position on the field by means of this one control.

The two men are fed to another NAND gate IC9d and because this time both are zero volts this gate gives a positive output for man A *or* man B. IC9d acts as a mixer therefore, enabling both men to be displayed simultaneously on the c.r.t. screen. IC8a inverts the output before it is fed to the game circuits to be mixed with the ball signal.

The ball circuit is shown in Fig. 7. This circuit is very similar to the man circuit already described except that it uses a second differentiator instead of a monostable. As with the men the ball's X and Y positions are controlled by adjusting the d.c. level of the incoming ramps. The ball control will depend upon the game designed: for the purposes of testing, the X and Y inputs can be connected to the wipers of a pair of 1kΩ pots strung between the +5V and −15V rails.

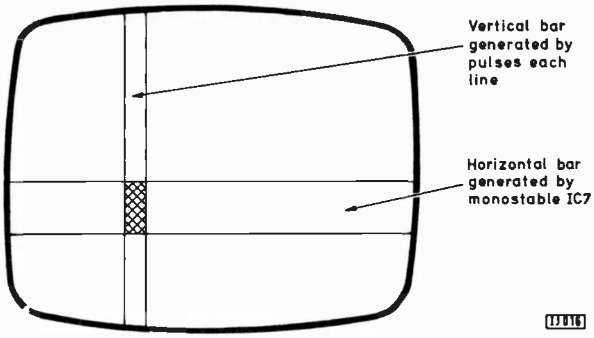


Fig. 6: How a man is produced on the TV screen.

With this arrangement the position of the ball can be displayed at any point on the screen. As described previously for the man circuit, IC4a is a schmitt trigger whose output pulse is inverted by IC8d to give a positive-going edge. This is differentiated by C24, R35 and applied (with a similar Y output from IC8f, C25, R36) to the NAND gate IC9c. The output of IC9c is zero when the X and Y inputs are coincident and positive for all other conditions. The height and width of the ball are determined by the time constants of C25 x R36 and C24 x R35 respectively.

Next Month

The layout of the circuit board carrying the man and ball circuits will be included in next month's article. This will also describe the ramp generators and joy-stick controls, and connections to a monochrome TV receiver.

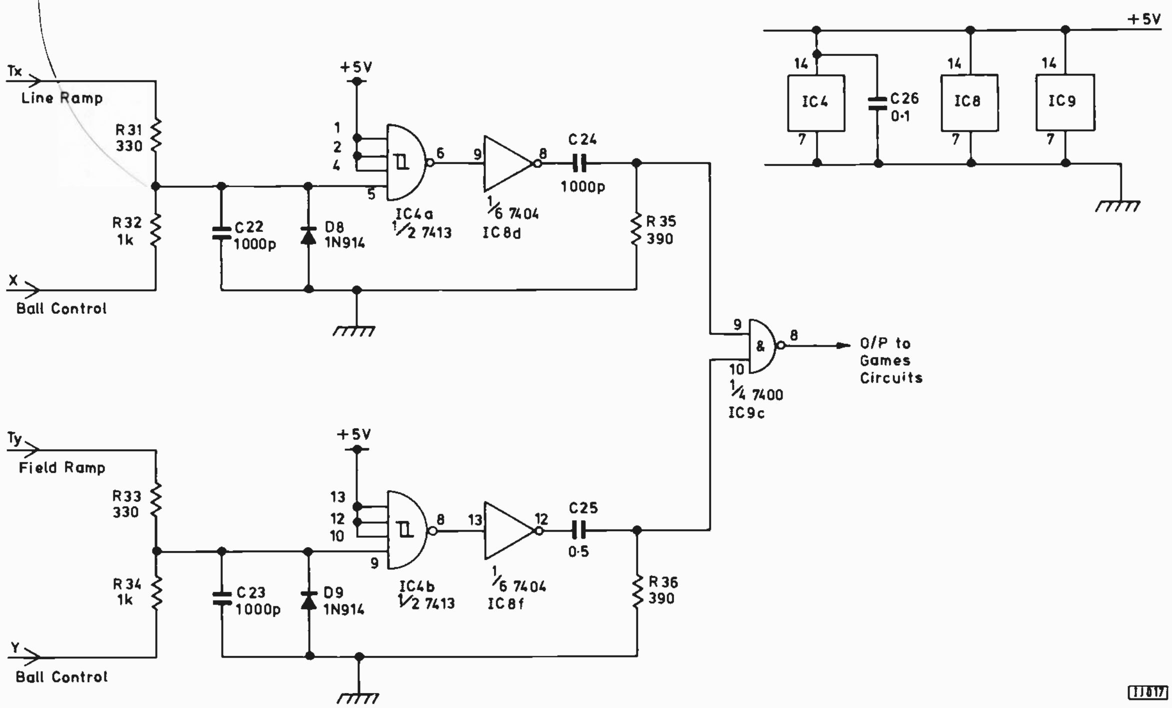
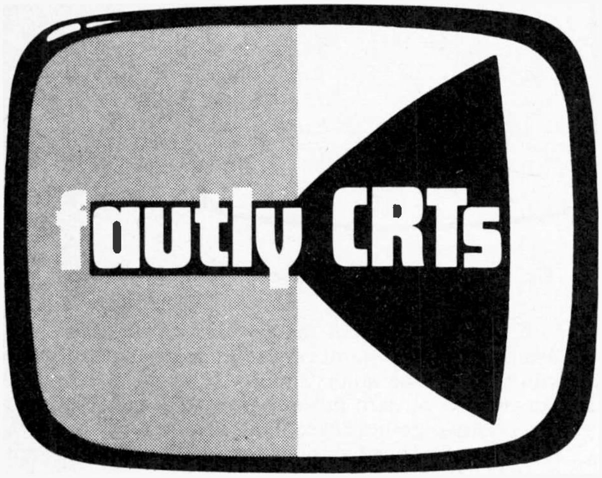


Fig. 7: Circuit diagram of the ball control system. This is built on the same board as the man circuits.

Dealing with faulty CRTs



Steven Knowles

PROBABLY the most common fault that arises with c.r.t.s after some years of use is low cathode emission. The symptoms of this fault vary according to how poor the tube is. The picture tends to be reproduced in an overall dullish grey, lacking any real "punch". The peak white parts of the picture tend to have a "shiny" look about them whilst the faces of people on the screen seem to "glisten". In really bad cases it may be impossible to view the set except in a darkened room and the picture may turn negative if the brilliance control is advanced beyond a certain point.

There are three ways of dealing with this fault. The first and most obvious is to replace the tube. Whether a new or a reconditioned type is used depends on the age and general condition of the set—and also of course on the owner's pocket. Shop around in either case as prices can and do vary quite considerably.

The second solution that can be tried is a session with a c.r.t. rejuvenator. Designs for rejuvenators have been published in previous issues of this magazine—most recently last month. Their principle is to reactivate the cathode by connecting the grid and cathode of the tube as a diode. How long the effect of rejuvenation lasts tends to vary quite a bit —anything from a few weeks to a couple of years.

Many service engineers employ the third alternative approach—to supply the tube with extra heater current. This is done by connecting a resistor from any convenient live a.c. mains point in the set—the mains fuseholder tag for example—to the "live" c.r.t. heater tag, leaving the existing heater connections as they are. A resistor of about 5kΩ rated at 10W will do—but mount it away from other parts of the set as it will run hot! This method cannot be used of course in hybrid sets in which the transistor supplies are obtained from the earthy end of a diode-fed heater chain.

The second and third methods will give only a temporary extension to the life of the c.r.t.: sooner or later a replacement will be inevitable.

Since the c.r.t.'s heater forms part of the series-connected heater chain along with the other valves if it goes open-circuit none of the valves will light up and the set won't work. Having established that it is the c.r.t. heater that is a fault and not that of one of the valves, there is a way in which the tube heater can be temporarily repaired whilst a new tube is being obtained. This is to apply a high-voltage pulse to one heater pin. The pulse will travel through the heater element, jump the break and in doing so (if successful that is) weld the two ends together. The high-voltage pulse is taken from the set's line output stage: the procedure is as follows and must be followed with *extreme care*.

Remove the c.r.t. base connector and link the two heater tags of the base connector together with a piece of wire to maintain continuity through the rest of the heater chain. Leave the tube e.h.t. connector in place. Connect a wire from one of the two c.r.t. heater pins to chassis. Attach one end of a short length of very well insulated e.h.t. lead to the line output valve anode (top cap). Keep the other end from touching any part of the set, switch on and allow the set to warm up. When the line output stage is fully operational briefly touch the end of the e.h.t. lead on to the other c.r.t. heater pin—only a very quick touch is needed. An arc will be seen inside the tube neck as the pulse jumps the break in the heater. Switch the set off and check the heater continuity with an ohmmeter. If the operation is unsuccessful it will have to be repeated. The procedure is usually successful, if not the first time then on the second or third attempt. Considering that there is everything to gain and nothing to loose it is well worth while "having a go"

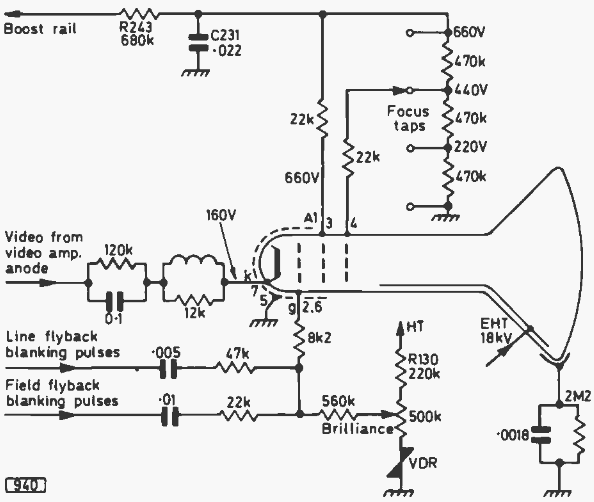


Fig. 1: Typical c.r.t. circuitry (GEC Series 1 chassis). Note that the brightness control is returned to chassis via a voltage dependent resistor: since the value of a v.d.r. increases as the voltage across it falls the c.r.t.'s grid voltage will rise on switching the set off, rapidly discharging the e.h.t. and thus removing the switch-off spot. In some receivers the earthy side of the brightness control is returned to the mains neutral side of the on/off switch for the same purpose, the c.r.t. grid then rising to h.t. potential when the set is switched off.

The symptoms displayed when a c.r.t. heater has a partial short-circuit are very similar to those of a low-emission tube since the cathode will not be heated to the full extent. The cure for this fault is to run the heater from a small transformer which gives the correct heater voltage—a heater rated at 6·3V will commonly show a reading across it of 4V if there is a partial short-circuit, therefore a transformer with a secondary winding rated to give 6·3V should be used. If the short-circuit should clear this will not matter since the voltage applied will remain the same. Connect the transformer primary winding to the *set* side of the mains on/off switch.

An open-circuit c.r.t. grid will result in a very dim raster which is unaffected by the operation of the brightness control. The pulse method can be used to weld the grid: adopt the same procedure as previously outlined but in this case connect the tube's cathode pin to chassis and apply the pulse to the grid. There are generally two grid pins—either will do.

A short-circuit between the grid and cathode of a c.r.t. will result in a brilliant raster being displayed since there is no tube bias. Operation of the brilliance control will again have no effect. The pulse method can be used (with kind permission of the line output valve) to clear the short. Connect up as for an open-circuit grid but this time touch the pulse voltage on and off three or four times quickly. When clearing shorts with the pulse method it is sometimes necessary to leave the c.r.t. heater in circuit as some shorts are present only when the heater is alight and the tube warm.

In most older sets an ion trap magnet will be found on the c.r.t. neck. If this is incorrectly positioned symptoms resembling those of a weak tube will be experienced. The purpose of the ion trap was to alleviate the problem of screen burn caused by bombardment of the fluorescent coating by negative ions travelling in the electron beam. Tubes with ion trap magnets had a bent electron gun so that the stream of ions and electrons emitted by the gun travelled towards the tube neck. The ion trap magnet was used to pull the electron stream—minus the heavier ions—back on to the correct course towards the tube screen. The magnet must be set for maximum brightness therefore: never use it to centre the scan. If after setting the magnet for maximum illumination the raster is found to be off-centre or corner cutting is in evidence the picture shift rings or controls should be used for correction.

It is often found that adequate screen illumination cannot be achieved even with the brightness control fully advanced—or alternatively that with the brightness control turned right down the raster is still visible. Both these defects can be caused by a faulty tube but more often the associated circuitry is at fault. The video signal is usually fed to the cathode of the c.r.t. while the brightness control varies its grid voltage (see Fig. 1 for example). In a number of sets the video signal is a.c. coupled to the cathode while the brightness control sets the d.c. level at the cathode. Sometimes the video signal is applied to the c.r.t. grid while the brightness control swings the cathode voltage (the ITT VC200 chassis appears to be the only modern example of this arrangement). Whichever method is employed any alteration in the value of resistors or other components used in the biasing or blanking circuits can produce a marked effect on the brightness control operation. The usual offender is the resistor on the h.t. side of the brightness control. Other offenders are leaky decoupling or blanking pulse coupling capacitors or change of value in a potential divider setting the mean cathode voltage where a.c. video coupling to the cathode is used or change of value of a resistor in the video circuit where d.c. coupling is used.

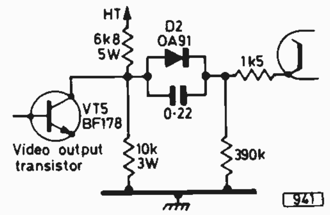


Fig. 2: Beam limiter circuit used in the Pye 173 chassis. Diode D2 in the feed to the c.r.t. cathode is normally forward biased and thus has no effect on the operation of the circuit. If the beam current is excessive however the diode becomes reverse biased and the positive potential developed at its cathode reduces the c.r.t current. The signal is a.c. coupled when the beam limiter comes into action.

If there is no raster at all but the e.h.t. is present how can you be sure whether the c.r.t. or one of the supplies to its electrodes is responsible? Assuming that the e.h.t. is present the c.r.t. first anode voltage should first be checked. Something of the order of 400–600V should be recorded. If this is absent check the decoupling capacitor, which is often leaky, and the feed resistor which sometimes goes open-circuit. As already pointed out an internal short between the tube's cathode and grid will result in a bright, uncontrollable raster. Thus if both the e.h.t. and the first anode voltages are present the next check should be to link momentarily with a piece of wire the tube's grid and cathode tags. If the tube is OK this action will result in the appearance of a brilliant raster. The fault must then be looked for in either the brightness control network (check that h.t. is present at the control etc.) or the video amplifier circuit and the video coupling to the tube. If with the e.h.t. and first anode voltages present linking the grid and cathode does not produce a raster the tube is definitely faulty and will have to be replaced.

Variations in brightness level can be caused by a defective tube but are more often caused by a fault in one of the first anode supply components or a faulty component or connection in the video amplifier circuit or tube bias network. Check the voltages at the various electrodes to find out where the variation is occurring. If the fault is in the video circuit you may have to check right back to the vision detector. In some recent chassis a pulse feed from the line output stage is applied to the v.d.r. on the earthy side of the brightness control to assist switch-off spot suppression: a faulty component in this feed can result in brightness variation.

In a recent case we encountered, a set fitted with the Pye group 173 chassis exhibited this fault along with slight streaking across the screen. Voltage variations were detected at the c.r.t. cathode. As in several single-standard chassis a beam-limiter diode is connected in the coupling circuit between the video output transistor and the c.r.t. cathode (see Fig. 2). The fault cleared when the diode was shorted across, proving that it was responsible.

Finally remember that extreme care is necessary when working with high pulse voltages as described earlier. If you are in any doubt, don't do it ! ! ■

CCTV

PART 4

Peter Graves

WE must next look at the video output waveform (the camera output) in some detail. Experience shows that the first step in many camera servicing jobs is to look at the output waveform on a 'scope, with the output properly terminated, and to compare it mentally with the expected output from a properly set up and working camera. The output voltage waveform is in most cases composite—i.e., it consists of three separate waveforms added together within the camera. These are the video waveform which is the electrical analogue of the brightness variations of the scene focused on the vidicon target—note that in standard equipment the white parts of the scene are more positive than the black—, the blanking waveform which cuts off the monitor scanning beam during the flyback periods, and the synchronising (sync) pulses that keep camera and monitor running in step.

While the video waveform is generated within the camera the blanking and sync pulses may be obtained from an external source (known as an "SPG"—sync pulse generator). The scans are kept in step by other pulses from the SPG which are fed to the camera oscillators ("line" and "field drives"). Alternatively the sync, blanking and drives may be generated within the camera circuits with internal links used to select the correct operating mode—we shall look at this when we come to scans.

Some installations (usually more sophisticated studios) use a non-composite output, the sync and blanking signals being added later after processing and mixing. There are technical advantages in this, principally that compensation can be introduced (by varying the timing of the final blanking pulse) for the signal delays produced by different length camera cables. Again, links disconnect the pulses from the video circuits.

Camera Output Waveform

Fig. 1 shows two lines of the output waveform of a correctly terminated camera which has an average scene varying from bright white to deep black focused on the vidicon's target. This is what you would see if your 'scope was set to display just these two lines—this would involve using a delayed timebase facility in the 'scope so that the 'scope's main timebase is triggered only for the time of the two particular lines per frame. Most 'scopes do not have this facility however (and many that do call for a degree of fiddling to get best results). Thus when we talk of the "line" waveform seen on a simple 'scope what is actually displayed is all the lines superimposed on top of each other, the 'scope timebase triggering off successive line sync pulses. This multiple picture is more useful however to the service engineer who can thus gain an overall picture of the output: maximum and minimum levels can be seen at a glance.

The frame waveform looks very similar—successive frames are superimposed, the 'scope timebase (now running at a much slower rate than the line rate) triggering off the frame pulses. There are so many lines (i.e. 625) that they merge and the overall effect looks the same: maximum and minimum levels can easily be seen.

Either waveform can be used for general servicing purposes. Personally I prefer the line waveform since the frame waveform tends to flicker slightly due to its lower repetition rate—this can be annoying if it has to be watched for long periods. If you are to service CCTV equipment you should be familiar with the appearance of both waveforms. Don't forget—the line waveform has all the lines superimposed, the frame waveform has them spread out, but individual lines are hard to distinguish—only a general picture emerges.

There are as shown in Fig. 1 standard voltage levels for each part of the composite waveform. Two overall standard voltage levels (bottom of the sync pulses to the peak white level) are in common use: 1V overall is used in studios and 1·5V overall for industrial applications. These standards are used throughout the industry and enable different manufacturers' equipment to be used together. The relative levels of the various components of the composite waveform are set by means of separate controls. The reason for two different standard overall output levels appears to be mainly historical: there is some overlap in use and modern cameras have sufficient gain to be set to either standard.

The voltage between the lowest level of the video

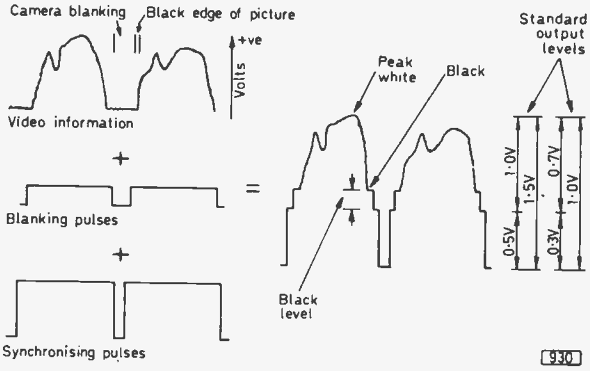


Fig. 1: Showing the make up of two successive lines of the composite camera output waveform (not to scale).

waveform (black) and the bottom of the blanking pulses is known as the "black level", "set up" or "pedestal"—in both systems it is set to 0·1V. The monitor's brightness control should be set so that video signals of the level of the bottom of the video waveform appear as black on the monitor's screen. The lower level of the blanking pulse then ensures that the beam is completely cut off during the monitor's flyback periods. Nothing can be blacker than this level so the sync and blanking pulses will not be seen if they are fed to the modulating electrode (grid or cathode). This means that additional clipping or limiting circuits to eliminate these parts of the composite waveform—leaving only the picture information—are not needed. For this reason any part of the waveform of a lower level than the bottom of the video component is referred to as being "blacker than black".

Setting the Black Level

The black level cannot be set accurately by eye in the same way that the beam control can be set —a 'scope is essential. The camera must of course be terminated. Sometimes auxiliary equipment can be used—monitors often have a built in terminating resistor which can be switched in and out as necessary, or alternatively a temporary termination consisting of a suitable plug to fit the output of the camera and containing an appropriate resistor connected between the output pin and earth can be used. This latter arrangement is known loosely as a "stuffer" and next month's article will show how to build a useful version that makes a good addition to the tool box. The 'scope, which has a high-impedance input that does not affect the termination, is connected at a convenient point at the output (our practical terminating resistor design has provision for this).

Focus the camera on a well illuminated scene (a test card is best for consistent results). Turn the black level control so that the bottom of the video waveform rises towards the peak white level, then reduce the black level until the lowest part of the video waveform is 0·1V above the bottom of the blanking pulse. Take care that "black crushing" does not occur: this is a cramming of the bottom of the video waveform. Picture a concertina suspended above the floor by holding its top end. If it is now lowered until the lower end just touches the floor all the folds will be uniformly spaced. Further lowering will cause the bottom folds to close up while the upper folds remain unaffected. This is what black crushing looks like on the 'scope. Some cameras can be set up by observing the onset of black crushing (it depends on the type of black-level circuit used) and setting the control to the point just before crushing starts.

Use of Black Crushing

Black crushing is normally undesirable since it produces distortion of the waveform. It is sometimes introduced deliberately however. Suppose we want to superimpose a white title (caption) on to the opening shot of a sequence from another camera. The caption camera will see only a small area of white against a dark background and its auto-target circuits, which work on the average picture level, will turn up the gain. This will result in the dark current increasing and becoming nonuniform. The uniform dark background to the caption will consist of various shades of grey therefore and if this is mixed with the other picture the result will be unwanted brightness level changes across the final picture. Provided the caption is well illuminated the black level control of the caption camera can be turned down to crush the greys into a uniform black, the bright, white caption being unaffected.

Before the caption camera can be re-used on a normal scene the black level must be reset and, as we have seen, this calls for an engineer with a 'scope and a test card. This is often impractical since the camera may be needed straight away. An auxiliary black level control which can be switched in and out as required (Fig. 2) can be fitted to overcome this problem. The switch (a miniature slide or toggle type) can be mounted on the rear of the camera together with the extra potentiometer which should be of the same value as the main black level control. Alternatively the switch can consist of the contacts of a relay, allowing remote operation. In the normal position set the main black level control as already described; in the crush position set the auxiliary control for best results on the caption being used.

Black Level Circuits

Black level circuits operate in several different ways. In simple circuits the black level control sets the operating point of a d.c. restoration circuit in the video amplifier—the arrangement is basically as is generally used for colour receiver brightness control in sets with colour-difference drive. In more sophisticated circuits the control sets the operating point of an "auto-black" circuit which compensates automatically for changes in dark current (this depends on temperature and the target voltage) and drift. Let's take a look at one method of doing this.

Vidicons are designed so that optimum results are obtained when the scanned area is restricted to a certain size (for a one inch vidicon it is a rectangle 0·375in. high by 0·5in. long). Methods of setting the scan size vary as we shall see when we come to discuss the scans, but some cameras have an opaque plastic mask (with the correct sized aperture cut out) which fits snugly over the vidicon faceplate—the mask often forms part of the target lead clamping assembly. If the target is overscanned (see Fig. 3) images of the rear of the mask can be seen. These images must be deepest black since they are in a permanent shadow created by the opaque mask. It was mentioned in a previous article that the system blanking pulse is longer than the camera blanking pulse which suppresses the scanning beam during flyback: it is longer in the time sense—it

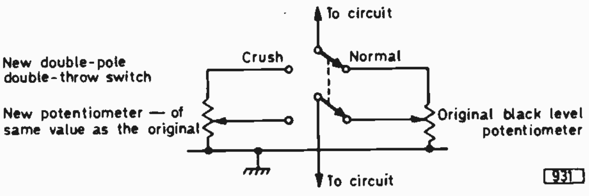


Fig. 2: Adding a black crush control.

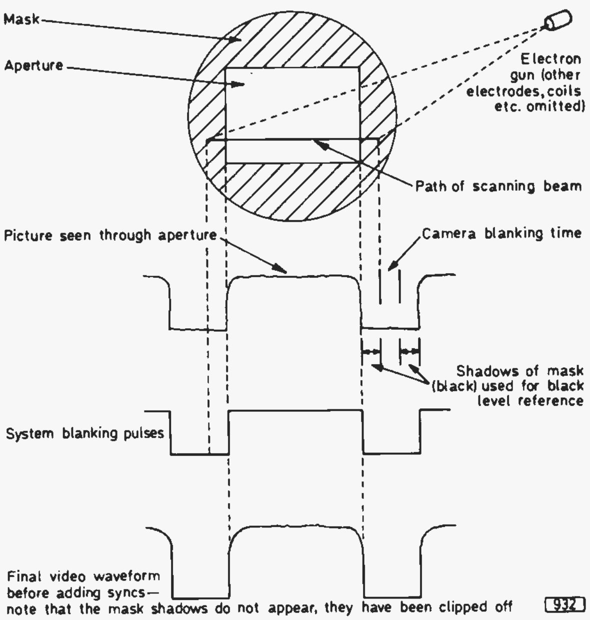


Fig. 3: One method of obtaining a black level reference.

lasts longer. Thus part of the picture "seen" by the scanning beam is blanked off by the system blanking pulse—the picture on the monitor is smaller than that scanned on the target. The scan sizes are adjusted until the vidicon mask edges are just out of sight on the monitor picture. The video circuitry up to the point where system blanking is applied "sees" a wider picture however: this would appear with black bars around it if it could be displayed on a monitor. Thus the mask provides a permanent black reference which does not depend on picture content. Being part of the picture however this reference level varies with changes in the dark current. This enables the auto-black circuit to make the necessary compensation to hold the black level constant at the level to which it has been set. Variations on this scheme use the blackest part of the actual picture as the reference (some systems can use either the mask or the blackest part of the picture)—different manufacturers have their own preferences.

Multi-camera studio installations have a particular problem with black level setting. If the individual cameras are not accurately matched, areas of grey or black will appear to change tone when the scene is viewed by a different camera. The cameras are first set up as previously described. Then, with approximately the same focal length lens on each camera so that they all see the same scene, they are moved together to view a suitable scene—say a large light box with an illuminated test chart on it. A video switch box or in sufficiently sophisticated set ups the vision mixing panel can be used to select the outputs from the various cameras. The switch box selector buttons are mechanically interlocked so that only one button can be depressed at a time, selecting the appropriate camera and terminating the unused inputs. Practical details for making one of these units will be included in next month's instalment. The camera outputs are then selected in turn and the black level controls finely adjusted for minimum tonal change between the cameras. This is a somewhat fiddly job!

Misadjustment of the black level control—too high or too low—can result in no pictures. When you have a correctly working camera in front of you try adjusting the control from one end of its travel to the other (in normal operation the control should be left somewhere near its mid-point) so that you are familiar with its effect. If you suspect that a camera's black level control has been tampered with (misadjustment is often encountered as a result of misguided attempts to "cure" a no picture fault) first mark its position then move it over its whole range of travel to see whether any sort of picture can be obtained. If not set it to about mid-point and check the other controls (beam and target or target limit first). Black level setting is another situation where after the adjustment has been made it is convenient to mark the final potentiometer position for future reference.

CONTINUED NEXT MONTH

ACOUSTIC WAVE FILTERS FOR TV

The acoustic or surface wave filter to replace the conventional i.f. transformer has been a long time coming—and hasn't arrived yet in production receivers. Mullard Research Laboratories who have been working on this development for some while have now reported however that advances in materials and design techniques have led to an acoustic wave, single-chip i.f. filter for television receivers suitable for large-scale production. The advantages of acoustic wave filters are their small size—a 50MHz filter measures about 30 microns—and the fact that no adjustments are necessary. The main problem seems to have been that of obtaining repeatable characteristics—in the case of filters for television use of getting the correct bandpass response.

The acoustic wave filter consists of two transducers—input and output—mounted on a piezoelectric ceramic or crystal chip. The signal is converted to an acoustic—ultrasonic properly speaking—waveform which is coupled by the chip from one transducer to the other. The design of the transducers, each of which consists of a pair of interdigital arrays—rather like two combs interleaved—, determines the bandpass characteristics. The construction of an acoustic wave filter is theoretically simple but the success of practical designs depends on the characteristics of the material used for the chip and the dimensions and spacings of the transducers. The Mullard researchers claim to have made advances in both these fields. Transducers have been computer designed and i.c. techniques adopted to deposit them on the chip. On the materials side large diameter crystal structures have been grown, reducing costs significantly. The television acoustic wave i.f. filter chip developed by MRL is 0·5mm thick, 8mm long and 4·5mm wide.

SERVICING television receivers

L. LAWRY-JOHNS

PHILIPS 300 CHASSIS—cont.

The Field Timebase

The field timebase consists of a PCL85 working in conjunction with an EF80. Over the years we have come to regard the EF80 as one of those nice reliable valves that rarely give trouble. This is true but it still pays to keep one or two around. We have found the EF80 to be the cause of no field scan in many instances though the PCL85 is by far the more likely offender.

Apart from valve failure it is an unfortunate fact that the field output transformer is the cause of many defects in this chassis. These range from an open-circuit winding causing complete field collapse to shorted turns causing lack of height and poor linearity or an open-circuit linearity winding causing excessively bad linearity.

Having said this however we would hasten to add that it pays not to condemn the transformer too readily. In a large number of cases the complaint of excessive height with poor linearity has turned out to be a defective linearity control. These have the habit of developing an open-circuit at one of the track end rivets (as pressure with a screwdriver will often prove). A 100kΩ resistor wired across the ends will give the effect of a midway setting until a new control can be fitted.

Do not omit to check the more run of the mill items in cases of reduced scan and poor linearity. The use of two output pentode cathode resistors (both 560Ω) on drop-off tags should not escape attention—it is not unknown for one to drop out of sight leaving the other to overbias the stage causing severe top compression. An open-circuit cathode electrolytic (C4011) will cause drastic bottom compression in addition to a less severe overall loss of height.

Even loss of height is generally caused by a failing PCL85, with the possibility of a change of value in a resistor in the height control circuit running this a close second. The resistors to check are R4039 (470kΩ) and R2165 (1·5MΩ). The latter is on the main panel whilst the former is on the separate field timebase panel along with the height control etc. The 33kΩ resistor R4048 (EF80 anode load) is a less common cause of this fault but is still one worth bearing in mind.

The value of R4042 (3·3MΩ) can change to push the hold control setting to or off the end of its travel.

Field Collapse

Whilst a straight white line across the screen can be due to several faults in the timebase (oscillator stage not oscillating or amplifier not amplifying) a line which is curved should immediately call attention to the field scan coils or the thermistor (R1652) in series with them. The latter can be checked without trouble by the simple expedient of shorting it across. More often however it will be found that if one lead is disconnected from the coils a meter check will show no continuity. In this event there is no alternative to ordering a new set of coils of the correct type. If a set of Philips coils is to hand there is no problem. Fitting a set of different make however will not solve the problem as the width and height will be of an unacceptable aspect ratio and the linearity will be poor.

Intermittent Hum

One of the regular complaints received about these and earlier Philips models is sudden appearance of hum on the sound with a less obvious slight curve to the raster. Whilst the trouble can quite correctly be identified as poor smoothing the capacitors are not likely to be at fault—we refer to the large smoothers to the left of the right-hand screened section. These are secured by a clamp and are earthed by a lead from the end tags to the field timebase panel frame. If the clamp is tightened and a further lead is taken from the end tags to an alternative earth point on the main deck no more trouble will be experienced. Later production runs were modified in this way and there are some models therefore that will not exhibit this defect.

Tuner Unit

The tuner is fairly trouble free except for the coil return spring which has a habit of snapping at the anchor end, making tuning impossible. If a spare spring of the correct type is to hand there is no problem of course. It is often the case however that the correct spring is not immediately available: rather than having the set out of commission for a week or so some sort of replacement can be made up and should serve as well as the original.

Probably the easiest way out is to employ a coil spring (such as is used for drive cords) with a length of nylon cord. Put a loop in the end of the cord and pass this under the bar recessed in the drive gear wheel. Take a turn round the gear wheel and attach the spring with a nut and bolt to a convenient point towards the rear of the tuner frame. Pass the cord

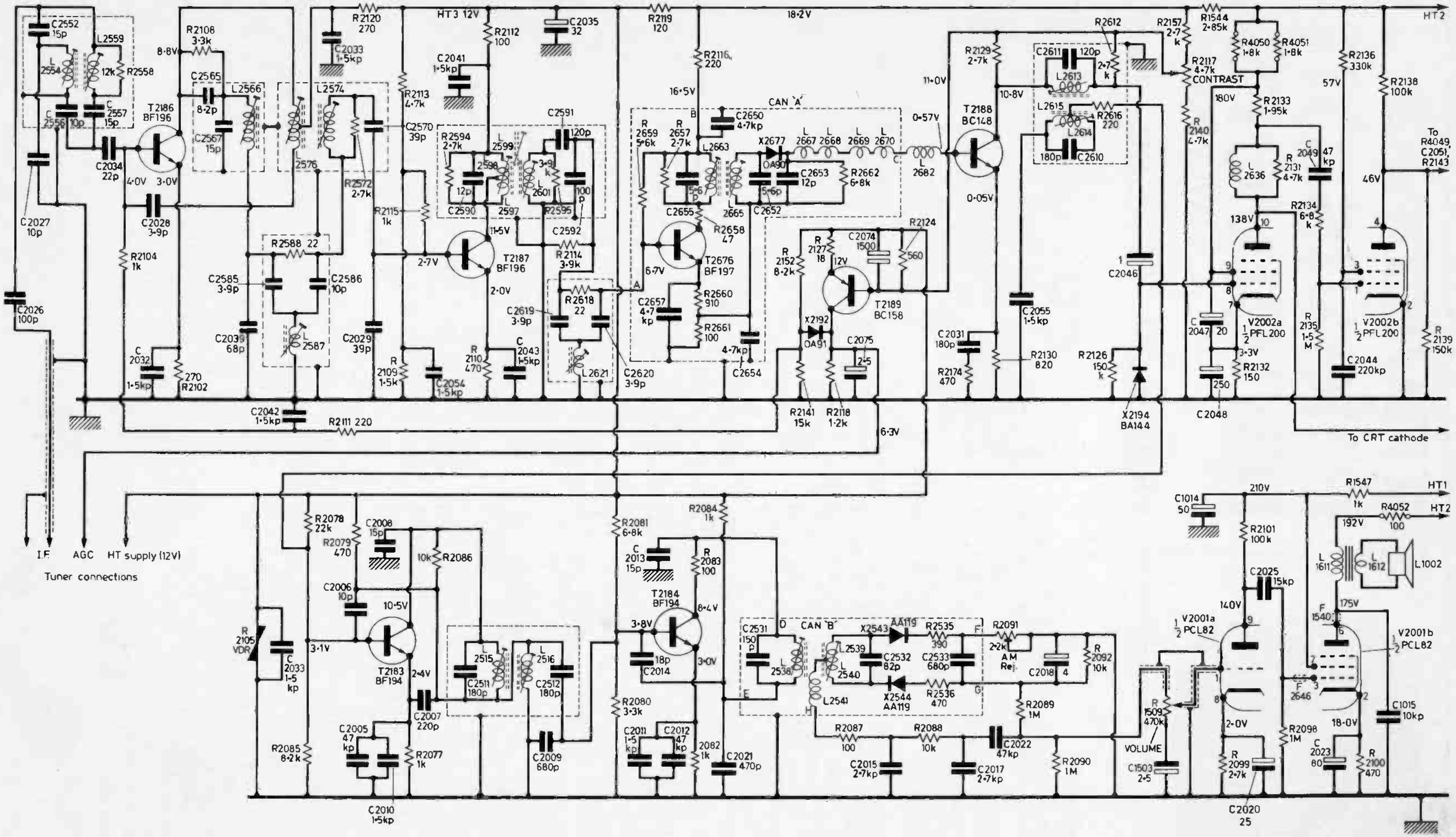


Fig. 3: Circuit of the i.f. strip, sound and video output stages and sync separator, Philips 300 chassis.

In some sets a 6.8k Ω resistor is connected in parallel with R2558. A 100 Ω resistor (R2103) is connected in series with the earthy side of C2039 in some receivers. Voltages measured with no signal and with the brightness, volume and contrast controls set to minimum, using a 100k Ω/V meter.

through the spring eye, stretch and knot and then ensure that the tension is enough to return the gear wheel and quadrant to the stop position as determined by the push-button selected and rotated.

The design of the tuner is quite simple compared to the earlier integrated (six button) type and apart from the necessity to replace one of the transistors once in a while (no signals or very noisy signals) no other trouble should be encountered.

IF Panel

The tuner output is taken to the i.f. panel where after filtering the signals are amplified by the controlled stage T2186 (BF196)—a.g.c. is also applied from T2189 collector to the tuner unit. The amplified signals are then applied to the straight amplifier T2187. Note that some circuit diagrams show R2115 from the base of this transistor connected directly to HT3. This is of course wrong: R2113 is connected from HT3 to the junction R2115, R2109, C2054 to bias the stage.

The output from T2187 is taken to can A which contains the final i.f. amplifier T2676—a large-signal transistor of the BF197 type—and the detector components. The output from can A feeds the video preamplifier stage T2188 which with the a.g.c. transistor T2189 is under the influence of the contrast control. The signals at the collector of T2188 pass via C2046 to the video amplifier V2002a (PFL200): the 6MHz tuned circuits in this coupling pick off the intercarrier sound signal for feeding to T2183 and prevent it reaching the video amplifier. C2046 removes the d.c. component from the video signal: this is restored by X2194 (BA144). D.C. coupling is then used from the video amplifier to the c.r.t. cathode. The "b" section of the PFL200 serves as the sync separator.

Faults in the IF Strip

The whole vision strip is fairly trouble free as a rule except for can A containing the final i.f. transistor and the detector components. Sometimes the trouble is due to the transistor being open-circuit (resulting in no picture or sound signals) but more often the fault is more difficult to diagnose due to its varying nature, the symptoms being intermittent loss or partial loss of signals which can be restored briefly by moving the can. Complete replacement of can A is the obvious solution but this begs the question of what was actually wrong. Very close inspection coupled with a resistance test will generally reveal an open-circuit track from point C to L2670. It can be repaired with a delicate touch without disturbing the other parts of this rather fragile assembly.

Another point which is always worth checking at an early stage is the supply track to the contrast control. This seems to become open-circuit at the drop of a hat. There should be about 11V at the slider.

Apart from the trouble described with can A there are few faults which cannot be located by taking voltage readings at the points indicated: roughly speaking if the emitter voltage is right the stage is working.

Diode X2192 can go open-circuit, removing the a.g.c from T2186 so that the picture is over contrasted and cross-modulation is present.

Points of Interest

We have already mentioned that the PCL85 pentode cathode resistors (R4036 and R4037) are of the "drop-off" type. There are other drop-off resistors on this same panel: these control the supplies to different parts of the rceiver.

R4052 (100Ω) is the h.t. supply resistor to the anode of the PCL82 sound output pentode (via the output transformer of course). In view of the fact that this valve runs into trouble quite frequently it may be thought that this resistor would be one of the first to fall away. This is not so however. On the rare occasions when it does drop off remember that after clearing the original fault (normally a defective PCL82) the absence of h.t. to the anode will result in heavy screen grid current with resultant overheating of R1547 which as already mentioned is situated between the tags of the smoothing electrolytics. We mention this as the positioning of components remote from the stage concerned can cause confusion.

Similar remarks apply to the video amplifier h.t. supply resistors R4050 and R4051. As the numbers indicate these two are also situated on the field timebase board, this time at the top right.

The position of the PL504 line output valve screen grid supply resistor R2158 should also be noted. This is on the front of the chassis to the right of the centre. In this position it is conveniently near the scan coils plug: when this plug is withdrawn the h.t. supply to the line output valve screen grid is removed thus rendering the stage inoperative and preventing the nasty burn at the centre of the screen that can occur if the e.h.t. is present and there is no deflection.

Finally an unusual fault that shows the trouble simple mechanical faults can cause. The symptom was no brilliance. The e.h.t. was present and the c.r.t. first anode and cathode voltages normal. There was no voltage however at the grid which is supplied from the brightness control. Disconnecting grid pin 2 enabled normal readings to be obtained from the brightness control circuit. The trouble was found to be due to a loose c.r.t. base spark gap ring shorting pin 2 to chassis.

NEXT MONTH: TCE 1590/1591 CHASSIS

RELAY STATION OPENINGS

The following relay services are now in operation:

Eyemouth, Berwickshire BBC-1 (Scotland) channel 33, BBC-2 channel 26. Receiving aerial group B.

Kings Weston Hill, Bristol BBC-1 (West) channel 45, BBC-2 channel 48. Receiving aerial group B.

Haltwhistle, Northumberland BBC-1 channel 55, BBC-2 channel 62, ITV channel 59 (Border Television). Receiving aerial group C/D.

Isles of Scilly BBC-1 channel 21, BBC-2 channel 27, ITV channel 24 (Westward Television). Receiving aerial group A.

Woolwich BBC-1 channel 57, BBC-2 channel 63, ITV channel 60 (Thames Television and London Weekend Television programmes). Receiving aerial group C/D.

All these transmissions are vertically polarised.

AFC MUTING

R. Brett-Knowles

As varactor tuners are rather prone to frequency drift they require a.f.c. in order to keep the signal properly disposed in the i.f. passband. This is particularly the case with colour receivers. Unfortunately it is uneconomic to make an a.f.c. system which does not lock to the first carrier presented to it. In the channel changing process the local oscillator sweeps to the chosen frequency and if the sweep is downwards the first major signal component to reach the a.f.c. discriminator will be the sound carrier. This is normally well outside the a.f.c. pull-in range but is probably within its holding range. To prevent the a.f.c. loop locking to any component other than the vision carrier the varactor tuner preset tuning voltage must be accurate enough to land the vision carrier within the a.f.c. pull-in range and the a.f.c. system must be disabled until the oscillator has had time to settle at the frequency required for this state of affairs. This latter requirement is normally met by shorting the a.f.c. discriminator output by means of a switch which operates while one of the channel selector buttons is depressed, the short being removed when the finger is taken off the button. The oscillator's sweep is fast enough compared to the dwell time of the finger and the brief shorting period is long enough for the i.f. signal to stabilise inside the a.f.c. system's pull-in range.

The tuning button assembly is generally a product of "value engineering". That is to say most units will work when they are made but it won't be long before trouble can be expected (the optimum time is just after the guarantee has expired). The well proved (and smaller) Yaxley switch is not usually considered to be an alternative since it does not offer the same convenient means of muting the a.f.c. system. If we are prepared to use a two-pole switch with non-bridging wipers however electronic muting can be designed. A slow run-up regulator is the basis of the design used with the author's a.f.c. circuit, which takes 7mA from an 11V source. An unregulated, none too smooth 20V supply was available to power it.

Basic Circuit

Looking at Fig. 1 we see that during the momentary supply break during channel change when the switch is between contacts C1 will discharge through the load and the transistor's base-emitter junction. When the break is over C1 charges via R1 and the supply is slowly reapplied to the a.f.c. circuit. This circuit does not work out well in practice however since R1 must feed at least 1mA to the zener diode D1 for satisfactory stabilisation while the load takes only 7mA. This means that the ratio of the charge to discharge time-constants cannot be better than 7:1 which does not prolong the break sufficiently. What happens is that if C1 is of small enough value to discharge during the break it will charge too quickly afterwards and the a.f.c. circuit will come into operation before the oscillator has settled: if on the other hand we try to prolong the break by increasing the value of C1 we run into trouble because it will not discharge during the break and the a.f.c. circuit will continue to operate without a stop —running on the energy stored in C1.

Improved Version

In Fig. 2 a second transistor TR2 has been added to discharge C1: it is switched by the break in the supply voltage. At the break C2 discharges through D2, TR1 and the load: TR2 is still cut-off but C1 discharges as before. In this circuit it is not essential for C1 to discharge—it is retained for smoothing purposes only. When the 20V supply is restored C2 is forced to charge slowly through R3 and the base-emitter junction of TR2, thus bringing the transistor to the point at which it conducts. C1 then rapidly completes its discharge via TR2 which will remain conducting until C2's charging current becomes too small to sustain it. TR2 then switches off again and C1 charges to the zener voltage. In this circuit then it is C2 which controls the delay. This capacitor is discharged via a low-resistance path and charges via a very much higher resistance. Thus the break is prolonged much more than the seven times that the previous circuit could give.

TR2 has to be able to carry not only the rush of current when C1 discharges but also the steady current through R1. Enough base current has to be supplied via R3 to sustain TR2 for the delay period: this sets an upper limit to the value of R3 and hence dictates the value of C2 for any given delay time.

FET Circuit

If a field effect transistor is available it can be used in place of R1 to enable smaller values to be used for both C1 and C2. Connected as shown in Fig. 3 the 2N3819 f.e.t. allows approximately 1mA to pass over a voltage range of 5 to 25V and

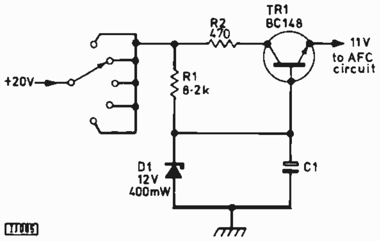


Fig. 1: Basic slow run-up regulator circuit adopted to provide electronic a.f.c. muting.

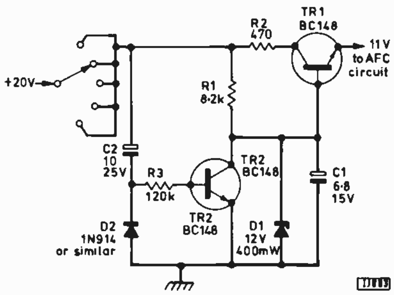


Fig. 2: Improved version—in this circuit C2 provides the delay, C1 providing smoothing.

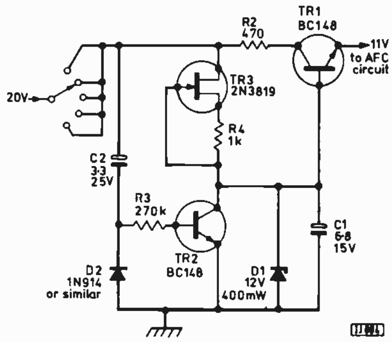


Fig. 3: An f.e.t. (TR3) can be used in place of R1: this enables smaller value electrolytics to be used.

materially assists C1 in smoothing any ripple on the 20V supply. It also limits the current which TR2 must be able to pass, in turn enabling a higher value to be used for R3 and a smaller value for C2. With 20V available the benefit in using an f.e.t. in place of a resistor is just under 2:1; with only 15V the improvement is 5 : 1. Thus an f.e.t. is not really cost effective unless a low or badly smoothed supply has to be used (or a cheap f.e.t. is to hand). Using a transistor with a high H_{FE} in position TR2 is more effective in allowing the value of C2 to be reduced and R3 increased for the same time-constant.

Circuit Protection

During development work I unfortunately shorted the 11V supply provided by this slow run-up regulator circuit. The result was to destroy TR1 and, consequent upon its demise, the zener diode went as well. For this reason the 470Ω resistor R2 is shown included in these circuits: if you are liable to this sort of accident its inclusion will save you from expensive damage by limiting the current which can be drawn to 40mA. If you need more than 16mA to work your a.f.c. circuit a lower value resistor can be used.

I also found that oscillation can occur unless the leads to the circuit are provided with h.f. decoupling—0·01μF is adequate. This is probably unnecessary if short connections to and from the circuit are used.

Conclusion

The circuit shown in Fig. 2 should be adequate in most cases—the values can be varied to suit needs different from the author's. R1 is the only voltage dependent component, its value in kilohms being numerically equal to the difference between the supply and the required load voltages (to pass 1mA). The other component values need no change for the usual extremes of supply voltage and load requirements within the range of the ratings of the suggested transistors.

Only one switch bank is shown in the diagrams: the other one required is used to select the wiper of one of the preset tuning potentiometers—these must be across a very stable 30V supply—and connect it via the a.f.c. source to the tuner's tuning voltage input pin just as the push buttons do in conventional systems. Any suitable switch can be used in the suggested arrangement—provided the wiper of the bank used for the delay breaks between positions, even if for only microseconds.

To set up the preset tuning potentiometers it is again necessary to mute the a.f.c. circuit. This can be done by shorting TR1 base to chassis, thus removing the feed to the a.f.c. circuit. By disabling the a.f.c. circuit in this way no change that could alter the conditions when the a.f.c. is restored is made to its output impedance.

The circuits suggested will operate only with a discriminator circuit which produces zero output voltage when on tune: this excludes most i.c. discriminators. ■

NEW UK COLOUR SETMAKER

Followers of the advertisements in the trade press will have been aware for some time that a somewhat mysterious organisation has been planning to enter the field of colour receiver production in the UK. Now all is revealed! The setmaker is Telpro Ltd. (Lyon Road, Springfield Industrial Estate, Kearsley, Bolton, Lancashire) whose parent company is Telefusion. Production of sets at the Bolton factory is already running at 1,250 sets a week and there is capacity to increase this to 3,000 a week. Initial production started back in November—only eleven months after the site for the factory was selected, which must be something of a record. The sets produced so far are understood to have gone to Telefusion's own 280 rental outlets and the group's discount warehouse operaton Trident. Now that production has built up distribution to the trade will be through Steepletone Products (2 Station Approach, Bicester, Oxfordshire) and Hamilton Wholesale Supplies (Bold Street, Altringham, Cheshire). There are two models at present, the Telpro 20, a 20in. set with a recommended price of £257.40, and the Telpro 22, a 22in. set with a recommended price of £294.80. A 26in. version is expected later this year at a price of around £334. A modular, hybrid (i.c.s, transistors and valves) chassis is used to give ease of servicing and optimum reliability. There are slider front controls, a varactor tuner and switchable a.f.c. to eliminate tuning drift which Telpro say is often the cause of unnecessary calls to correct loss of colour. The convergence panel is available from the front of the set.

FAULT FINDING GUIDE

John Law

GEC 2015 13" PORTABLE

Dating from 1966 the GEC Crystal Model 2015 is an early dual-standard mains portable set of very compact dimensions. It weights only 20lb and is fitted with a 13in. c.r.t. Some of these receivers are now turning up on the second-hand market and are well worth reconditioning as second sets. The u.h.f. tuner uses transistors, the v.h.f. tuner and the rest of the set valves. A typical GEC printed panel with connections on both sides contains the timebase components and stands upright at one side of the chassis. Another panel with the system switch attached lies flat on the bottom of the chassis. The tuners and control knobs are mounted on the other side.

Access to Chassis

The chassis is retained in the cabinet by a screw through the handle at the top and two screws at the bottom. After removing these screws and the knobs at the side the chassis can be withdrawn to the extent of the deflection coil and e.h.t. leads. Because of the compact dimensions some parts of the chassis are rather cramped, complicating service work. To change the e.h.t. rectifier for example it is quicker to remove the line output transformer from its cage—it's secured by a single screw—together with the rectifier base rather than fiddle with two fingers in cramped conditions trying to remove the valve and insert the replacement. This is part of the price one must pay for such a conveniently sized receiver.

Circuit Notes

This article deals with the video amplifier, sync separator and timebase stages, these being the areas under greatest stress and therefore most likely to be in need of attention after some years in use.

System switch section SW2-6 serves two functions. It switches the vision detector output—in conjunction with SW2-7—so that a signal of the same polarity is applied to the video amplifier on both systems and, since a.c. coupling (C91) is used on 625-lines, it applies a bias on this system from the junction of the potential divider R66/R62 to the video amplifier's control grid to make the necessary adjustment to the valve's working point. The video amplifier's screen grid is fed by R63, decoupled by C93—this point also feeds the EH90 sound detector/amplifier anode and can result in vision-on-sound when C93 dries up. L46a is tuned to 6MHz and serves to remove the intercarrier signal from the video feed and provide a suitable point for tapping off to the sound channel—via C103. On 405 lines SW2-5 brings L46b into circuit to provide rejection at 3·5MHz. It also alters the cathode compensation applied to the stage. SW2-8 modifies the sync coupling: on 625 lines C97 is added to reduce the effective coupling capacitance value whilst R71/C98 are brought into circuit to reduce the possibility of h.f. interference affecting the operation of the sync separator. The video signal is fed to the c.r.t. cathode via the anti-flutter network C102/R72 which provides l.f. attenuation.

Sync Circuit

The B section of the PFL200 is the sync separator: the valve itself is mounted on the receiver unit board whilst its anode components are on the timebase board. R110/C157 integrate the field sync pulses. Antiphase line sync pulses are developed by T9 and fed to the flywheel sync discriminator diodes MR1/MR2. A reference pulse from the line output transformer is taken via PC19 and the integrating network R114/C163 to the junction of the discriminator diodes. A d.c. voltage of amplitude and polarity determined by the phase relationship between the sync pulses and the reference sawtooth waveform is thus produced and fed to V10A grid.

Timebases

The line generator V10 is a conventional PCF802 sinewave oscillator—it is interesting to note however that GEC group sets of this vintage were amongst the first to adopt this circuit. The line output valve screen grid is fed via R124 and R125 and decoupled by C171: R125 is connected to PC17 which thus acts as a width control. The boost reservoir capacitor C174 develops about 350V to supply the c.r.t. first anode and focus circuit and the height control network.

The field timebase consists of a cross-coupled PCL85 with C147 the charging capacitor. Note the connection of R104 between the triode anode and SW2-10: this resistor is brought into circuit on 405 lines to counteract the different boost voltages on the two systems and thus balance the height.

Fault Finding

Because the set is so compact the heat developed in the plastic case leads in time to capacitors drying out, resistors changing value and even valve

System switch SW2 shown in 625-line position

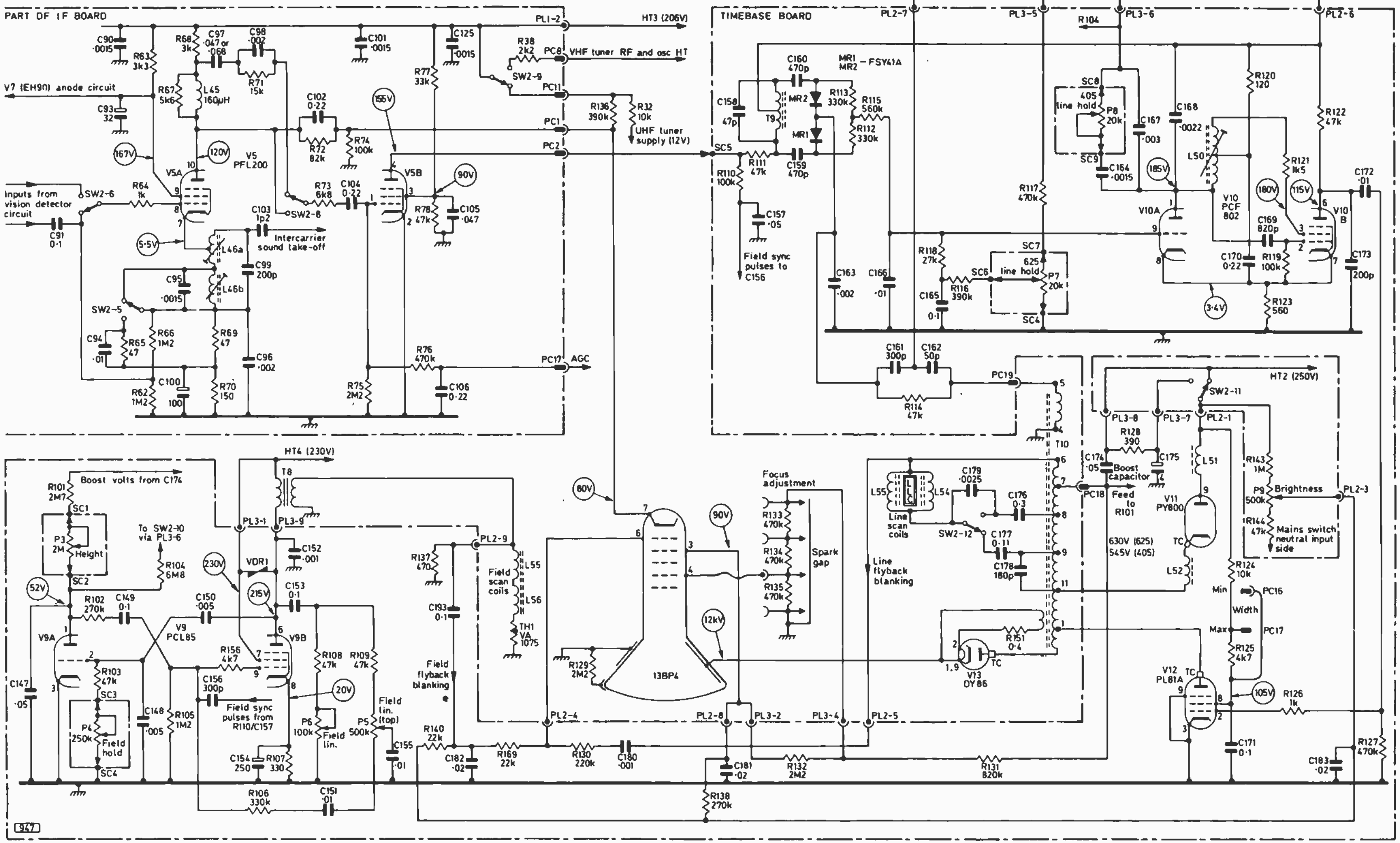


Fig. 1: The video amplifier, sync separator, timebase and c.r.t. circuit.

Voltages measured on 625 lines. They are generally rather higher on 405 lines. VDR1 is type E298CD/A258.

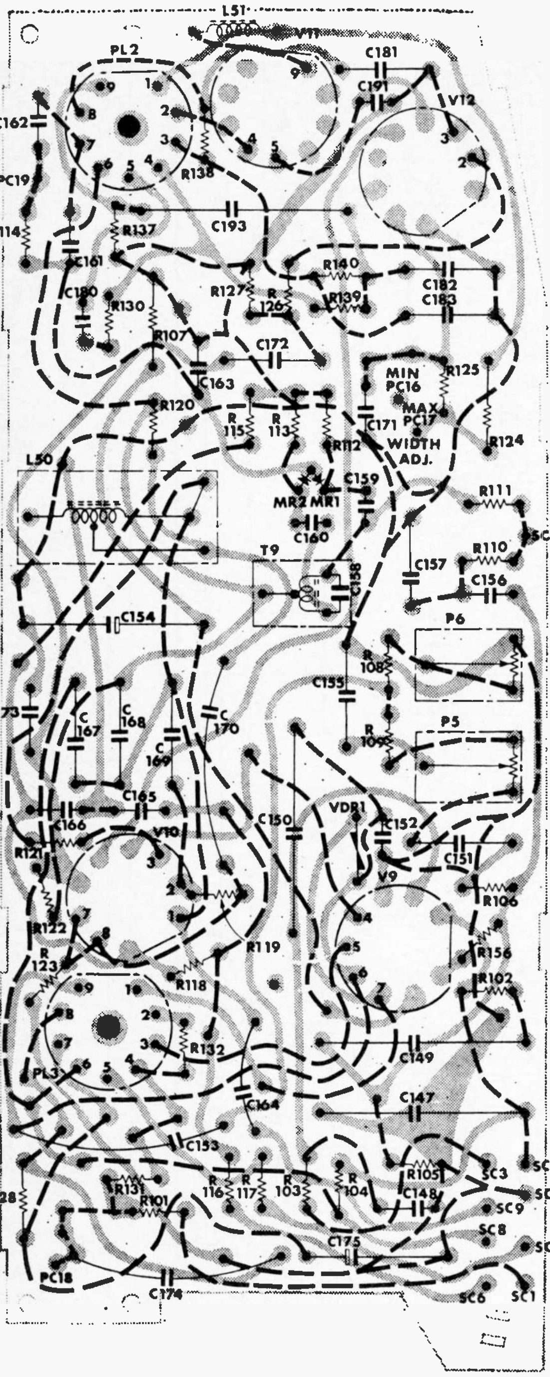


Fig. 2 (left): Layout of the timebase panel, viewed from the tin dip side (components on other side).

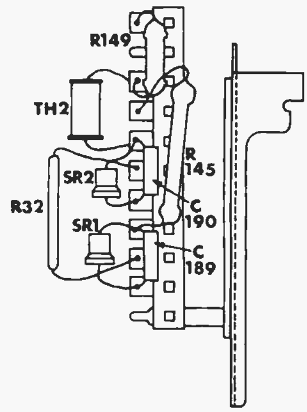


Fig. 3 (right): Components mounted behind the u.h.f. tuner.

deterioration. If the set has been stored or used in damp conditions the valve pins, especially of the DY86 e.h.t. rectifier, the valve sockets and system switch contacts deteriorate. If you have an opportunity to buy one of these sets therefore have a close look inside it. The back can be lifted away to expose the chassis after removing four screws, one at each corner. Inspect the chassis for signs of bodging and for corrosion.

What to Look for

In addition to checking the system switch contacts for corrosion look for signs of burning on the sections carrying h.t. current, for weak or broken contacts and for clean, positive movement when the system change knob is operated. Look also for leakage from the main electrolytic capacitor blocks C185-C188 which are mounted under the i.f. panel. Check for discoloured resistors and for signs of burning on the printed panels.

Awkward Access

Tracing faults on this chassis can be more difficult than on a standard chassis since the components are to some extent built around the c.r.t., making access more awkward. With care and a bit of common sense however this problem can be overcome—though the job will take longer.

Video/Sync Faults

Starting with the PFL200 video/sync valve, faults here can lead to symptoms varying from no picture to weak contrast and poor line/field sync. With any poor picture quality symptom first try a new valve. Next check the screen grid and anode resistors for change of value, and check C93 for loss of capacitance—as we have seen this capacitor can also affect the sound channel. Also check the action of the system switch contacts in this area.

A defective PFL200 can distort the sync pulses, resulting in line or field slip. Check the voltage conditions on the valve and the coupling capacitor C104 for leakage. Line slip can also be caused by a faulty PCF802 or by associated components. The flywheel sync discriminator diodes MR1/MR2 must have equal forward resistance for example in order to preserve the balance in the circuit. Measure their value using an ohmmeter: also check their load resistors R112/R113. If the diodes have different values replace them with a matched pair of BA144 gold-bonded silicon diodes. Similarly make sure that R112/R113 are matched in value. Faulty diodes can also cause line drift.

If the diodes are replaced reset the line hold controls as follows. Switch to 625 lines and with the tuner turned to a blank position adjust the 625 line hold control P7 for 2V positive between its slider and chassis. Adjust the core of L50 so that on tuning a signal in the picture locks instantaneously. Check that the same results are obtained on 405 lines—they should with the 405 line hold control P8 at approximately mid-travel. A slight readjustment to

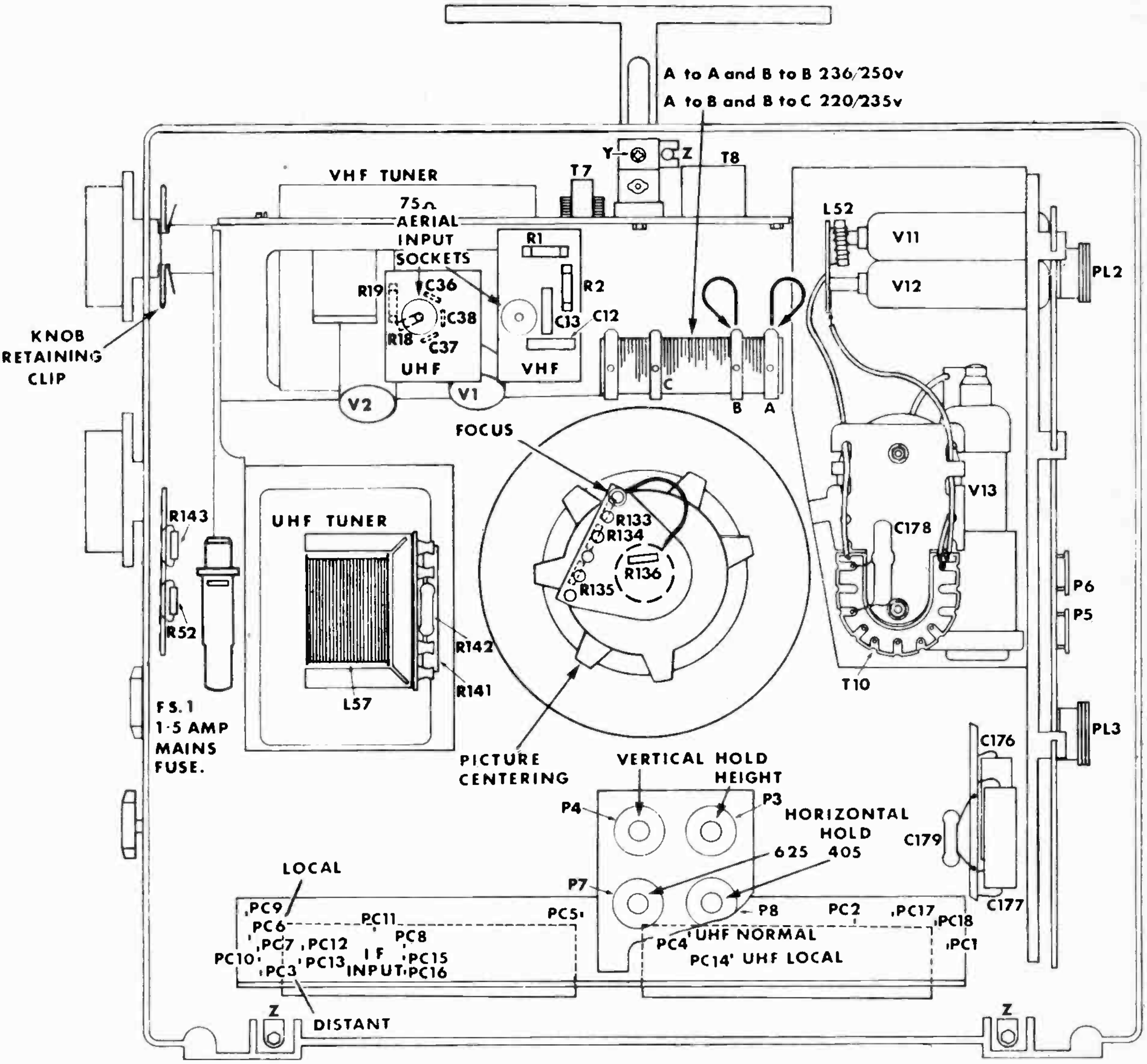


Fig. 4: Rear view of the receiver with the cabinet back removed. Screw Y and distance piece secure the handle. The three screws Z secure the chassis to the cabinet.

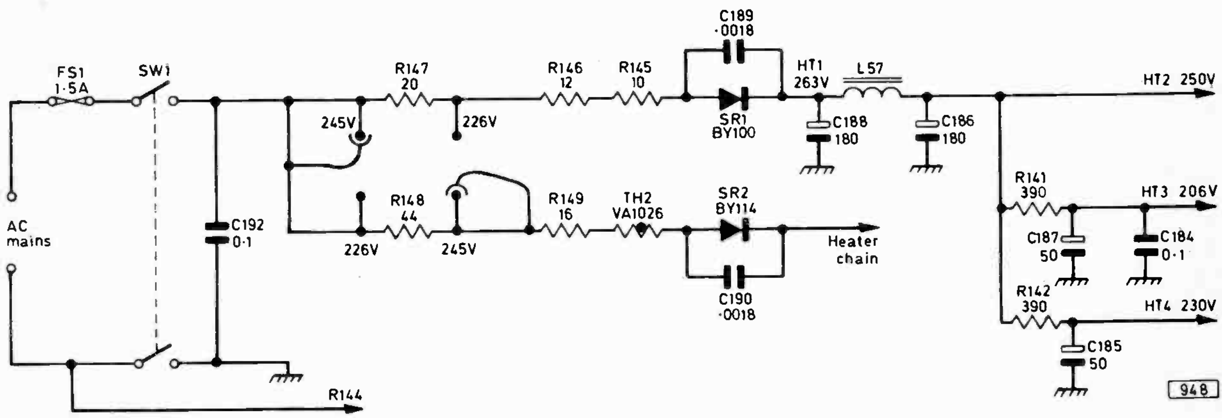


Fig. 5: Power supply circuit. H.T. voltages apply on 625 lines—they are slightly higher on 405 lines.

L50 may be necessary to achieve satisfactory lock on both systems.

Line Timebase Faults

Failure of the line generator to oscillate has been traced to the valve, to L50, C170 and to an open-circuit hold control.

Failure of the line generator will remove the negative bias from the grid of the PL81A line output valve, resulting in overheating and eventual breakdown of the valve or the line output transformer or the boost diode V11 if the customer decides to hear the end of the programme instead of switching off immediately the picture disappears.

When faced with the symptom no picture then, first see whether the line output valve is overheating. If so check the line oscillator. If not check the line output valve and boost diode. If no raster appears when the brightness control is turned up switch to 405-line operation and listen for the line whistle. If it is present look for the glow in the DY86 e.h.t. rectifier. No glow probably means an open-circuit heater so try a replacement. A normal glow should direct attention to the c.r.t. base. If the first anode voltage (pin 3) is absent decoupler C181 is probably short-circuit. If the line whistle is low or absent however take the e.h.t. cap off and hold it near the chassis to see if there is a spark. If not replace the e.h.t. cap and remove the PY800 boost diode top cap. If this action restores some signs of life the boost capacitor C174 is faulty and replacement will cure the condition. If removal of the PY800 top cap makes no difference check the PL81A line output valve screen grid resistors and decoupling capacitor C171.

Low width is generally caused by a weak line output valve or boost diode. It can also be caused by change of value in the line output valve screen grid feed resistors R124/R125.

Field Timebase Faults

Field timebase troubles are generally caused by a defective PCL85. The present-day substitute (PCL805) is much more reliable. If valve replacement does not cure the fault check its voltage conditions. A low voltage at pin 1 should draw attention to R101 in series with the height control. This resistor can increase in value over the years leading eventually to low voltage at pin 1 and a consequent reduction in height—usually with no alteration to the picture's linearity. A change in the value of R104 will result in different heights on 405 and 625 lines.

Bottom compression of the raster, leaving a gap at the bottom of the picture, is usually due to the pentode cathode decoupler C154 (250μF)—when not caused by the valve. Connecting another electrolytic capacitor of about 100μF across C154 will cure this but it is better to replace the faulty component—"when in doubt cut out" is a good motto for television repairs. The correct value is 250μF but anything over this value will be equally suitable. At the same time check the cathode bias resistor R107. A faulty PCL85 drawing excessive current can overload R107 so that it changes value. Check its appearance: if it is discoloured replace it. The excessive voltage produced by excessive PCL85 pentode cathode current will be across C154 as well of course. As a result it can be damaged.

Top compression of the picture indicates a fault in the field linearity feedback loop: check capacitors C153 and C151 and the linearity presets P5 and P6.

A spot of Servisol on the linearity controls often works wonders—particularly where the fault is a tendency for the bottom of the picture to flutter up and down spasmodically.

Field Collapse

Complete field collapse—a single horizontal white line across the screen—will occur if the field timebase fails to oscillate. The multivibrator cross-coupling capacitors C149 and C150 will produce this fault if one or the other fails. C150 is subject to the high peak voltages which occur at the anode of the output section of the valve and is under more than average stress therefore. Failure of the charging capacitor C147 will also produce field collapse, as will a break in the field hold control.

In the field output stage an open-circuit field output transformer primary winding will stop h.t. reaching the pentode anode and again collapse the picture. Before replacing the transformer however check R142 in the h.t. supply to this stage—it may be open-circuit. Don't forget connections PL3-1 and PL3-9. If these contacts are in order and there is voltage at PL3-1 but nothing at the PCL85 pentode anode the output transformer primary winding is open-circuit—a resistance test will confirm this.

Finally on the subject of field collapse check the leads to the scan coils, and their tag connections for dry-joints—these can show up for no apparent reason after many years' use. Don't forget to check the thermistor TH1 tucked into the scan coil assembly if necessary.

Scan Coil Breakdown

Scan coil breakdown is not a common fault but it does occur from time to time. The GEC replacement supplied may be an alternative type with a six-pin plug and different coloured leads. Take care to make a note of the connections and colours before removing the faulty coils.

Shaded Bar

A shaded bar moving slowly but steadily up or down the picture is hum on the field and can be caused by heater-cathode leakage in any of the valves. Progressive valve substitution will locate the one which is responsible. Check the main smoothing capacitors as well however, including C185 which decouples the HT4 supply to the field output stage.

Conclusion

The foregoing comments cover most of the faults we have encountered in the GEC 2015. Despite its compact dimensions and somewhat cramped assembly we have found this set to be no less reliable than its contemporary partners in standard chassis form. Its line output transformer is certainly reliable: this may well be due to the relatively low boost and e.h.t. voltages. Because of this there is less strain and lower heat dissipation in the set—giving the benefit of longer, more reliable operation.

All in all then this mains portable receiver is well worth spending some time and money on for use as a second set.

LONG-DISTANCE TELEVISION

ROGER BUNNEY

APRIL seems to have passed very quickly what with the prolonged high-pressure system that hovered over and adjacent to the British Isles and gave enhanced tropospheric reception. The signals during this period did not reach the remarkable levels of last January but even so most of us have reason to be thankful for the signals we received. In addition there was an excellent Sporadic E opening during the late afternoon/early evening of the 17th. I noted very strong SpE from about 1730 (when I arrived home) until fade out at 1840 or so. Signals from CST (Czechoslovakia) ch. R1, MT (Hungary) ch. R1 and TSS (USSR) ch. R2 predominated. I understand that in the Derby area JRT (Yugoslavia) appeared at 1930 on ch. E4. The Lyrids Meteor Shower was a washout on the 21st—the peaking day—although the R channels were lively during the previous evening. There has been a tendency over the month for signals to build up to something more prolonged and definite instead of the normal bursts and pings—an indication I feel for a good SpE season ahead. In fact on the morning of the 26th I was delighted to see quite substantial though weak periods of the T05 (Telefunken) card on ch. E2a from ORF (Austria)—a welcome sight indeed in these days of the PM5544!

In place of my usual depressing (!) log Clive Athowe (Norwich area) is reporting this month. We all know what the East Anglia area is to TV DXers: with the above average trops of the past month Clive's report shows what can be received—and conditions were on this occasion less than excellent! All regular loggings (i.e. stations received daily from NOS-Holland; WG-West Germany; BRT-Belgium) have been omitted.

1/4/74 WG ch. E2—MS (Meteor Shower).
2/4/74 ORTF (France) E47—trops.
3/4/74 TVE (Spain) E4—SpE; NOS E49; BRT/RTB E45, 48; WG—ZDF E30, 33, 34, 35, 37, 39, 40, WDR-1 E46, WDR-3 E48, 50, 58, NDR-1 E41, 50, 53, NDR-3 E40 43, 48—all WG reception via trops.
4/4/74 SR (Sweden) E2; WG E2; Swiss E2—all MS; WG WDR-1 37, 46, WDR-3 39, 40, 42, 46, 48, 49. 50, 53, 55, 57, NDR-1 41, 42, 50, 53, 55, NDR-3 39, 40, 42, 43, 44, 45, 47, 49, 57, 58, 60, ZDF 21, 24, 26, 29, 31, 32, 30, 33, 35, 37, 39—all trops.
The following days are very similar until:
9/4/74 DFF (East Germany) E5, 8, 11, 29, 31; SR E23, 33, 43; DR (Denmark) E5, 6, 8, 10, 7; WG—NDR-1 E2, 5, 10, 42, 41, 50, 53, 55, NDR-3 31, 34, 40, 42, 43, 44, 45, 47, 48, 49, 53, 57, 59, RB E22, WDR-3 E45, 46, 48, 49, 50, 55, 56, 60, ZDF E21, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 35, 37; NOS E49—all trops.
10/4/74 "Virtually a repeat of the 9th" plus WG—SWF-1 E47, SWF-3 E44; SR E23, 24, 26, 30, 46—all trops.
11/4/74 SR E2; WG E2—both MS. Also diminished trops from WG at u.h.f.
12/4/74 Swiss E2; WG E2—both MS; WG—ZDF E31 trops.
13/4/74 WG NDR-1 E10, 41—trops.
14/4/74 "Dead loss."
15/4/74 DFF E4; WG E2; TVE E2—all MS; WG ZDF E33, 34, WDR-1 E46, NDR-3 E43—all trops.
16/4/74 WG WDR-1 E46, NDR-3 E43, 48; CLT (Luxembourg) E7—all trops.
17/4/74 N. Ireland B9, 24.
18/4/74 WG E2; TSS R1—both MS.
19/4/74 WG E2—MS.
20/4/74 WG E2; SR E2—both MS; WG SWF-1 E8, 10, 23, 25, ZDF E21, 28, 30, 34, 35—all trops.
21/4/74 SR E2—MS; CLT E7—trops.
22/4/74 SR E2; WG E2; TSS R3—all MS.
23/4/74 SR E2, 4; WG E2; Swiss E2; DFF E4; RAI (Italy) IC; TSS R3; NRK (Norway) E2; TVE E2—all MS; CLT E7—trops.
24/4/74 WG E2; NRK E2; SR E2—all MS.
25/4/74 Swiss E2; SR E2, 4; WG E2; TVE E2, 4; CST (Czechoslovakia) R1; DFF E4—all MS.

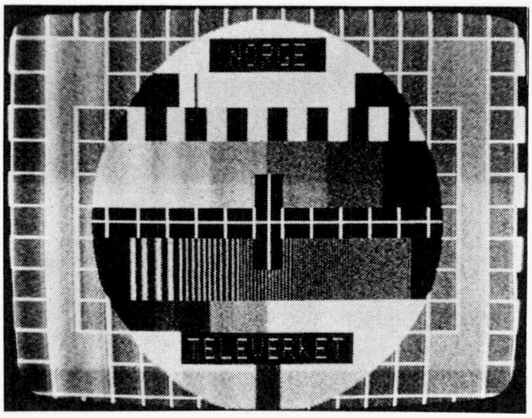
Clive's log makes extremely interesting if not envious reading. The ch. IC RAI MS burst on the 23rd lasted a full 3 seconds and was virtually noise free. It is interesting to note that whereas Clive tends to go for WG E2 via MS, on most days I tend to go for DFF E4.

In March Clive received an 819-line relay on ch. E45 (system L) from Paris Nord—all full 7kW e.r.p.! A number of reports have come in about Auroral activity during March though there have been no actual signal reception reports. James Burton-Stewart reports AR on the 29th from 1615 to after 2300 BST; Garry Smith earlier that month noted AR on the 16th and 21st. More exciting March news from our Cyprus contact A. Papaeftychiou: Gwelo Rhodesia ch. E2 has been in again via TE/F2 (Trans-Equatorial skip) with the usual checkerboard and the characteristic fluttery, unsteady video signal. The 3rd brought vision and sound but later in the month the test pattern only was noted "on many afternoons for very limited durations." A minor SpE opening was noted there with TVP and TSS on February 2th at sunset.

We have heard that the EBU (Brussels) has published (or is about to publish) a book(let) covering European test cards and costing 80 Belgian Francs. As of this date we have no further information and have not seen a copy but any further information received will be passed on.

News Items

West Germany: There is a morning programme transmitted for the GDR (East) and at present being radiated over Kreuzberg E3, Ochsenkopf E4, Hoher Meisner E7, Rimberg E25.
Holland: There are at least two so-called pirate radio stations off the Dutch coast at present. The Radio Veronica/Radio Nordzee groups have been given time on Dutch TV, Veronica Omroep Organisatie as a class C and the Stichting RTV Noordzee as a beginner class. The latter class qualifies for TV time with a membership of



PM5544 test card as used by NRK, Norway.

Programme chart, Norway.

Photographs courtesy R. Spence.

at least 15,000 but must endeavour to increase this to 100,000—as class C—within a two year period. The class C broadcaster is allowed 2½ hours on the air each week, beginner 1 hour.

Monte Carlo: Tele-Monte Carlo changed its transmission standard on December 23rd last from the 819-line system to a 625-line standard (assumed to be system L as per ORTF-2, 3). Occasional SECAM colour tests have been carried out.

Czechoslovakia: The now famed electronic pattern (CS U 01 type) with its various identification numbers has caused some confusion as to the originating transmitter. Thanks to the Europese Testbeeldjagers we can now report that the numbers are as follows: 01 to 38 from Prague; 41 from Brno; 50 to 59 from Ostrava; 60 to 86 from Bratislava; 90 and 91 from Kosice.

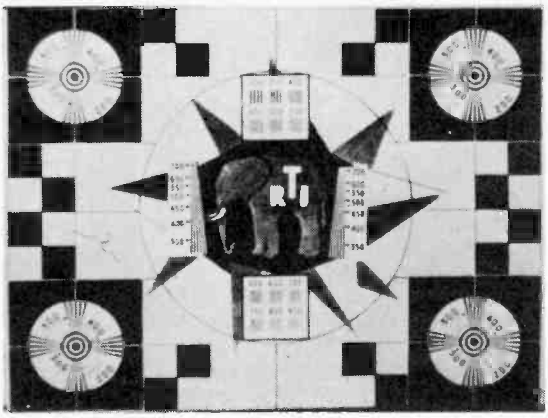
France: From the same source comes a report that ORTF-1 will go to 625 lines (system L?) "at the end of this year or beginning 1975. The change will be abrupt, so most viewers won't be able to receive the ORTF-1 programme if their receivers don't have system L facilities."

From Our Correspondents . . .

Bruce Spence (Yell, Shetland) has been using a Philips

Typical Programme Times for Minimum Eurovision Week at end March 1974

Network	*Sunday*	*Monday*	*Tuesday*	*Wednesday*	*Thursday*	*Friday*	*Saturday*
ORTF–1 (France)	0855–2340	1230–2250	1230–2245	1230–1335 1620–2250	1230–1335 1615–2255	1230–1335 1615–2255	1130–2335
ORTF–2	1230–0015	1900–2240	1430–1640 1900–2300	1430–1605 1920–2250	1430–1610 1900–2245	1430–1610 1900–2300	1000–2340
ORTF–3	1845–2230	1830–2245	1830–2215	1830–2200	1830–2215	1830–2215	1830–2330
BRT (Belgium–Flemish)	1430–2315	1500–1600 1800–2300	1400–1600 1800–2300	1630–2230	1500–1600 1800–2305	1400–1600 1800–2340	1400–2330
RTB (Belgium–French)	1015–1145 1200–2330	1645–2300	1645–2320	1320–2345	1810–2330	1700–2300	1130–1545 1615–2300
NOS–1 (Holland)	1543–2230	1905–2230	1845–2240	1700–2200	1905–2300	1905–2330	1710–2230
NOS–2	1850–2230	1905–2200	1905–2230	1845–2200	1845–2230	1930–0020	1905–2230
ARD–1 (W. Germany)	1015–2320	1615–2400	1615–2340	1615–2345	1615–2330	1550–2400	1430–2345
ARD–2	0945–2320	1700–2255	1630–2340	1620–2245	1630–2300	1100–1130 1630–2310	1345–0050
SWISS (French)	0955–2250	1645–2300	1755–2300	1645–2230	1755–2330	1755–2310	1330–2325
SWISS (German)	1100–2230	1730–2215	1615–2300	1730–2230	1530–2245	1730–2330	1400–2330
RTL (Luxembourg)	1315–2235	1750–2245	1750–2245	1700–2255	1750–2255	1750–2250	1700–2310



This month's exotic test card—Television Ivorienne, Abidjan, Ivory Coast. Courtesy K. Hamer.

Model G20T and a simple Band III H aerial with some quite dramatic results. Examples of his signals are shown this month—see the Fjernsyn (programme) caption and the type PM5544 test card from Bergen ch. E9. These are some of his first DX receptions—I'm sure that the coming months will greatly enlarge his loggings!

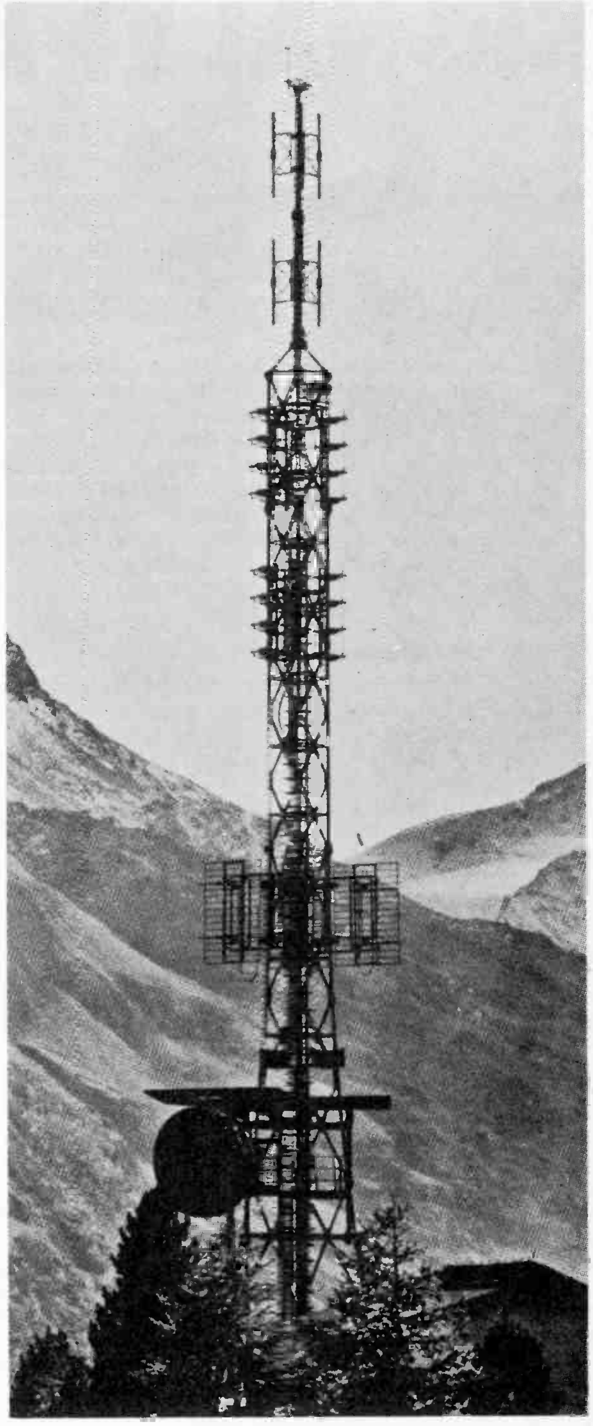
Farther South Dr. E. Duncan of St. Andrews, Fife received excellent colour from both Sweden and West Germany on the 8th and 9th of April on his Sony Model KV1320UB, with a group A Multibeam aerial and preamplifier. In all he logged 22 u.h.f. transmitters (other than UK) on the 8th. Still farther South—in Teesside—Derek Dyson is using a conventional receiver with the tuner unit modified to act as an i.f. preamplifier which is fed in turn from an external transistor tuner. He received most European countries via SpE last year, including prolonged Finland ch. E3—this is a rarity in many parts of the UK. Derek also noted clear Scandinavian signals during the period of good tropospherics recently.

Keith Hamer tells us that a ch. R1 PM5544 card has been noted prior to 0800BST but with a "dark" background. This is suspected TVP (Poland).

Dr. Fadel (Kuwait, Persian Gulf) writes on conditions and reception in Kuwait. He uses a "very sensitive" 12in. Sanyo model, an 18in. Toshiba set and a Korting colour receiver. His really exotic DX reception to date has been Karachi ch. E4 and USSR ch. R1 via SpE. The more regular signals received are from HZ22-Aramco TV, Bahrain E4, Abu Dabi, Iran, Saudi Arabia, Qatar and Bazra. An interesting note: on the birthday of the Prophet of Islam Abu Dabi increased its e.r.p. to the extent that it was being received "around the clock" and causing interference with Saudi Arabia and Bazra. The next of Dr. Fadel's projects apparently is to improve his reception from Bahrain. To this end he has ordered from the US a high-gain array—Lafayette type 18F 02206WX. Unfortunately no light can be placed on the location of the ch. E2 Iranian station—Dr. Fadel views ch. E7, the Abadan outlet.

Brazilian Travels

Following a glorious picture post card from Rio a long letter has arrived from the Othon Palace Hotel, Sao Paulo: Hugh Cocks—our DX TV expert from Mayfield, Sussex—has gone somewhat farther afield in his search for exotic signals! In accompanying his father on a business trip he is taking the opportunity to



The Monte Celerina, Switzerland transmitter, at 2100 meters a.s.l. Ch. E7 3kW Italian; ch. E9 6kW German. Photograph courtesy Radio Electronics, Holland.

let us know about the latest TV sightings over there. All TV sets used there are assembled in Brazil but carry names such as Philips, Sanyo, ABC, Zenith, Philco and Admiral. Aerials are mainly log-periodic types for Bands

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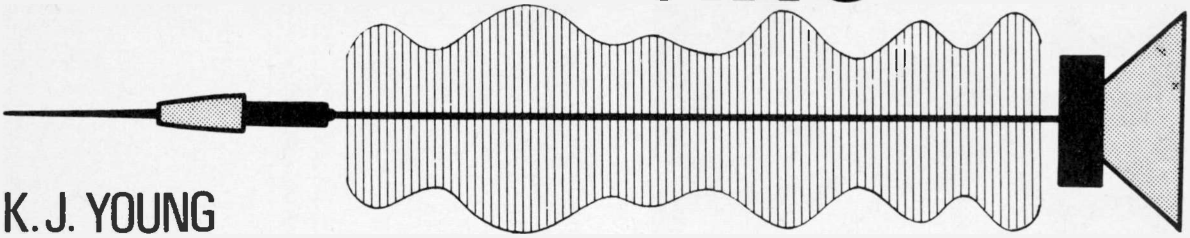
SIGNAL TRACING



K. J. YOUNG

THERE are two basic approaches to the problem of lost or severely attenuated signals. If the a.f. section and loudspeaker of the equipment under test are still working a signal generator or signal injector can be used to inject a modulated signal at i.f. or r.f. at various points in the receiver to find where the discontinuity lies. Alternatively a signal tracer, which is fundamentally a receiver modified to accept inputs from the various stages of the equipment under test, can be used to track down the faulty stage.

Possible Arrangements

The more ambitious a signal tracer is the nearer it approaches to being a complete receiver itself—indeed a modified complete receiver can be used if the tapping points are carefully arranged so that the temporary inputs do not cause unacceptable detuning or loss of gain. The simplest a.m. signal tracer of all can be made from a junk transistor radio by adding a lead from the volume control to an additional jack socket (which may be 2·5 mm if the existing 'phone jack is 3·5mm or vice versa): this enables the two portions of the set to be used separately, though in a somewhat crude manner.

There are various opinions as to the best arrangement for a signal tracer. It is generally considered best to avoid a superhet design however in view of whistle complications and the gap in coverage. T.R.F. designs with many switched bands have sometimes been used in the past. There is now a Ferranti i.c. (type ZN414) which forms the basis of a t.r.f. receiver and could perhaps be used as the basis of a compact a.m. signal tracer. The Y amplifier of an oscilloscope also provides a signal tracer of course but in most cases suits video and pulse circuits better than audio—except where waveforms are being investigated with the aid of an audio signal generator. An a.c. millivoltmeter also has its uses for signal tracing, but for quick appreciation of faults an audible output is usually preferable. A rather unusual signal tracer design by Telefunken is discussed later.

Tracers recently advertised seem to concentrate on the a.f. stages. One can either buy one of these therefore and add a "front end" to it, or use an integrated circuit or thick-film module with output stage plus loudspeaker and work back from there. The more alternatives provided the more switching or patched plug-in links are required. Thus some compromise is usually desirable. It is surprising how useful even quite simple arrangements are however for servicing and quick checks. Various alternatives are presented in this article—readers can then try out the method which caters best for their own requirements, adapting it as necessary. For dealing with orthodox a.m. receivers for example a simple design suffices. For 405-line television sets where the modulation is still a.m. rather more difficulty arises because of the much higher intermediate frequency, as well as safety considerations. If 625-line television sets and f.m. radio receivers (i.f. usually 10·7MHz) are to be handled a discriminator is also needed. For checking stereo receivers more elaborate means would be needed though a simple a.f. tracer will locate signal discontinuity in the right or left channels.

Block Diagram Outline

An outline of a signal tracer with several optional features is shown in Fig. 1. Since the input sensitivity of most a.f. modules is not quite adequate it is best to insert a volume control—calibrated if desired—at the input and add a screened preamplifier even if this consists of only a single transistor stage. The volume control and a.f. input leads should be screened and an overall insulating sheath provided. The preamplifier is preceded by a detector (or discriminator)—a transistor a.m. detector working on the "anode-bend" principle is more sensitive than a diode but the latter can be used if additional r.f. gain is available. To give broadband r.f. amplification prior to the detector a linear i.c. is best. This can be preceded by an optional single tuned circuit, with coil-switching according to the bands it is desired to cover. Alternatively one can for simplicity be satisfied with broadband working without tuning. A compromise alternative is to use coil-switching and include one untuned position, using a resistor.

Input Probe

For the input to the tracer an emitter-follower, bootstrap or other high-impedance low-capacitance input probe is almost essential in order not to load or detune appreciably the portions of the receiver under test. A complementary pair with input impedance of 1MΩ was described by D. E. O'N. Waddington in the March 1966 issue of *Wireless World*. If the main instrument is at all bulky the probe will have to be housed separately in a small screening box such as a cigar cylinder, preferably with overall insulating covering, such as heat-shrinkable plastic. Connection to the main instrument should be made with four-core miniature screened cable with insulating sheath. It is desirable to have rather more gain than is usually available in a receiver, both on the

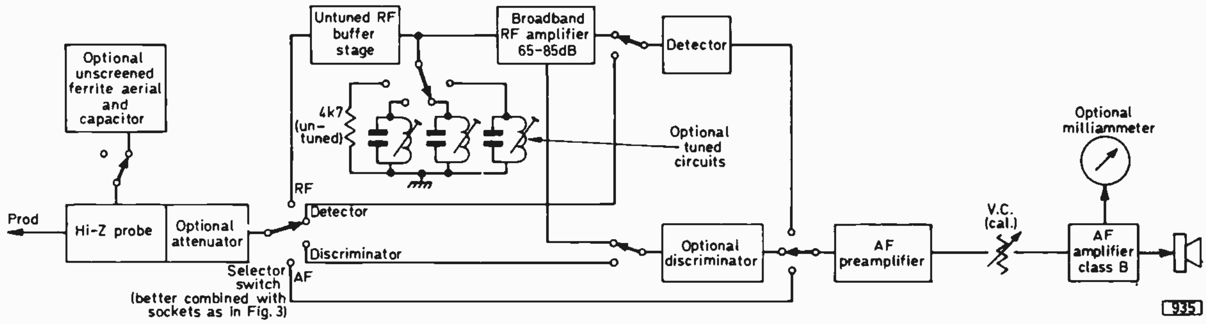


Fig. 1: Signal tracer block diagram, showing optional features that can be incorporated to increase the instrument's usefulness. The untuned r.f. buffer stage would be needed only to isolate the optional tuned circuits from the optional attenuator.

r.f. and the a.f. sides, since one is looking for fault conditions. Moreover the use of a low-value input capacitor in the probe—to avoid loading and minimise detuning—calls for additional gain to compensate, though instability must of course be avoided. Switching an optional ferrite-rod aerial at the input enables the tracer to be used as a flatly-tuned a.m. receiver if desired, or provides a quick check on the operation of the tracer itself.

A self-contained, battery-operated instrument eases the safety problems since the whole thing can be insulated—except the tip of the probe which is taken to an input capacitor of high voltage rating. Using i.c.s only, the entire instrument can be reduced to what used to be regarded as probe proportions, provided one is content with a very small loudspeaker or the loudspeaker and battery are the only items not in the "probe" itself. To protect solid-state circuits from large input signals—particularly if valve equipment is being tested—overload diodes can be added across the input. For testing television sets or other a.c./d.c. equipment particular care is necessary from the safety point of view. When such equipment is operated under test with the back off it should be supplied from a double-wound isolating transformer.

Output Meter

If the a.f. amplifier is Class B—usually the case

Table 1: Useful Integrated Circuits.

Type	*Maker*	*Function*	*External items needed*
TAA661B	SGS	f.m. coincidence detector	Mixer stage, two tuned circuits at 10.7MHz and a.f.
TAD100	Mullard	a.m. receiver	a.m. mixer stage, i.f. tuning and a.f.
TBA690 or TBA700	Mullard	a.m. and f.m. receiver	a.m. and f.m. mixer stage with a.m. mixer switchable as first f.m. i.f., ratio detector and a.m. detector (includes a.f.)
TAA350	Mullard	f.m. limiter-amplifier	f.m. mixer, discriminator and a.f.
TAA300	Mullard	a.f. and 8 Ω output	Gives up to 1W with 9V battery
CA3089E	RCA	f.m. i.f., discriminator, a.f.c. and a.g.c.	f.m. mixer stage and a.f.
CA3076	RCA	10.7MHz amplifier-limiter	f.m. mixer stage, i.f. tuned circuits, discriminator and a.f.
CA3075	RCA	10.7MHz amplifier-limiter and detector	f.m. mixer stage, i.f. tuned circuits and a.f.
CA3089	RCA	f.m. receiver with a.f.c. and a.g.c.	f.m. mixer stage
SL610	Plessey	Gain-controlled r.f. amplifier	Tuned circuits as necessary
SL612	Plessey	Gain-controlled i.f. amplifier	Tuned circuits as necessary
NE561B	Signetics	Phase-locked loop f.m. i.f. and detector *or* a.m. i.f. and detector	f.m. mixer stage, first f.m. i.f. and a.f. / a.m. mixer stage, and a.f.

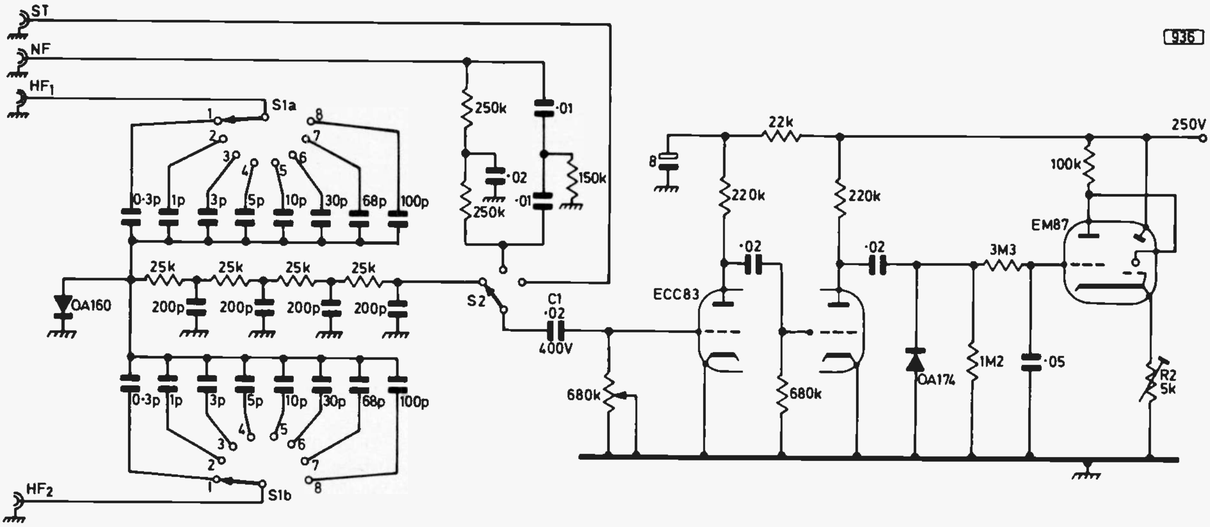


Fig. 2: Circuit (slightly modified) of the Telefunken design for a signal tracer and frequency comparator. Note that networks of capacitors like those at Sla and Slb could also be used at the ST and NF inputs—without the OA160 and 25k Ω/200pF filter.

for battery economy—the current drawn will be roughly proportional to the input signal. It is useful to add milliameter showing the battery current therefore, though allowance must of course be made for the no-signal current (of the order of 10mA). Even without refinements this meter enables comparative tests of stage gain to be made in conjunction with a good receiver or signal generator, particularly if a variable attenuator is provided near the input and the volume control is calibrated in mV at the a.f. input for a given current reading.

Other Uses

Signal tracers can be used for purposes other than receiver testing, for example for checking the resonant frequency of an *LC* combination temporarily fed from a signal generator. A signal tracer is more handy for this particular purpose than an expensive *Q*-meter which can usually test only the coil or the capacitor separately, albeit with increased accuracy. Another application is as a rough wavemeter to check local oscillator frequency and amplitude. Instances have been known where the oscillator is working on the "wrong side" of the i.f. in a receiver under test. It is also sometimes found that although working, the local oscillator output is well below optimum amplitude.

Telefunken Design

A useful instrument by Telefunken (now withdrawn from sale) on which no patent rights are claimed combines the functions of a signal tracer and frequency comparator. The circuit—slightly modified—is shown in Fig. 2. When the instrument is used as a signal tracer an input in the frequency range up to 500kHz can be taken to input ST: its amplitude will be shown by the width of shadow on the EM87. If a 50Hz hum filter is required the input can be taken to input NF instead. In this case frequencies below 100Hz are attenuated, 50Hz being attenuated particularly sharply. One advantage of a magic-eye over a meter is that it cannot be "bumped": moreover R2 can be preset to ensure that the EM87's two light bands just touch when zero input is applied to C1.

When this instrument is used as a frequency comparator the frequency range is much higher—up to 350MHz. The frequency to be compared is taken

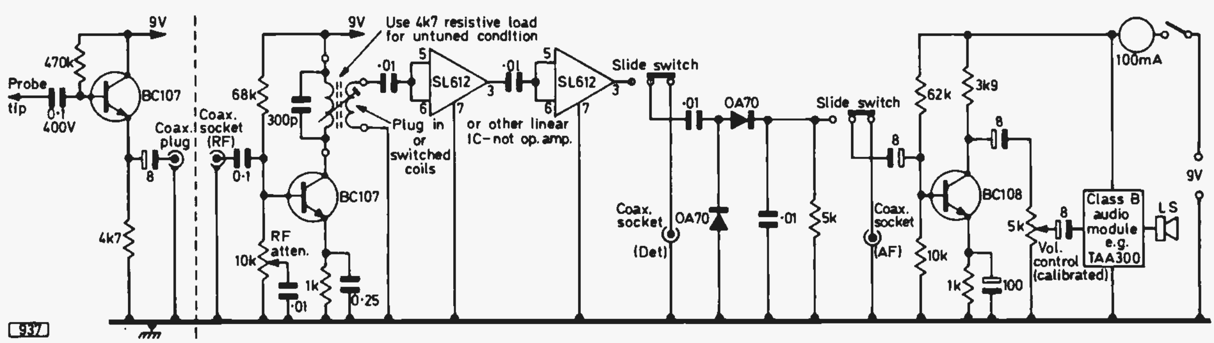


Fig. 3: A.M. signal tracer. All sections of the circuit except the class B audio module and the loudspeaker should be screened. The SL612 requires 6V at pin 2: pins 4 and 8 should be earthed and there is no connection to pin 1.

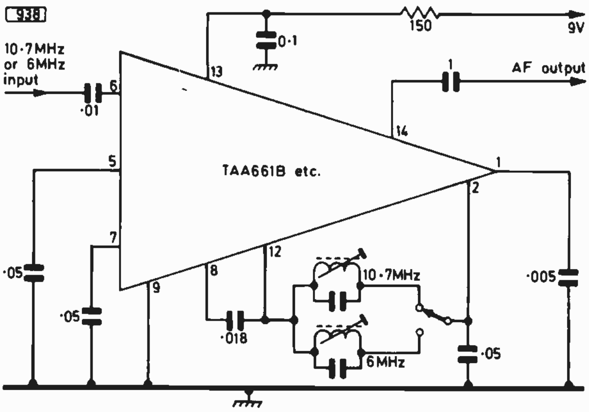


Fig. 4: Use of a coincidence (quadrature) f.m. discriminator integrated circuit.

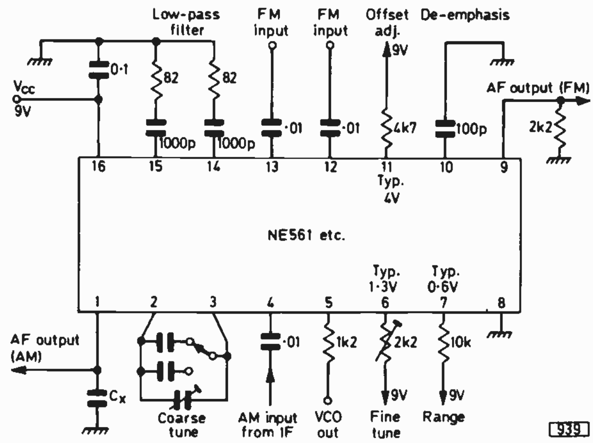


Fig. 5: Use of a phase-lock-loop discriminator/detector i.c. The signal inputs must be via capacitors. The f.m. input pins 12 and 13 feed a balanced circuit: if an unbalanced input is used earth one pin via the capacitor.

to HF1 or HF2 and a signal generator's output to the other, with input amplitude 20mV. The frequencies are mixed in the OA160 diode and a shadow appears on the EM87 for frequency differences not exceeding 200Hz (higher frequencies are attenuated by the low-pass filter). For frequency equality a sharp null in the shadow is obtained.

AM and FM Tracer Circuits

Fig. 3 shows a signal tracer design for a.m. only, without refinements such as a.g.c. It has only one tuned circuit, and an optional attenuator. Links between stages are provided by slide switches which when disconnected from the previous stage make instead a connection to input coaxial sockets. This arrangement minimises lead lengths and the risk of stray couplings. Details of the simplest possible emitter-follower probe, of moderately high input impedance, and of a single extra screened a.f. stage are also shown. The input probe is untuned and is used for all tests. It should preferably have its own miniature mercury or other battery, enabling a single-core screened lead with insulating sheath to be used for the link to the remainder of the tracer.

To cater for f.m. a discriminator and i.f. limiter amplifier are needed, capable of working at 6MHz or 10·7MHz. Versatility is increased if the number of *LC* circuits is reduced to the minimum. This consideration makes either the coincidence (quadrature) detector or better still the phase-lock loop the best choice in a tracer. The coincidence discriminator used in the TAA661B, TBA690, TBA700 or CA3089 i.c. needs one tuned circuit for the discriminator. A p.l.l. (e.g. Signetics NE561B) needs none whatever. In both instances a 10·7MHz input tuned circuit switchable to 6MHz is probably desirable however. Foster-Seeley and pulse-counter discriminators are probably best avoided in this context. The TBA690, TBA700 and NE561B also cater for a.m.

Fig. 4 shows an outline design catering for f.m. with a coincidence detector i.c. and Fig. 5 an outline design using the phase-lock loop.

Useful i.c.s are listed in Table 1. ■

LONG-DISTANCE TELEVISION

—continued from page 415

I and III (actually their "low band" and "high band") and a type used mainly in valleys with a central dipole encircled by a metal ring (similar to the old J Beam "Q Beam" but sufficiently large to encircle a half-wave dipole). The quality of Brazilian TV "is not too hot"—this applies to the sound quality on Brazilian radio as well! Film quality leaves something to be desired and VTR (videotapes) tend to suffer from colour banding—due to machine misalignment.

In Sao Paulo there are six local stations: ch. A2 TV Educativa—an educational channel—not seen on test; ch. A4 TV-TUPI using the PM5544 card between 1000-1100 (no identification and less the central vertical bar); ch. A5 TV Globo using a crosshatch plus colour bars plus pulse and bar at bottom (i.e. beneath the colour bars); ch. A7 TV Record using frequency gratings and colour bars for one hour a.m.; ch. A11 TV Gazeta (also on ch. A64) using colour bars from 1300; TV Bandeirantes on ch. A13 using the RETMA card and colour bars. An interesting point is that the line frequency has been reduced to 15.734kHz due to the field frequency reduction to 59.94Hz.

Atop the airport buildings in Brazil are huge S.W. log-periodic arrays and many radio station broadcast buildings in the main towns have their S.W. arrays (for broadcasting to the interior) on the roofs—the local service M.W. mast is usually out of town. Article reprints from *Practical Wireless* and several US technical magazines are found, translated into Portuguese—our old friend Gordon King also stars there in Portuguese! When Hugh returns we hope to include further information and test card photographs.

Programme Timing Chart

We have received from Ian Beckett a copy of *Tele 7 Jours*, a TV guide that gives many of the mid-European programme timings. The copy is a typical week's issue in which there were very few Eurovision items to extend the basic programme periods. The accompanying chart has been compiled to show this information.

transistor circuits

LINE TIMEBASE

Part 2: COLOUR

S. GEORGE

WHILST a transistor blocking oscillator is used as the line generator stage in a number of smaller screen solid-state colour receivers imported from Japan (e.g. Hitachi, Mitsubishi and Sony) the larger screen models, whether home produced or imported, employ either a transistor sinewave oscillator or an integrated circuit line generator stage. There are two possibilities on the output side, either a one- or two-transistor stage which is basically an up-rated version of the BU105 circuit described last month, or a thyristor output stage. The latter approach is confined to a few imported 110° sets however—e.g. Asa, Finlux, Grundig and Sharp. (A separate article on this type of line output is in preparation—*Ed.*) Whatever combination of these two generator and output stage possibilities is used a driver stage will be found between the oscillator and the output stage.

Transistor sinewave line oscillators operate in conjunction with a reactance stage which is used to apply a.f.c. to the oscillator. The sinewave oscillator is highly stable by itself of course since a high-*Q LC* tuned circuit has a natural tendency to run at the correct frequency, most of any deviation occurring during the initial warm-up period. There are only two ways in which the frequency of an *LC* tuned circuit can be controlled: either by actually or by in effect varying the *L* and *C* values. The first involves some complication—varicap diodes can tune a lecher line right through the u.h.f. bands but their capacitance is much too small to tune the comparatively low-frequency line oscillator coil, though it is possible to make use of them as we shall see later. The second approach is realised by using a transistor reactance stage to simulate the required *L* or *C* variation.

A transistor acts as a reactive circuit element when its current leads or lags the applied voltage by 90°—current lead giving the effect of capacitive reactance, current lag of inductive reactance, the reactance value in either case depending on the current flowing which is in turn dependent on the forward bias applied to the transistor. If a transistor operated in this manner is connected so as to form part of the oscillator tuned circuit the frequency of the latter can be controlled by varying the current in the transistor therefore. The forward bias for the reactance stage is obtained from a conventional flywheel line sync discriminator circuit.

The basic transistor capacitive reactance stage is shown in Fig. 1 where it is in parallel with the oscillator tuned circuit. The oscillator waveform is applied to the base of the transistor from the junction of a small value capacitor and a small value resistor, these components being connected in series across the oscillator coil. Since the reactance to the line frequency of a small capacitor is much larger than the value of the resistor the *RC* combination is predominantly reactive, taking a current almost in quadrature with the voltage. The greater the ratio of *X*c to *R* the more nearly the current is 90° in advance of the voltage. If this is taken too far however the result can be that insufficient voltage is developed across the transistor's base-emitter junction.

A reactance stage incorporated in a practical oscillator circuit tends to look somewhat different—see for example Fig. 2 which shows the line oscillator stage used in the Philips G8 chassis.

The oscillator coil L501 is connected via R510 and C502 between the collector and base of the oscillator transistor Tr511. The tap on the coil provides the collector supply for both the oscillator and the reactance transistor (Tr500) and is decoupled signalwise by the electrolytic capacitor C520: oscillation is maintained by the positive inductive coupling between the two coil sections and the resultant feedback between the collector and base of Tr511. The amplitude of the sinewave developed across Tr511 base circuit and Tr500 collector circuit is 10·5V peak-to-peak. It is this waveform and not the large amplitude waveform developed at the collector of the oscillator stage that is passed via the shaping/attenuating network R529/R505/C504 to the base of the "trigger amplifier" Tr514 (see Fig. 3) which in turn feeds the driver transistor Tr519.

The oscillator transistor is forward biased by the potential divider R503/R509. D513 in its emitter lead provides base-emitter junction protection: since

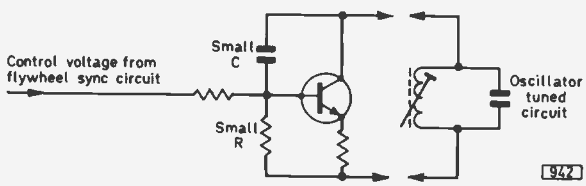


Fig. 1: Basic transistor reactance (capacitive) stage: the base signal is supplied from the junction of a small value capacitor and a small value resistor, the reactance of the capacitor being high compared to the resistor value at the frequency concerned. The combined impedance of the capacitor and resistor at the frequency of operation is almost wholely reactive therefore and the transistor's base current leads its collector voltage by 90°, i.e. the two are in quadrature. In this condition the transistor acts as a variable capacitor of value determined by the d.c. bias applied to its base.

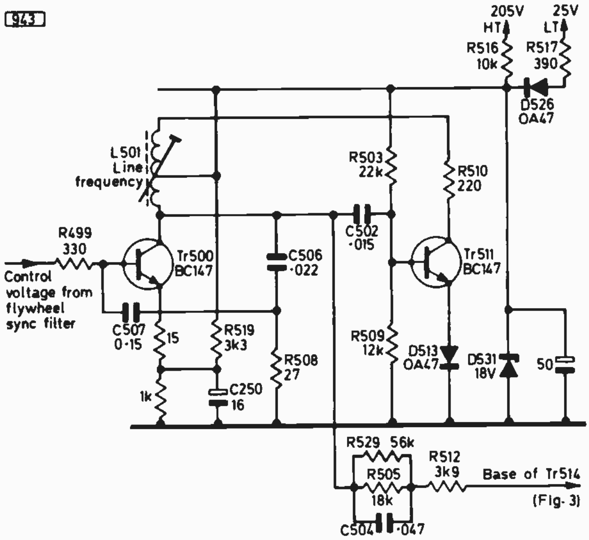


Fig. 2: The line generator circuit used in the Philips G8 chassis. The reactance transistor Tr500 tunes the lower half of the oscillator coil L501.

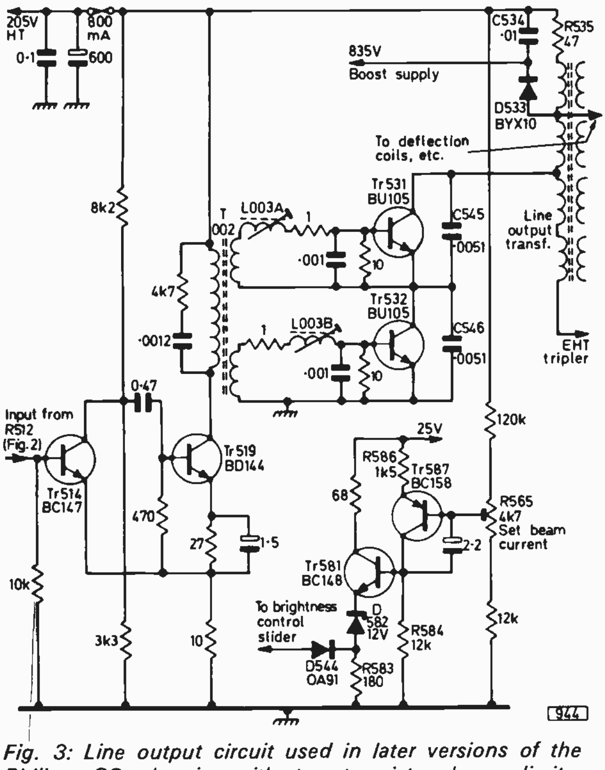


Fig. 3: Line output circuit used in later versions of the Philips G8 chassis, with two-transistor beam limiter circuit. (BY14 scan unit.)

the diode has a much higher reverse resistance than the transistor's base-emitter junction the major part of any excess reverse potential will be developed across the diode rather than the transistor junction.

C506 and R508 provide the 90° phase-shifted waveform which is coupled to the base of the reactance transistor Tr500 by C507. R519 provides a current drain to Tr500's emitter circuit to stabilise the d.c. working conditions of the stage. The control voltage from the flywheel sync filter is applied to the base of the reactance transistor via R499.

During normal operation the supply for the two stages is obtained via R517 and D526 and stabilised by the zener diode D531. Since the receiver's l.t. supplies are obtained from the line output stage however there will be no l.t. potential at switch on. To start the circuit power is obtained via R516 from the 205V h.t. rail.

Two line output units have been used in the G8 chassis, the main difference between them being the different beam limiting arrangements employed. The beam limiter circuit originally used was illustrated and described in a recent letter to the editor (see Letters, page 228, March 1974). Fig. 3 shows the circuit of the later line scan unit.

The output from the trigger amplifier Tr514 consists of a near rectangular 6V peak-to-peak waveform. This is applied to the driver transistor Tr519 which develops a 400V peak-to-peak waveform across the primary of the step-down driver transformer T002. Separate secondaries on this transformer drive the pair of BU105 line output transistors. In addition to providing the deflection and horizontal convergence currents the line output transformer provides various pulse outputs and feeds rectifiers which provide the l.t. supplies and the high voltage required for the c.r.t. first anodes.

The two-transistor (Tr581, Tr587) beam limiter circuit operates by comparing the 25V l.t. rail voltage—developed by the line output stage and thus varying slightly with e.h.t. demand—with the 205V thyristor stabilised h.t. rail voltage. The output is applied via D544 to the slider of the brightness control. This arrangement minimises beam current limiter drift due to h.t. voltage variations. Comparison is carried out by the pnp transistor Tr587 whose emitter is fed from the 25V rail while its base is supplied with a small positive potential tapped from R565. If the l.t. voltage falls—associated with excessive e.h.t. current demand—the forward bias on Tr587 decreases, the voltage across its collector load resistor R584 falls, the d.c. coupled npn transistor Tr581 conducts less and the lower voltage across R583 reduces the brightness level. The zener diode D582 in this circuit can cause various troubles, e.g. absence of picture or a very dark one on switching on with the brightness control having no effect, normal operation starting after five minutes to a quarter of an hour. For replacement purposes a BYZ61/C12 is recommended.

Three components in the line output stage play vital roles, the two 0·0051μF capacitors C545 and C546 across the line output transistors to equalise the reverse potentials developed across them during the flyback period, and the 47Ω resistor R535 in series with the h.t. supply to the stage. This resistor has two purposes: it protects the transistors from the effects of flashovers within the c.r.t. and reduces picture "breathing", i.e. slight variations in picture size as a result of wide changes in the e.h.t. This latter advantage arises since the picture width is directly proportional to the h.t. voltage applied to the stage but inversely proportional to the square root of the e.h.t.: by supplying the h.t. to the stage via a resistor of suitable value the effects of reduced h.t. and change in e.h.t. cancel one another.

As in several other chassis the two line output transistors are connected in series and driven by separate, matched in-phase secondary windings on the driver transformer. The small, adjustable inductors in series with the bases play an important part in the operation of the stage by compensating for the different charge storage times (see Part 1) of the two transistors. These inductors are preset so that the two transistors switch off coincidentally.

At switch-off a large positive pulse (750V peak) appears at the collectors of the transistors: the subsequent negative-going voltage swing forward biases the collector-base junctions of the two transistors, current flowing across these junctions to chassis via the low-impedance base circuits. A separate efficiency diode is not necessary therefore. D533 acts as a boost diode, rectifying the flyback pulses to produce 835V across C534 for the c.r.t. first anodes.

Amongst other chassis using this type of line output stage are the single-standard 90° ones from Rank-Bush-Murphy: the main difference with these is the use of a different beam limiter circuit (see "Beam Limiting in Colour Receivers", *Television* February 1974). The two line generator circuits that have been used in these RBM chassis have a number of interesting features and to conclude this instalment we will take a look at them.

The circuit of the earlier line generator is shown in Fig. 4. The oscillator transistor is VT5 which is forward biased by R29 and R30 from the positive l.t. rail. At switch-on a heavy current flows through the primary winding of T2, the potential induced in the secondary winding being fed back to VT5 base via C21. After a few cycles of oscillation a negative bias is developed at VT5 base so that it then operates virtually in Class B, the positive half cycles developed by the oscillator tuned circuit driving it to saturation. In consequence although the stage is nominally a sinewave oscillator the output waveform developed across R30 is rectangular. The electrolytic capacitor C23 couples this to a two-stage driver circuit. Protection diode D5 prevents the negative half cycles of the waveform applied to VT5 base exceeding its maximum permissible base-emitter voltage.

In circuits using a conventional reactance transistor the output from the flywheel sync circuit is as we have seen applied to the base of the reactance transistor to adjust its apparent capacitance. In this circuit however the output from the flywheel sync circuit is applied to a varicap diode (D4) which in series with C15 and C16 forms a capacitive feedback loop between the collector and base of VT4. As a result the output from the flywheel sync circuit varies the quadrature current taken by VT4. This transistor in effect "multiplies" or amplifies the capacitive changes in D4 produced by the bias obtained from the flywheel sync circuit, and since VT4 forms part of the oscillator tuned circuit the correct phase and frequency conditions are established.

The over-volts protection transistor VT3 is shunted via R20 between the oscillator tuned circuit and chassis. During normal operation it is without forward bias and therefore has no effect on the circuit. The neon lamp in its base circuit is connected to the resistive chain R11, R12 and RV1 across the h.t. line. Assuming that RV1 is correctly set, if the h.t. voltage increases by more than 10%, thus increasing the line output and e.h.t. voltage to an excessive level, the neon will strike. VT3 will be biased into saturation and the oscillator feedback loop short-circuited. Unlike a line output valve which will pass an excessive and damaging current when the drive is removed, a line output transistor simply cuts off in the absence of line drive since it is without forward bias. Removing the drive to a line output transistor leaves it in a completely safe condition therefore.

Major changes will be evident in the line generator circuit (Fig. 5) used in later versions of this chassis. First a conventional sinewave line oscillator/reactance transistor circuit of the type previously described is employed; secondly a completely different line output stage protection circuit is used.

The supply to the emitter of the pnp reactance transistor is stabilised by the zener diode D3 and smoothed by the electrolytic capacitor C13: the high value of the emitter resistor R19 further enhances the stage's stability.

The predriver stage VT11 is without fixed forward bias and in conjunction with the d.c. restorer diode D9 acts primarily as a squarer of the already near rectangular waveform from the line oscillator transistor VT6—this is developed across R38.

VT8 acts to protect the line output stage, replacing the over-volts circuit used in the earlier unit. It is normally non-conductive and in consequence has no effect on the operation of the circuit. The key to the control action is D7 which is a four-layer semiconductor device—really a small thyristor without a gate connection. This will conduct only when its anode is sufficiently positive with respect to its cathode—its breakover potential is 30V ± 5V. Diode D14 rectifies the pulses developed across a winding on the line output transformer and in consequence establishes a voltage across its reservoir capacitor C43. If excessive h.t. voltage or a fault in the line scan unit—such as an open-circuit tuning capacitor—results in excessive line output and e.h.t. the pulses applied to D14 will increase and the voltage across C43 rise. D7 will then conduct, discharging C33 as it does so. The current drain through D11 and R45 will hold D7 latched on and switch the protection

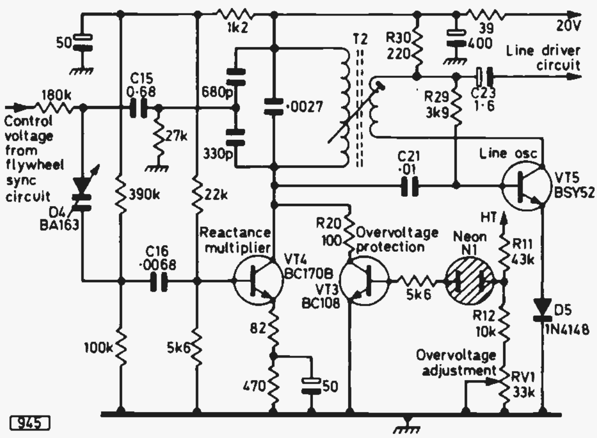


Fig. 4: Line generator circuit used in earlier versions of the RBM 90° single-standard colour chassis. The capacitance of varicap diode D4 is varied by the output from the flywheel sync discriminator circuit. Since D4 is connected in the capacitive feedback loop between the collector and base circuits of VT4 this adjusts the degree of reactive feedback. In effect VT4 acts as a reactance multiplier, amplifying the small capacitance changes in D4.

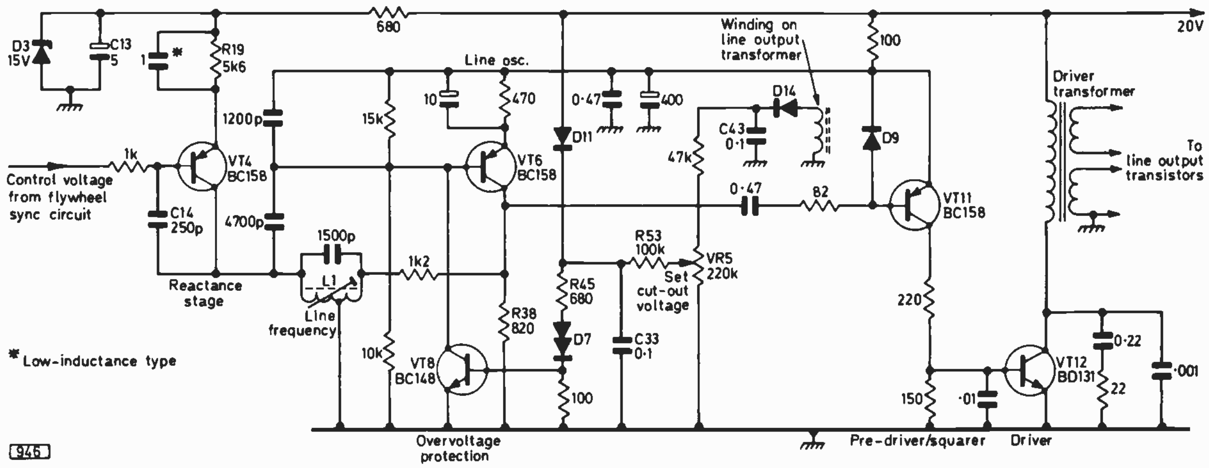


Fig. 5: Line generator and driver circuits used in later RBM 90° single-standard colour chassis.

transistor VT8 on, short-circuiting the base of the oscillator transistor VT6. Since during normal operation the voltage applied to D7 anode is in excess of the l.t. rail voltage D11 is normally reverse biased, isolating the protection circuit control potential from the l.t. supply. The time-constant of C33 and R53 prevents D7 responding to high-amplitude transients which may be conducted by D14. The line oscillator commences operation on the h.f. side of the line frequency, thus initially producing a low line output to prevent D7 being tripped following switch on. Altogether an ingenious protective arrangement which responds to excessive line output for any reason.

A stable line oscillator is essential in a colour receiver since pulses from the line output stage are used for colour signal processing in the decoder.

In the final part of this series we will look at the l.t. production arrangements found in transistor line output circuits.

LETTERS

I have had a problem with the "Television" colour receiver that I have not seen mentioned so far in your columns. Like several other readers I had trouble getting the ident circuit to operate correctly. In my case the trouble persisted even when the ident coil was correctly tuned and giving an output which should have been more than sufficient in amplitude. On investigation I found that the phase of the ident signal was such that it was passing through zero instead of being maximum or minimum when the line pulses arrived to trigger the bistable circuit—in other words the ident signal was 90° out of phase. I then noticed that the value of the reference oscillator control loop filter capacitor C12 was different from that specified in the original Mullard circuit—0·033μF instead of 0·01μF. Changing C12 to 0·01μF completely cured the fault.

I have also found it essential to provide additional smoothing on the 40V rail. A very simple and satisfactory way of doing this is to place an npn audio power transistor in series with this line: decouple its base to chassis with a 50μF electrolytic capacitor and connect a 1·5kΩ resistor from the collector to base to obtain the right operating conditions for the transistor. The output is taken from the emitter of course. Hum is reduced to about 30mV r.m.s. when this is done.—**H. Pursey** *(New Malden).*

A simple, cheap and positive way of applying remote control, with little to go wrong, to the "Television" colour receiver is to use a Ledex motor relay with 150V coil as shown in Fig. 1. Six channels can be selected and back again in seconds by this method. Channel indication can be provided by incorporating six small indicator lamps. An a.f.c. relay in parallel with the Ledex relay makes contact and then opens when the channel has been selected. An extra wafer can be added to bring in another aerial source. Note that rubber mounts are necessary for the motor.

I would like to meet anyone in the Colchester area who has constructed the receiver, in order to compare notes and ideas.—**B. D. Dodd** *(12 Rowhedge Road, Colchester, Essex).*

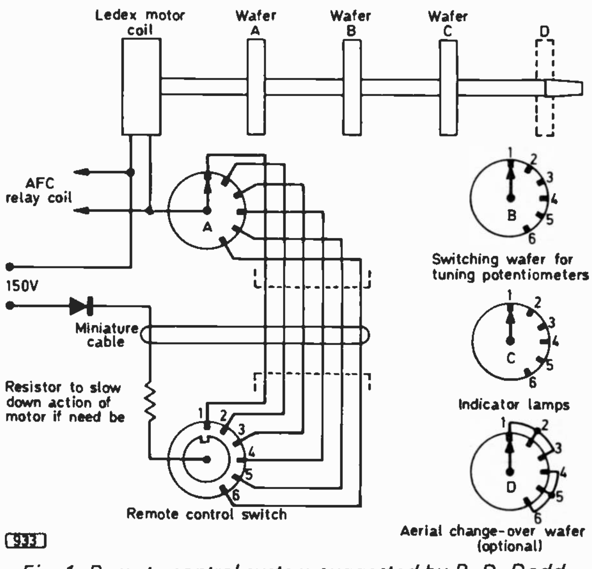


Fig. 1: Remote control system suggested by B. D. Dodd.

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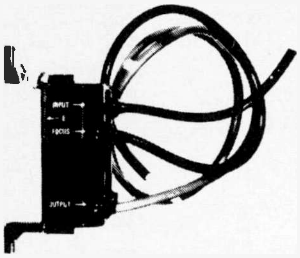

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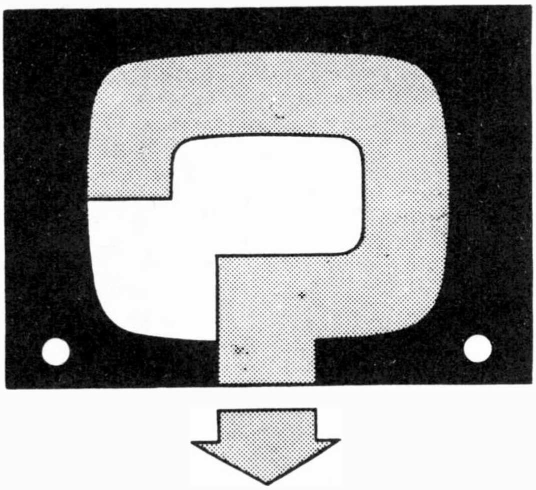

YOUR PROBLEMS SOLVED

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KB KV005

Vertical lock is lost after about four hours of normal operation, the raster slipping down about half way then occasionally slipping back into sync. If the field hold control is set to overcome this the picture rolls when the set is switched on from cold.—J. Harvey (Rochester).

The cause of the trouble is either weak sync or field oscillator drift. If the former, it will be difficult to overcome the rolling by adjusting the field hold control and the picture will lock over only a small range of this control. Should this be the case check the PCF80 sync separator anode load resistor R66 (220kΩ) and the upper resistor R63 (330kΩ) of the potential divider feeding its screen grid. It is more likely however that the field oscillator is drifting. Check, in the following order, the PCL85 field timebase valve, the PCF80 (the triode section forms part of the field oscillator), R88 (390kΩ) which is in series with the hold control and C77 (0·047μF) which decouples the oscillator circuit cathodes. (STC/ITT VC3 chassis.)

PYE CT200

The fault on this set shows up one-two hours after switching on and usually occurs on a change of programme or when advertisements are being transmitted. The picture may be perfect while a film is being transmitted but then on switching to a studio broadcast the fault will suddenly appear. The symptoms are that if the camera pans to the right so that a bright object moves just off the left-hand side of the screen a dark streak the height of the object is present right across the screen while if the object that moves off is dark a bright streak occurs. Bright or dark objects within the field of view do not cause this trouble. The problem seems to arise only when a high or low level of luminance signal is present adjacent to the sync pulses. The aerial is good and attenuation has been tried without improving matters. —E. Johnson (Derby).

The trouble is due to the gating/clamping pulse amplitude control R325 on the chrominance board being off adjustment. It is situated just by the glass delay line. Loosen the paint seal carefully and try adjusting it a little to the right, i.e. clockwise of its present position.

BUSH CTV25

The problem with this set is poor focus. It originally started with an intermittent focus electrode spark gap discharge on switching on—two or three discharges during the first five minutes. Attempts to improve matters by resetting the focus control and by changing over the coarse focus selector connections have failed to improve matters. The picture brightness and size are normal. By unplugging the focus lead at the tube base with the set operating the picture comes into focus and then drifts completely out of focus.—E. Joseph (Manchester).

In some cases this fault can be cured by removing the focus spark gap, thoroughly cleaning the area around it with methylated spirits and then fitting a new one. The focus and e.h.t. potentials are critical however: ensure that the voltage selector is correctly set and carry out line drive and e.h.t. adjustments as given in the manual. Check the high-value resistors in the focus circuit, particularly those on the earthy side of the focus control. (Mk. 3 version timebase).

RGD 711

The picture on this set moves up and down, each movement leaving a blank space at the top or bottom as the picture floats: the field scan also appears to distort slightly. The field timebase valves have been tested and found to be up to standard and all the controls operate normally. There is plenty of field scan amplitude.—J. Cusson (Newport).

As the controls operate normally our suspicion is that the h.t. smoothing is impaired. Try connecting a large-value electrolytic across each of the smoothing and decoupling electrolytics in turn. We have known such a floating effect to be caused by heater-cathode leakage in a valve, not necessarily in the field timebase but in an i.f. or tuner stage and without a noticeable hum bar being present. Another possibility is an increase in the value of one of the field oscillator or output stage grid leak resistors.

DECCA MS2400

When a speaker appears on the screen and his or her name etc. is flashed on the screen this is accompanied by a loud crackling on the sound. The interference clears when the caption is taken off. It is also difficult to find a fine tuning position which gives freedom from vision-on-sound in one direction of travel or ringing in the other. The faults sometimes clear themselves.—G. Reynolds (Trowbridge).

If the EF184 second i.f. amplifier is weak the a.g.c. can be inactive leading to troubles such as you describe. There are only two coils tuned to 6MHz, L215 and the quadrature coil L207 by the i.c. These should be adjusted using a wobbulator and oscilloscope, but very careful adjustment on a test pattern should enable small levels of vision-on-sound to be cleared. If the vision-on-sound clears on its own however the most probable cause is a dry-joint or a hairline crack on the printed panel. The only way of finding this is by careful inspection.

EKCO T434

The picture on this set is good except that we keep getting grey lines or sometimes grey and black lines together moving either upwards or downwards and which when bad break the picture where the lines pass through. At times the fault does not show up for two or three hours. The signal is good in this area and an efficient aerial is installed.—W. Harper (Croydon).

The trouble is most likely to be due to a defective valve and/or poor contact between valve pins and sockets. Clean and scrape the pins of all the valves except the line output valve and boost diode and put a drop or two of switch cleaner in each holder. Then while the set is working tap and rock each of the valves in their holders to see if any cause visual effects. If so replace them. Also put a drop or two of switch cleaner on the system switch contacts. If the contrast varies when you wobble the aerial plug in its holder there is probably a crack in the soldering between the centre pin and the feed to the coaxial cable to the tuner—resolder if necessary. The two PCL84 valves in this chassis are both liable to give trouble—if they look old, change them. Note that the setting of the preset contrast control (top left-hand corner) is very important in this chassis—if set too far the result will be a flat picture. Adjust the main contrast control to full before adjusting the preset contrast control for a slightly over-modulated picture: then readjust the main contrast control as necessary. (Pye 11U series.)

DECCA CS2213

There is an unusual field linearity fault on this set—an approximately one inch cramped vertical band towards the top of the screen. New valves have been tried, the field linearity circuit thoroughly checked and the field output transformer replaced but the fault persists.—T. Grant (Woolwich).

If you have been used to servicing monochrome sets you may not have noticed that the PL508 field output valve has a screen feed resistor (R418), especially as this is situated on the power supply board rather than the timebase board. The fault you describe is generally due to this component being faulty. (Decca series 10 chassis.)

BUSH TV125

The problem with this set is sound but no raster. The line whistle faded away slowly and the high-wattage resistor below the line output valve started to overheat. The line timebase valves have all been checked and found to be up to standard.—R. Plover (Bradford).

The resistor you mention is the line output valve screen grid feed resistor. It seems likely therefore that the associated 0·1μF decoupling capacitor 3C19 is shorting, robbing the screen grid supply. Check this. If 3C19 is o.k. it would appear that there is no supply to or from the PY88 boost diode. Check the choke to the valve's top cap and the choke connected to pin 9 on the base.

PHILIPS G19T210

The problem with this set is bent verticals. The fault seemed to start after an open-circuit dropper section was replaced. Suspecting mains hum I replaced the smoothing block but this made no difference. A slight improvement can be obtained if the contrast control is advanced.—B. Greene (Salford).

The fault is likely to be in the phase comparator circuit used in this chassis. Check the voltages around the sync pulse amplifier/phase comparator valve (V2003). A positive reading at the grid (pin 2) of the comparator section indicates leakage in C2057 (0·0015μF) which feeds back reference pulses from the line output transformer. The fault could well be due to C2052 (20μF) which decouples the h.t. supply to this stage. If necessary try transposing the two ECC82 valves, then check C2053 (150pF) which couples the pulses from the amplifier section to the anode of the comparator section of the valve. The thermistor (R2153) in the flywheel sync filter circuit is also suspect—try replacing it temporarily with a 100kΩ resistor. As a last resort check all smoothing electrolytics. (Philips 210 chassis.)

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TELEVISION JULY 1974

TEST CASE

139

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 Ferguson colour receiver fitted with the 8000 series chassis was said to be suffering from intermittent colour which could sometimes be corrected or precipitated either by channel changing or by retuning to a selected channel. As the fault appeared only once during the period of inspection at the viewer's home the receiver was brought into the workshop for a protracted soak test.*

After some hours' operation the colour disappeared on a camera change and it was found that by critically adjusting the fine tuning streaks of colour could be obtained followed by good colour lock. As the receiver temperature increased so the symptom became more apparent. Neither the luminance performance (good black-and-white picture) nor the sound was affected by the colour fault.

Oscilloscope testing proved that the composite video signal was present at the detector output and that the chroma signal was getting into the chroma channel, also that the signals here were unaffected by the fault condition.

In view of the symptom and the results of the tests carried out where was the most likely fault area and what steps should be taken to isolate the source of the fault? See next month's Television *for the solution and for a further item in the* Test Case *series.*

SOLUTION TO TEST CASE 138

Page 379 (last month)

An insight into the fault condition described last month was given by the loading on the line output valve control grid circuit by the test instrument. Since making a meter check at this point restored both picture width and brightness one would suppose that the grid circuit was incorrectly loaded. It will be recalled however that the grid circuit components including the v.d.r. were found to be in order. Normally if a grid return resistor goes open-circuit either the valve "blocks" or its bias is changed sufficiently to cause severe overheating. Neither of these symptoms was apparent.

The only possibility left was the pulse feedback from the line output transformer to the v.d.r. This was found to be via a 10MΩ resistor in parallel with a 270pF capacitor from a tap on the line output transformer to the top of the v.d.r. The capacitor was in order but the resistor had gone open-circuit: a replacement completely cured the trouble. The capacitor couples the pulse voltage to the v.d.r., the resistor giving a d.c. datum which was deleted by its being open-circuit.

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