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ECC84	0·28	EL84	0·22	KT74	0·63	PEN46	0·20	R52	0·34	U31	0·30
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ECC807	1·70	ELL80	0·75	M8162	0·63	PL36	0·47	TP2620	·98	U49	0·56
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ECF82	0·26	EM81	0·39	N78	2·05	PL81	0·44	UAF42	0·49	U76	0·24
ECF86	0·64	EM83	0·75	N108	1·40	PL81A	0·48	UBC41	0·45	U78	0·20
ECF804	2·10	EM84	0·31	N308	0·95	PL82	0·30	UBC81	0·40	U107	0·92
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ECH42	0·60	EM87	0·35	N359	0·44	PL84	0·30	UBF89	0·30	U251	0·65
ECH81	0·27	EY51	0·33	P61	0·44	PL302	0·58	UBL21	0·55	U281	0·40
ECH83	0·39	EY81	0·35	PABC80	·33	PL504/500	0·62	UC92	0·35	U282	0·40
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ECL82	0·30	EY87/6	·30	PC95	0·53	PL509	1·30	UCF80	0·33	U404	0·38
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ECL86	0·35	EZ40	0·40	PCC85	0·26	PX25	0·98	UCL82	0·33	VP23	0·40
EE80	0·60	EZ41	0·42	PCC88	0·41	PY33/2	·50	UCL83	0·48	VP41	0·38
EF22	0·63	EZ80	0·21	PCC89	0·45	PY80	0·33	UF41	0·50	VT61A	0·35
EF40	0·49	EZ81	0·22	PCC189	·48	PY81	0·24	UF42	0·60	VU111	0·44
EF41	0·58	EZ90	0·20	PCC805	·58	PY82	0·24	UF80	0·35	VU120	0·60
EF42	0·33	FW4/500	0·75	PCC806	·67	PY83	0·26	UF85	0·34	VU120A	·60
EF54	0·98	FW4/800	0·75	PCF80	0·28	PY88	0·32	UF86	0·63	VU133	0·35
EF73	0·75	GZ30	0·34	PCF82	0·30	PY301	0·58	UF89	0·27	W76	0·34
EF80	0·22	GZ32	0·41	PCF84	0·40	PY500	0·95	UL41	0·54	W107	0·50
EF83	0·48	GZ33	0·70	PCF86	0·44	PY800	0·33	UL84	0·31	W729	0·60
EF85	0·26	GZ34	0·48	PCF87	0·77			UM80	0·33	X41	0·50
EF86	0·29	GZ37	0·67	PCF200	·67			UR1C	0·53	X63	0·33
EF89	0·23	HABC80	·44	PCF800	·60					XE3	5·00
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6BW7	·50	DY86	·23	EY86	·28	PL504	·61
6F1	·57	DY87	·23	EZ80	·20	PY81	·23
6F23	·67	DY802	·30	EZ81	·21	PY82	·24
6F25	·51	EABC80	·30	KT61	·54	PY800	·32
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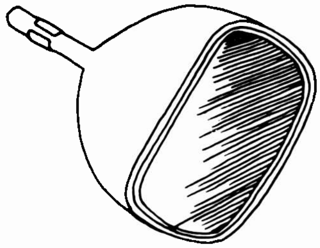

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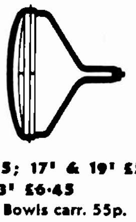

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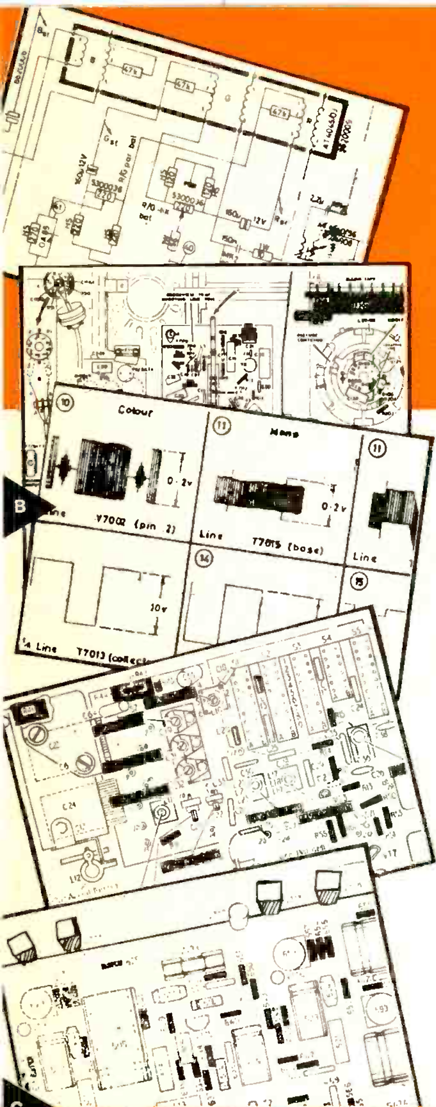

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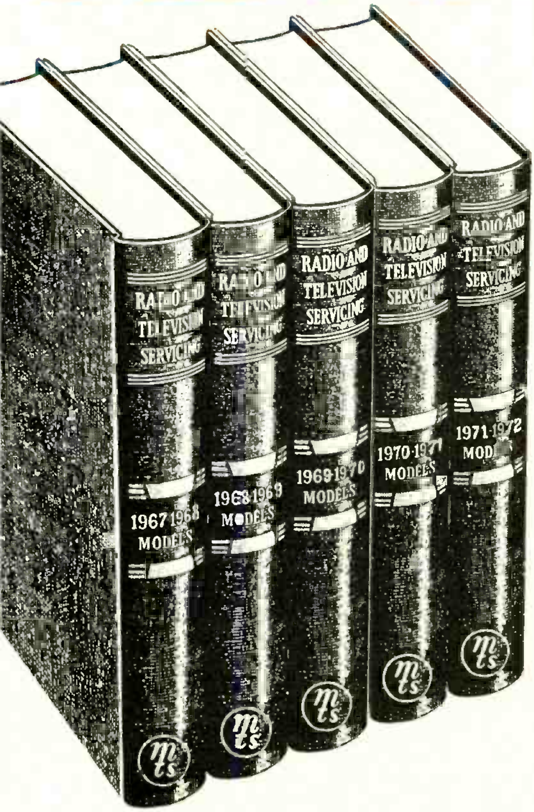

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TELEVISION

SERVICING·CONSTRUCTION·COLOUR·DEVELOPMENTS

VOL 22 No 7
ISSUE 259

MAY 1972

PIPE DREAMS?

To many observers piped television may have seemed to be slumbering gently in the background. New developments however are thrusting it back into the foreground, the catalyst strangely enough being a relative minnow in the world of relay TV. Greenwich Cablevision (with 13,000 subscribers) has obtained from the Minister of Posts and Telecommunications a licence to relay locally-originated programmes. This is a purely local, non-profit-making service designed to explore the visual presentation of local events and affairs. It is however a fundamental policy reversal: relay companies have previously only been allowed to feed their subscribers with a diet of generally available off-air programmes originated by the BBC and ITV. It is significant that Rediffusion (the world's largest piped TV company with over one million subscribers) have announced that they too will be applying for licences for one or more of their 200-plus networks in the UK. The Minister has said he is willing to discuss other applications.

It is likely however that only some half-dozen licences will be granted, on an experimental basis, before the BBC/ITA charter renewals in 1976. Nevertheless the new policy is a straw in the wind for future developments in domestic TV. One has only to look at local programming trends in North America and to a lesser extent Europe to get an idea of what may be in store for us. At the simplest level programmers provide details of time, weather, local news, etc. Some companies however have small studios for live broadcasts and use portable VTRs to tape local happenings. In the USA the FCC has introduced new regulations specifying that cable systems must provide one non-broadcast channel for each broadcast channel in addition to a public access, a state and local government and an educational channel, with surplus channels made available for lease to all potential users. On top of this all new cable systems must have two-way capability: with viewer response facilities built in, new vistas open.

The mind boggles at the possibilities, especially with viewer response capability. Surely it is only a matter of time before services such as facsimile newspapers, community TV, banking facilities and hosts of others appear. Leading perhaps to the ultimate horror, "communicating to work": a pipe dream or part of the evolution of man's environment from "free range" to "battery"?

W. N. STEVENS, *Editor*

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THE NEXT ISSUE DATED JUNE WILL BE PUBLISHED MAY 15

Hold-overs: We have devoted much of our space this month to getting started with the Colour Receiver Project, giving complete details of the decoder. In consequence a number of articles we had planned to include have had to be held over. We shall be resuming *Colour Receiver Circuits* next month and also hope to be able to publish the concluding instalment of our series on *ICs for Television*.

TELETOPICS

FREEZING THE PICTURE

One of the greatest problems of TV as an information medium is that once the programme has passed on to something else that's it, no matter how carefully you wanted to study some particular detail. The problem is not insoluble however and RCA have demonstrated what they call a home TV information centre. This consists of a console with two TV screens. One of these is used to display the off-air picture: the other can display a frozen shot so that this can be examined in detail. Individual pictures can be frozen by pressing a button, a silicon storage tube being used to store the individual frame and display it as required. The system has been developed at RCA's Princeton Research Centre. Something else to look forward to!

TV SET DEVELOPMENTS

It seems that we are on the threshold of a lot of changes in the design of TV sets. We have been particularly struck by details of a recent German Grundig colour chassis not yet used in models on sale in the UK. First the line output stage is the design using thyristors that we featured in our March issue—the ITT one for use with 110° shadowmask tubes—but used with a wide-neck 110° tube! Then the thing fairly bristles with i.c.s—11 of them at a quick glance at the circuit (needless to say about two yards long!)—four of which are in the—wait for it!—touch-sensitive channel selection unit! Isn't anything going on at home then? Well for a start it looks as if the days of discrete component i.f. strips are numbered. A provisional specification is around for a Plessey Microelectronics i.c.—type SL437B—which is a composite TV i.f. section providing the following: vision i.f. amplifier with a.g.c., synchronous vision demodulator, intercarrier sound amplifier plus quadrature detector and d.c. volume control, gated a.g.c., delayed a.g.c. output for the tuner unit, a.f.c. output, and a video noise inversion system—the video output is compared with an internal reference voltage slightly above peak white and any noise above this level is returned to mid-grey. That's a hell of a lot for one chip!

Well now back to current releases. Pride of place here goes to **BRC** who have introduced their first solid-state monochrome receiver. The first model to use this new chassis is the **Marconiphone** Model 4816, a mains/battery receiver with four optional extra sets of battery leads for different d.c. systems. The set has a loop aerial and a personal earphone socket. Recommended retail price is £59·50. It is fitted with a 12in. tube giving a picture diagonal of 11·6in. Note that: we're about to diverge for a minute! The recent TV set case (not involving BRC in any way) under the Trade Descriptions Act has put the whole industry into a bit of a tiswas since as we all know the tube sizes we glibly quote by long accustomed tradition as picture sizes are actually the maximum tube diameter measured from one extremity of the glassware to the other! (No one ever got round to including the mounting lugs!) And this it seems will no longer do. Although we've all known all along what was actually meant by say a 19in. model probably it's best that in future the customer should actually get the screen size suggested in sales literature. So anyway following the now famed case you've got to watch what you say. If you say a set is fitted with a 19in. *tube* that's OK under the Trade Descriptions Act: so long as you don't say the set is a 19in. model implying that the screen is in some way measurable to the viewer actually 19in. On then to the next releases, from **Pye.** Two new colour receivers here, the CT201 at £250 (fitted with a 19in. *tube*) and the CT202 at £279 (fitted with a 22in. *tube*), incorporate the new 697 series chassis. This is similar to the previous 693 chassis but uses a new varicap tuner unit with improved signal-to-noise characteristics. From **Saba**—marketed by Lampitt Electronics—comes the second 110° colour set to appear on the UK market, the S3715G Telecommander. This features a remote control system with an ultrasonic unit (do you remember those old Murphy sets, the V659XS series, back in 1962?) operating at a nominal 20kHz and powered by a 1·5V cell to give control of volume, colour, brightness, channel selection and switch-off from any part of the room. The recommended retail price of the set including the remote control unit is £420. Lastly this month a new 10in. tube import, the **Toshiba** Model 10TB, which is being distributed by Hanimex (UK) Ltd. This portable mains/battery model carries a recommended retail price of £75·95, features a dark tinted screen and black filter to eliminate glare and reflection and is available with either a red or a white high-impact moulded polystyrene case.

Back to the thyristor line output stage for 110° colour receivers: ITT have now introduced in this country the two fast thyristors, types BT119 and BT120, and two fast turn-off rectifiers, types BY189 and BY190, for this circuit. They can be employed in circuits for use with thin- or thick-neck 110° tubes.

Mullard have introduced a new transistor for use in line timebase driver stages. The BD232 has a V_{cer} rating of 500V enabling it to be operated from the full output stage h.t. supply so that maximum advantage of scan rectification can be achieved without the need for complex and expensive circuitry.

ITT Semiconductors have introduced a new video output transistor, type BF137, to supersede the BF117 in the ITT range. The *V*ceo is 160V and power dissipation at 25°C ambient temperature 680mW.

TRANSMITTER NEWS

With the start of ITV transmissions from **Selkirk,** which carries Border Television programmes on channel 59 (horizontal polarisation, receiving aerial group C), the ITA has completed Phase One of its main u.h.f. station building plans. This is the twenty-seventh main high-power transmitting station to be opened by the ITA since the start of their colour service in November 1969. The ITA has also opened four more relay stations: **Saddleworth,** carrying Granada programmes on channel 49 (receiving aerial group E), **Bromsgrove** carrying ATV programmes on channel 24 (receiving aerial group A), **Tunbridge Wells** carrying Thames Television and London Weekend Television programmes on channel 41 (receiving aerial group B) and **Mynydd Machen** near Caerphilly carrying HTV Wales programmes on channel 23 (receiving aerial group A). The ITA u.h.f. service now reaches 84% of the population.

The BBC Wales u.h.f. service from **Blaenplwyf** is now in operation on channel 31 (receiving aerial group A with horizontal polarisation). The BBC-1 service from the **Chesterfield** relay station on channel 33 (receiving aerial group A) and the BBC-2 service from the **Bath** relay station on ch. 28 (aerial group A) are also now both in operation. The polarisation for all these ITA and BBC relay services is vertical.

1971 TRADE RESULTS

Set deliveries to the trade in 1971 were at 2,685,000 the highest annual total since 1959 and represented a rise of 16% over 1970. The advance was due to the increase in colour set deliveries which at 917,000 for the year represented a rise of 82%. There was a very small drop of 2% in deliveries of black-and-white sets. So dealers should be rubbing their hands and if the prediction of Sydney Parker, Chairman of the National Television Rental Association, that the number of colour sets in people's homes will double this year they will be able to continue doing so!

THE NEW AVOMETER

Our note on the new Avometer, Model 72, under the heading *For the Service Engineer* last month was rather hurriedly prepared from advanced information and did not give a very accurate account of the ranges. These are as follows: d.c. volts 1, 2·5, 10, 25, 100, 250 and 1kV f.s.d.; a.c. volts 10, 25, 100, 250 and 1kV f.s.d.; direct current 0·05, 1, 10, 100, 1,000mA f.s.d.; resistance 1Ω-20MΩ f.s.d. in three ranges. The meter uses a centre-pole movement—a completely new development—for its good self-screening properties and mechanical reliability under shock and vibration and close-tolerance thick-film modules. A single selector switch covers all ranges.

STEREO RECORDS FROM TV

Sound facilities which make it possible to produce stereo disc records from "on-location" television recordings have been brought into use by Thames Television. The company has been using its new sound dubbing system—called the "Medway"—with a new mobile sound control room designed to provide facilities normally found only in modern recording studios for a recently completed series of 13 shows featuring Tony Bennett at "The Talk of the Town". The use of the Medway synchronisation system enables separate music, effects and dialogue tracks to be recorded on an eight-channel Scully recorder on location for later dubbing, balancing and transfer to edited v.t.r. tapes at Teddington studios. During sound dubbing and editing a helical-scan Sony recorder is used for atmosphere and checking. This is locked to the audio tape by means of a ten-bit binary address code. The audio machine is similarly locked later to the quadruplex v.t.r. broadcast machine during the production of the final edited programme.

There have been—in Japan particularly—a number of moves towards the use of stereo sound with TV. Could this be another pointer to future developments along these lines here?

TV ICs FOR THE CONSTRUCTOR

Those TV i.c.s we've been talking about in recent issues are now becoming available to the constructor. Chromasonic Electronics of 56 Fortis Green Road, London N10 3HN, stock the following i.c.s in the Mullard TBA range: TBA500 at £3·15; TBA510 at £3·08; TBA520 at £3·20; TBA530 at £2·40; TBA540 at £2·40; TBA550 at £2·40; TBA750 at £2·05. Brief details of these i.c.s were given in our March issue (*ICs for Television*, part 6) and further details will follow. They also have the Plessey/RBM i.c.s mentioned in our November issue, the SL435/SL901 colour demodulator at £2·00 and the SL436/SL917 colour signal processing i.c. at £2·90. The Plessey intercarrier sound i.c. type SL432 is available at 87p.

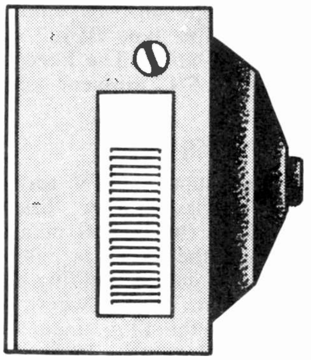
PORTABLE TV SCREEN

An experimental 16cm. TV screen that can be attached by lead to a TV set to provide TV viewing in different rooms has been produced by a USSR plant at Lvov. The attachment has its own sound, brightness and contrast controls and is intended to be mass produced.

LONG DISTANCE TELEVISION BOOK

Many readers will recall the saga of Roger Bunney's Long Distance Television pamphlet late last year. The demand was overwhelming and after wearing out the Roneo masters there was only one answer left—to do a properly printed book. This naturally enabled the coverage to be expanded and in particular a number of illustrations, both line and half-tone, to be added. An advance copy has landed on the Teletopics desk and an attractive and very worthwhile effort it is: full marks Roger! The information contained includes details of TV transmission standards, modes of long distance TV signal propagation, receiver requirements, colour reception, aerials, preamplifiers, interference, off-screen photography and station identification. Copies (at 50p each, post included) can be obtained from Weston Publishing, c/o 58 Ticonderoga Gardens, Weston, Southampton SO2 9HD to whom POs and cheques should be made out.

Renovating the RENTALS



CALEB BRADLEY B. Sc.

3 PYE 11U AND COMPANIONS

THESE are 19 and 23in. sets which share one of the most popular rental chassis made and which can now be bought fairly cheaply—see end of article. An enormous range of models from about 1963 to 1965 is involved bearing the names Pye, Pam, Invicta, Nightrider, Ekco, Ferranti and Dynatron. Two sets from the range are shown in our first photograph: most are of similar appearance with only minor electrical variations. The common ex-rental models are mainly the Pye 3, 11, 12, 13, 14, 15 and 20, Pam 5100 to 5141, and Ekco T418 to T433. The Pye and Pam model numbers have the suffix letter U if a u.h.f. tuner is fitted, otherwise there is space to add one. We shall concentrate on the Pye Model 11U here, the full circuit of which is shown in Fig. 3 (during the lengthy life of this model there were however a number of minor component variations).

Few chassis can compare with this one for accessibility. If two screws at the top of the chassis are removed it can be partly swung down: inspection of the bottom hinges will then reveal how by removing two further screws the chassis can be swung down completely as shown in our second photograph. The chassis layout is shown in Fig. 1. The circuit component references are clearly printed on the wiring boards.

If the u.h.f. and v.h.f. tuners have to be removed from the cabinet one may be baulked by the impossibility of pulling off the tuner knobs. The trick needed is to slide a slim screwdriver behind the knob and push in a locking peg in the neck of the knob: it then comes off easily.

When returning the chassis to its upright position make sure the system switch linkage re-engages correctly. The way it should mate up will be obvious.

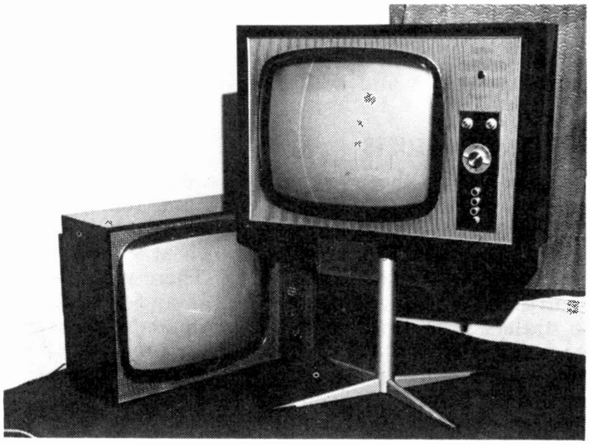
One model is remarkable in having an entirely plastic cabinet, albeit with imitation wood grain. This set, the Pye 12, is visible at the top of the March issue cover. If the set is laid on its face on a soft surface and the screws at the back loosened, the single moulding which forms the rear, sides and top (plus a separable plastic grille at top rear) can be lifted off. Usually these plastic cabinets stand up as well or better than the conventional wood ones, except that the heat produced by the mains dropper can melt the top into strange shapes if ventilation is restricted!

Stock Faults

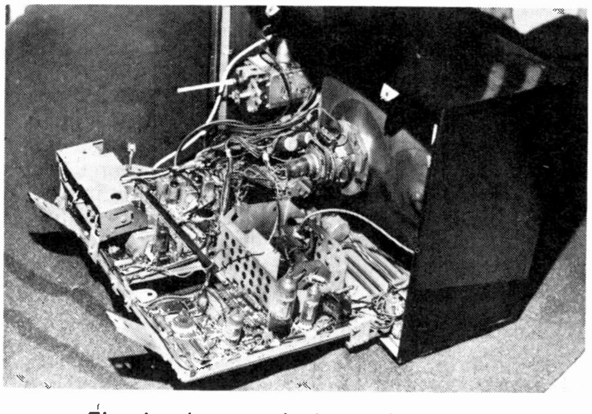
The u.h.f. and v.h.f. aerial sockets are a weak point and should always be given a quick check. They may not grip the aerial plug well, or the solder connections on the socket panels may need remaking.

Fine tuning on v.h.f. is by a plastic knob on a spindle which projects through the back of the set, behind the v.h.f. tuner. The action is to press the knob inwards to engage the fine tuning screw for the channel in use. Unfortunately this control is rather vulnerable and often gets broken off. The spindle can be replaced fairly easily using ¼in. dowel and Araldite, and in any case the v.h.f. tuner is sufficiently stable not to need frequent retuning once the screws are correctly set.

A rotary-tuned u.h.f. tuner is used on most models, with a little window above the tuning knob showing



Two 19in. sets from the Pye 11U series. On the left an Invicta 7194U and at the right on the pedestal a Pye 23F. Most other models in the series are similar.



The chassis swung horizontal for servicing.

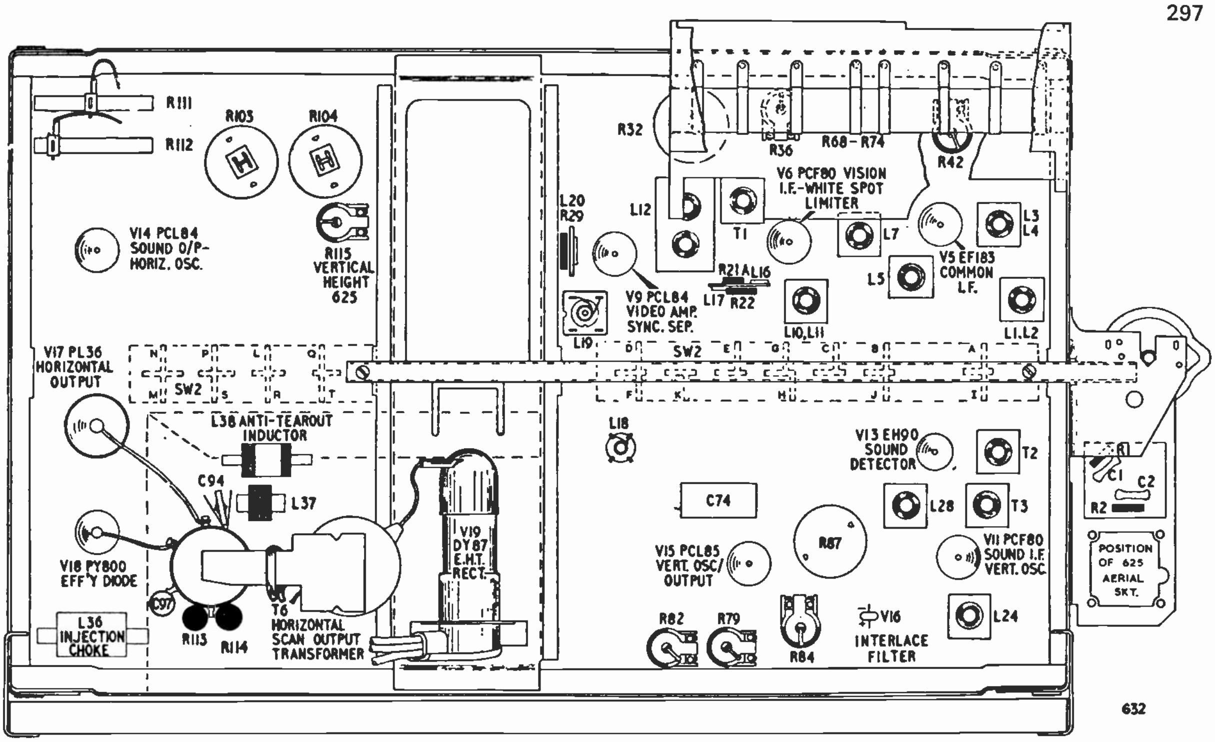


Fig. 1 : Chassis layout (Pye 11U) from the front. L38 and C94 are not fitted on chassis using flywheel sync. Early versions have a single preset contrast control, later versions two, one for each standard.

the channel in use. A rather hairy cord arrangement drives a plastic drum printed with channel numbers 21 to 67, seen through the window. If the cord breaks or snarls up it is necessary to remove the complete tuner assembly and lace the cord as detailed in Fig.2.

Grainy pictures on u.h.f. only can almost always be cured by replacing the u.h.f. tuner valves (PC88 and PC86) since these are bound to have aged after several years' use.

VHF Tuners

Several types have been fitted and none seem to give much trouble except for the usual dirty contacts. It is important to fit the correct valves as a mistake can burn up components in the tuner. The pairs of valves used by different tuners that may be encountered are PC97/PCF86, PCC89/PCF86, PCC89/PCF801, PCC189/PCF86 and 30L17/30C17. In each case the former valve is the r.f. amplifier which is located farthest from the fine tuner control.

Contrast Troubles

There is a preset contrast control on these sets which operates in the conventional way by feeding positive current into the a.g.c. line. The operator's contrast control at the back of the set (R32) is a high-level type which feeds the c.r.t. cathode with video from the video output valve anode. The idea of this arrangement is that the sync separator receives the full video level whatever the viewing contrast, hence sync stability is good. The main contrast control may give an abrupt change of contrast at a point in its travel, indicating that the track has broken. Although this control is a 25kΩ centre-tapped potentiometer it is not essential to use a centre-tapped replacement and a higher resistance value is acceptable. Connect C36 to the slider of such a replacement.

Low Gain

Loss of gain on both 405 and 625, resulting in a thin, low-contrast picture and little or no sound, usually has its cause in or about the first i.f. amplifier (V5 EF183). If replacing the valve brings no improvement check all its pin voltages with special attention to the cathode (pins 1 and 3). This should

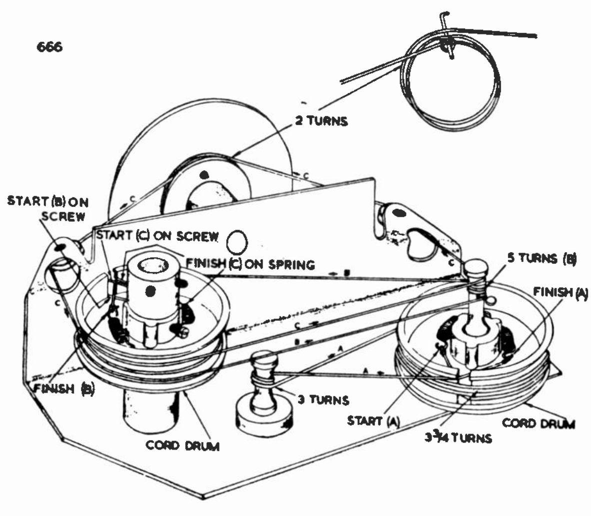


Fig. 2: This diagram shows exactly what to do if the u.h.f. tuner drive cord breaks !

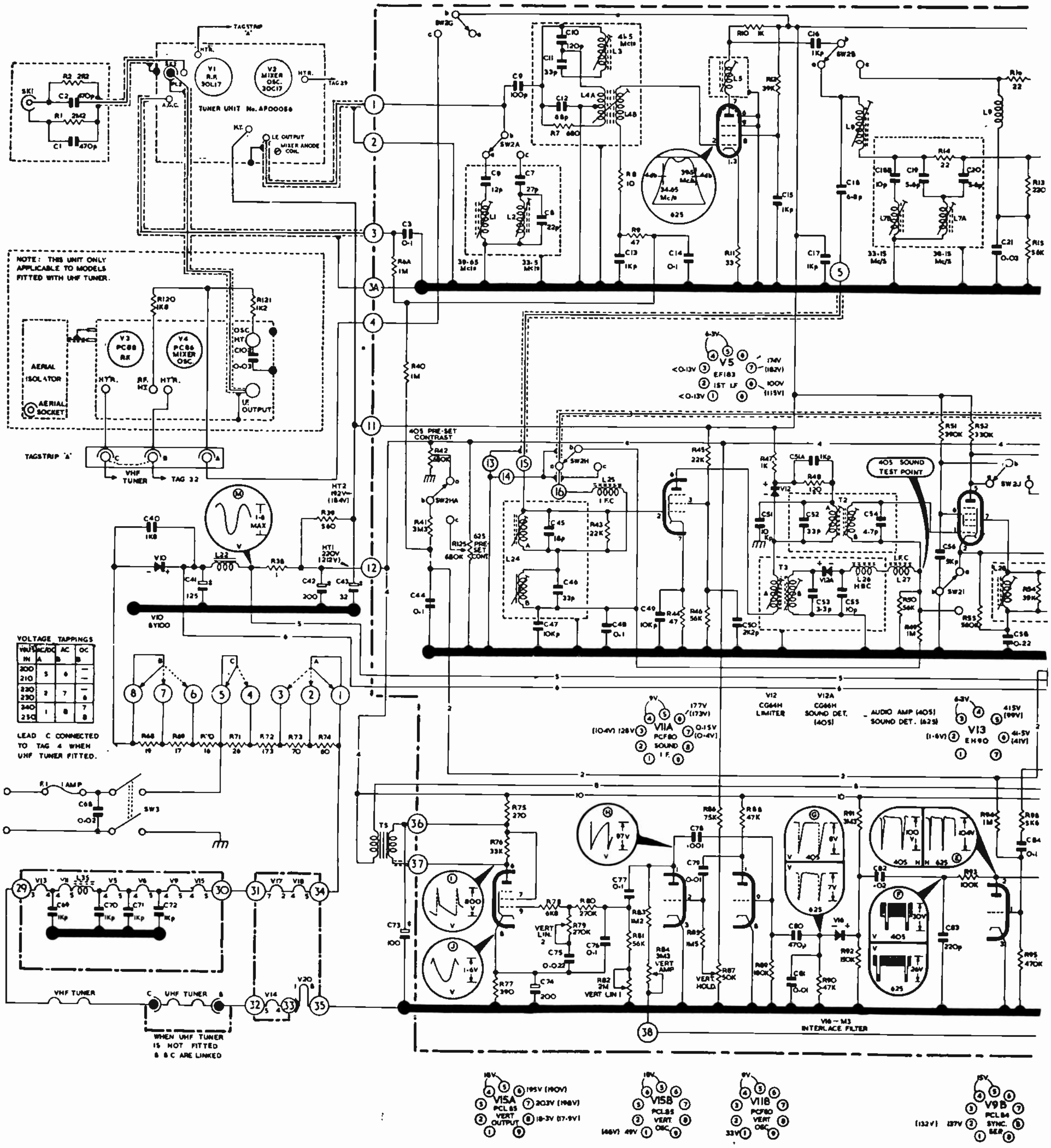


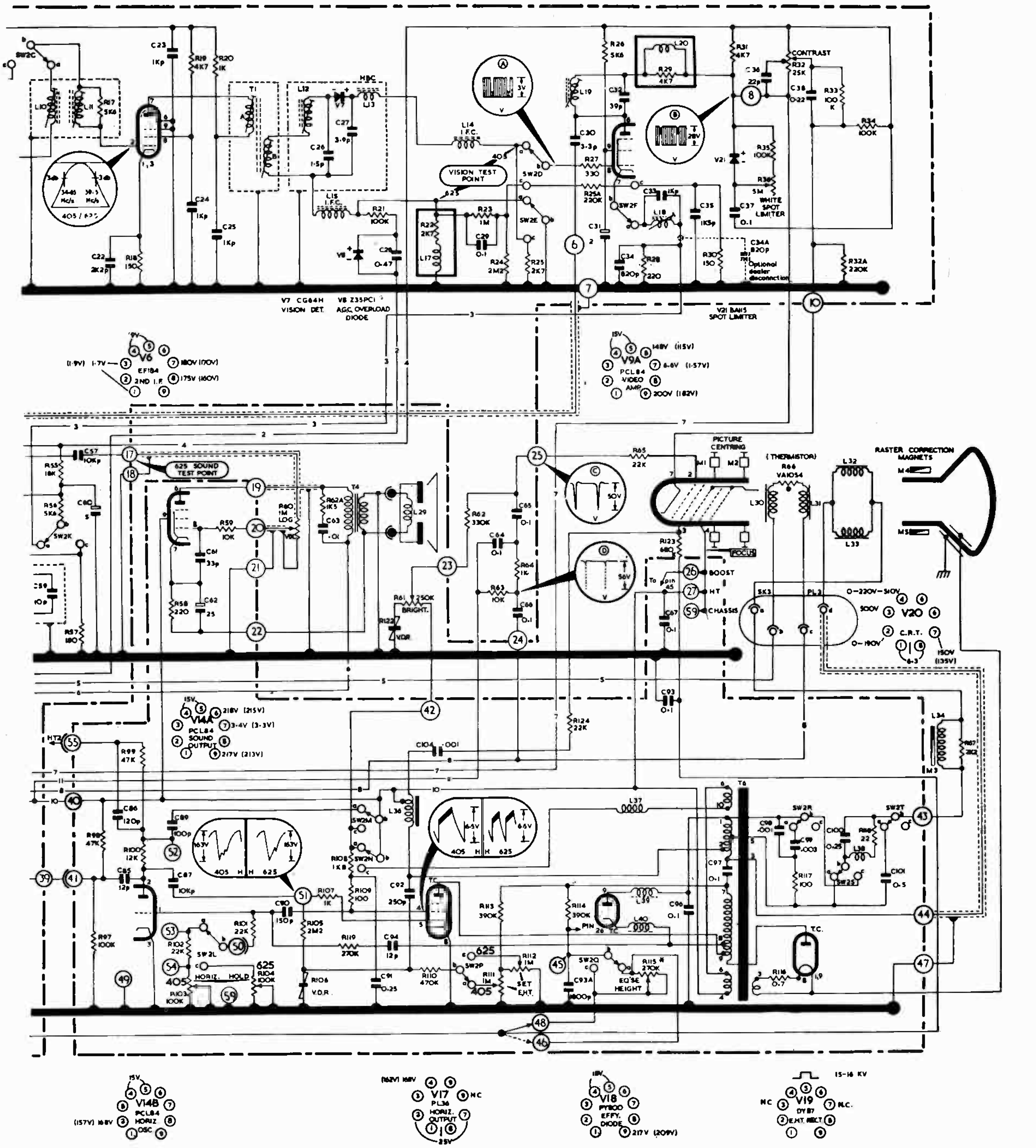
Fig. 3 : Circuit diagram, Pye 11U series. There were several minor circuit changes during the long production run of these potential divider across the h.t. supply. The system switching (SW2) is

run at 0·13V with no signal and decrease when a signal is tuned in. Incorrect readings may be due to the screen feed resistor R12 (39kΩ) changing value but very often the preset contrast control R42 (270kΩ) is the culprit. Inspect it for slider contact troubles or cracks in the track. If this control is not doing its job of inhibiting the a.g.c. there will be virtually no picture or sound and V5 cathode will be at about 0V. In later versions of the chassis separate 680kΩ preset controls for 405 and 625 lines are used as shown in Fig. 3.

Loss of gain in the first i.f. stage has also been found to be caused by adjacent turns of L5 shorting. This is not shown up by d.c. voltage tests. The offending turns must be carefully prised apart to regain performance.

Cross-Modulation

Where the received signal is so strong that simultaneous sound-on-vision and vision-on-sound interference occurs first see if this can be removed by



models. In particular in earlier versions there was a single 270kΩ preset contrast control and V5 screen was fed by a shown in the 405-line position. Some sets are fitted with a flywheel line sync board.

adjusting the preset contrast control(s). If this is not effective it is useful to know that the situation can be improved by removing the 47kΩ resistor which on earlier versions is connected from the screen grid of V5 (pin 8) to chassis (in parallel with C15): remember that this will reduce the i.f. gain on all channels.

625 Sound Buzz

One's first reaction to the common symptom of intercarrier sound buzz, which varies with picture content and is especially strong when captions are displayed, is to look for the balancing preset in the 625 sound ratio- or phase-discriminator circuit. The surprise on this chassis (and some GEC group models) is that neither of these common double-diode f.m. sound detectors is used; instead there is a locked-oscillator quadrature detector circuit using a heptode valve (V13, EH90).

It works as follows. After being picked up from the video amplifier (V9A) by L24B and amplified by V11A the 6MHz f.m. sound signal is applied via

T2 to grid 1 of the EH90. A 6MHz tuned circuit L28/C59 is connected to grid 3 which is the other control grid of the heptode. Electrical coupling exists between grid 1 and grid 3 due to space charge conditions inside the valve, so the signal makes L28/C59 oscillate. The space charge coupling has a reactive component such that L28/C59 oscillate about 90° out of phase with the signal and cannot follow its frequency modulations instantly.

The EH90 is best thought of as a kind of "AND" logic element, i.e. it can only conduct when both control grids are positive. Clearly since the signals at the two control grids are 90° out of phase it conducts during part of each 6MHz cycle only. What is less obvious is that when there is a slight change in this phase difference, due to the tuned circuit being slow to follow the modulation of the signal frequency, the width of the conduction pulse changes. Effectively the circuit converts the 6MHz f.m. signal into a 6MHz width-modulated pulse train at V13 anode. This only has to be smoothed (done partly by C61) to regain the audio modulation.

625 Sound Alignment

When correctly aligned the circuit has good a.m. (i.e. vision signal) rejection but for this the setting of L28 is quite critical. It is easy to align the whole 625 sound channel if a strong signal is available since the 6MHz intercarrier frequency is precisely fixed at the transmitter. Using a proper hexagonal plastic trimming tool adjust L28, T2 (upper and lower cores) and L24B (lower core) for maximum sound and minimum buzz. Two "buzz minimums" may be found for L28—choose the one with the core closest to the front of the set.

General Sound Faults

On 405 the EH90 just acts as an audio driver. Failure of 625 sound and partial or complete failure of 405 sound should direct attention first to the audio output valve (V14A, PCL84) and then to the EH90 since this valve has more electrodes than usual to go wrong. Voltage checks on all pins can be revealing, especially if R51 or R52 has changed value.

Field Timebase Faults

Inadequate height normally makes one suspect the field output valve (V15A PCL85) and its cathode bypass electrolytic (C74, 200μF) but on these sets it is often caused by R83 (1·2MΩ) in series with the height ("vertical amplitude") control R84 changing value. A difference in height on 405 and 625 should be cured by adjusting R115 ("equalise height") which compensates for the slightly different boost voltage supplies to the field oscillator from the line output stage on the two standards. If R115 seems to need adjustment beyond its zero resistance extreme try moving the flying connection from tag 48 to tag 46 instead.

Line Timebase Faults

Besides the usual line output stage faults (see last month's "General Fault") there are with this chassis two peculiar ones either of which can cause intermittent operation. One is an intermittent open-circuit

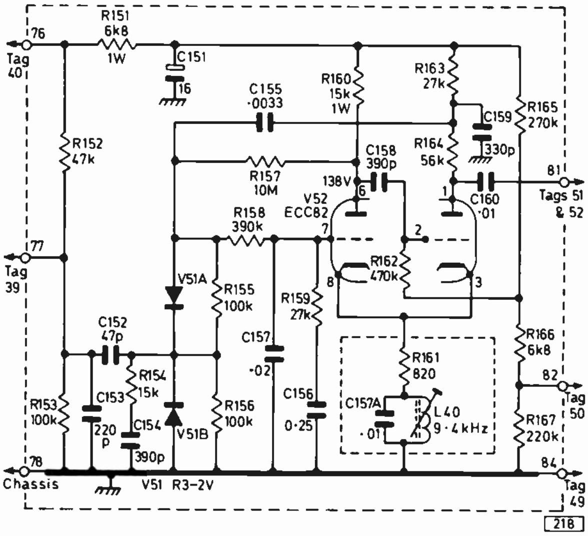


Fig. 4: Several different flywheel line sinc boards are used with this series of models—this is the one generally encountered. A signal generator is needed to set L40.

of the line output valve screen feed resistor R108 (1·8kΩ, 6W wirewound). The other is failure of the "set e.h.t." preset for 405 or 625 (R111 and R112 respectively). If the slider of one of these fails to make contact with the track the picture width shrinks due to the line output valve (V17, PL36) control grid charging excessively negatively, with only R105, R106 and R107 in series to act as a grid leak.

Unless you have an e.h.t. voltmeter to set the e.h.t. to 16kV the "set e.h.t." presets are best left alone or set for just adequate width. Overdriving the line timebase will shorten the life of the line output transformer T6 which is not particularly long-lived on these sets. Replacements are readily available though and are not hard to fit if one keeps track of the original connections.

This chassis, in common with many others, uses a desaturated line output transformer: the boost capacitor is C97, h.t. being fed to the stage via L36.

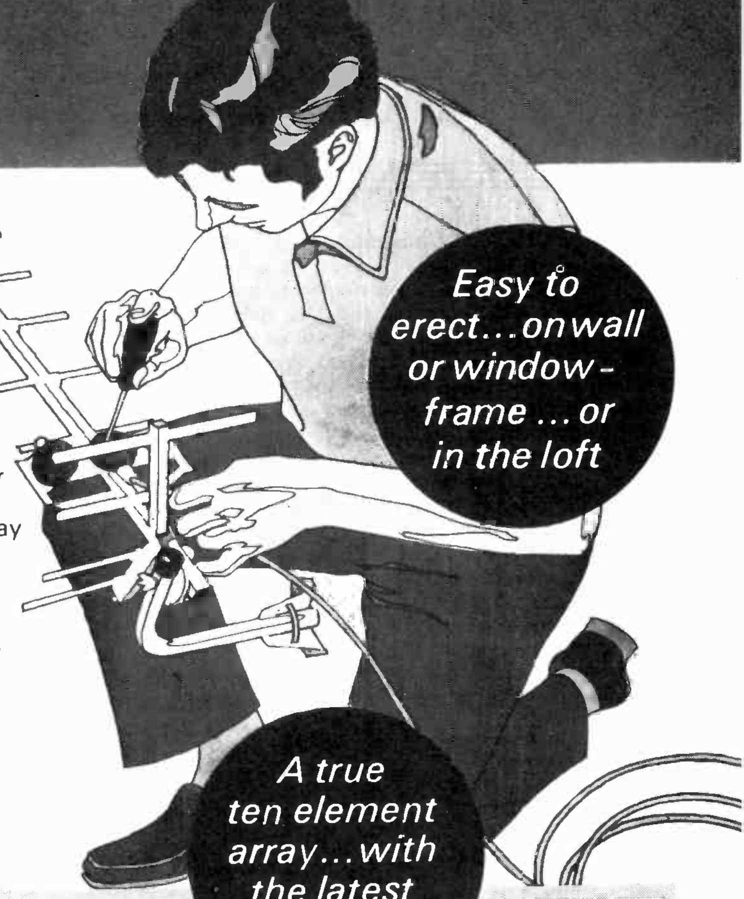
Flywheel Sync

Models with a suffix letter F, plus some others, are fitted with an extra "piggy-back" board which provides flywheel sync facilities. Three different boards have been used. The circuit of one, which has an ECC82 (V52) acting as a cathode-coupled multivibrator, is shown in Fig. 4. This gives excellent line hold stability and any line speed troubles can usually be cured by replacing the ECC82. The flywheel diodes V51A and B sometimes fail giving a no picture, no whistle situation. S shaped verticals may be due to C151 drying up or to similar loss of capacitance of the main h.t. smoothing capacitors C41 and C42.

The way the flywheel sync board fits into the full circuit can be found by following the tag numbers. The previous line oscillator triode V14B becomes redundant when this flywheel board is fitted although a 1MΩ resistor is thoughtfully left feeding h.t. to its anode to prevent cathode poisoning. Regular TELEVISION readers will surely need no prompting to try turning this spare triode into something useful such as a black-level clamp, or an h.t. regulator, or a

—continued on page 304

Now...here's a do-it-yourself aerial kit!



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wideband BAND I aerials

Roger BUNNEY

The wideband aerial has made itself known in recent years for use on Band III and at u.h.f. There has, however, been little or no demand for an array with total Band I coverage in the UK mainly because a common BBC-1 programme is transmitted on all Band I channels with only the occasional regional variation. In the Americas and other parts of the world alternative programmes are available on the channels in Band I (Low Band to use the American term) so that aerials for this use with a wide or semi-wide bandwidth are commonly available.

For long-distance television reception (TV-DX) and for use in certain areas overseas where alternative programmes are available from neighbouring countries, a wideband Band I array is extremely helpful, especially if used with an aerial rotor unit. It overcomes the need to erect separate arrays for each Band I transmitter and the inconvenience of replugging aerial feeders: instead a single high-gain array with maximum performance on all the required channels is employed.

Wideband Band I arrays have been in very limited use in the UK for a number of years, mainly for TV-DX use. Unfortunately however commercial wideband Band I arrays are not readily available as there is so little demand. There also appears to be a lack of any information on aerial design for wideband Band I coverage. To this end this article presents three such designs together with basic information on how they were evolved.

Basic Aerial Characteristics

A half-wave dipole cut to a particular frequency will absorb maximum signal energy from an electromagnetic field oscillating at that frequency. The bandwidth of a single half-wave dipole depends to some extent on the diameter of the rods used for the dipole elements and the frequency. It is common practice to use ½in. elements for Band I and ⅜in. thickness elements for Band III. These diameters allow sufficient bandwidth to cover a single channel efficiently.

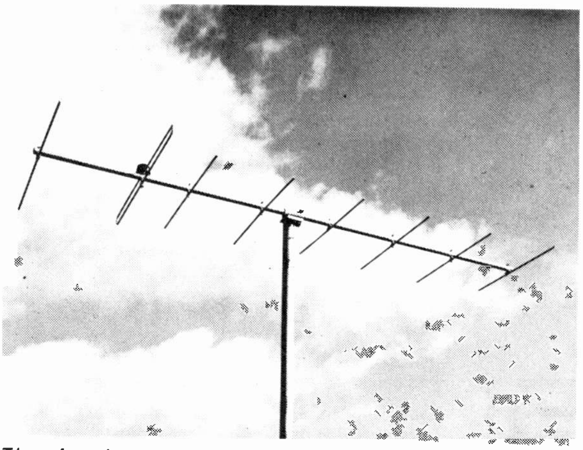
The impedance at the centre of a half-wave dipole is 75Ω and to achieve maximum transference of signal energy to the receiver, cable having a characteristic impedance of 75Ω must be used. Coaxial cable having a characteristic impedance of 75Ω is normally used in the UK but alternative feeders and impedances may be encountered in other parts of the world. Ribbon feeder with an impedance of 300Ω is, for example, commonly used in Europe and the Americas. If the aerial does not match the feeder accurately there will be signal loss, the amount depending upon the extent of the mismatch. Similarly if the cable is terminated with a device such as a receiver or aerial amplifier that does not present an accurate match to the cable impedance further losses will result. Reflections will occur due to the mismatch and an effect known as standing waves will be set up. This effect is measured as the ratio of the maximum to the minimum current or voltage along the line and is termed the standing wave ratio (S.W.R.). A further point to bear in mind is that the thickness of the dipole elements affects both the bandwidth of the system and the dipole impedance.

Yagi Array

To increase the gain of an aerial system additional elements can be added adjacent to the dipole. Such elements mounted in front of the dipole are known as directors and are slightly shorter; elements mounted behind the dipole are known as reflectors and are slightly longer than the dipole. Unfortunately increasing the gain of an aerial system by adding such elements (known as parasitic elements) lowers the dipole impedance. The extent of the variation of the dipole impedance and the gain of the array depend upon the spacings of the parasitic elements relative to the dipole. Consequently to use such an array some method is necessary to return the dipole impedance to 75Ω so that there is a correct match to the feeder.

Matching and Bandwidth

The single dipole can be folded, giving a four times increase in impedance. Alternatively the dipole can be tapped at a point where the impedance is 75Ω: this method is known as delta matching. The bandwidth of a folded dipole array will tend to widen somewhat, whereas the delta matched array will remain relatively unaffected. A close study of the many current commercial u.h.f. arrays shows that various methods are adopted to give an accurate match over the bandwidth of an aerial group. J Beam make use of a special transformer—their patented inverse balun. Aerialite and Antiference use specially shaped dipole



The Astrabeam wideband Band III array type ABM8 (J Beam Engineering Ltd.).

units with variations in the element thickness. The purpose of this is to reduce the capacitive and inductive reactance swing either side of the dipole resonance point in an effort to maintain a central 75Ω dipole impedance to match into the feeder. On such arrays the director and reflector elements are cut to dimensions somewhat greater than the usual 5% limits used on many single-channel aerials. This is done to obtain the required wide bandwidth operation. The J Beam Astrabeam Band III array (see photograph) which has a 170-220MHz bandwidth is an example of this method of tuning the active and parasitic elements to various frequencies within the desired bandwidth: the reflector is tuned to the low-frequency end, the dipole to mid-band and the director(s) to the high-frequency end of the band. The J Beam inverse balun ensures that an accurate impedance match is obtained over the band.

Arrays for Band I

We can in a similar manner construct an array for Band I with a coverage over the band and reasonable performance. It is impossible without the use of expensive measuring equipment to produce an array which gives an accurate match over the band but the designs shown (Figs. 2-4) will enable the constructor to produce an array with a reasonable performance sufficient for all but the most demanding requirements.

The problem of matching accurately into 75Ω over a bandwidth of 30MHz at Band I is considerable. Consequently two of the designs use a conventional straight (unfolded) dipole whilst the third one goes some way to achieve an improved match over the 30MHz bandwidth by using a parasitic dipole. Despite the apparent disregard for matching on two of the designs the performance is adequate over the bandwidth and good results have been obtained over a number of years by long-distance television enthusiasts.

All three designs use elements tuned to various parts of the desired bandwidth. In each case the reflector is tuned to the low-frequency end of the band at 40MHz, the dipole is cut to mid-band at about 55MHz and the director(s) to the high-frequency end at 70MHz. Additional reflectors may be added to improve the front-back ratio.

Practical Designs

The designs shown in Figs. 2 and 3 are basically similar. J Beam's three-element design has coverage over 40-70MHz, with the 75Ω coaxial feeder connected directly to the straight dipole. J Beam comment that with such an array a voltage S.W.R. of 3:1 can be expected over the total bandwidth and the

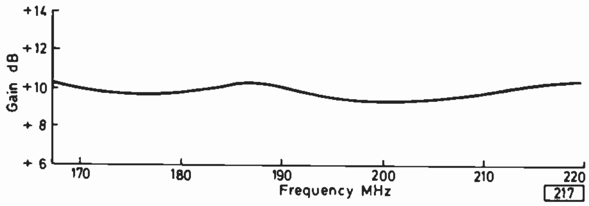
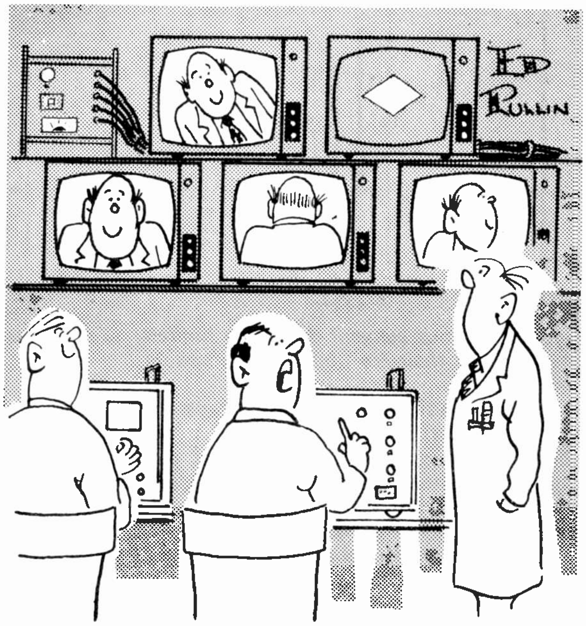


Fig. 1: Gain/frequency characteristics of the Astrabeam Model ABM8, showing the level response over the bandwidth.



"Check for an offside flat on No. 1 dolly!"

Antenna Engineering Handbook by Jasik states that a practice has been established for a 3:1 V.S.W.R. with a two-band array and 2:1 for a single-band array.

The array designed by Ian Hickling (Fig. 3) is similar but has rising gain at the h.f. end of the band. It gives a gain of 6·5dB at 40MHz rising to 8·5dB at 70MHz. Reference to the *Antenna Engineering*

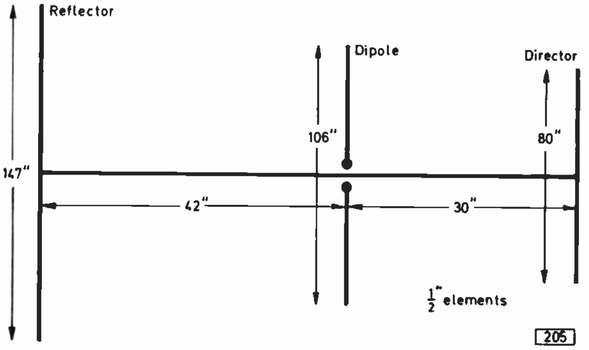


Fig. 2: Three-element design by J Beam.

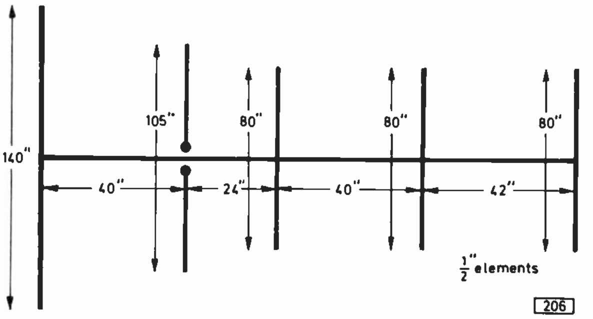


Fig. 3: Five-element design by Ian Hickling.

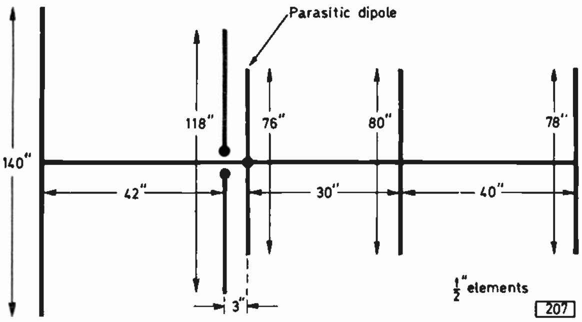


Fig. 4: This four-element design by Antiference Ltd. uses their Tru-Match dipole system.

Handbook indicates that with arrays of this type (i.e. having several directors) there is a tendency for a slight fall in gain over the central part of the frequency bandwidth. For our purposes however this effect can be ignored. Ian Hickling comments that the advantages of a single-radiator system (it is often more convenient to consider a receiving dipole in its reciprocal role as a transmitting element) are that the reflector and directors steer the radiation from the point source in a more predictable manner than would happen if multiple radiators were used to obtain a wide bandwidth coverage. This results in a cleaner polar diagram.

The third design (Fig. 4) shows a suggested wideband array by Antiference Ltd. with a measure of impedance correction over the extended bandwidth. Antiference comment that: "The length of the driven dipole is longer than half wave so as to be inductive at the lowest frequency while the parasitic dipole is less than half wave so as to be capacitive at the highest frequency. This produces at resonance a resistive impedance higher than that obtained with a single straight dipole (which would be much lower than 75Ω in the two examples shown in Figs. 2 and 3) while at frequencies off resonance the reactive swings are much lower due to the mutual correction provided by each dipole element. The ratio of driven to parasitic element length increases as (i) the transformation impedance ratio required increases and (ii) as the required bandwidth of the array increases." Antiference also suggest that a certain amount of experimentation around the dimensions given may help, particularly the dipole lengths.

Reflector

Each design uses a reflector tuned to 40MHz. The bandwidth could however be decreased somewhat, say to 45MHz. The formula $468/f(\text{MHz})$ gives the resonant length in feet. A double or even triple reflector configuration as shown in Fig. 5 could be used. This will have little effect on gain but will improve the front-back ratio somewhat.

Results

The Ian Hickling design has been in use for several years by long-distance television enthusiasts in various parts of the UK and has given extremely good account of itself. At my previous location in the Romsey, Hampshire area I was able to receive the IOW Ventnor relay at some 30 miles on a daily basis despite a very shielded location and a hilly transmission path. In

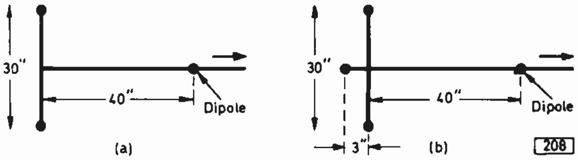


Fig. 5: (a) Double reflector; (b) triple reflector.

passing it is worth pointing out that although an array of five elements possesses fairly good directivity which is ideal for weak Tropospheric signals it can be a disadvantage with Sporadic E signals: I have on more than one occasion missed signals from Finland on ch.E2 with my array aimed to the south-east whilst a near colleague tuned to the same channel was receiving weak signals from the Finnish transmitter using an omni-directional Band I. array. Thus it may be better to use a three-element design to exploit its wider forward acceptance angle despite its lower gain. It is of course essential to use three elements in order to obtain the required resonant points and hence the bandwidth.

Finally we are looking into the possibility of a companion wideband aerial amplifier using field effect transistors for use with these wideband Band I arrays.

Acknowledgements

Our grateful thanks for information and assistance to: V. R. Hartopp, J Beam Engineering Ltd., Northampton; F. J. Tomlin, Antiference Ltd., Aylesbury, Bucks; and I. Hickling, Moulton, Northants.

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Antenna Engineering Handbook, edited by H. Jasik, published by McGraw-Hill Book Company.

RENOVATING THE RENTALS

—continued from page 300

cathode-follower hi-fi sound output, or a spot-wobbler, or an audio preamp for feeding a record pickup or microphone into the television . . . ! The other boards use a flywheel sync controlled blocking oscillator arrangement: with these V14B is used either as the oscillator or as a phase-splitter driving the flywheel sync diodes.

Spares

The service organisation is Combined Electronic Services Ltd., 604 Purley Way, Waddon, Croydon, CR9 4DR. Telephone 01-686 0505. In all enquiries it is important to quote the chassis reference number (prefixed RV) as well as the model number.

Availability

R-B Television, 82 North Lane, East Preston, Sussex, have stocks of these sets which are sold unselected and only in "as-is" ex-rental condition. When ordering specify Pye 11U series and the screen size required: 19in. price £16 plus £1·50 carriage, 23in. price £19 plus £2·10 carriage.

SERVICE NOTEBOOK

G. R. WILDING

Poor Contrast

THE importance to time saving of checking all coincident symptoms no matter how small when tackling a faulty set was clearly brought out when we were recently testing a set fitted with the ITT-KB VC1 chassis for the complaint of poor contrast. The rear-mounted contrast control appeared to operate normally while as the picture was free of grain the aerial and tuner could be discounted. The cause of the trouble was therefore likely to be a low-gain i.f. stage, high-resistance vision detector diode or a defect in the video stage.

On changing the rotary tuner from a dead to a live channel however the contrast level was observed to increase for a brief fraction of a second. This clearly suggested an a.g.c. fault and that while the a.g.c. potential was very small on no signal it rose excessively on signal input, the brief delay being due to the time-constant of the a.g.c. system.

We removed the base inspection panel and although we did not have the circuit diagram to hand the i.f. and tuner a.g.c. rails were readily identifiable by the two clamping diodes which, with their cathodes connected to chassis, prevent the rails going positive. On just touching the i.f. a.g.c. rail with the meter test prod the gain improved greatly while on shorting the rail to chassis the contrast became excessive. In this chassis—as in most valved types—the negative potential developed at the sync separator grid is used as the a.g.c. voltage, backed off by a positive potential from the contrast control potentiometer shunted across h.t. and chassis. In addition (see Fig. 1) a small negative feed is taken from the grid of the line output valve in this chassis—to ensure that some negative bias is always present. Tests showed however that although the voltage at the slider of the contrast control advanced from zero to the h.t. rail potential as the control was rotated clockwise there was never any positive voltage present at the end of R73 which couples the contrast control to the a.g.c. circuit. Due to the high value of this resistor (4·7MΩ) there would of course be only a small meter deflection anyway, but on temporarily shunting R73 with the meter set to its 500V range the contrast became normal. Clearly although R73 was almost open-circuit it must have had some slight conductance otherwise the contrast control would have been inoperative while the fault persisted.

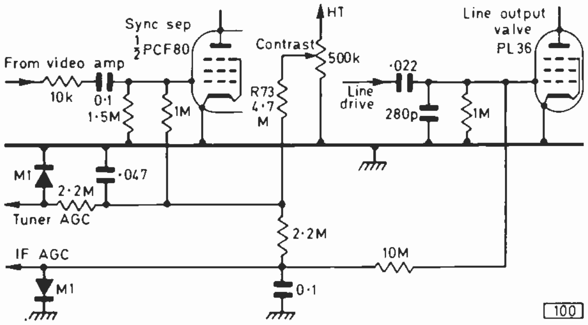


Fig. 1: A.G.C. circuit used in the ITT-KB VC1 chassis.

We replaced R73 and restored normal results. But the main point is that observing the very brief burst of contrast which occurred when changing the tuner from a dead to a live channel position had undoubtedly saved much time in unnecessary valve changing and voltage checking.

In another of these receivers v.h.f. reception was intermittent though u.h.f. reception was always constant. Naturally our first move was to replace the PCF801 v.h.f. mixer for although the pentode section is used as an i.f. amplifier on u.h.f. the intermittency could well have been due to failure of the triode section to oscillate. The fault persisted and after replacing the PCC89 v.h.f. r.f. amplifier—also without success—we started checking voltages.

There are several components mounted on the top of the push-button tuner and we found that an 11kΩ resistor had the full h.t. voltage at one side but zero voltage at the other. This resistor was not discoloured and had not therefore been burnt out as the result of a short-circuit. On referring to the manual we discovered that the resistor was R9 and supplied h.t. to the triode section of the PCF801. On replacing the resistor normal results were obtained and it became apparent that the occasional loss of v.h.f. results had been due to one of the leadout wires failing to make contact with the composition interior of the resistor. This type of resistor failure frequently occurs if the assembler unduly stretches the readout wires, subsequent thermal changes finally causing a complete or intermittent break.

No Sound or Vision

No sound or picture was the complaint with a Sobell Model 1038 and on removing the cabinet back the reason was obvious—a 15Ω replacement resistor which had been previously fitted by someone across an open-circuit section of the h.t. dropper had become unsoldered and fallen on the chassis below. We resoldered it into position but this time first mechanically secured it with short pieces of stout-gauge single-strand wire around the tags. This unsoldering of a replacement dropper section frequently occurs when a short-circuit develops in a receiver causing excessive heater or h.t. current.

Tests confirmed however that there was no short-circuit, so the set was switched on, producing an excellent picture but very distorted sound. A new PCL84 audio valve somewhat improved the sound quality but it was obvious that a major fault was present in the a.f. circuitry. On turning the cabinet upside down the underside of the PCL84 was exposed and the 1kΩ feed resistor to the pentode screen grid

—continued on page 309

COLOUR RECEIVER INSIGHT

S.GEORGE

GRUNDIG 717GB

THE Grundig colour Model 717GB being sold in the UK is a 26in. set which is almost completely transistorised. Only four valves are employed, in the line and field timebases. Colour-difference tube drive is used, with transistor colour-difference and luminance output stages. The latter uses two transistors in what is virtually a super-alpha combination. There are two main i.c.s in the circuit, a TAA640 which provides the intercarrier sound channel and a TAA630 which carries out chrominance signal demodulation, G−Y matrixing and PAL V switching. In addition a small TAA550 i.c. stabilises the supply to the varicap tuner unit. Other interesting features are the use of printed circuit coils in the sound and vision i.f. modules, a field multivibrator consisting of a triode cross-coupled to a transistor, a noise-limiter circuit in the input to the sync separator and a tint control which operates by varying the first anode potential of the c.r.t. red gun. This control is mounted along with the colour, brightness, contrast, volume, tone and picture clarity controls at the front of the cabinet. The picture clarity switch introduces an additional optional series *RC* combination across the emitter circuit of the luminance output transistor. There are four positive and two negative h.t. lines and three positive and one negative l.t. rail.

Luminance Circuits

As fully-transistorised luminance and colour-difference tube drive circuitry has not been used in UK produced colour receivers we will start by taking a look at these sections of the receiver. Fig. 1 shows the video detector D335 and the following emitter-follower stage Tr355 which provides drives to the luminance and chrominance channels and also the a.g.c. circuit. Also shown are the beam-limiting circuit and the initial parts of the luminance channel—the luminance delay line and colour subcarrier (4·43MHz) notch filter. The video detector output developed across its load resistor R335 is negative-going and is superimposed on the base bias for Tr355 which is taken from the junction of R352 and R354. The contrast control is in series with R354 and thus adjusts the forward bias applied to Tr355 and in consequence its gain.

Beam Limiter

The beam-limiter transistor Tr351 is connected across the contrast control circuit. At normal picture brightness levels it has no effect since it is held cut-off by the negative potential applied to its base via R358 and R359. This negative potential offsets the positive potential developed across D566 which is fed via C566 with pulses from the e.h.t. tripler circuit. If the tube beam currents rise to an excessive figure the amplitude of the pulses fed to D566 increases and Tr351 is in consequence forward biased. It then shunts the contrast control circuit, reducing the forward bias applied to Tr355 and thus the drive to the tube.

Switched Notch Filter

The 4·43MHz notch filter is effective on colour only so that the full luminance bandwidth is retained on monochrome reception. On monochrome there

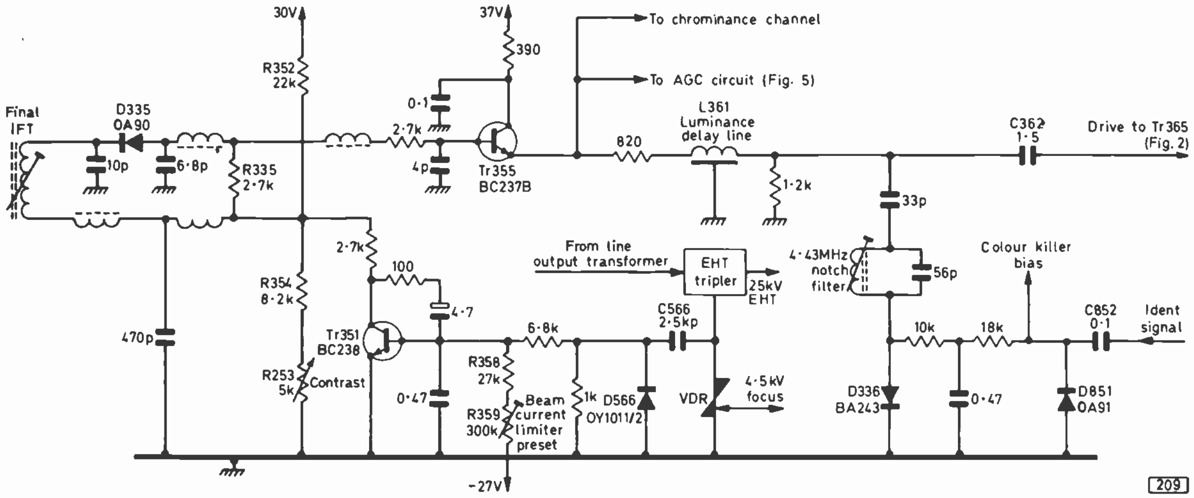


Fig. 1 : The video detector (D335) and the luminance/chrominance emitter-follower (Tr355). The beam limiter (Tr351) acts on the contrast control circuit, pulling back the gain when the e.h.t. rises excessively.

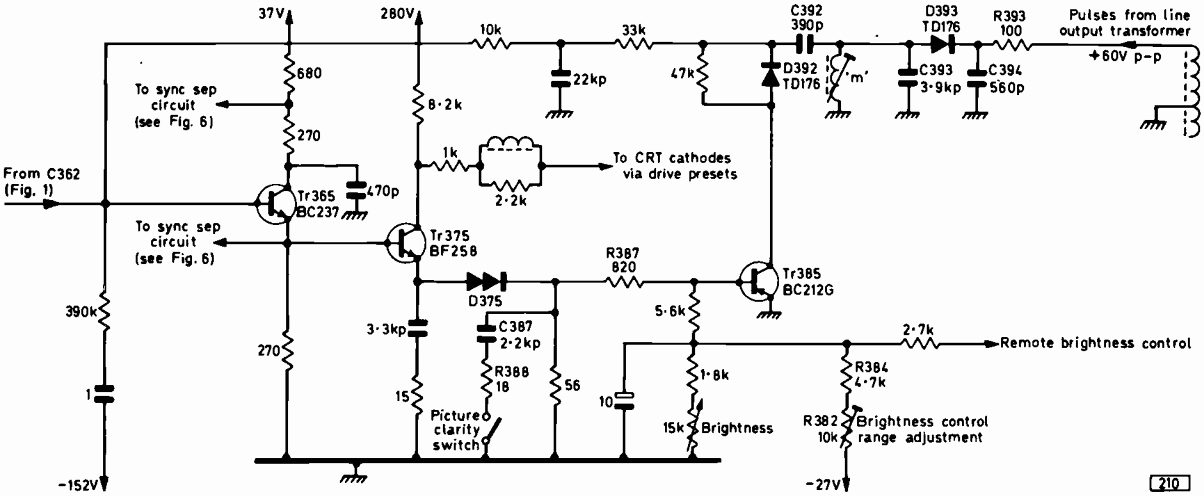


Fig. 2: The luminance amplifier comprises in essence a "super-alpha" pair (Tr365 and Tr375). The black-level clamp transistor (Tr385) sets the bias applied to the first transistor of the pair.

is no forward bias for the diode D336 in series with the earthy end of the filter which is consequently virtually open-circuit. On colour the ident signal appears and is fed via C852 to diode D851 which provides a positive potential to give the colour killer turn-on bias to bring the chrominance circuitry into operation and also to forward bias D336 so that the notch filter is then in circuit to remove the chrominance subcarrier from the luminance channel.

Black-level Clamp

The luminance signal is then fed via C362 to the luminance output stage shown in Fig. 2. This consists of two transistors Tr365 and Tr375 which basically form a super-alpha pair to ensure high gain and, with the high input impedance of this configuration, as little loading as possible on the preceding stage. As capacitive coupling (C362 Fig. 1) is used to Tr365 the d.c. component of the signal is lost so that d.c. restoration or clamping is required at this point. The black-level clamp consists of Tr385. This transistor is a pnp type and its base is fed with a negative potential (via R384 and R382) whose amplitude is determined by the setting of the brightness control, and the luminance signal from the emitter of the output transistor Tr375 via D375 and R387. The clamp action however is controlled by the way in which the collector of this transistor is gated so that it conducts only during the constant-amplitude back porches of the sync pulses (black level). Positive-going flyback pulses from a winding on the line output transformer are fed to D393 cathode. As the winding is tuned by C394 there is a negative-going overshoot following the flyback pulse. This overshoot corresponds in time with the back porch period and switches D393 on. As a result the tuned circuit C393 and coil "m" rings. The initial negative overswing of this ring provides the collector potential required for Tr385 to conduct, and since this occurs during the back porch period Tr365's base bias is adjusted during this time to a level determined by the base circuit of Tr385, i.e. the picture black level and brightness control setting. The use of the tuned circuit with adjustable coil "m" enables the phase of the turn-on pulse for Tr385 collector to be adjusted to give very accurate control of the black-level sampling time.

Picture Clarity Switch

The action of the previously mentioned picture clarity switch is also shown: this introduces R388 and C387 in the emitter circuit of the luminance output transistor, accentuating the h.f. response so the outlines are more boldly defined and the definition generally enhanced.

Colour-difference Amplifier

Having seen then how the luminance signal is amplified with constant black level for application to the cathodes of the shadowmask tube let us see how the colour-difference signals are handled and, also with a constant d.c. level, fed to the appropriate tube grids. The three colour-difference output circuits are naturally very similar and all receive preamplified negative colour-difference signals from the TAA630 i.c. The main difference between the three stages is that the R−Y and B−Y circuits each use a BF259 transistor while the G−Y circuit shown in Fig. 3 uses a BF258

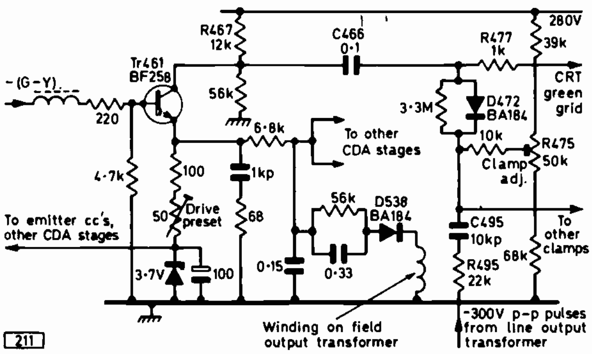


Fig. 3: One of the colour-difference output stages (G−Y). As the output is a.c. coupled to the tube grid a clamp circuit is incorporated. Line and field flyback blanking are also carried out in this part of the receiver.

as the output required is less. The output transistor shown, Tr461, operates as a conventional *RC* amplifier with its output developed across R467 and fed via C466 and R477 to the appropriate grid of the shadowmask tube. This a.c. coupling means that once more a clamp is required to ensure that at the beginning of each line the feeds to the grids are at a constant d.c. potential. The clamping action in the G—Y stage is performed by D472. At the end of each line a negative-going pulse from the line output transformer is fed via R495 and C495 to this and the clamp diodes in the other colour-difference amplifier (CDA) stages so that they are briefly switched on returning the signal coupling capacitors to the potential set by the clamp adjusting preset R475. During the succeeding line of picture information the colour-difference signal adds to or subtracts from this preset d.c. potential in accordance with the instantaneous value of the colour-difference signal. Colour-difference signals vary between positive and negative values to increase or decrease the beam contributions of the individual guns to the picture, and with the luminance drive applied to the cathodes the RGB matrixing is achieved within the tube. The long time-constant of the colour-difference signal feed capacitors (C466 $0 \cdot 1\mu F$ in the green channel) and the associated $3 \cdot 3M\Omega$ resistors across the clamp diodes holds the d.c. grid potential with little loss during the line period.

Flyback Blanking

An unusual feature of this set is that line and field flyback blanking are carried out in the colour-difference circuits. The negative-going pulses used for clamping also perform the line flyback blanking function. Field flyback blanking is carried out by applying negative-going pulses via D538 from a winding on the field output transformer to the emitters of the colour-difference amplifiers as shown in Fig. 3. These negative pulses appear at the collectors and consequently cut off the tube grids. The forward bias required by the colour-difference output stages is supplied along with the signals themselves by the TAA630 i.c.

Chrominance Channel

The chrominance channel was described recently by Gordon J. King in his *Colour Receiver Circuits* series, see the December 1971 issue, Fig. 2 page 65 and the accompanying text, so it is unnecessary to deal with this subject again here. The a.c.c., colour-killer and burst blanking circuits were all fully described in the article referred to.

Line Timebase

The line generator (Fig. 4) is conventional in using a PCF802 with the pentode section as sinewave oscillator (feedback via coil ZO and C614 from screen to control grid) and the triode section as a reactance control valve (acting as a variable capacitance across the coil). C612 and C613 provide decoupling to ensure that spurious signals do not affect the operation of the stage. An unusual feature however is the use of a transistor pulse amplifier (Tr621) between the line generator and the line output valve. A 4·5V p-p pulse waveform is developed across the cathode resistor

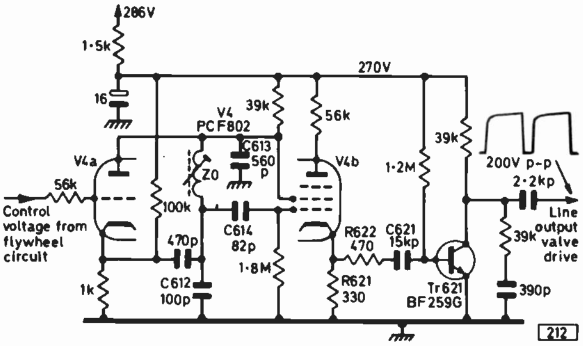


Fig. 4: A conventional sinewave line oscillator is used but with a transistor pulse amplifier (Tr621) to drive the line output valve.

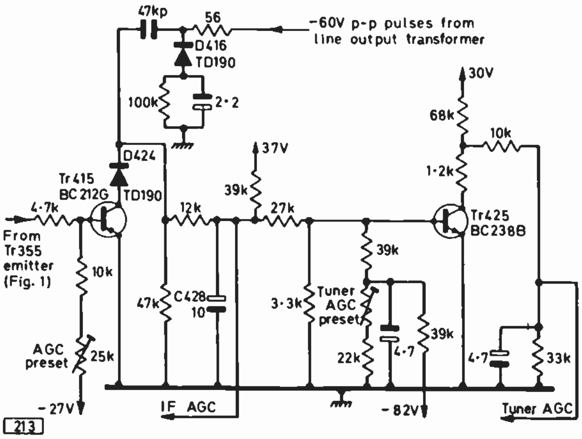


Fig. 5: The sync tip a.g.c. circuit uses a gated amplifier (Tr415). Delayed tuner a.g.c. is provided by Tr425.

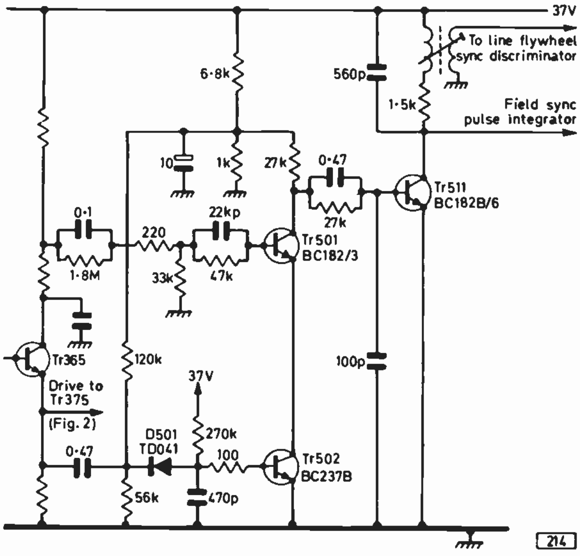


Fig. 6: The sync separator (Tr511) is preceded by a noise-limiter circuit (Tr501 and Tr502) which clips the sync pulses to improve the sync action.

R621 of the line oscillator. After passing via R622 and C621 to the base of the pulse amplifier the p-p value of this pulse waveform is reduced to 1·4V, but as this transistor is a high-voltage type fed from a 270V h.t. line it is able to produce a 200V p-p waveform to drive the line output pentode. A thermal cut-out is included in the cathode lead of the line output pentode to remove the d.c. supplies should absence of line drive, anode voltage or an overload in the output circuit cause excessive cathode current (while absence of anode voltage naturally cuts off the anode current the resulting heavy increase in screen current can amount to several times the normal anode current).

Gated AGC Circuit

A gated a.g.c. circuit (Fig. 5) is used, driven from the post video detector emitter-follower Tr355. The input to Tr415 base consists of positive-going luminance signal with negative-going sync pulses. As Tr415 is a pnp type transistor it conducts on the tips of the negative-going sync pulses, charging C428 positively to provide the a.g.c. potential for the controlled i.f. stage. Gating to ensure that Tr415 is not triggered on by interference pulses is carried out by feeding negative-going line pulses via D424 to Tr415 collector. As this is the only supply to Tr415 collector it can conduct only during the sync pulse period. D416 and its associated components comprise a protection circuit to avoid damage to Tr415. Delayed a.g.c. for the tuner is provided by Tr425 and its associated components.

Sync Circuit

The sync separator Tr511 and its noise-limiter circuit Tr501 and Tr502 are shown in Fig. 6. All these transistors are normally held conductive by the positive feeds at their bases. Negative-going sync pulses appear at Tr365 emitter and positive-going sync pulses at its collector. The former are fed to Tr502 base, cutting it off, whilst the latter are fed to Tr501 base so that it conducts more heavily. Thus when a sync pulse arrives the emitter of Tr501 moves positively while its base is also driven positively. The result of this is a limiting action, with noise on the tip of the sync pulse removed. Thus a clean pulse is produced to drive the sync separator Tr511.

Convergence

The convergence circuitry is interesting in that the static convergence controls do not consist of the usual permanent magnets. Electromagnets whose flux density can be varied by controls on the front-mounted convergence panel are used instead. This arrangement has the advantage that complete convergence setting up can be done from the front of the receiver.

Altogether this is a chassis fairly bristling with interesting technical features. The later 1500/3010 chassis is very similar but uses an i.c. type TBA510 for chrominance signal processing.

SERVICE NOTEBOOK

—continued from page 305

was found to be grossly discoloured and when checked of less than 100Ω resistance.

We replaced this resistor and switched on again. The sound was no better and it was found that there was over 10V at the pentode cathode instead of the scheduled 4·1V on v.h.f. and 3·0V on u.h.f. although an ohmmeter test showed that the cathode resistance to chassis was about 40Ω instead of the 150Ω of the cathode bias resistor R96. It was obvious then that the excessive anode/screen currents of the PCL84 pentode had caused the replacement dropper section to overheat and that the excessive current was due to greatly reduced bias caused by either a heavy leak in the electrolytic cathode bypass capacitor or by a reduction in value of the cathode bias resistor. On removing the chassis the latter was found to be the case and after replacing this component—but leaving in the new PCL84—first-class sound was obtained.

The cathode resistor probably decreased in value first and the resulting heavier screen—as well as anode—current decreased the value of the screen feed resistor, raising the screen grid voltage and further increasing the cathode current in a cumulative manner.

Decoder Fault Diagnosis

JUST how much can be achieved when tracing colour television decoder faults with a voltmeter on its own or in conjunction with a simple probe is well illustrated by the decoder fault location chart recently issued by the GEC/Sobell group, for out of the 22 step-by-step tests listed only three required a 'scope.

The three 'scope tests are (1) At PC28/29, i.e. the 18pF high-pass filter capacitor C301 which feeds the first chrominance amplifier. A burst amplitude of 200-500mV here indicates that the receiver is correctly tuned in and fed with an adequate aerial input. (2) The collector of the ident amplifier Tr330 where a 24-30V p-p sinewave should be present. (3) At the collectors of the bistable circuit transistors Tr332 and Tr333 where 14V p-p squarewaves should be present.

Eleven tests simply require the use of a meter, the remaining eight being carried out with a diode probe linked to a meter having a resistance of 20,000Ω/V (such as the Avo Model 8). Two types of probe are used, both illustrated in Fig. 2, and are invaluable when diagnosing faults in the decoder circuitry of these popular receivers.

While in no way minimising the importance and value of 'scopes—without which many tests and adjustments cannot be made—the fact remains that such meter-probe combinations can enormously aid servicing in the customer's home—and the plain economics of the servicing business mean that faults must be cleared wherever possible on the spot.

Failure of the bistable circuit to operate will of course in any colour receiver result in incorrect hues with Hanover blinds and this can be easily confirmed by voltage tests at the collectors of the transistors concerned for one will then be high and the other low—when functioning normally their *mean* operating voltages will be virtually equal.

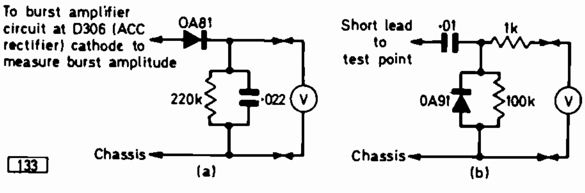
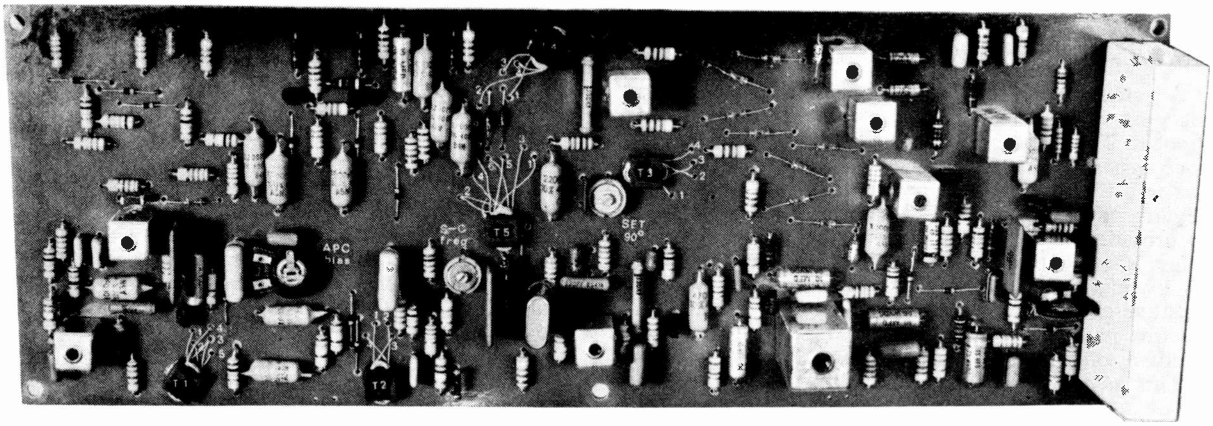


Fig. 2: Voltmeter probes for decoder fault diagnosis. V is a 20kΩ/V meter on its 10 or 25V d.c. range.

THE 'TELEVISION' COLOUR RECEIVER PART 2

PAL-D DECODER



THIS MONTH we give full details of the construction of the PAL-D decoder used in our colour receiver project. This is an extremely important section of the receiver but as its circuitry makes it one of the least critical from the constructional viewpoint it is an appropriate module with which to make a start.

Components

The complete list of components for the decoder is given in Table 1. As can be seen they are grouped in "Component-Packs" which are available from the named suppliers at the prices shown. We don't necessarily suggest that this is the cheapest way of obtaining the components but most constructors will undoubtedly find it the most convenient. It will be noticed from the list that all the components are available from the stockists including the printed circuit board and the inductors used in the circuit. The only complicated constructional work that must be undertaken on this module consists of winding five small transformers on ferrite formers. Details are given later.

The first stage—before actual construction—should be to obtain the complete set of components for the decoder. Note that the coils can be obtained either ready wound or in a kit form ready for the constructor to wind. Full winding details are given but we cannot recommend your own winding unless you have some previous experience. Many constructors will we feel consider the price differential only marginal.

Printed Circuit Board

Some constructors may wish to etch their own printed circuit board in order to save a little money (or to make the project more of a challenge!). As we are unable to print a full-scale drawing of the board in the pages of the magazine we can instead supply to those readers who require it a full-scale copy of the print layout at a charge of 10p (plus a stamped and addressed envelope). The same arrangement will apply to the future circuit boards.

An accurate tracing paper copy of the full-scale drawing should be made and placed over the copper side of a piece of copper-clad board cut to size. Place carbon paper (ink side to the copper) between the tracing copy and the copper and secure the sandwich of these pieces flat by folding over the edges and Sellotaping them on the other side of the board. The layout should then be accurately run round with a fine-tipped ball-point pen so that an ink impression is left on the copper surface (it is useful if the copper is first rubbed down with a proprietary wire wool so that the carbon ink impression is clear). Take care not to miss any parts of the circuit layout.

After removing the tracing and carbon paper the whole copper surface should be covered with overlapping pieces of Sellotape. The wider this tape is the better—$1\frac{1}{2}$in. tape can be obtained quite readily from stationers. The outline of the print pattern should then be run round with a fine-pointed modelling knife so that the Sellotape is cut through without damaging the copper surface. The Sellotape covering the copper *to be left* after etching should now be lifted off with a pair of tweezers and the exposed copper painted over with a cellulose paint (such as car touch-up paint). Allow the paint to harden after being applied fairly accurately with a fine brush. Then lift the rest of the Sellotape off using tweezers and taking care not to damage the painted copper sections especially round the edges. This process leaves the board with the copper exposed where etching is to take place. The etching should be done quickly after the Sellotape coating has been removed to prevent the build up of oxide on the surfaces.

The ferric chloride crystals that you obtained last month should now be ground down into a fine powder (preferably using a mortar and pestle) and then mixed with water to make as concentrated a solution as

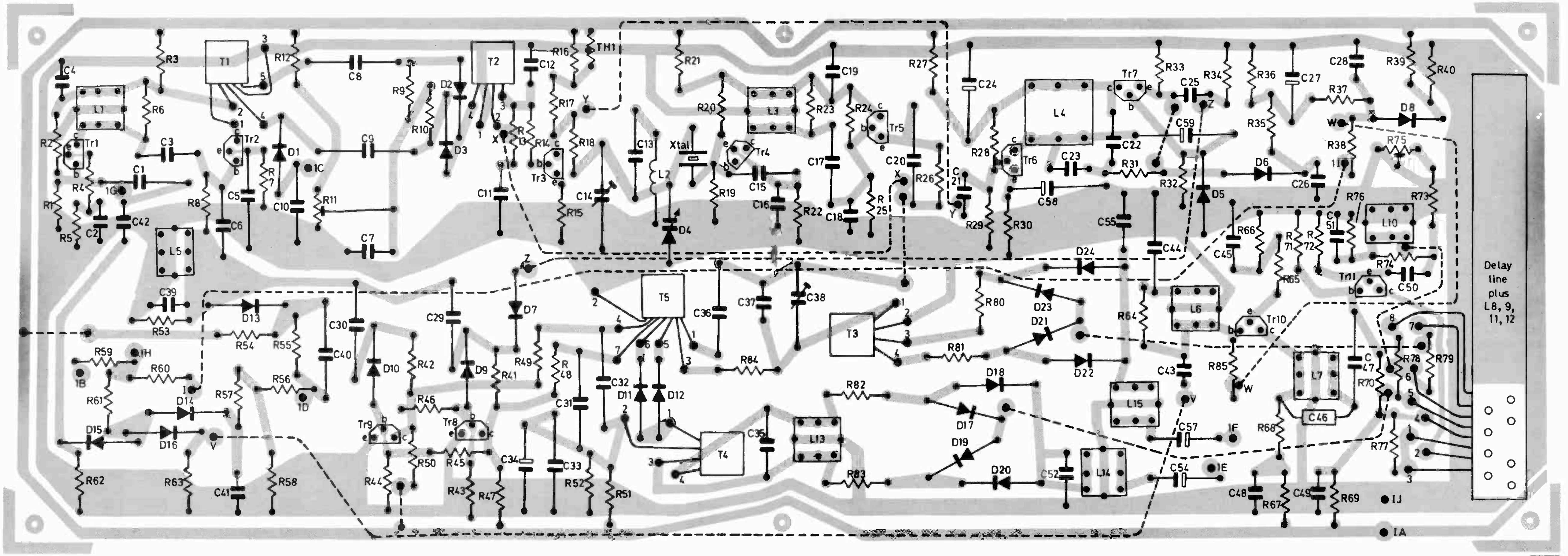


Fig. 1 : Layout of the PAL-D decoder board, viewed from the copper print side. Except for C46 all components are mounted on the other side of the board. Although shown in broken line the jumper leads are on this side. The six mounting holes are $\frac{3}{16}$ in., the coil mounting and pin connection and the delay line mounting holes $\frac{1}{16}$ in., the component and transformer lead holes $\frac{1}{32}$ in. C53 and C54 are mounted inside the screening cans of L14 and L15. The transformer squares indicate the positions in which they are stuck to the board.

possible. If the water is warm this will aid the etching process. The container used for making up the solution should be one that you are able to commit to etching solution use: glass in particular is difficult to get absolutely clean of the ferric chloride. The solution should not of course be made up in a metal container.

The circuit board is large and a suitable etching bath must be found. This should preferably be plastic and it will probably be found that a paint roller tray will be reasonably suitable although with this only half the board can be etched at a time. If possible a large dish designed for photographic work should be used. With the board in the bath and enough solution applied to cover it by about $\frac{1}{4}$in. complete removal of the copper should take about half an hour. With a cold solution or one that is not well saturated with the ferric chloride the etching may take considerably longer. In any case a gentle agitation of the bath will assist. Etching can be speeded by adding a small amount of hydrochloric acid but we consider this unnecessary for domestic work and certainly not worth the safety risk.

Any ferric chloride that gets on your skin or clothes should be washed off with water right away. Should a mishap occur such that the ferric chloride gets in your eyes they should be washed out with a liberal amount of water. If there is *any* sting left after this you should obtain medical assistance without delay.

Once etching is complete wash the board in water and remove the paint from the remaining copper areas. This can be done with a cellulose paint thinner or, rather less messily, with a wire-wool pad saturated with soap. After further washing you have your completed board.

Those who buy the printed circuit board will already receive it in this condition. Holes must now be made in the panel (Fig. 1) in order to mount the components. The majority of the component leads require only $\frac{1}{32}$in. holes but note should be taken of those (coils, trimmers, etc.) that require larger ones (Fig. 1). The six mounting holes around the edge of the board should also be made at this stage. When drilling the board mark off and drill from the copper side. Use a small hand brace and apply only the minimum pressure needed to go through. An excess will only tear the paxolin as the drill breaks through the board.

Check that all the required holes have been made

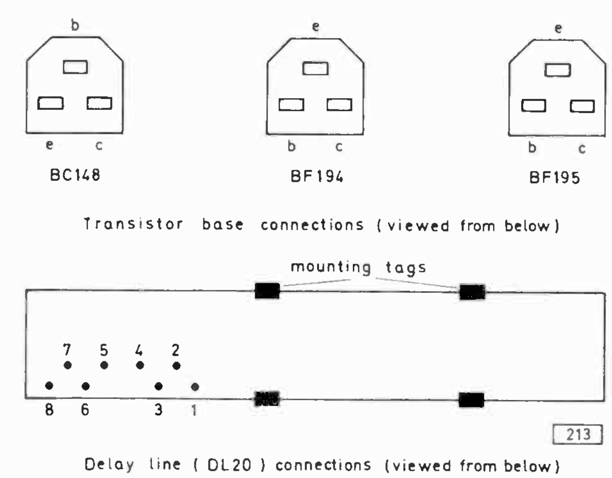


Fig. 2 : Transistor and delay line connections.

and that they are correctly situated. Although none have to be particularly precise some difficulty will be experienced if the transistor and coil holes in particular are not reasonably accurate. Any holes that you miss at this stage will have to be made with components mounted on the board: this is both awkward and liable to cause damage to the components already mounted.

At this stage you should also make the cut-out at the end of the board for the delay line connections. Using the line shown on the diagram as a guide a series of holes, say $\frac{1}{16}$in., should be drilled around the outline, the centre piece knocked out and the hole neatly finished off with a small, flat file.

Coils and Transformers

All the pieces required for winding your own coils can be obtained from the suppliers of Component-Pack No. 3. When ordering make it clear that you want the *kit* of parts.

The winding details are given in Table 2 and Fig. 3. With this information and the kit of parts from the suppliers mentioned the reader experienced in winding coils should have a straightforward job. For those without this experience we would advise the little extra expenditure involved in purchasing the ready-wound set.

There are five little transformers that the constructor must wind on the FX2249 Ferroxcubes in

Table 2: Coil winding data

Ref.	*Former*	*Core*	*Wire (s.w.g.)*	*No. of turns*	*Note*
L1	722/1	6/500	42	55	2
L2	CH2/7/500		42	51	2
L3	722/1	6/500	42	30	2
L4	5014/4E	6 × 1 × 12·7/100	42	1200	3
L5	722/1	12·7/500	42	250	1
L6	722/1	6/500	42	80	1
L7	722/1	6/500	42	65	1
L10	722/1	12·7/500	30	22	2
L13	722/1	6/500	42	30	2
L14	722/1	6/500	42	120	1
L15	722/1	6/500	42	120	1

Wire used may be en cu, ess or similar.
All cores for Neosid 722/1 formers are 4 × 0·5mm.
Choke CH2/7/500 is by Neosid.
L4 former is 0·3 in. diameter.
L8, L9, L11 and L12 are contained in the delay line (DL20) housing.

Notes:

(1) Wave-wound over ¼in.
(2) Wound in a single layer.
(3) Scramble wound over about ⅝in.

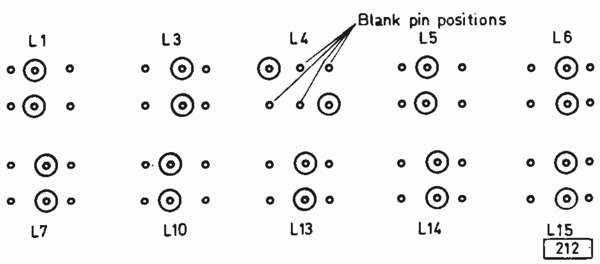


Fig. 3: Coil pin connections: the circled pins are those to which connections should be made.

Component-Pack No. 2. All are wound with 38 s.w.g. wire which should be double-cotton covered (d.c.c.). Enamelled copper wire in particular must *not* be used because when this is passed tightly through the Ferroxcube short-circuits are inevitable.

The turns are wound in and out of the two apertures of the Ferroxcubes forming complete loops around the centre. Details of the windings are given in Table 3. When the wire is passed around avoid kinks and pull each pass through an aperture tight before making another pass. The transformers T2, T3 and T4 are the most straightforward, with the required number of primary turns being put through first and the secondary turns then wound through on top. Mark the wire ends with a piece of lettered Sellotape before proceeding with the the next winding. The markings that should be used are shown in Table 3 and are the same as those used in the circuit diagram (Fig. 7).

The bifilar windings should be made by passing two pieces of wire together around the Ferroxcube. The two transformers having bifilar turns are also the most difficult to wind because the total number of turns is very close to the limit that can be passed through the cube. Some patience is required for these and it is important that all the early turns are tight so as to allow maximum space for the later ones. Provided you mark each winding as you complete it you should have no trouble. Note that the secondary of T5 is bifilar wound but the ends are not connected together. The two wires must be identified with the starts of the windings (using an AVO or other test meter) and marked as shown.

Component Mounting

The order of mounting the components on the board is a matter of taste but our experience provides some guidelines which the reader might care to follow.

When you receive your various packs of components you should check them as soon as possible against our components list (Table 1). All questions of shortages should be raised with the suppliers. In order to check the components you must obviously be able to identify them. Apart from the standard colour coding on the resistors there is a separate coding system for ceramic capacitors and for Mullard miniature-foil capacitors (see Table 4 and Fig. 4).

Some organisation of the components into values or circuit reference number order can pay dividends in the construction.

Care should be taken during all soldering to avoid excessive heat either on the components or the copper. Do not use too much solder and be particularly careful where printed copper strips run close to one another not to inadvertently bridge the gap between.

We suggest mounting the coils first. None of the coils on this board can be mounted the wrong way but it should be noted that the assembly of the Neosid coils and the single large (ident) coil (L4) are different. All the smaller Neosid coils (except L14 and L15)

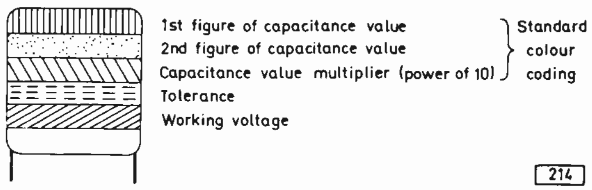


Fig. 4: Colour coding system used on Mullard miniature-foil capacitors.

Table 1: Components List

Component—Pack 1

D1	BA154	D21	OA90	C4	100nF	C22	47nF	C40	2·2nF
D2	BA154	D22	OA90	C5	10 μF	C23	47nF	C41	47pF
D3	BA154	D23	OA90	C6	470pF	C24	10 μF	C42	47nF
D4	BA102	D24	OA90	C7	100nF	C25	220nF	C43	120pF
D5	BA154			C8	1nF	C26	10nF	C44	1nF
D6	BA154	Tr1	BF195	C9	1nF	C27	25 μF	C45	10nF
D7	BA154	Tr2	BF195	C10	470nF	C28	100nF	C46	15pF
D8	BA154	Tr3	BC148	C11	470nF	C29	1nF	C47	1nF
D9	BA154	Tr4	BF195	C12	33nF	C30	1nF	C48	47nF
D10	BA154	Tr5	BC148	C13	470pF	C31	2·2nF	C49	47nF
D11	OA47	Tr6	BC148	C14	3-40pF	C32	2·2nF	C50	100nF
D12	OA47	Tr7	BC148		(compression	C33	4·7nF	C51	560pF
D13	BA155	Tr8	BC148		trimmer)	C34	10 μF	C52	100pF
D14	BA154	Tr9	BC148	C15	220pF	C35	330pF	C53	8·2pF
D15	BA154	Tr10	BF194	C16	390pF	C36	2·2nF	C54	2·5 μF
D16	BA154	Tr11	BF194	C17	330pF	C37	68pF	C55	100pF
D17	OA90			C18	680pF	C38	3-40pF	C56	8·2pF
D18	OA90	C1	1nF	C19	220nF		(compression	C57	2·5 μF
D19	OA90	C2	47nF	C20	4·7nF		trimmer)	C58	10μF
D20	OA90	C3	150pF	C21	10nF	C39	10nF	C59	10μF

Capacitors 8·2pF up to 390pF are ceramic; 470pF and 560pF are mica; 680pF is ceramic; 1nF to 4·7nF are C296, 400V polyester; 10nF to 470nF are C280, miniature foil; 2·5 μF are 64V electrolytic, 10 μF are 25V electrolytic, 25 μF is 25V electrolytic. Trimmers are RS components.

R1	10k Ω	R18	47k Ω	R36	22k Ω	R54	2·2k Ω	R72	1k Ω
R2	120k Ω	R19	6·8k Ω	R37	22k Ω	R55	2·7k Ω	R73	47 Ω
R3	120 Ω	R20	22k Ω	R38	100k Ω	R56	100k Ω	R74	100 Ω
R4	56 Ω	R21	470 Ω	R39	3·3k Ω	R57	10k Ω	R75	500 Ω
R5	1·2k Ω	R22	1·2k Ω	R40	680 Ω	R58	4·7k Ω		(preset)
R6	4·7k Ω	R23	3·3k Ω	R41	22k Ω	R59	22k Ω	R76	100 Ω
R7	330 Ω	R24	22k Ω	R42	22k Ω	R60	56k Ω	R77	100 Ω
R8	4·7k Ω	R25	10k Ω	R43	1k Ω	R61	10k Ω	R78	220 Ω
R9	180k Ω	R26	270 Ω	R44	1k Ω	R62	2·7k Ω	R79	220 Ω
R10	180k Ω	R27	180 Ω	R45	4·7k Ω	R63	2·7k Ω	R80	470 Ω
R11	5k Ω	R28	120k Ω	R46	4·7k Ω	R64	2·2k Ω	R81	470 Ω
	(preset)	R29	33k Ω	R47	1·5k Ω	R65	27 Ω	R82	470 Ω
R12	10k Ω	R30	1k Ω	R48	560 Ω	R66	1·2k Ω	R83	470 Ω
R13	2·2k Ω	R31	680 Ω	R49	560 Ω	R67	220 Ω	R84	1·5k Ω
R14	15k Ω	R32	10k Ω	R50	1·5k Ω	R68	1k Ω	R85	4·7k Ω
R15	1·5k Ω	R33	2·2k Ω	R51	470 Ω	R69	390 Ω		
R16	100k Ω	R34	6·8k Ω	R52	1k Ω	R70	6·8k Ω	Th1	VA1055S
R17	27k Ω	R35	4·7k Ω	R53	270 Ω	R71	5·6k Ω		

Resistors are all ½W 5% except R77, R78 and R79 which are ¼W 5%. Presets are 0·3W skeleton: R11 horizontal mounting, R75 vertical mounting.

Component—Pack 2

4·43361875MHz wire-ended crystal. Delay-line type DL20 (63·943 μs). 5 FX2249 Ferroxcube formers.

Component—Pack 3

1 set of ready-wound coils together with cans and cores *or* 1 kit of parts including wire lengths for winding coils.

Miscellaneous

Printed circuit board.

Component—Pack Suppliers

No. 1 A. Marshall & Son Ltd., 28 Cricklewood Broadway, London, NW2.
Cost: £7·63 including postage.

No. 2 Forgestone Components, Low Street, Ketteringham, Wymondham, Norfolk.
Cost: £6·65 including postage.

No. 3 P & R Windings, Industrial Estate, Happaway Road, Barton, Torquay, South Devon.
Cost: ready-wound set £2·10 including postage
kit of pieces £1·40 including postage.

Printed Circuit Board (TV Dec. 1)
E. J. Papworth and Son Ltd., 80 Merton High Street, London, SW19.
Cost: £2·32 including postage.

Readers should order components from the Suppliers as "Component-Pack No. . . ." for the TELEVISION Colour Receiver Project. For Component-Pack No. 3 it should also be noted on the order whether the ready-wound or the kit is required. Any enquiries regarding the supply of individual components should be addressed directly to the suppliers.

Table 3: Transformer winding data

Ref.	*Turns*	
T1	Primary 5	Mark start as 1 Mark finish as 2
	Secondary 5 + 5 bifilar	Mark one start as 4 Mark second start as 5 Join finishes together and mark as 3
T2	Primary 5	Mark start as 1 Mark finish as 2
	Secondary 5	Mark start as 4 Mark finish as 3
T3	Primary 4	Mark start as 1 Mark finish as 2
	Secondary 6	Mark start as 4 Mark finish as 3
T4	Primary 6	Mark start as 1 Mark finish as 2
	Secondary 6	Mark start as 3 Mark finish as 4
T5	Primary 4 + 4 bifilar	Mark one start as 1 Mark second start as 3 Join finishes together and mark as 2
	Secondary 4 + 4 bifilar	Mark one start as 4 and finish of same winding as 5 Mark second start as 7 and finish of same winding as 6

are supplied with the cans already mounted over the formers, the cores partly screwed in and prevented from dislocation by a little flexible core-locking compound. On L14 and L15 the cans are not secured to the base and these should be gently lifted off and C53 and C56 (both 8·2pF) wired across the windings. Push the cans back over the formers (taking care not to brush the windings). Should the cans be a little slack over the base nick the two opposite sides of the cans at the bottom to secure them. The same technique should be used by the constructor who is winding his own coils.

Mount the coils through the appropriate set of holes in the board so that the can is flat against the paxolin side. Bend the mounting tags over on to the copper and solder down. The connecting pins must now also be soldered and it is *vital* to ensure that the pins are not overheated—otherwise the windings may themselves be disconnected. It is safest to solder the pins at the side (rather than the end) and as close as possible to the copper surface. As you will have no other components on the board at this stage you can check the d.c. continuity of the windings on the resistance range of a multimeter.

There are only two wires on the ident coil (L4). The can is already over the former and there is no need for this to be connected to the chassis line: it is used for appearance and protection of the winding.

With all the screened coils in position the inductor sequence can be completed by putting L2 (the choke inductor) in place. Its wire ends should be bent over at right angles and dropped through the mounting holes, about $\frac{1}{8}$in. folded over on the copper side and the rest of the wire snipped off before soldering.

We suggest you then proceed using the same technique with all the resistors and then all the capacitors. Remember to check the polarity of the electrolytic capacitors as you put them in and that three capacitors are not mounted through the board (C53 and C56 which are mounted across L14 and L15, and C46—15pF—which is connected across the copper side of the board). Check the positions and values of your resistors and capacitors before going on. Although it takes a little more care and time we like to mount capacitors so that their values can be easily read. This helps during any later servicing.

Next mount the diodes. The cathode of all the diodes in this circuit is indicated by a coloured band. The hole positions on the board are spaced to allow a good length of the diode wire-ends to be left on the paxolin side. This is done both for tidiness and to give extra protection against heat damage when soldering. The transistors can now be mounted and as each is inserted into the board it should be pushed in just hard enough so that the lock-fit pins make it secure while giving a fair amount of pin to fold over and solder. The usual heat dissipation precautions must of course be taken when soldering. The transistor base connections are shown in Fig. 2.

Next to go into the board can be the thermistor (Th1) and the crystal. The latter should be mounted with about $\frac{1}{4}$in. of lead above the board.

All that are left are the Ferroxcube transformers, the delay line and C46. The transformers should be

Table 4: Ceramic capacitor colour coding

Capacitors may be marked with four, five or six dots or bands. The first mark is the one closest to the ends of the component. The other dots or bands are then read left to right from this first mark. For components with four dots or bands the value (in pF) is as follows:

Colour	*1st dot or band*	*2nd dot or band*	*3rd dot or band*
Black	—	0	1
Brown	1	1	10
Red	2	2	10^2
Orange	3	3	10^3
Yellow	4	4	10^4
Green	5	5	—
Blue	6	6	—
Violet	7	7	—
Grey	8	8	10^{-2}
White	9	9	10^{-1}

The fourth dot or band indicates the tolerance.

With four dot or band coding the body colour represents the temperature coefficient. With five dot or band coding the first represents the temperature coefficient and with six dot or band coding the first represents the temperature coefficient and the second the coefficient's multiplication factor.

stuck to the paxolin side of the board in positions adjacent to the series of holes provided for the lead-out wires. Approximate positions are shown in Fig. 1. The adhesive used need be only ordinary Evostick or a little Araldite. After the transformers have been allowed to set in position at least overnight the various leads can be passed through the correct holes, the ends cleaned off and soldered down. Be very careful about cleaning off the ends: if you are careless and end up with too short a lead you will have to remove the transformer from the board and rewind it!

Because of the weight of the delay line it is liable to cause warping of the printed circuit board after it is mounted. It is therefore best to leave this component to last. The various interconnections across the copper side of the board can be made first (as shown in Fig. 1) using of course insulated wire. The longer interconnections should be secured to the board and this can be done with a smearing of Evostick at a few points along their lengths. C46 should also be soldered in position.

The delay line can now be inserted and the four mounting tags bent over on the copper side and soldered down. If your holes are accurate the pin connections to the delay line should be available through the cut-out. Eight connecting leads should be soldered to these pins and taken off to the correct points on the copper. These points are marked 1-8 on Fig. 1 and the corresponding pin notation of the delay line is given in Fig. 2. It must be pointed out that the mounting and space allowed on the board is only suitable for the DL20 delay line.

You have now completed your PAL decoder with —we hope—no tears and no components left over!

Because it will be some time before the decoder panel will come to be used in the receiver it is inadvisable (because of the warping mentioned above) to leave the board unsupported for very long. Six small mounts should be made of hard wood to the details shown in Fig. 5. These should be attached to the board using 4BA bolts and the outer holes should be used to secure timber battens along the edges of the board, also using 4BA bolts. The battens will be disposed of later when the board is mounted in the receiver but the mounts can be used again and it is an idea to give them a protective coat of clear polyurethane.

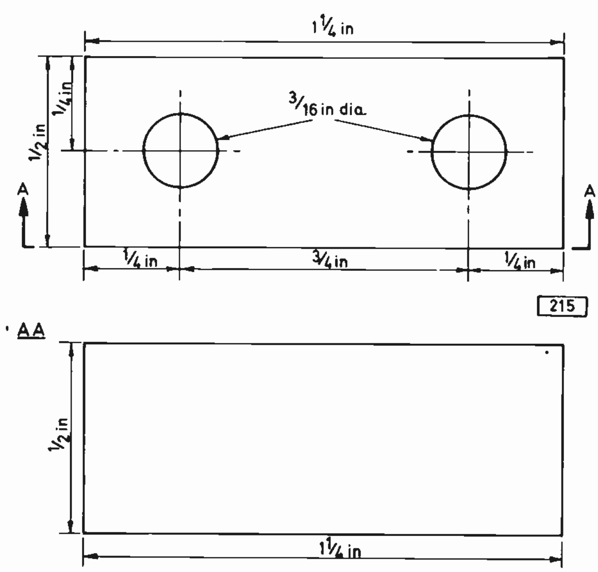


Fig. 5: Hardwood mounts for the board.

Circuit Description

Following the constructional details we will as promised give a full circuit description of the decoder whose basic design is by Mullard. The module is designed to accept the chrominance signal from the chrominance/6MHz sound detector after it has been brought up to a level at which the reference subcarrier burst is about 100mV peak-to-peak. The decoder outputs are the two transmitted colour-difference signals—R – Y and B – Y—with the R – Y signal at a peak-to-peak level of about 500mV and the B – Y signal at about 300mV. These outputs are fed to a separate module along with the luminance signal to produce the R, G and B outputs to drive the cathodes of the shadowmask tube.

The chrominance input is at point 1G on the circuit (Fig. 7). The signal is taken to two separate paths—the reference signal chain—Tr1 etc.—and the chrominance signal path—Tr10 etc.

Reference Signal Chain

The PAL subcarrier at 4·43361875MHz (which we will just call 4·4MHz) is suppressed during transmission to minimise the effects of crosstalk between the chrominance and luminance information. The colour information therefore is transmitted as double-sideband amplitude modulation around the subcarrier frequency. For demodulation of this colour information a subcarrier signal is necessary and for this purpose a *burst* (approximately 10 cycles) of subcarrier is transmitted during the back porch of the line synchronising waveform. This burst *swings* line-by-line through 90° to give an identification of the alternate line phasing of the transmitted R – Y signal. It can also be used therefore to provide a suitable signal for removing the R – Y alternate line phase inversion which is a feature of the PAL system.

Although the chrominance areas of picture will contain subcarrier it will not be at the centre frequency and will probably be continually varying in phase and frequency and cannot therefore be directly used for demodulation. The burst has to be separated in the decoder from the rest of the chrominance signal and is then used to lock an oscillator which runs continuously at the correct frequency and provides the subcarrier reference signal required for correct demodulation. The burst channel is inoperative during the lines of picture information but is gated on once each line, during the sync pulse back porch period when the burst signal is present. The burst channel then amplifies the burst and feeds it to a discriminator circuit which controls the subcarrier reference oscillator. The pulse used to perform the gating action, i.e. to switch the burst channel on when the bursts are present, is derived from the line output transformer.

Burst Channel

The 100mV input applied at point 1G is coupled by C1 to the tuned burst amplifier stage Tr1. To reduce the effects of noise on the signal and to maintain a reasonable input impedance this stage is operated with a lowish bias voltage (derived from the potential divider R2/R1) and a highish coupling reactance (C1). The collector circuit of Tr1 is tuned to the subcarrier at 4·4MHz although this only peaks the signal, most of the stage gain coming from R6.

The signal then passes via C3 to the base of Tr2 (the gated stage) which is normally cut off because of the heavily decoupled emitter resistor (R7 decoupled by C5). This stage must be gated on during the burst period and this is done by applying a positive pulse to the base of the transistor. For this purpose a negative-going line flyback pulse of about 80V peak amplitude derived from the line output transformer is fed into the module at point 1D. This is differentiated by the network C40/R55 (see waveforms in Fig. 6) and at this point the signal will also have been reduced to about –8V by the potential divider R55/R53. Being negative-going this pulse passes through D13 which is reversed biased from the +20V rail by R54 so that it does not conduct on noise or small-amplitude signals from the line timebase.

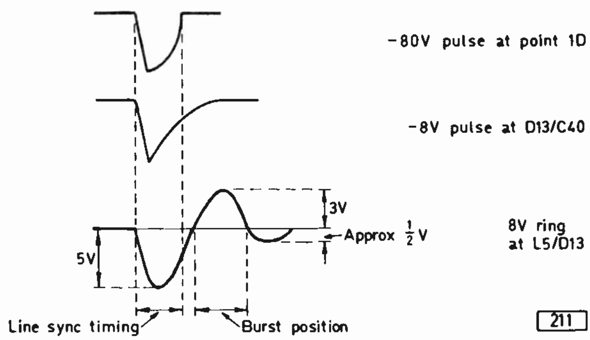


Fig. 6 : Derivation of the burst gating pulse.

The pulse present on the anode of D13 rings the circuit L5/C39 into oscillation. Because the initial edge of the pulse is negative the oscillation starts with a negative half cycle. This reaches about –5V before returning to the base line to form a positive half cycle. The ringing circuit is quite heavily damped by the 270Ω resistor R53 so the positive half cycle of oscillation is only +3V and the subsequent negative and positive half cycles are negligible in amplitude. The first positive half cycle is timed—by the frequency of oscillation—to occur during the burst period and after passing through R8/C6 turns on Tr2 for the required period. The purpose of R8 is to isolate the burst circuits from the ringing circuit and to prevent the possible turn-on of Tr2 by any small amplitude rings subsequent to the intended one. The parallel capacitor C6 forms a small differentiator with R8 to sharpen the trailing edge of the pulse to ensure that the transistor turns off rapidly.

Automatic Phase Control (APC)

The amplified burst of about 10V is then fed by transformer T1 to the phase detector circuit. The signals at points 5 and 4 of the centre-tapped secondary will always be in phase with respect to the earthed connection (point 3). Part of the burst is also half-wave rectified by D1 and smoothed by C10 and subsequent load resistance to provide a negative control voltage for automatic colour control (a.c.c.). This a.c.c. bias is applied to the stage in the i.f. strip that drives the decoder module to maintain by a.g.c. action the input level at the 100mV already quoted.

The phase detector compares the incoming burst signal with the locally generated subcarrier signal which is fed back to the detector via T2. Without the a.p.c. bias circuit (R11/R12) there would be zero output from the junction point of the detector diodes D2 and D3 when the incoming burst is at exactly the same frequency and phase as the local subcarrier: D2 and D3 would then conduct alternately on the alternate half cycles of burst, exactly cancelling the subcarrier signal fed back. The swinging burst feature has no effect on this process because this only changes which diode is conducting at a particular instant. If there is an error in the frequency or phase of the local reference subcarrier then there will not be complete cancellation and there will be a ripple signal at the junction of the diodes. This signal (the error signal) is filtered and used to control the subcarrier oscillator by adjusting the bias on a varactor diode (i.e. a diode whose capacitance changes with the d.c. potential across it) in the oscillator circuit. The frequency control is improved if the diode operates over a linear part of its capacitance characteristic range. In the case of the BA102 diode used this requires a reverse bias of about 6V. The error signal from the phase detector is therefore superimposed on a small d.c. bias from the potential divider chain R12/R11, the variable part R11 being known as the a.p.c. bias preset. The d.c. is supplied through a high resistance (R9 and R10) to each leg of the detector so that the conduction characteristics of the diodes are affected in a similar manner. The bias is decoupled by C7 and the d.c. blocking capacitors C8 and C9 are included to prevent it being short-circuited through T1 secondary.

APC Loop Action

The error signal is brought up to a suitable level to control the varactor diode and because the important signal is the d.c. content the amplifier used (Tr3) is directly coupled.

An error signal is only produced during the burst period. Furthermore during the rest of the line time the feedback subcarrier will be present. This subcarrier must be removed and the error signal must be maintained over the full line period. This can only be achieved by slowing the response action of the oscillator—in other words by filtering the error signal fed to the oscillator so that it apparently exists for a longer period than the actual time during which it is generated. The slower the reaction however the narrower will be the range of pull-in should the oscillator drift off or start at the wrong frequency. With the type of oscillator circuit used stability can be approximated to about ±100Hz and a pull-in range of about ±200Hz is achieved with the values selected for the filter which consists of C12/R14 and the damping path R13/C11.

The d.c. amplifier collector load consists of two parts: the fixed resistor R17 and the parallel combination R16/Th1. The negative temperature coefficient thermistor Th1 compensates slightly for temperature drift in the d.c. amplifier and in the varactor diode D4 which is fed with the error signal through R18.

Reference Oscillator Circuit

The subcarrier oscillator itself is a Colpitts crystal oscillator (note the split capacitance C15/C16, characteristic of a transistor Colpitts circuit) with Tr4 used as the maintaining amplifier. Fine frequency control is provided by the effect of the changing capacitance of D4 as the d.c. voltage across it varies. The crystal itself acts as the necessary d.c. block between the error signal and the base of Tr4.

Only the variation in capacitance is required for fine frequency control. The centre capacitance—the capacitance of the diode with no error voltage, only the standing d.c., across it—must be a known, fixed value so that the crystal can be designed for this form of operation. A fixed value cannot however be guaranteed because of the manufacturing spreads in the diode's characteristic. To ensure stable operation over the most linear portion of the characteristic the absolute value of diode capacitance is balanced out by the reactance of the tuned circuit C13, L2 and C14. C14 is variable to accommodate the diode spreads and the variations in circuit stray capacitances. The resultant anti-resonant frequency of the combination of C13, L2, C14 and D2 is set at 0·7 times the subcarrier. Above this frequency the resulting reactance of the circuit is capacitive but to a value more dependent on the fixed components of the circuit than on the absolute capacitance of the diode and therefore more reproducible in individual circuit modules.

The collector load of the maintaining transistor Tr4 is tuned to 4·4MHz to give maximum gain at the subcarrier frequency and the signal is fed through C17 to the emitter-follower output stage Tr5. This stage is biased for linear operation (R24/R25) and higher-frequency harmonics of the subcarrier are partly removed by the shunt capacitor C18 connected from Tr5 base to chassis.

The emitter-follower provides a low-impedance output and isolates (or buffers) the oscillator stage from any changes in loading that might occur in the circuits external to the oscillator chain. The load of the emitter-follower is the winding 1-2 of T2 which induces the reference signal back to the phase detector. The signal also passes of course to the synchronous demodulators—via the PAL switch and 90° shift arrangements.

Ident Circuit

To cancel the alternate line 180° phase reversal of the R – Y signal in the PAL system the reference signal fed to the R – Y synchronous demodulator is phase reversed on alternate lines and this phase reversal must be synchronised with that carried out to the R – Y signal at the transmitter. This is where the burst swings come in since they enable the decoder to *identify* the phasing of the transmitted signal.

When describing the burst phase detector we said that the swinging burst action has no effect on the nature of the error signal. It hasn't but there is always some imperfection in the diode switching action and this results in a small *ripple* on the error due to the swinging burst. This ripple signal at the collector of the d.c. amplifier is coupled through C21 to an amplifier stage Tr6 which is tuned to the fundamental frequency of the ripple. As the burst phasing is the same every second line this ripple frequency is at half line frequency—7·8kHz.

A fairly high *Q* inductor L4 and the capacitors C22 and C23 form the 7·8kHz collector tuned circuit of Tr6, giving a clean sinusoidal signal—the *ident* signal. This is coupled to the emitter-follower Tr7 via C59 (note its large value because of the low frequency). At the base of this transistor the signal is d.c. restored by D5 and R32 so that the complete sinusoidal waveform is then positive with respect to zero volts. Only this signal contributes to the conduction of Tr7, no separate base bias being provided.

Part of the output of Tr7 is fed back through R31 to the ident amplifier collector circuit. There is no phase shift through an emitter-follower so the feedback is positive. This assists the maintenance of the ident signal level at the collector of Tr6 but cannot cause the combination of Tr6 and Tr7 to go

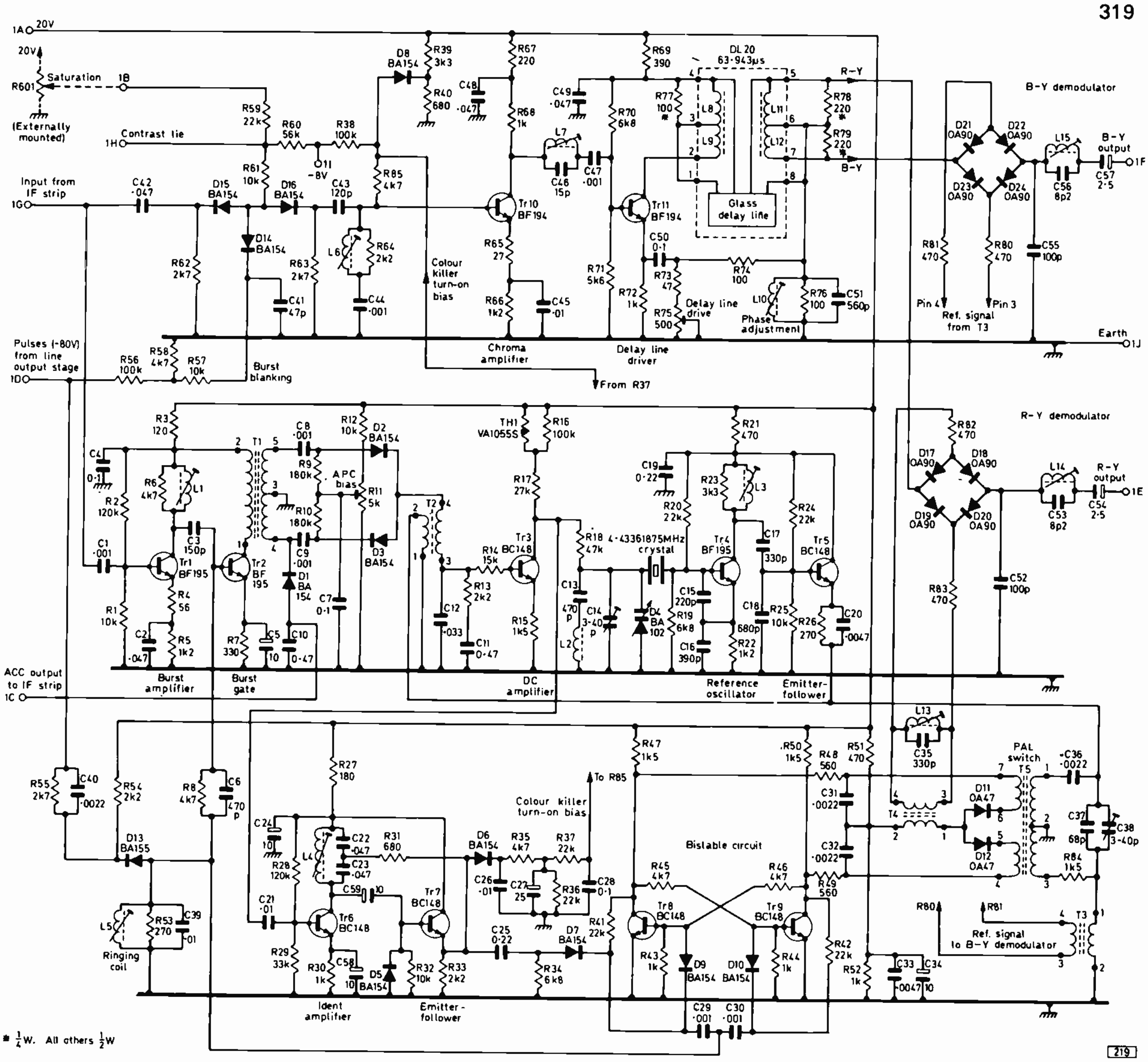


Fig. 7 : Complete circuit of the PAL-D decoder.

into oscillation because one of the conditions for oscillation—a loop gain greater than unity—is not met by the very nature of the slightly less than unity transfer ratio of an emitter-follower. This is therefore controlled positive feedback. The feedback signal is taken to the junction of the split tuning capacitance (C22 and C23) to reduce the effects of loading on the amplifier stage by external circuitry and to obviate the need for a separate d.c. blocking capacitor in the feedback path.

Bistable Circuit

The ident signal output is shaped by the differentiator C25/R34, the negative part of the signal passing to chassis through R34 as it is unable to pass through D7. This diode provides positive-going output pulses which if necessary inhibit the operation of the PAL bistable circuit Tr8 and Tr9.

The bistable is continually triggered by the negative part of the pulse waveform produced by the ringing circuit already described. These pulses are passed to the bistable through C29 and C30 and the steering diodes D9 and D10. Each incoming line frequency pulse changes the state of the bistable, alternately turning off Tr8 through D9 and then Tr9 through D10. The positive ring used for burst gating has no effect on the bistable because of the polarity of connection of D9 and D10.

Should the bistable be running out of phase it must always be a full 180° out of phase—i.e. each side of the bistable is being triggered one line out of phase. This is the condition in which the ident signal takes effect. Because it is positive-going it holds D9 cut off when a negative line pulse arrives to turn Tr8 off. The transistor therefore stays conducting until the next line pulse arrives. This turns Tr8 off because the ident signal, being at half line frequency, is not then present. The line pulses then continue to trigger the correct transistor at the correct time and the ident signal has no further effect unless there is some subsequent disturbance to the line pulses—due for example to a channel change.

PAL Switch

R47 and R50 form the collector loads of the bistable transistors and as the emitters are connected directly to chassis the voltage at the collectors changes alternately between the +20V rail and very nearly zero volts. Thus out-of-phase squarewave signals are generated at the two collectors and these are coupled directly through R48 and R49 to the phase-switching transformer T5. These 560Ω resistors are current limiters for the d.c. passing through D11 and D12 when they conduct. Only one diode conducts on each line, the changeover being caused by the out-of-phase squarewave signals. The switching speed is hardly affected by the decoupling capacitors C31 and C32. The diodes actually cut off when the switching voltage falls below the 12V bias set on the diodes by the potential divider R51/R52. This protects against switching as a result of random noise from the bistable. The potential divider is decoupled for both switching signal (C34) and sub-carrier frequencies (C33).

The subcarrier which is to be inverted on alternate lines before being used by the R – Y synchronous demodulator is applied to T5 through C36 (with respect to the chassis). Because of the bifilar winding of 1-2-3 the same signal is present at point 3. Depending on which diode is conducting the secondary side of the transformer develops a reference subcarrier across either winding 7-6 or 5-4 and this is fed out from either point 6 through D11 or from point 5 through D12. These signals are 180° out of phase so that the subcarrier coupled through T4 (the R – Y reference transformer) to the R – Y synchronous demodulator alternates as required line by line. The secondary of T4 has a parallel tuned circuit (L13/C35) across it. This is tuned to 4·4MHz and thus presents a high impedance to the subcarrier while short-circuiting any 7·8kHz switching signal and any harmonics of 4·4MHz (caused by the switching action) that may be present at that point. Provided the bifilar windings of T5 are accurately wound and the subcarrier amplitude is less than the forward/reverse squarewave switching voltage across the diodes efficient phase reversal of the R – Y subcarrier will be achieved.

The permanent 90° phase shift which is required in the B – Y subcarrier feed is provided by C37/C38 across which the main subcarrier input is effectively applied. Exact quadrature will depend on the leakage of these capacitors compared to the resistive path available and this is accurately set up by the trimmer C38. The phase shifted subcarrier is coupled through transformer T3 to the B – Y demodulator. In the feed paths to the demodulators are included 470Ω resistors to give some source impedance to the subcarrier.

Colour Killer

Like any electronic circuit the chrominance channel of a colour receiver produces a certain amount of noise. Normally this noise is in acceptable proportions in comparison to the main signal being carried but this is not true if the main signal is not present. The noise in the chrominance channel in fact *increases* when the transmissions are monochrome because the a.c.c. signal which as we have seen is derived from the bursts does not exist and the controlled stage just before the decoder therefore operates at full gain. The result is that on monochrome transmissions there would be coloured noise on the screen—which is subjectively annoying to the viewer—if steps were not taken to avoid this action. To prevent the appearance of this noise it has always been accepted that the chrominance channel should be switched off electronically during monochrome transmissions. One of the obvious indications of a monochrome transmission is the absence of reference burst and therefore of course the absence of ident signal. The ident signal that is generated on colour can therefore be used to provide a control signal to switch the chrominance chain on (colour) and off (monochrome when it is absent).

An ident signal feed is taken from the emitter-follower Tr7 to diode D6. This provides half-wave rectification of the sinusoidal ident signal, allowing only the positive half-cycles through. This output is smoothed by the capacitor input filter C26/R35/C27 so that a positive d.c. potential of about 7·5V appears on colour at the anode of D8. This diode has a negative bias of about – 2V at its anode (potential divided from – 8V at 11 by R38/R37/R35 etc.) and a positive bias of about 3V at its cathode (potential divided from the +20V rail by R39/R40). The – 2V bias ensures that the controlled stage Tr10 is cut off even in the presence of a noisy monochrome signal, whilst the difference in bias potentials gives a clipping action to the bias when it exceeds the sum of the reverse biasing (i.e. 5 volts) so preventing the colour killer operating bias from going too high. The negative bias at the diode is decoupled by C28 while R37 is not only part of the potential divider but also prevents excess current drain from the ident circuits.

The resultant positive bias is taken via R85 to act as a switch-on bias for the first chrominance amplifier Tr10. The resistor must be included to isolate the chrominance chain signal from the colour killer biasing circuit. When a monochrome transmission is being received the bias provided by the colour killer circuit falls from about +5V to about – 2V (or a voltage nearer zero if the monochrome signal is very noisy). In neither case will Tr10 conduct, thus cutting off (or *killing*) the chrominance channel.

Colour Control and Blanking

The chrominance input at point 1G passes not only to the reference chain as already described but also to the chrominance chain through C42. Manual control of the chrominance level (saturation) is provided by controlling the conduction of a pair of back-to-back diodes (D15 and D16). The variation is effected by means of the d.c. bias at the common anode point, this voltage being fixed by the setting of the saturation control R601 which is external to the decoder module. The use of the back-to-back diodes ensures cancellation of the non-linear effects of each; the total resistance of the diode pair also gives smoother control of the signal level passing through them. R61 isolates the control from the signal path while R62 and R63 provide the return conduction path for d.c. through the diodes during conduction and also complete the shunt elements (with the diodes as the series element) of a pi-section attenuator.

Because the saturation control is d.c. operated the leads to it need not be screened and the means is available for linking the saturation control with the contrast control of the receiver making viewer setting-up adjustments easier. The saturation d.c. control

potential appears at point 1H where it is coupled off to the contrast control circuit so that a change in chrominance amplitude causes a similar effect in the contrast level—in effect maintaining a reasonably constant chrominance/luminance ratio.

The d.c. clamping circuits used in the colour output stages of the receiver operate during the line blanking period of the waveform. In order to maintain an efficient clamping action the d.c. level during the time when the clamps act must be constant every line and reasonably free from noise: otherwise the clamps must be extremely "hard" in their action. The latter involves rather expensive and relatively complicated clamping circuitry which would be a less acceptable solution than removing the possible interference signals and then using a fairly simple "soft" clamp.

The saturation control circuit is the ideal place to provide the additional signal blanking needed. This is often referred to as *burst blanking* but in fact rarely is. The requirement as already stated is to blank the signal during the period that will later be used for the clamping. This can be done using the same pulse source as that used for the actual clamping action—once again line flyback pulses.

The same line flyback pulse input (1D) used for burst gating and PAL bistable triggering is also used for this flyback blanking. The amplitude of the –80V pulses is considerably reduced by the T-section attenuator formed by R56, R57 and R58. The negative pulses then pass through D14 to reduce the conduction of D15 and D16 during the blanking period. The 47pF decoupler C41 provides a path for any noise and chrominance signals that might be present on the blanked part of the waveform. This capacitor has no effect of course when D14 is cut off during the rest of the line period by the positive bias at its cathode fed via R54, etc. Notice that diodes D15 and D16 would only turn fully off if the saturation control was turned down very low, the negative bias being –2V from the line blanking pulse and –8V from the external supply connection at point 1I. This external bias also ensures that the diodes are fully cut-off when the saturation control is turned right down.

Chrominance Channel

The attenuated and blanked chrominance signal is applied through the coupling capacitor C43 to the base of the first chrominance amplifier stage Tr10. This is biased on during reception of colour signals by the positive colour killer bias already described. The input capacitance of the transistor is tuned out to give maximum response at 4·4MHz by resonance with the inductor L6. The *Q* of this circuit is limited by the damping resistor R64 so that the bandwidth of the stage is not restricted unnecessarily and the a.c. signal path is completed through C44 (this is necessary because the bias for the stage is provided by the colour killer circuit and any other connections to the base must therefore be d.c. blocked).

The transistor input capacitance problem is further reduced by the negative feedback provided by the undecoupled resistor R65. This feedback also gives some gain stabilisation to the chroma signals—this is necessary because no further form of a.c.c. can be used after the burst take-off.

The collector load of the chrominance amplifier is resistive (R68) and the reference burst amplitude is about 0·5V at this point. The output passes through a bandstop rejector circuit (L7 and C46) tuned to 6MHz principally to remove any intercarrier signal which may have reached this point. If this was allowed to reach the non-linear demodulator circuits the chrominance and sound signals would interfere with one another to produce an intermodulation distortion product at 6 – 4·4MHz, i.e. at about 1·6MHz, which would be visible on the display. The rejector also has some effect on the top end of the upper sideband of the chrominance signal but this should exactly match a similar rejection on the lower sideband produced by a tuned circuit at the output of the chrominance/sound detector in the i.f. strip. The signal passes to the delay line driver stage Tr11 which has a high base bias (R70/R71) to give very linear operation. The function of the delay line has been explained before in these pages and it is not felt necessary to go over the same ground in the present article. It should be mentioned howeved that the particular delay line used—the DL20—is the latest in the series for discrete component decoders and includes its own matching transformers L8, L9, L11 and L12. Also it is of the economy variety, using only half the thickness of glass employed in the first lines. L11 and L12 are bifilar wound to give equal antiphase output signals so that comb filter action takes place in conjunction with the direct signal fed in from the emitter of Tr11 via C50 and R74. The matching impedance of the DL20 is 100Ω and this is provided directly at the input by R77 and at the output by the parallel effect across the line of R78/R79. These latter resistors are also those across which the modulated R – Y and B – Y signals are developed.

With an input impedance of 100Ω the delay line cannot be driven directly from a transistor so the input transformer L8/L9 is set up by the manufacturers to give a 1·6kΩ load to Tr11. The loss in the delay line varies from sample to sample. To get pure R – Y and B – Y output signals the effect on the delayed signal of the gain of Tr11 plus the delay line loss must match the signal fed direct to the matrix L11/L12 from the emitter circuit. The gain of Tr11 is therefore adjusted by varying the negative feedback applied to the stage by means of R75. Note that variation of this resistor's value does not affect the level of the signal at the emitter—only the output impedance. Variations in this are limited by the constant value of R74 in series with the feed. The d.c. conditions of the driver transistor are maintained by R72 so that the stability does not suffer due to alterations in the gain control setting.

Small tolerance variations in the delay line output transformer windings and circuit stray capacitances can cause small phase errors in the signals across the summing resistors (R78 and R79). These errors can be corrected by connecting a reactance across the line. This is done by means of the resonant circuit L10/C51: when this is tuned to resonate above 4·4MHz the impedance it presents to the signal will be inductive; when it is tuned below 4·4MHz its impedance will be capacitive. The degree of correction required is not large so the *Q* factor is limited by the damping resistor R76. This also prevents undesirable effects on the chrominance signals themselves by giving the corrections a large enough bandwidth.

Synchronous Demodulators

The modulated but separated R – Y signal passes to its synchronous demodulator (D17-D20) across which is also applied the required subcarrier from R82 and R83. This is effectively a four-diode clamp circuit. The clamping signal is the reference subcarrier which switches the diodes on and off at the same rate at which the chrominance information was modulated. Provided the reference subcarrier is synchronised correctly (and as we have seen a lot of trouble has been taken to ensure this) we will recover the original modulating signal—the R – Y colour-difference signal. Provided also the reference subcarrier is of rather larger amplitude than the modulated signal the circuit efficiency is quite high and because of the diode formation the output impedance is quite low.

Inevitably there will be some subcarrier output from the bridge as well as the recovered colour-difference video signal. This is rejected by the half-section filter—the 4·4MHz tuned circuit L14/C53—and the low shunt impedance of C52. There will also be harmonics of 4·4MHz produced by the switching action but because of their high frequency in comparison to the colour-difference video signals (i.e. 8·8MHz second harmonic compared to a maximum video frequency of 1MHz) these are adequately removed in the later frequency-limited amplifier stages. The output coupling from the module for the R – Y colour-difference signal is through C54 and as this is now a video signal the coupling capacitor value must be adequately large.

The B – Y synchronous demodulator and output circuit are precisely similar except of course for the difference in the phasing of the reference subcarrier fed to the diode bridge (D21-D24 in this case). The output levels also differ because of the higher weighting of the B – Y signal carried out at the coder. This difference in signal output must be taken up later in the matrixing circuits.

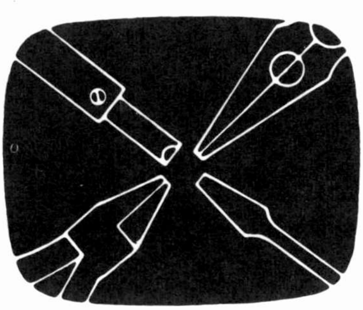
Checking Your Decoder

It is not possible to line up the decoder module completely without a source of chrominance signal, a source of negative line flyback pulses and the correct power supplies. Many of our readers will not be in a position to supply these things at this stage but later on when the other parts of the receiver have been completed they will be available. Full alignment of the decoder module will therefore be left to that time. Before moving on however some basic checks should be made on the constructed module.

First the layout of the components should be checked to the point of boredom against our drawings. Check particularly the values of the components fitted, the polarity of the electrolytics, the correct pin connections of the transistors, that all the circuit diodes are correctly in position and so on.

When this checking has been completed the resistance between the +20V rail on the printed circuit copper and the earth rail should be checked using a meter such as the AVO 8. On the resistance range a reading of between 624 and 640Ω should be obtained with the positive lead from the meter connected to the positive rail, and between 730 and 740Ω in the reverse direction. Any deviation from these limits almost certainly means a wiring or component error which should be traced immediately.

Next Month: We reduce the constructor's nightmare circuit to manageable proportions—The I F. Strip.



SERVICING television receivers

L. LAWRY-JOHNS

PHILIPS 19TG108U SERIES

SOME years ago we dealt with the Philips 17TG100U series, discussing the faults and their remedies that affected this range which was then comparatively new. Since then of course many other defects have had time to show up and as we have never dealt with the subsequent models—which have printed panels amongst other developments—it should now be possible to cast a more comprehensive net in order to cover a larger shoal of fish.

With a little give and take here and there we hope to cover a range of models from the above mentioned 17in. model (17TG100U) through the 21in. to the 19 and 23in. later versions (23TG107U, 19TG306U, etc.). Note that all these models have a 0 in the number: models such as the 19TG112U (which have a 1 in the centre of the basic number) are completely different and are not covered by these notes.

Circuit refinements which may be found in some models include Videomatic contrast control (using a light-sensitive resistor—type ORP60) and remote control facilities. These can be regarded as additions to the basic circuit and do not change the run of faults and remedies. Considering the age of these sets and their continued use the condition of the majority serviced by us is still very good and the Mullard tubes fitted live up to their reputation for long life and consistently high (hard) vacuum.

Common Faults

The h.t. supply is from two PY82 valve rectifiers. This is quite a reliable system, being kind to the two valves, components and the dropper due to the slow warm up and rise of h.t. voltage. When trouble does come however it can be nasty owing to the habit of one of the valve rectifiers developing a cathode-to-heater short which causes the other to suffer a burnt out heater. Therefore an open-circuit heater in one rectifier may well indicate a short in the other. The advice here then is to replace both valves. This way the set starts off from scratch with a new lease of life. The alternative of fitting a silicon diode is one which may be considered but it should be borne in mind that the set as a whole has been used to a slow build up of voltage and that even if a thermistor is wired in series with the diode to limit the initial current flow the no-load potential will be just as high. Therefore we do recommend fitting valves where these have been used.

In addition to the likelihood of valve failure it is also most likely that the surge resistors will have suffered. Most often this will be R703 and R704 (leading to pin 9 of each PY82 valve base) but one may find on odd occasions R705 or R706 damaged. The failure of either of the latter two will stop the h.t. supply completely whereas the failure of either of the former two will only stop one of the rectifiers working. The symptoms produced by only one rectifier working depend to a large extent upon the efficiency of that rectifier. Having worked for some considerable time the rectifier is hardly likely to be 100%. Therefore the picture will probably be reduced in size at least. The drill is to check the mains at both anodes (pin 9 of each valve base) to ensure that the surge resistors are in order and then to replace both PY82 valves if necessary (unless one is obviously new for example).

The Tuner Unit

Trouble will almost certainly be experienced with the tuner contacts and at first sight access may look awkward—up to a point it is. Most readers will be aware that the chassis is latched at both upper sides. Removing the lower screw of the right latch and swinging this up allows the chassis to be opened for access to valves, etc. Raising the left side latch allows the whole chassis to be lifted out and laid flat. This is to allow major parts (i.e. electrolytics etc.) to be replaced and the tuner to be manhandled. A handy access to the tuner contacts however is through the left side field timebase panel as this is only held by a few screws and can easily be swung open leaving a fair sized hole to enable the side of the tuner to be removed and the contacts cleaned in situ or the relevant biscuit removed to allow more thorough cleaning. Polishing the top edges is the only action needed as a rule. Care must be exercised not to damage the tuner leaf contacts or bend them in any way. Do not adjust the coarse threaded screws on top of the tuner or break the seal of them.

Lack of Height

This fault will be encountered on nearly every model. The symptoms are an equal loss of height top and bottom, with some loss of brilliance and focus. In almost every instance the trouble is due to the focus control itself. This 2MΩ element has a habit of falling in value and pulling down the boost line voltage available to the height control, the tube first anode and the audio stage. A replacement focus element will restore normal height. Alternatively a 1MΩ resistor wired in series with the existing control will produce the same effect. The resistor R420 (390kΩ) also causes loss of height when it rises in value but this does not happen nearly so often.

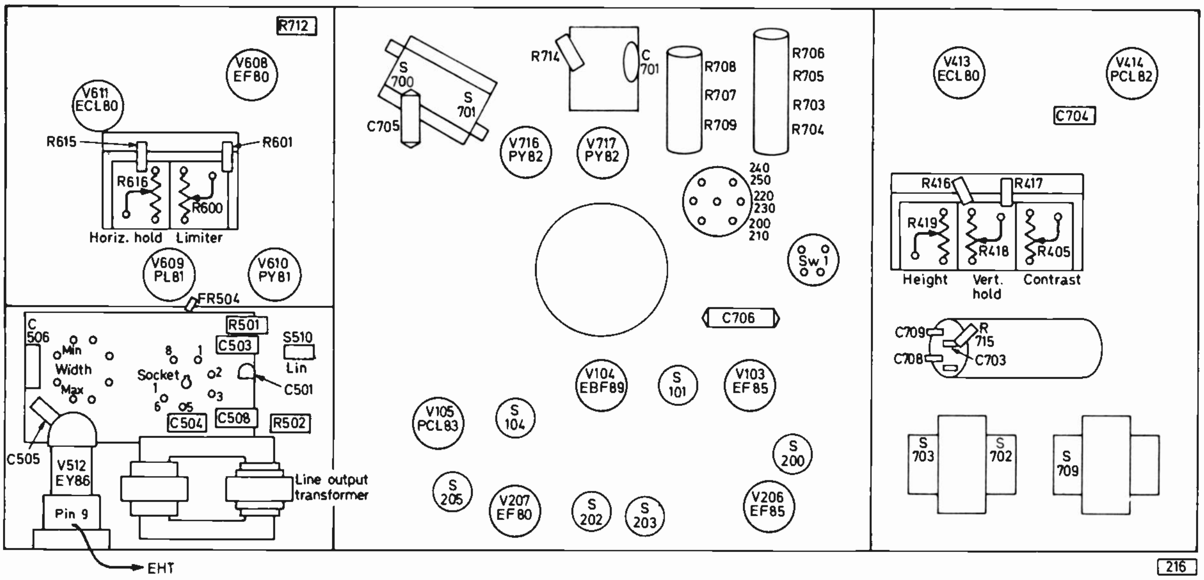


Fig. 1 : Front chassis view, Model 17TG100U. Later models are similar but have two printed panels.

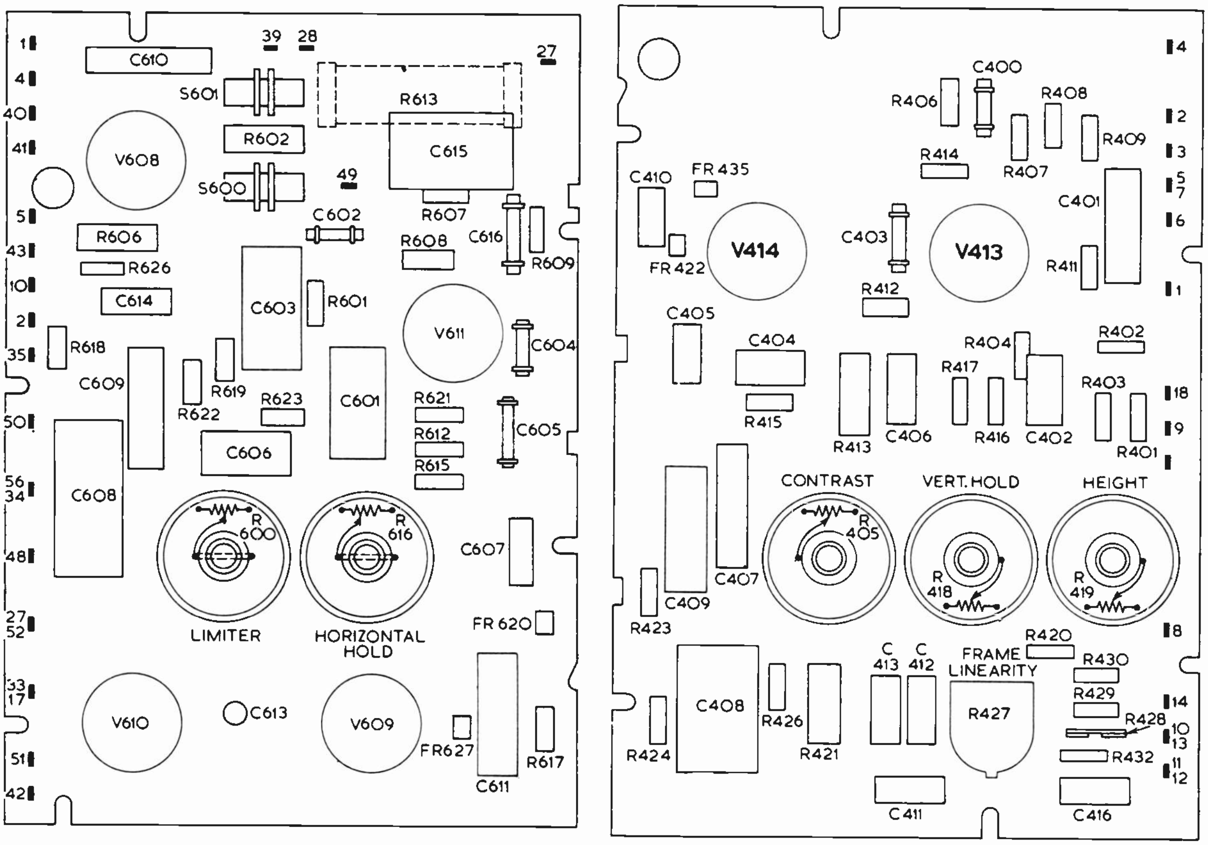


Fig. 2 : Component layout of the two printed panels used in later models in the series.

Sound Defects

It may seem that we are hopping around from one part of the set to another but in fact we are mentioning the faults in the order in which they will most frequently be encountered. Sound troubles are definitely high on the list. The complaint may be no sound at all or low and distorted sound. The villain of the piece is the PCL83 and in many cases a new valve will restore normal conditions, but . . .

When the PCL83 develops an internal short, as it often does, some damage may result in the cathode and grid circuits. The cathode resistors (mainly R111,

—continued on page 328

LONG-DISTANCE TELEVISION

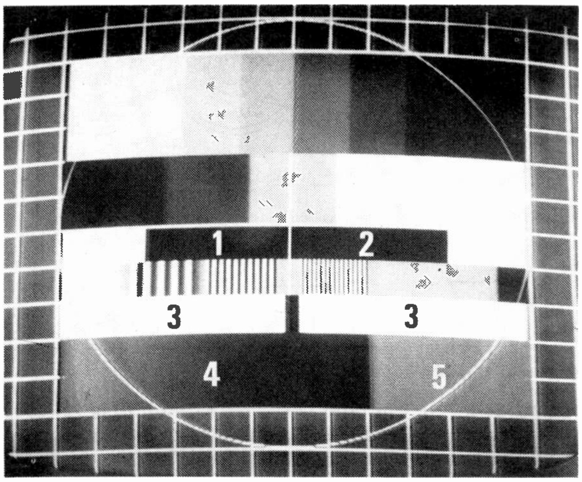
ROGER BUNNEY

THE first three months of the year tend to be rather quiet and certainly February 1972 has followed the pattern of previous years. Reception in the main has been via MS (Meteor Shower) although several enthusiasts have reported an improvement in Tropospherics on the 1st February and again on the 19th. The latter produced enhanced signals from various Dutch, Belgian and West German u.h.f. transmitters. My own log for the rather quiet period is as follows:

1/2/72 DFF (East Germany) E4; SR (Sweden) E2—both MS.
2/2/72 WG (West Germany) E2—MS.
3/2/72 ORF (Austria) E2a—MS.
5/2/72 NRK (Norway) E2—MS; BRT (Belgium) E2—trops.
7/2/72 Unknown Sporadic E signals ch.E2 at 0735 GMT (football match).
8/2/72 SR E3; NRK E3; CT (Czechoslovakia) R1—all MS.
11/2/72 WG E4—MS.
13/2/72 RAI (Italy) IB—MS.
14/2/72 NRK E2—MS.
15/2/72 SR E3—MS.
17/2/72 SR E2, E3; WG E2—all MS.
18/2/72 ORF E2a—MS; unknown Sp.E signal at 0828 GMT (line sawtooth pattern).
19/2/72 NRK E2—MS.
20/2/72 Improvement in Tropospherics—various N. French v.h.f. transmitters; also BRT E2.
21/2/72 SR E2; WG E2—both MS.
22/2/72 SR E3; NRK E3; CT R1—all MS.
23/2/72 CT R1—MS.
24/2/72 NRK E2—MS.
26/2/72 DFF E4; SR E4—both MS.
28/2/72 DFF E4—MS.

As can be seen there is usually something about most days, albeit rather sparse. I tend to spend about 15 minutes on any one channel before changing to another and undoubtedly some signals may be lost by this method. The most productive times are the early morning spells before 1000: fortunately a number of countries are on early with test transmissions. Over the past two months the Scandinavian direction seems to be most favoured (I am still active with the temporary omni-directional array) with the East European "R" channels the least favoured. This is of course my own personal observation and others may find reception favouring other directions.

One interesting point arises from the Swedish reception on the 1st February when signals were noted at 0755 GMT. The "SKOL" schools caption was noted with the familiar pocket watch design but with the figure 1 in white at the top right-hand corner—I assume to indicate the 1st programme chain.



SWF/YLE type test card. This is now used by Swiss TV with variations in the areas which have been numbered above—see News Items.

News Items

Belgium: Following our earlier report of a change in v.h.f. transmission standards the EBU Brussels have advised that as of October 30th 1976 the present System C will be discontinued and replaced with System B. This will enable colour broadcasting to be commenced at v.h.f.

South Africa: News is now coming in about the proposed commencement of television. It seems that Band I will *not* be used for television, all TV transmissions being within an extended Band III (up to 254MHz at the h.f. end) and with PAL colour. Initial plans also include provision for u.h.f. transmissions. Eventually three simultaneous transmissions at v.h.f. or four at u.h.f. will take place from each transmitter site. It is hoped that initial transmissions will commence towards the end of 1974.

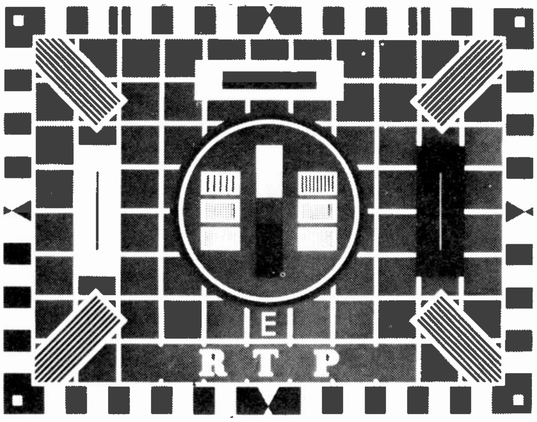
Jordan: An expansion of television facilities is to take place within the next year or two. New transmitters are to be opened and increases in e.r.p. of existing transmitters will also take place. The two high-powered transmitters at present in operation at Suwaileh with 100kW on both ch.E3 and ch.E6 will continue but the ch.E6 transmitting mast will be increased by another 150ft. The two transmitters will at times have separate programmes, ch.E3 being mainly all Arabic and ch.E6 Arabic with certain European language programmes. Whereas the ch.E6 transmitter is intended for reception within Jordan the ch.E3 transmitter has its output beamed towards the North on Damascus, Syria. Our old friend Roy Shepperd has kindly advised us of typical programme timings: Daily 1000-1200 educational programmes, 1700-2400 normal programmes. Fridays 1600-2400. (All times local time, i.e. GMT plus 2 hours.) There are *no* set trade test transmissions and consequently the test card (Marconi No. 1) will not be seen regularly. The programmes are at present generally Arabic language but with some programmes in English (e.g. films, videotape) carrying Arabic subtitles. The first 30 minutes of the evening transmissions usually consist of cartoon features.

Switzerland: I have speculated recently on the forthcoming change to the Swiss test card and now have definite information to hand. Keith Hamer at Derby has received a letter from the Swiss broadcasting authorities and we are indebted to Keith for passing on the information to us with no delay. It seems that the SWF/YLE type electronic card will be in use. Fortunately there will be some changes and form of identification and we have detailed this with the aid of a photograph (left):

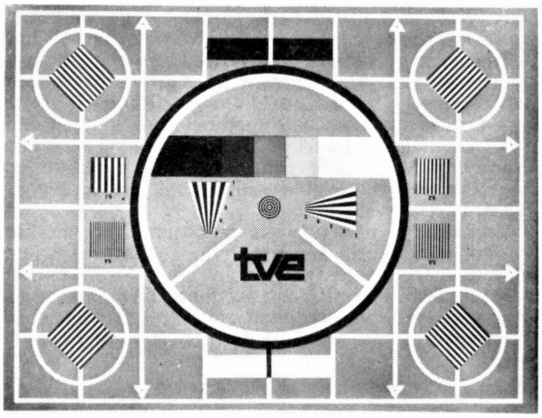
1 An identification + PTT will appear here.

2 An identification here indicating the programme language and chain as follows: SRG 1, 1st programme German language; SSR 1, 1st programme French language; TSI 1,

DATA PANEL 10—2nd series

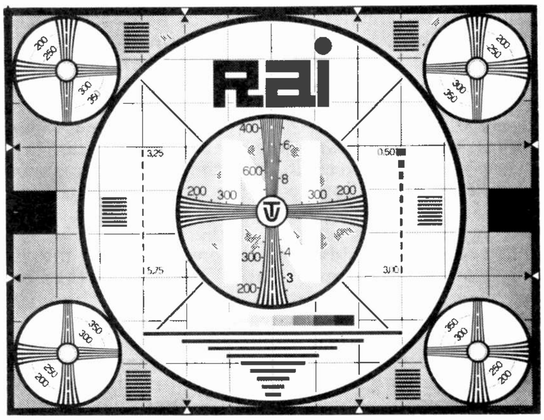


Radiotelevisao Portuguesa (RTP) Portugal—test card E (test card D is also used).



Test card used by Television Espanola (TVE)—Spain.

The test card at present being used by Radio Telefis Eireann (RTE)—Ireland.



Test card used for The Radiotelevisione Italiana (RAI) first programme chain.

Photographs this month courtesy RTE, RAI, Garry Smith and Keith Hamer of Derby.

1st programme Italian language.

3 This section will be grey.

4 This section will be split horizontally, the upper being red and the lower blue.

5 This section is split into two grey squares.

Data Panels

The Radio Telefis Eireann broadcasting authority has kindly supplied us with the current test card. Test card type E as shown in Data Panel 7 is not in use at present. Data Panel 9 included the RAI (Radiotelevisione Italiana) test card for the 2nd chain: the 1st chain card is similar and is included this month. The 2nd chain operates at u.h.f. and the 1st at v.h.f.

New Transmitters

Austria: ORF-2 Klagenfurt/Dobratsch ch.E24 1250/500kW hor. This has a split e.r.p. with the 500kW section to the North West. Located in the central South of the country.

France: ORTF-2. Dunkerque/Monts des Cats ch.E39 hor. Again a split e.r.p. radiation pattern, 200kW to the West and 100kW to the North. On the North French coast. Hirson/Landouzy ch.E48 500kW hor., Eastern France. Alecon/Monts D'Amain ch.51 100kW hor, North of Le Mans. Le Puy Saint-Jeam de Nay ch.57 100kW hor., Central France.

Monaco: Monte Carlo ch.E35 2kW hor. This has a radiation pattern to the South-East and is termed experimental by the EBU. Notwithstanding recent discussion on this matter we have included the listing although it is unlikely to be received at any great distance.

From Our Correspondents

A new correspondent is Terry Nunn of Dover and I recall that this is the first letter from that town. For those who are unfamiliar with Dover the town is severely screened to the West, North and East and is certainly a very difficult location for TV-DX—at least as far as Tropospheric signals are concerned. Terry however has managed to receive several ORTF transmitters at u.h.f. although as he says the results are somewhat noisy. The best signals to date have been from the Boulogne relay on ch.E34. A BRC 1500 chassis is in use with vision standard switching accomplished by means of a microswitch and relays.

Another new name is Ronald Exeter at North Berwick, Edinburgh. His Sporadic E successes include most countries in Europe, mainly on ch.E2/R1/F2. Unfortunately Tropospherics are restricted to the South by severely rising ground but to the North-East a clear view to the sea has allowed excellent reception from NRK Norway. Similarly various Danish and West German transmitters have been noted at fair strength. In Ronald's case a Philips TV-ette has been brought into use with modifications to the video detector switching. The aerials are very limited and this does show that given the conditions and a degree of patience reception is possible without the use of highly complicated aerial systems.

Our final letter this time details recent u.h.f. reception in the Wood Green, North London area. C. Orme sketched several test charts for us to identify from his reception on the 19th February. By all accounts three countries were received—Holland, Belgium and West Germany. In Mr. Orme's words "the test cards were so good and clear".

Sporadic E Propagation & Reception

With the approach of Summer experienced enthusiasts look forward to the "Sporadic E Season". This annual phenomenon produces signals at enhanced strengths from transmitters operating in Bands I and II (TV) and very occasionally at the low-frequency end of Band III. When reaching the horizon v.h.f. signals normally continue travelling and are lost in space. At times however intense ionisation within the E Layer some 70 miles high occurs and reflects such incident signals. The reflected signal is thus received at the distant point—usually between 500-1400 miles from the transmitter—at strengths ranging from very weak to exceedingly strong. On occasions double or even triple hop reception occurs. The signal when returning to Earth after its first reflection is again reflected by the Earth's surface. If the signal then again encounters suitably highly ionised conditions in the E Layer it once again returns to Earth. Signals can thus be received over distances in excess of 1800 miles although such multiple hop signals occur infrequently.

The highly ionised area within the E Layer may be small or widespread making possible signal reception from either one direction and distance or alternatively from many areas simultaneously. Such ionised areas may move within the E layer at high speed resulting in changes of skip distance and alternative transmitter reception. Signals can be reflected at angles off the true bearing of the transmitter—in other words the received signal may be at its strongest from a direction which isn't the true direction of the transmitter. One feature of intense Sporadic E openings is the high signal levels and often multiple signal path reception resulting in severe ghosting and phase reversal.

Signal reception via Sporadic E can occur at any time of the day or night although there are of course limitations due to TV transmission times. Such signal openings may be of only a few minutes duration or alternatively can last for hours on end. In fact it is not uncommon to experience openings of over 12 hours during a good season. There has been a tendency during high sunspot activity for Sporadic E to decline and with a decrease (as we are experiencing now) so Sporadic E has improved. This effect has not been noticed on other Continents but has held true for the Western European area over the past 10 years: there is every hope therefore that 1972 will be an extremely good year.

The season lasts from early May to September. In good years an opening in mid-April usually means a good season and by the time this is read we may indeed have an indication of the next few months' conditions. Another good sign was the increased Sporadic E activity during the December/early January period just passed.

Sporadic E reception is recommended for the beginner to this hobby. Signal reception is possible with the minimum of apparatus and aerials since many of the signals are strong. At present there seems to be no way of predicting an opening, but experience often seems to indicate when to switch-on. Certainly thundery weather favours Sporadic E activity and it is a help to note the various European weather maps.

DX-TV Book: "Long Distance Television"

Following the great interest shown in the "Basic Guide to DX-TV" pamphlet several months ago I have been preparing an expanded guide to the subject. This is now at last ready. It covers all aspects of the hobby and this time has been printed professionally. The cost is 50p inclusive of postage and may be obtained from Weston Publishing, c/o 58 Ticonderoga Gardens, Weston, Southampton SO2 9HD. Please make POs or cheques payable to Weston Publishing and not to Roger Bunney or to IPC Magazines Ltd. Reception reports and other letters should as usual be sent to the column c/o TELEVISION.

SERVICING TV RECEIVERS

—continued from page 325

but check through the path to chassis—R109, R108, R112) should always be checked as a new valve can speedily be ruined by insufficient bias caused by a damaged resistor. It is in the grid circuit however that most annoyance is caused. If there is a short in the PCL83 and the volume control is turned down a low-resistance path to the chassis is presented to the short and heavy current flows through the lower section of the track thereby damaging it. A new PCL83 can be fitted but the volume control will make its complaint known loud but not too clear.

The obvious remedy is to replace the dual control unit and this will be done if this is a customer's repair. If however this is your own set (or brother Bill's) the following may be of interest. The volume control in these sets is used as the grid leak resistor. As such it is very sensitive. The valve's grid pin is 9. If the existing lead to pin 9 is lifted off an 0·1μF capacitor can be put in series with it (i.e. the lead goes to the capacitor and the capacitor goes to pin 9) and a fixed resistor of 470kΩ can then be fitted as the leak from pin 9 to chassis. The volume control is then much less noisy and the damaged track can be thickly pencilled with a soft pencil (only the damaged part that is) to complete the circuit. As the slider will not normally be required to travel over this part of the track this bodge will last for some considerable time. Since there is no on-off switch on the back of the control access is quite easy; well, reasonably so.

It must not be inferred from what has just been said that all cases of distortion are due to the PCL83 valve. In many instances distortion is due to severe clipping in the audio amplifier stage (PCL83 triode section). This happens when the anode resistor R113 (2·7MΩ) goes high-resistance or C114 leaks slightly. In either case the result is reduced anode voltage at pin 1 with distortion. The amount of clipping depends upon the time-constant of R113 and C114, this determining the noise-limiting action. It must be well and truly noted that these remarks apply to all models *without* v.h.f. radio facilities. Models with v.h.f. radio, such as for example the 17TG306U, use a modified circuit which cuts out the triode stage on v.h.f. and divorces the volume control from the PCL83 grid in a similar manner to that described earlier.

CONT.—WITH COMPLETE CIRCUIT—NEXT MONTH

YOUR PROBLEMS SOLVED

★ Requests for advice in dealing with servicing problems must be accompanied by a 10p postal order (made out to IPC Magazines Ltd.), the query coupon from page 331 and a stamped, addressed envelope. We can deal with only one query at a time. We regret that we cannot supply service sheets or answer queries over the telephone.

GEC 2015

The problem with this set is hum on sound on both systems. It is worse on 625 and the BBC 405 channel. I assume it is a vision-on-sound problem as the hum varies with the type of picture. Fine tuning does not cure the problem. The valves in the sound section have all been checked and found to be OK.—T. Radford (Deal).

The video amplifier screen decoupler, C93 32μF, also decouples the supply to the EH90 in the sound section. Consequently there will be a tendency to the trouble you are experiencing if C93 looses capacitance.

PHILIPS 17TG106U

The fault on this set is a vertical black line about 1½in. wide at the right-hand side of the screen. It goes occasionally for about 10 seconds. Also the sound is quiet and not very clear.—T. Bradshaw (Holloway).

The black line could be due to the line hold control not being correctly set or a defective line oscillator valve, V611 ECL80. The sound fault is probably due to a leaky a.f. coupling capacitor which may in turn have affected the audio output valve (V105, PCL83).

GEC BT302

The picture, mainly on ITV, had a tendency to break up. This could be cured for a short while by operating the channel switch. The picture is now weak with severe loss of contrast, more pronounced on ITV. By changing the video amplifier a reasonable picture can be obtained but after an evening's viewing the fault recurs. The tuner switch contacts have been cleaned and the aerial gives very good results on another set.—J. Rider (Bristol).

As the picture fades after an evening's viewing it seems that there is a low-emission valve and we suspect the tuner r.f. amplifier valve, type B319. The video amplifier anode load resistors R44 and R45 (each 12kΩ) should be checked, also R123 (1MΩ) which is in series with the slider of the contrast control. It would be worthwhile comparing the anode, screen and cathode voltages of the video and i.f. valves after a period of two-three hours as this should help in isolating the defective stage.

HMV 2635

On 405 the picture is greyish and the v.h.f. contrast control has no effect. The 625 line contrast control is operative but the circle on the test card is a long elipse (the circle is OK on 405). There is only one width control and of course adjusting this to get 625 right upsets the operation on 405.—G. A. Wise (Manchester).

Replace the 4·7MΩ resistor (R22) in series with the slider of the 405 contrast control. This resistor is roughly at the rear centre of the chassis. Check the resistors in the width control circuit (R130, R131 and R133) but note that the line output transformer can cause lack of width on 625 only on this chassis (Thorn 950).

PYE 61

The picture crept in at each side, and also at the top and bottom, to become a square in the centre of the screen. The line and field timebase valves have been replaced without making any difference. The preset height control has been turned up to maximum but although this has extended the picture slightly at the top and bottom the screen is still not completely filled. —B. Halliday (Rugby).

Check that the h.t. line is over 220V and then ensure that the system switch is going fully over. Check the value of the line drive coupling capacitor C111 (0·047μF) as if this is low the line drive will be weak.

DECCA DM36

The set operates correctly for about two hours then, especially on channel 3, the sound becomes harsh and gets gradually weaker. The picture shows sound-on-vision. On adjusting the fine tuner a perfect picture with weak sound can be obtained or alternatively if maximum sound is tuned in the picture either breaks up or shows a severe herring-bone pattern.—J. Hitchcock (Leith).

There could well be more than one fault present. Check first the 1·5MΩ resistor which feeds the anode of the sound interference limiter diode. Then check the common vision and sound i.f. valve (EF183) as this may well be running into grid current. Check the PCL82 audio valve.

FERGUSON 3636

The field hold on u.h.f. is very critical and has to be adjusted when returning to 405. When on u.h.f. the field is not actually slipping there is slight judder every second or so. The PCL85 field timebase valve and PFL200 video/sync valve have been replaced but the fault is still present.—H. Dow (London NW2).

The sync separator screen (pin 3 of the PFL200) is fed from a potential divider across the h.t. line and chassis: check the upper of the two resistors, R48 47kΩ, as this often changes value. Then if necessary check the sync feed components and the main electrolytic block.

BUSH TV109

The picture is clear but not very crisp, i.e. appears flat in artificial light and seems to waver slightly. There is also streaking from bright letters and objects. —G. Feldman (Hoxton).

The trouble is due to the stabilising resistor in the video amplifier changing value. This is R31, the second resistor from the top on the upper left panel. It should be 33kΩ 2W. It often overheats to cause your symptoms.

SOBELL ST290DS

A couple of hours after switching on the screen goes blank for 3-5 minutes or sometimes longer. It always comes back again and the sound is always perfect.— G. Vaughan (Hillingdon).

Check the potential at the grid (pins 2 and 6) of the c.r.t. This should be 0-90V depending on the setting of the brightness control. If intermittent, suspect R136 (680kΩ) which supplies h.t. to the brightness control and C145 (0·022μF) which decouples the feed to the c.r.t. grid. It is also possible that the DY86 e.h.t. rectifier has an intermittent heater.

McMICHAEL 3002

The field starts to bounce whenever a mainly white picture appears. Before this happens the hum, which is always present in the background, increases becoming very noisy. At times the picture starts to roll. The set is used on u.h.f. only and the trouble is experienced on all three channels. The field hold control is at the end of its travel.—F. Williams (Oxford).

You will find a small grey capacitor, C91 0·01μF, behind the field hold control. This should be replaced. Also change the 32μF capacitor behind the PFL200. This is C51 and decouples the screen grid.

BUSH TV135R

This set gives a good picture but field flyback lines can be seen when there is no picture. The coupling capacitor 3C37 in the field flyback blanking circuit has been changed but this has made no difference. —G. Tyler (Harrow).

The coupling capacitor referred to takes its suppression pulses from the junction of a series resistor and capacitor across the field output transformer secondary. The capacitor of this combination, 3C36 (0·01μF), should be checked as it could have gone short-circuit. If necessary then check the PFL200 and its associated components.

RGD RV302

The DY87 e.h.t. rectifier fails prematurely in this set after only a few months. The heater voltage has been checked and is roughly right at 1·6V. Can you suggest any remedy?—A. Poole (Exeter).

If the width is normal we suggest you try a U26 in place of the DY87. If the width is excessive check the line drive and reduce as necessary.

GEC BT318

The field timebase is unstable, the picture rolling a few times then remaining stable for a little then rolling again. The interlace intermittently separates very slightly, most noticeably at the top of the screen, with a wave of expansion and contraction slowly moving up the screen. Some of the lines black out intermittently at the bottom half of the screen. Contrast is poor, the control having no effect. Also the screen is only about 80% filled with picture.—H. Race (London SE5).

The symptoms are those of low h.t. and poor smoothing so the rectifier and electrolytics should be checked. As the contrast control is not working we suggest you replace R133 (1MΩ) in series with the slider, the a.g.c. reservoir capacitor C135 (0·25μF) and the sync coupler C134 (0·5μF) while for poor interlace the field oscillator valve V16 (B729) should be replaced and the associated components checked if necessary.

BUSH TV165

All was well until the 14Ω section of the dropper resistor burnt out. This was replaced and all went well again for a while. Now the picture is perfect until something bright—e.g. sea or snow—appears. The picture then tends to go negative and balloons and disappears for about eight seconds or until the camera shot changes. The ballooning is sometimes accompanied by buzzing and oscillations. The same effect is obtained if the contrast and brilliance controls are turned up. The PFL200 video valve has been changed without improving matters.—W. Richie (Baldock).

The problem is the e.h.t. supply and we are inclined to suspect the line output transformer of having shorted turns. This is quite common with this model. Before changing the transformer however try changing the e.h.t. rectifier valve, DY87 or DY802. If this has only a temporary effect use a U26 until a new transformer can be obtained: the U26 has a different heater rating and relieves the load on the transformer to a slight extent.

PETO SCOTT TV960

After retuning the set two or three times as described in the service sheet using a signal generator we still have offset u.h.f. sound. With a good picture on the screen the tuning knob has to be turned clockwise to bring in the sound but when the sound is tuned in the picture begins to lose lock. Even with maximum picture tuning there is still snow on the picture. All relevant valves have been checked.—T. Wall (Barrow).

The most likely cause of the trouble is lack of signal from the aerial. The aerial and its siting should be checked, also the cable and the aerial input socket.

McMICHAEL MT764DST

The sound is OK but there is no raster. E.H.T. is present at the top cap of the DY86 but there is no heater voltage at the base from the single wire wrap-round on the lower half of the line output transformer.—T. Gale (Sutton).

Check that the ends of R134 (0·65Ω) are not open-circuit. This component consists of a small coil of resistance wire in series with the heater and is mounted under the valve base inside the shroud. If you need to replace the heater winding use a length of aerial coaxial inner cable.

SOBELL 1013DST

There is no picture or sound. The PY800 boost diode overheats but this subsides on removing the top cap. The tuners and line output transformer seem to be OK and the line output stage valves have all been replaced.—T. Wall (Sydenham).

Your trouble is lack of line drive which is causing the PL504 and PY800 to draw excessive current. This is probably due to failure of the line oscillator stage and we suspect in particular V10 (PCF802), the tuning capacitor C168 (2·2kpF), the feedback capacitor C170 (820pF) and the coupler to the output stage C173 (0·01μF). As a result of this failure the HT3 smoothing resistor R143 (330Ω 5W) has probably become open-circuit, accounting for the loss of vision and sound. R143 is one of the vertically mounted resistors adjacent to the 9-pin plug on the timebase panel.

PYE V410A

There is trouble with the automatic tuning. Frequently when the auto button is pressed the tuner moves but does not stop, continuing to change channels until the set is switched off (to prevent the motor running too hot).—G. Finnegan (Sunderland).

Either the motor has slipped in its mounting so that the rotor does not spring back quickly when stopping or the button over-ride contact above the red plastic stops is set too fine.

MURPHY V280

The trouble is that the lines are splayed out at the sides of the picture: also they seem to move up and down. This gives an out-of-focus effect at the sides of the picture.—V. Weller (Nottingham).

Such scanning distortion is likely to be due to a fault somewhere around the scan coil assembly. If the trouble rectifies itself with increased brightness suspect that the c.r.t. has accumulated a glass charge.

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TELEVISION MAY 1972

TEST CASE

113

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.

? *This month the symptom is an over-bright picture accompanied by streaking on blacks on a Bush Model TV161U. The field technician found that even with the brightness and contrast controls fully retarded a raster was still visible and hence brought the set into the workshop for detailed analysis.*

The first check was on the brightness control circuit which consists of a voltage dependent resistor, a couple of ordinary resistors and the control potentiometer itself. The resistors were easily checked and found to be in order but there was some problem with the v.d.r. since almost normal control could be obtained by shorting it out. Subsequent replacement however failed to cure the trouble.

The set uses the notoriously "unfaithful" PFL200 video amplifier valve. This was next checked by substitution but still without luck. The network from the amplifier to the picture tube also appeared to be free from any faults which could be checked by ordinary testing procedures.

Eventually the trouble was traced and by the replacement of one component normal working of the brightness control was restored with clearance of the smearing. What is the most likely component failure for trouble of this kind? See next month's TELEVISION *for the solution to this problem and for a further item in the Test Case series.*

SOLUTION TO TEST CASE 112

Page 282 (*last month*)

As in most sets today the height control circuit of the Thorn 950 chassis is stabilised by a voltage dependent resistor. This component is a fairly common cause of intermittent and drifting height trouble. When it was removed from the receiver in question the height increased dramatically as is usual. The important point however was that the height remained substantially constant for a protracted test period under this condition. This suggested that the v.d.r. was indeed the cause of the trouble and after obtaining and fitting a correct replacement component the fault was cleared. The moral then is that with intermittent height trouble the v.d.r. in the generator circuit should be checked at an early stage in the proceedings.

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As in previous months

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Single Gang **12p**; with Switch **24p**

T.V. TYPE ELECTROLYTICS

		£ p
100 + 200μF	275V-W	75
100 + 400μF	275V-W	1·15
100 + 200 + 60μF	300V-W	93
100 + 300 + 100 + 16μF	275V-W	1·23
100 + 300 + 200 + 100μF	275V-W	1·23
125 + 200 + 100 + 32μF	275V-W	1·23
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Complete with 13 channel tuners. Good cabinets. Carriage £1·50 extra.

19"/21" slimline (110° tube)	**£5·00**
23" slimline	**£7·50**
19" BBC 2 sets	**£14·50**

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19"/21" any type	**£3**
23" any type	**£4**

TWIN PANEL (BONDED)

19" bonded	**£5**

All tubes add £1 carriage

VALVES EX EQUIPMENT

EB91	5p	30L15	12½p	PL36	22½p
EBF89	12½p	30P4	12½p	PL81	17½p
ECC82	12½p	PC97	17½p	PY81	15p
EC180	7½p	PCF86	17½p	PY800	15p
EF80	12½p	PC84	7½p	PY82	7½p
EF85	12½p	PCF80	7½p	PY33	22½p
EF183	12½p	PCC89	12½p	U191	17½p
EF184	12½p	PCL85	22½p	6F23	17½p
EY86	17½p	PCL82	17½p	30PL1	22½p
30PL13	20p	PCL86	17½p	30P12	20p
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AW36-21, 36-80	£5·75
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AW43-88, 43-89	£6·75
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AW53-88, 53-89	£8·25
AW59-90, 59-91	£9·00
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CME1402	£5·75
CME1601	£10·50
CME1602	£12·00
CME1702, 1703	£6·75
CME1705	£7·75
CME1713/A44-120	£14·50
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CME1908	£7·75
CME2013	£12·50
CME2101, 2104	£8·25
CME2301, 2302, 2303	£9·00
CME2305	£14·75
CME2306	£13·50*
CME2308	£9·95
CME2413R	£16·50
CRM93, 124	£5·50*
CRM141, CRM142	£5·50
CRM171, CRM172	£6·50
CRM211, CRM212	£7·50*
MW36-24, 36-44	£5·50
MW43-69	£6·75
MW43-80	£6·75
MW53-20, 53-80	£7·50
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***These types are FULLY rebuilt.**

ALL TUBES ARE TESTED AND GUARANTEED FOR 12 MONTHS

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COLOUR TUBES

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

New R.C.A. **A49-15X** £35

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WE GIVE GREEN SHIELD STAMPS

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(Mullard, Thorn, Telefunken, etc.)

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EB91	22p	PCF801/2	59p	PY800/1	47p	20P4	90p
ECC82	42p	PCF805	83p	R19	80p	30C15	86p
ECL80	47p	PCF808	80p	U25	91p	30C17	91p
EF80	39p	PCL82	48p	U26	91p	30F5	91p
EF85	41p	PCL83(S)	60p	U37	75p	30FL1 & 2	62p
EF183/4	54p	PCL84	57p	U191	86p	30L15	91p
EH90	51p	PCL805/85	63p	U193	47p	30L17	86p
EY51	60p	PCL86	63p	U251	91p	30P12	90p
EY86/7	40p	PL36/8	83p	U301	85p	30PL1	86p
PC86 & 8	72p	PL81	75p	U801	99p	30P4MR	£1·00
PC97	42p	PL83	81p	6/30L2	86p	30P19	83p
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PCC84	47p	PL500	86p	6BW7	78p	30PL14/5	95p
PCC89	58p	PL504	86p	6CD6G	90p	etc., etc.	
PCF80	50p	PY81	47p	6F23	90p	**Trade prices**	

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25" D/STD. COLOUR TVs. All makes available. 19"/23" BBC 2 TVs from £5. Smiths Switchmaster Mk III reconditioned decimalized meters perfect working order, 10 for £20 delivered. Sample meter, send £2·50 c.w.o. Ring Mr. Kent, Bradford (0274) 665670. Thornbury Trade Disposals, 1043 Leeds Road, Bradford 3.

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

DY87	37p	PC86 & 8	50p	PCL805	45p	U193	35p	30L17	75p
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EB91	15p	PCF80	32p	PL36	52p	6/30L2	60p	30PL1	60p
ECC81	37p	PCF86	52p	PL81	46p	6BW7	60p	30P4MR	95p
ECC82	30p	PCF801	50p	PL84	55p	6CD6G	90p	30P19	70p
ECL80	40p	PCF802	50p	PL500/4	65p	6F23	75p	30PL13	75p
EF80	27p	PCF805	50p	PY81	35p	6F28	48p	30PL14	75p
EF183	37p	PCF808	60p	PY800	35p	20L1	85p	etc., etc.	
EF184	37p	PCL82	37p	PY801	35p	20P4	90p	**NOTE**	
EH90	45p	PCL83(s)	50p	U25	65p	30C15	70p	**BY100/BY127**	
EY51	50p	PCL84	37p	U26	60p	30FL1 & 2	75p	**equiv only 20p**	
EY86/7	37p	PCL85	45p	U191	65p	30L15	75p	**with resistor.**	

POST FREE OVER £2, BELOW 3p EACH.
MAIL ORDER ONLY.

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There really are no such things!

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EAST CORNWALL COMPONENTS P.O. Box No. 4 SALTASH, CORNWALL

RECORD TV sound using our loudspeaker isolating transformer. Provides safe connection to recorder. Instructions included. £1 post free. Crowborough Electronics (T), Eridge Road, Crowborough, Sussex.

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LADDERS, 24½ft., £9·80, carr. 80p. order C.O.D. Phone 02-993 5222. (Dept. PTT). Home Sales, Baldwin Road, Stourport, Worcs. Callers welcome. Ansafone installed.

ELECTRONIC SCOOP PURCHASES!

(Fantastic sell-out from last advert, new stocks arriving)

* 4 Channel 19" UHF TVs dispatched tested, and in full working order, £20.
* 19" Slimline, only require UHF tuner for BBC2, untested, complete, £8.
* As above but with UHF tuner, £12.
* 2 Channel (with 405/625 Timebase) 19" 110° tube, untested, £5.

(Carriage £1·50 extra all models)

FREE CIRCUIT DIAGRAM WITH EACH MODEL

GY-NORMOUS RADIO BARGAINS!

* 3 types, all superhets with push-pull O/P to internal L.S., complete with carrying case, earphone and batteries.

Type A—Bargain as advertised last month, still only £1·50+20p p & p. Type B—Large battery operated model, full LW, MW coverage. Ideal for kitchen or car. Complete with swivelling telescopic aerial, £5·80+45p p & p. Type C—Large portable radio as sold nationally, A.M. and F.M. coverage (88-108 MHz.). Horizontal pointer tuning scale. Operates from own dry batteries or A.C. mains from internal transformer isolated power pack, with provision for rechargeable cells (not supplied), £8+50p p & p.

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* CASSETTE PLAYERS—last few only —uses standard musicassettes—possible conversion to full recorder. Deck alone worth our price of £8·99+55p p & p.
* C120 Cassettes. Top quality, 75p+7½p p & p.
* SAVE £££'s ON BATTERIES, run your transistor radio, etc., from the mains with our 9v eliminator, £1·50 +15p p & p.
* LABGEAR "Magic Circle" indoor UHF aerial only £1·25+15p p & p.

SUMIKS

7 High St., Langley, Warley, Worcs.

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Colour:

19" £23	22" £26
25" £28	26" £30

(Also NEW 19" Colour Tubes available.)

Standard Types:

17" £5	19" £5·50
21" £6·50	23" £7·50

Metal Band Types:

19" £7	23" £9

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(Plus carriage all types.)

Complete new gun fitted to every tube. 2 years' guarantee monochrome, 1 year colour. 15 years' experience in tube rebuilding. Trade enquiries welcomed.

N.G.T. ELECTRONICS LTD

(Nu-Gun Teletubes)

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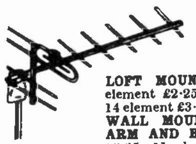
Telephone: 01-778 9178

U.H.F. TV AERIALS

Suitable for Colour and Monochrome Reception



All U.H.F. aerials now fitted with tilting bracket and 4 element reflector.

LOFT MOUNTING ARRAYS. 7 element £2·25. 11 element £2·75. 14 element £3·25. 18 element £3·75. **WALL MOUNTING c/w WALL ARM AND BRACKET.** 7 element £3·25. 11 element £3·75. 14 element £4·25. 18 element £4·75. **CHIMNEY MOUNTING ARRAYS c/w MAST AND LASHING KIT.** 7 element £4. 11 element £4·50. 14 element £4·75. 18 element £5·25. **MAST MOUNTING** arrays only 7 element £2·25. 11 element £2·75. 14 element £3·25. 18 element £3·75. Complete assembly instructions with every aerial. LOW LOSS coaxial cable 9p yd. KING TELEBOOSTERS from £3·75. LABGEAR all band V.H.F.-U.H.F.-F.M. radio mains operated pre-amps £7·50. State clearly channel number required on all orders. P.p. on all aerials 50p. Accs. 15p. C.W.O. Min. C.O.D. charge 25p.

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BBC (band 1) Wall S/D £2. **LOFT** inverted 'T' £1·25. **EXTERNAL** 'H' array only £3. **ITV** (band 3) 5 element loft array £2·50, 7 element £3. **COMBINED BBC-ITV** loft 1+5 £2·75. 1+7 £3·50. **WALL AND CHIMNEY UNITS ALSO AVAILABLE.** Pre-amps from £3·75. **COMBINED** U.H.F.-V.H.F. aerials 1+5+9 £4. 1+5+14 £4·50. 1+7+14 £5. **FM RADIO** loft S/D £1. 3 element £3·25. 4 element £3·50. Standard coaxial plugs 9p. Coaxial cable 5p yd. Outlet box 30p. P.p. all aerials 50p. Accs. 30p. C.W.O. Min. C.O.D. charge 25p. Send 5p for fully illustrated lists.

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OPEN ALL DAY SATURDAY

K.V.A. ELECTRONICS

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London Road, Mitcham, Surrey
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19" Monopanel	=	(A47/14W—CME 1908)	£6·50
19" Rimband	=	(A47/26W—CME 1913)	£7·00
20" Rimband	=	(A50/120W—CME 2013)	£8·75
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23" Rimband	=	(A59/23W—CME 2313)	£10·50
24" Rimband	=	(A61/120W—CME 2413)	£12·50

(19" A47/2813W Plus Kit = 19" Twin Panel) £10·00
(23" A59/2316W Plus Kit = 23" Twin Panel) £13·00

(NO MODIFICATIONS REQUIRED)

Full range available—Bulk user discounts.
Also rebuilt CRT'S with 2 year g'tee from £4·00

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Reverse charge telephone calls accepted from anywhere.
Free Delivery South London.
LESS 10% IF YOU COLLECT. LESS 10% IF YOU BUY 25 OFF. 1521

AERIAL BOOSTERS

We make four types of Aerial Boosters. **L45** 625 U.H.F., **L12** V.H.F. TV. **L11** V.H.F. Radio, **L10** M/W & S/W. Price L45, L12 and L11 **£2·95**, L10 **£2·45**.

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Any 5—45p, 10—70p:
ECC82, ECL80, EF80, EF85, EF183, EF184, EBF89, EB91, EY86, PCC84, PCC89, PC97, PCF80, PCF86, PCL82, PCL83, PCL84, PCL85, PL36, PY33, PY82, PY800, PY801, 30L15, 30C15, 6-30L2.

19" TV £6·50

19" 405 Slimline Televisions in good working order, with complete set of spare valves.
Price £6·50. Carriage £1·50.

PRINTED CIRCUIT BOARD

2-8 ins. by 4 ins. boards complete with etching compound and instructions. **40p.**

500MFD CAPACITORS

500mfd-25v/w Brand New Electrolytic with long leads. **11p** each.

POST AND PACKING: Under **£1, 5p.** Over **£1, 10p.** S.A.E. for leaflets on all items. Money back guarantee if not completely satisfied.

VELCO ELECTRONICS

62A Bridge Street, Ramsbottom, Bury, Lancs.

WITWORTH TRANSFORMERS

TV Line out-put transformers

ALL ONE PRICE £4·50 EACH + 20p P. & P.

ALBA

T1090	T1435
T1095	TD1420
T1135	TD1435
T1195	TD1824
T1235	TS 1320
T1395	TS 1724

BAIRD

600	628	662	674
602	630	663	675
604	632	664	676
606	640	665	677
608	642	666	681
610	644	667	682
612	646	668	683
622	648	669	685
624	652	671	687
625	653	672	688
626	661	673	

Please quote part No. normally found on tx. base plate; 4121, 4123, 4140 or 4142.

COSSOR

CT1700u	CT1975a	CT1962-77*
CT1910a	CT1976a	CT1954-77*
CT1911u	CT2100u	CT1964-78*
CT1921a	CT2310a	
CT1922a	CT2311a	
CT1935a	CT2321a	
CT1937a	CT2331a	
CT1938a	CT2372a	
CT1972a	CT2373a	
CT1973a	CT2375a	
CT1974a	CT2378a	

*Two types fitted one has pitch o/w, the other has plastic moulded overwind—please state which type required as they are not interchangeable.

BUSH

TUG versions	TV125
TV75 or C	TV125
TV76 or C	TV128
TV77	TV134
TV78	TV135
TV79	TV135
TV83	TV138
TV84	TV138
TV85	TV139
TV86	TV141
	TV145
TV91	TV148
TV92	TV161
TV93	TV165
TV94	TV166
TV95 or C	*TV171
TV96 or C	TV175
TV97	TV176
TV98C	TV178
TV99 or C	181S
TV100C	183
TV101C	183D
TV102C	183S
TV103 or D	183SS
TV105 or D or R	185S
TV106	186
TV107	186D
TV108	186S
TV109	186SS
TV112C	191S
TV113	191D
TV115 or C or R	193S
TV118	193D
TV123	
TV124	

From model TV123 to TV139 there have been two types of transformer fitted. One has pitch overwind, the other has plastic moulded overwind. Please state which type required as they are not interchangeable.

KB

PVP20	QV30 (90°)	WV90	SV20	KV055	KV136
WV05	QV30FM (110°)	MV100/1	SV30	056	138
KV001	QV30-1	OF100	SV042	065	155
KV002	30	PV100	SV048	066	156
KV005	NV40	KV101	SV054	113	165
KV006	NF60	KV105	SV142	114	166
RV10	RV60	KV107	SV143	124	
O15	WV60	115	SV148	125	
TV15	XV60	117	MV818	126	
O17	NF70 or FM	119	MV819	127	
QV20	PV70	KT400A } VC1 or VC2	MV903	134	
WV20-1	QV70				
RV20	RV70	KT405A } VC1 or VC2			
TV20	VV70	by chassis No.—			
WV20	WV70	VC1 VC4 VC52	VC200		
QVP20	WV75	VC2 VC5 VC53			
OV30	QF80	VC3 VC51 VC100			

MURPHY

V310	V430	V520	V879 or C*	V789	V2015SS
V310A	V430C	V530	V923*	V153	V2016S
V310AD	V430D	V530C	V939 or L*	V159	V2017S
V310AL	V430K	V53D	V973C*	V173	V2310
V310CA	V440	V539	V979*	V179	V2311C
V320	V440D	V540	V653X	V1910	V2414D
V330 or D	V440K	V540D	V659	V1913	V2415D
V330F or L	V470	V649D	V683	V1914	V2415S
V410	V480	TM2 Chassis	V739	V2014	V2415SS
V410C	V490	V843*	V753	V2014S	V2415SS
V410K	V500	V849*	V783	V2015D	V2416S
V420	V510	V873*	V787	V2015S	V2417S
V420K	V519				

*Two types fitted. One has pitch overwind, the other has plastic moulded overwind. Please state which type required as they are not interchangeable.

FERGUSON, ULTRA, MARCONI, H.M.V. (BRC, Jellypots).

ALL MODELS IN STOCK.

E.H.T. RECTIFIER TRAYS

Suitable for: FERGUSON, ULTRA, MARCONI, H.M.V.

Series	Series	Series	1500 Series
850	950 MKII	980	3 stick £3·00 each
900	960	981	5 stick £3·70 each
911	970	982	
950 MKI	1400		When ordering, model number and series must be quoted.
£3·00 each	£3·70 each	£3·00 each	

FIXING:
Direct BRC replacement, will clip into existing transformer.

PYE

1
2
3 or u

11u Series	
12u	
13u	State Pt. No. required—
14u	AL21003 or 772494
15u	
20u	

SP17	62
21f or uf	63
22uf	64
23uf	68
24uf	75
31uf	76
35uf	77
36	80
37	81
40f	83
48	84
49	85
53	86
58	95
59	96
60	
61	

PV110	State Pt. No..required—
PV110	771980 or 772013

V210 or A	
V220	
V410 or A	State Pt. No. required—
V420A	771927 or 771920
V430A	
V510	
V530	

V200 or LB
V300s
V310 or s
V400
V600
V620
V630

V700 or A or D	
V710 or A or D	State Pt. No.
V720	required—
V830A or D or LBA	772444 or
	771935

PHILLIPS

1768u	
1792u	Exchange
1796u	Units
2168u	
2192u	
2196	

	19TG122a
	19TG123a
	19TG125a
	19TG133a
	19TG142a
	19TG148a
	19TG152a
	19TG153a
17TG100	19TG154a
17TG102	19TG155a
17TG106	19TG156a
17TG200	19TG158a
17TG306	19TG164a
19TG108u	19TG170a
19TG111a	19TG171a
19TG112u	19TG172a
19TG114u	19TG173a
19TG116u	19TG175a
19TG121a	19TG176a
19TG178	19TG177a
19TG179	

21TG100u	G19T210	G23T210
21TG102u	G19T211	G23T211
21TG106u	G19T212	G23T212
21TG109u	G19T213	G24T230
23TG107u	G19T214	G24T232
23TG111a	G19T215	G24T236
23TG113a	G20T230	G24T238
23TG121a	G20T232	G24T300
23TG122a	G20T236	G24T301
23TG131a	G20T238	G24T302
23TG142a	G20T300	G24T306
23TG152a	G20T301	G24T307
23TG153a	G20T302	G24T308
23TG156a	G20T306	
23TG164a	G20T307	
23TG170a	G20T308	
23TG171a		
23TG173a		
23TG175a		
23TG176a		
23FG632		

GEC

BT302	BT314	BT321	BT336	BT449	2000	2015	2022	2043	2064
BT303	BT315	BT322	BT337	BT450	2001	2017	2023	2044	2065
BT304	BT316	BT324	BT342	BT451	2010	2018	2032	2047	2066
BT305	BT318	BT326	BT346	BT452	2012	2019	2033	2048	2082
BT308	BT319	BT328	BT347	BT455	2013	2020	2038	2063	2083
BT312	BT320	BT329	BT448	BT456	2014	2021	2039		

DECCA

DR20	DR34	DR71	DR505
DR21	DM35	DR95	DR606
DR23	DM36	DR100	666TV-SRG
DR24	DM39C	DR101	777TV-SRG
RD29	DR41	DR121	
DR30	DM45	DR122	MS1700
DM30	DR49C	DR123	MS2000
DR31	DM55	DR202	MS2001
DR32	DM56	DR303	MS2400
DR33	DR61	DR404	MS2401

SOBELL

T24	ST284 or ds	1010dst	1033
SC24	ST285 or ds	1012	1038
TPS173	ST286 or ds	1013	1039
TPS180	ST287 or ds	1014	1047
ST195 or ds	ST288ds	1018	1048
ST196 or ds	ST290ds	1019	1057
ST197ds	ST291ds	1020	1058
SC270	ST297ds	1021	1063
T278	1000ds	1022	1064
ST282	1002ds	1023	1065
ST283	1005ds	1032	1066

EKCO

TC403	TC437	T513	531
404	T442	514	T532
406	T500	515	533
T418	TC501	520	535
TC419	T502	521	536
T420	503	524	540
TC421	504	525	541
T422	505	526	
433	506	527	
434	510	528	
TC435	511	529	
T436	512	530	

FERRANTI

1075	TC1122	1163	1155	1175
1080	1123	1164	TC1157	1176
1081	1124	1165	1158	T1181
1082	1125	T1174	1159	T1182
1083	TC1126	T1175	TC1160	T1185
1093	1137	TC1135	1162	T1186
1094	T1154	1136	1163	
1095	T1155	1137	T1164	
1096	1157	1138	T1165	
1097	1159	1140	1173	
1121	1160	T1154	1174	

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