TELEVISION

25p

SERVICING · CONSTRUCTION · COLOUR · DEVELOPMENTS

MARCH 1974

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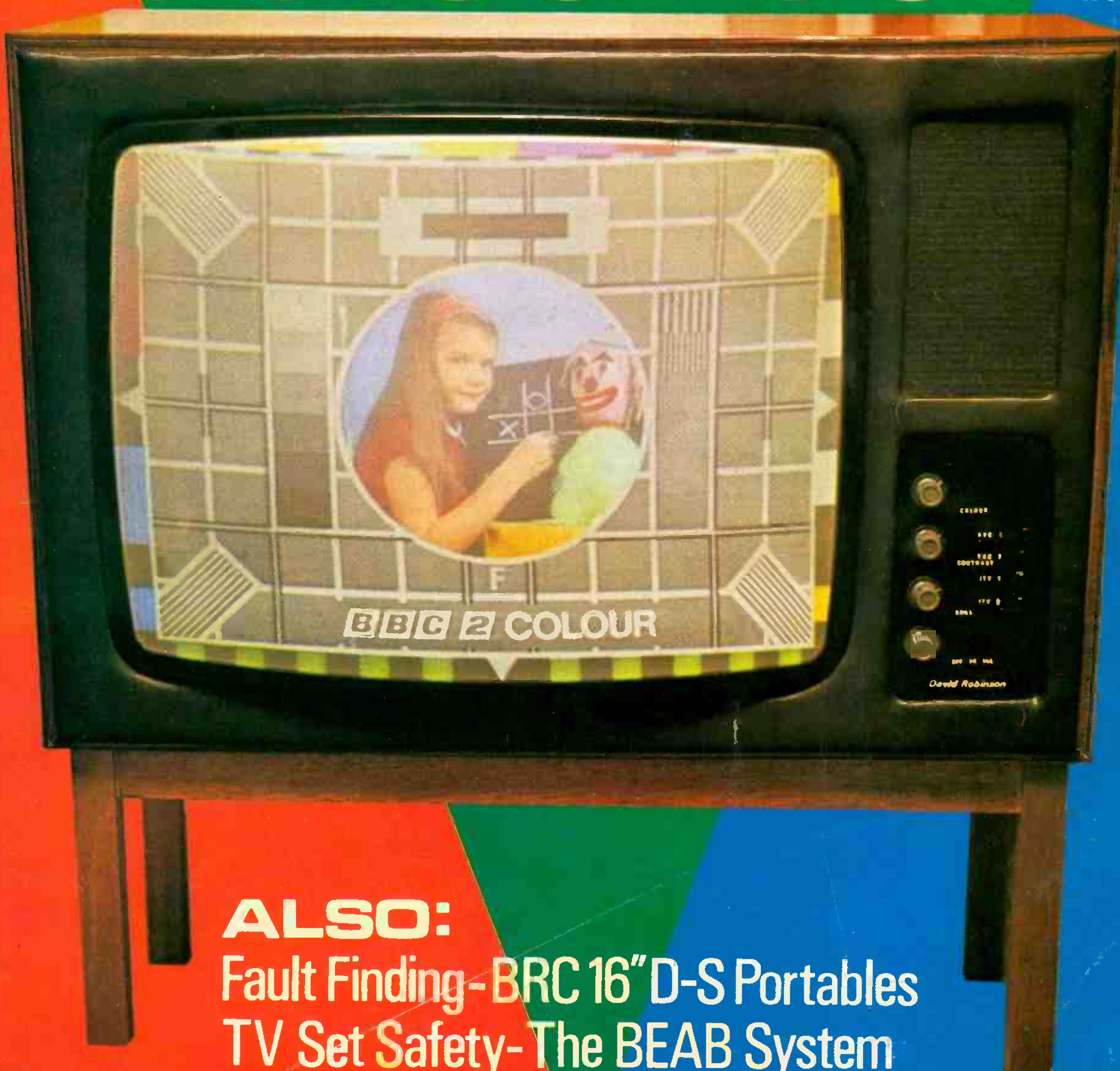

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ECC84	0·30	EL84	0·23	KT66	2·40	PEN453DD		UAF42	0·55	U191	0·70
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6AC7	0·49	6D3	0·60	6U7G	0·75	12SG7	0·38	30PL1	0·66	ATP4	0·40
6AG5	0·27	6DE7	0·75	6V6G	0·17	12SH7	0·35	30PL12	·32	AZ1	0·60
6AH6	0·50	6DT6A	0·75	6V6GT	0·38	12SJ7	0·44	30PL13	·75	AZ31	0·60
6AJ5	0·75	6EW6	0·75	6X4	0·30	12SN7	0·60	30PL14	·80	AZ41	0·65
6AK5	0·34	6E5	1·00	6X5GT	0·28	12SQ7GT	·65	30PL15	·95	B36	0·60
6AK6	0·60	6F1	0·70	6Y6G	0·65	14H7	0·55	35A3	0·65	CL33	1·50
6AM6	0·30	6F6G	0·50	6Y7G	1·00	1487	0·75	35A5	0·80	CV6	0·53
6AM8A	0·55	6F13	0·55	7AN7	0·40	19AQ5	0·42	35D5	0·75	CV63	0·53

DM70	0·44	ECF86	0·75	EM83	0·55	N339	2·00	PL82	0·37	UCF80	0·65	U4020	0·55
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DY802	0·33	ECH42	0·70	EMM803		PC88	0·60		0·67	UCL82	0·38	VT61A	0·35
E80CC	1·65	ECH81	0·30		2·00	PC95	0·75	PL508	0·90	UCL83	0·60	VU111	0·44
E80F	1·20	ECH83	0·44	EY51	0·40	PC97	0·45	PL509	1·15	UF41	0·70	VU120	0·60
E83F	1·20	ECH84	0·44	EY81	0·40	PC900	0·45	PL802	0·95	UF42	0·70	VU120A	·60
E88CC	0·80	ECL80	0·40	EY83	0·54	PCC84	0·40	PM84	0·60	UF80	0·35	VU133	0·35
E92CC	1·00	ECL82	0·34	EY84	0·70	PCC85	0·44	PY33/2	·50	UF85	0·44	W76	0·38
E180F	1·00	ECL83	0·57	EY87/6	·33	PCC88	0·60	PY80	0·38	UF86	1·00	W107	0·65
E182CC	1·00	ECL84	0·60	EY88	0·40	PCC89	0·50	PY81	0·31	UF89	0·38	W729	0·75
E1148	0·53	ECL85	0·60	EY91	0·58	PCC189	0·53	PY82	0·25	UL41	0·65	X41	1·00
EA50	0·27	ECL86	0·40	EZ40	0·55	PCC805	0·75	PY83	0·33	UL84	0·38	X63	1·25
EA76	1·00	EF22	1·50	EZ41	0·50	PCC806	0·70	PY88	0·33	UM80	0·44	X66	0·65
EABC80	·30	EF40	0·60	EZ80	0·24	PCF80	0·28	PY301	0·70	URIC	1·00	XH/1·5	·48
EAC91	0·75	EF41	0·70	EZ81	0·25	PCF82	0·33	PY500	0·80	UU5	1·00	Z329	0·85
EAF42	0·50	EF42	0·55	FW4/500	£1	PCF84	0·59	PY500A	·80	UU9	0·55	Z749	0·85

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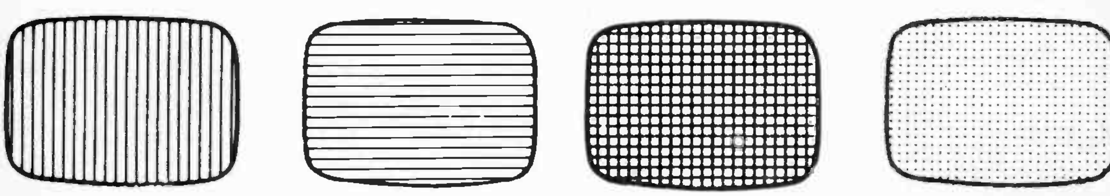

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TELEVISION

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SERVICING·CONSTRUCTION·COLOUR·DEVELOPMENTS

MARCH 1974

CONFIDENCE IN COLOUR

In spite of the gloomy winter with restricted industrial activity, production of colour television receivers is still proceeding more or less as planned. There was a surge of demand during 1973 but it seems likely that this will level off during 1974. Sitting back in our armchairs we tend to be not too concerned about the buzzing activity behind the scenes at the setmakers. Once we have a working receiver we perhaps become too engrossed in the programme material to think about how it is we have a set at all.

Despite the current pessimism colour television is here to stay and the subsequent servicing must somehow follow. But what of new models? One of the problems of a manufacturer is to remain viable and this means he must always be looking ahead. Apart from technical developments however new models are being introduced because of the odd conditions at present: once a model is introduced its price is fixed, but a new model can have a new price! Is this an answer to or a cause of inflation? A difficult point to weigh up.

It is easy enough to produce a "new" model by simply making a few stylistic changes—it is likely that this approach will be adopted in many fields. One advantage for the service engineer is that it minimises the need for continual re-education. The demands for skill, knowledge and experience remain vital however if he is to maintain a worthwhile service to the public. For colour servicing a total understanding of setting-up procedures is more important than with monochrome and to hope for, let alone achieve, perfect results with minimum equipment and knowledge is being optimistic.

There are ways round many problems however. One of our authors has shown how by using basic skills and common sense a great deal can be achieved. David Robinson described in the January issue (see "Forum") how one can satisfactorily set up a PAL decoder using very limited equipment. In this issue he embarks on the first part of the fascinating story of how he carried out his own colour television receiver assembly and alignment independently, using mainly modules and components from surplus stock. Whilst we cannot vouch for the current availability of all the parts used, nor the consistent reliability of such modules as are readily available, this report is being published in the next few issues of TELEVISION because it gives a valuable insight into the various problems involved and tackles them with confidence. It is an education in itself and well worth reading, if only to gain a better understanding of colour techniques.

M. A. COLWELL—*Editor*

THIS MONTH

EVERY EFFORT WILL BE MADE TO PUBLISH THE APRIL ISSUE ON THE USUAL DATE BUT AS A RESULT OF THREE-DAY WORKING IN THE PRINTING INDUSTRY THERE MAY BE SOME DELAY

COVER PRICE

Like most other magazines and paper products TELEVISION has become a victim of the present world paper shortage which has resulted in massive cost increases. For this reason we have been compelled, as announced last month, to increase the cover price of TELEVISION to 25p from the current issue. We regret the necessity to take this action.

TELETOPICS

A VISIT TO RRI

During a recent visit to Rank Radio International we were shown prototype versions of their latest 12in. mains/battery monochrome portable. The chassis is now in production at RRI's new Stoke, Plymouth factory and the first model fitted with it, the Murphy V1230 Traveller, has been released. RRI, who have imported most of their previous mains/battery portables, comment that production of such sets in the UK is now fully competitive.

The sets can be operated from a 12V car battery or internal batteries. RRI do not offer batteries themselves but recommend the use of a pair of Sonnenschein sealed lead-acid or Varta nickel-cadmium batteries. The approximate life of these on a full charge is four hours. A feature of the set is that these batteries can be charged using mains power, at full or maintenance rate according to their state. The set cannot be used for viewing when switched to full charge, which is indicated by a lamp. The maintenance charge facility however can be used whenever the set is being operated from the mains supply. Connecting leads for car battery operation are provided.

A varicap tuner unit is used, the tuning scales and edge wheels—which provide four preset stations—lying behind a flap on the front panel. There is a square-loop aerial at the back and provision is also made to use the normal domestic aerial installation. The recommended retail price of the Murphy Traveller is £69·95 including VAT.

The set is extremely compact and one of the most remarkable features is the Plessey SL437F i.c. used on the i.f. panel. This 24-pin i.c. provides the entire vision i.f. gain and incorporates in addition the intercarrier sound channel. It is in fact a complete television i.f. system! Fig. 1 shows a block diagram of it. The composite video output signal obtained at pin 13 is applied to the sync separator and video output stages and also a 6MHz filter (a ceramic filter is used in the RRI chassis) which returns the intercarrier signal to pins 19/20 of the i.c. A d.c. volume control system controls the output obtained from the sound synchronous detector at pin 15. A gated a.g.c. system is built in and the i.c. also provides a delayed a.g.c. feed to the tuner unit. An output to drive an a.f.c. discriminator is available at pin 10, but this is not used in the RRI portable chassis.

Two other i.c.s are used in the chassis. The field output stage consists of a TBA641B whose output is capacitively coupled to the field scan coils, while the audio channel consists of a TAA611B.

The AU113 line output transistor is connected as an emitter-follower and is operated, along with the line driver stage, from a 26V boost rail. A stabilised power supply is used, with the series regulator tran-

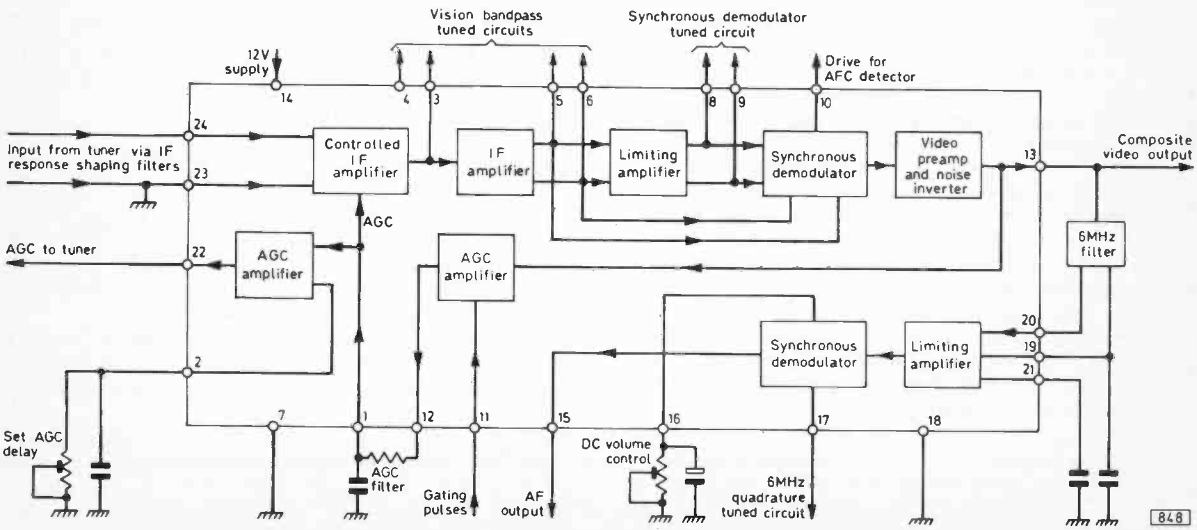


Fig. 1: Block diagram of the SL437F i.c., which provides a complete TV i.f. system.

sistor in the negative supply line. A TV11 silicon e.h.t. rectifier provides 11kV for the c.r.t. final anode, other rectifiers providing 360V and 100V lines from windings on the line output transformer.

Other models on display during our visit to RRI included the Bush CTV1526, the first model to incorporate the new RRI 110° chassis (type Z179) which was described in some detail in our October issue, and a new Murphy 20in. monochrome set, Model V2021, which is fitted with the A774 hybrid chassis (basically as used in the V2016 series, see *Servicing Television Receivers* April/May 1973). The recommended retail price of the 110° colour receiver is £327·18 and of the new monochrome set £77·50, including VAT in both cases.

Our visit to RRI included a tour of the department where equipment for testing TV chassis during manufacture is designed and built. The test rigs shown were those recently evolved for use with the new 110° colour chassis. RRI design and produce their own specialised test equipment for testing and setting up individual boards and complete subassemblies. Signals and supplies are applied using the "bed of nails" technique. Individual test signals are selected by push-buttons and the outputs visually displayed, a sequential programme enabling setting-up adjustments to be carried out. The simple push-button test signal selection, visual display and sequential test programming enables relatively unskilled operators to be used to carry out complex alignment procedures.

CIRCUITS FOR THE PI TUBE

Details have been released recently by the ITT Central Application Laboratories at Esslingen, Germany of circuits for use with the PI colour tube. This new type of colour tube was described in detail in our June 1973 issue. It is a development of the shadowmask tube, using three precision guns mounted in line and a precision wound toroidal yoke which is permanently fixed to the tube neck. With these techniques it is not necessary to apply any dynamic convergence correction, thus considerably reducing costs and manufacturing and servicing problems.

The PI tube is a thin-neck type (diameter approximately 29mm.) and ITT have adapted for use with it the thyristor line output stage originally developed for use with thin-neck 110° shadowmask tubes. The deflection energy required by the 90° PI tube is substantially less than that required by a 110° tube, easing the design problems considerably. In addition a single transductor can be used for pincushion distortion correction instead of the separate EW and NS pincushion distortion correction transductors used in the 110° design.

Since all the grids and anodes of the PI tube are common only the cathodes are individually available. This makes the design of the video output stages quite a complex problem, highlight and background adjustments, blanking and beam limiting all having to be applied in this part of the circuit.

The 90° PI tube might be regarded as a retrograde step following the 110° shadowmask tube. The PI tube requires no internal pole pieces for convergence purposes however so that the gun is shortened and the overall tube length reduced considerably, making it comparable to a standard 110° shadowmask tube rather than a 90° one.

ITT's thyristor line output stage for use with narrow-neck 110° shadowmask tubes was described in some detail in our March 1972 issue. While it has not been used so far by any UK setmakers it is nevertheless found in a number of 110° colour sets imported from Europe, including those in the Finlux, ASA and Grundig ranges.

TRANSMITTER NEWS

Both the BBC and IBA have brought into service their **Rumster Forest** (NE Scotland) main u.h.f. transmitters. The IBA channel (Grampian programmes) is 24, BBC-2 27 and BBC-1 31. A horizontally mounted group A receiving aerial should be used. Maximum e.r.p. is 100kW.

The following relay stations are now in operation:

Abergavenny BBC-Wales channel 39, BBC-2 channel 45. Receiving aerial group B.

Abertillery BBC-Wales channel 22, BBC-2 channel 28. Receiving aerial group A.

Brecon BBC-Wales channel 58, BBC-2 channel 64. Receiving aerial group C/D.

Carnmoney Hill (N. Ireland) IBA channel 43 carrying Ulster Television programmes. Receiving aerial group B.

Ladder Hill BBC-2 channel 26, BBC-1 (North West Region) channel 33. Receving aerial group A.

Mynydd Bach BBC-Wales channel 58, BBC-2 channel 64. Receiving aerial group C/D.

Plympton (Plymouth) BBC-1 channel 58, BBC-2 channel 64. Receiving aerial group C/D.

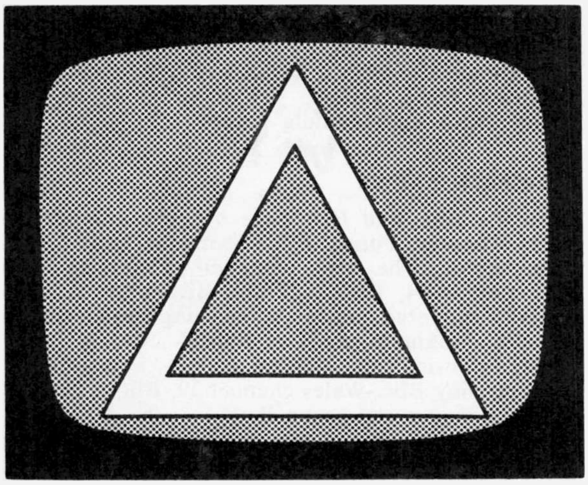
All these relay transmissions are vertically polarised.

TV DEVELOPMENTS IN THE USSR

An exhibition of holographic devices has been held for the first time in Moscow. Amongst the projects shown was a holographic video recorder for use with domestic TV sets. Instead of a magnetic head a laser beam is used, with the signal recorded on film as a three-dimensional image. Reproduction is not three-dimensional, but as a result of recording the signal in holographic form even a frame which is nine-tenths damaged will provide a good picture. RCA in the West have done a great deal of work on holographic video recording (the attraction is the cheap film storage medium) but this has not so far resulted in an economically viable system. Soviet scientists however are paying a great deal of attention to systems using lasers. Work on a new and cheaper colour TV display system using a laser tube instead of the conventional c.r.t. is in progress at the Lebedev Institute in Moscow. Experimental models are expected to be ready by the end of the year. The new technique could be applied relatively inexpensively to colour screens several yards wide as well as to smaller domestic TV screens.

A satellite TV link between Havana (Cuba) and Moscow has now been tested. Transmissions have been sent both ways between the Intersputnik international space communications system in Havana and a space communications station near Moscow via a Soviet earth satellite. Excellent results have been reported. Regular TV programme exchanges are expected to start later this year.

TV SET SAFETY



The BEAB System

PART 1 **E. J. HOARE**

A NEW situation has developed in the UK regarding the safety requirements of television receivers. This has an important effect on the activities of service engineers and to a lesser extent home constructors. Greater emphasis is now being placed on the need for safety and properly organised testing (the BEAB — British Electrotechnical Approvals Board — system) has come into operation. It is essential therefore that all engineers concerned with domestic television become familiar with the new arrangements and understand their responsibilities.

The UK setmaking industry has for many years adopted a responsible attitude to matters of safety and has complied reasonably well with the requirements of BS415 although under no legal obligation to do so. BS415 is the British Standard Specification relating to safety requirements for mains-operated household sound and vision equipment. With the sale of such vast numbers of television sets however it was inevitable that a number of incidents caused by fire or electric shock should occur. With the advent of more complex equipment such as colour receivers the risks naturally increased, though it is fair to say that the incidents that have occurred have involved only a minute proportion of the total number of sets in use.

As a result of discussions between the Home Office and representatives of industry it was agreed to put safety requirements on a different footing. BS415 was revised in order to achieve higher standards of safety, and is now broadly similar to a document (IEC65) issued by the International Electrotechnical Commission. UK setmakers now submit new models to the British Electrotechnical Approvals Board to be tested for compliance with the revised requirements of BS415: 1972. Models passing these tests satisfactorily are issued with certificates of approval by the BEAB and markings to this effect will be found on the back cover.

Legal Implications

These new arrangements have important implications for both setmakers and service engineers. BS415 is a long and detailed document which has to give specific instructions about a very complex subject. Trying to unravel all the do's and don'ts and to be quite clear about all the requirements that have to be met is a complicated matter. Some of the requirements are unexpected and subtle. In fact setmakers have to employ full time staff who are solely engaged on identifying safety problems and then finding solutions: also in making sure that nothing happens during the production run of a receiver to invalidate any of the safety measures that have been so carefully designed in. We shall see later just how difficult this can be.

Service engineers have a special responsibility too. Supposing that a fault is diagnosed and a certain component changed, using a similar but not identical type. Later on this component may in turn fail, and in doing so may cause overheating which starts a fire. The setmaker is not guilty of negligence because he obtained BEAB approval on the basis of the original component used. But the replacement component substituted is different. If it invalidates the set's BEAB approval the service engineer is in a difficult position: it is likely that legal action could be started against him on the grounds of negligence. Service engineers would be well advised therefore to get guidance on such points and make every effort to comply with the letter and spirit of the safety regulations.

The home constructor is in a rather different situation. If he uses his equipment himself then presumably no legal problems will arise if he has a burn-up — except that claims under an insurance policy might receive a less sympathetic hearing. But what happens if his equipment is passed on to someone else? Can the requirements of BS415 be used as evidence against him if a legal problem arises?

Clarification of such legal issues will doubtless be forthcoming before long.

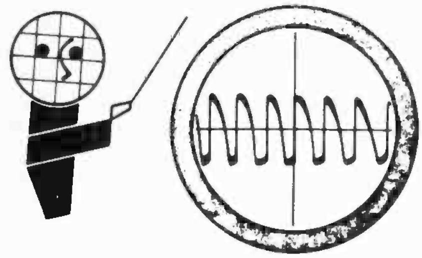
Technical Requirements

Having sounded a note of warning about the new arrangements let us pass on to the more interesting aspect of the matter: namely the technical requirements of BS415: 1972 and how these are complied with in practice.

The Standard's requirements are intended to ensure a high degree of personal protection against the following hazards: electric shock; high temperatures; ionising radiation; implosion; fire and mechanical instability. The requirements have to be met both under normal operating conditions and also under certain specified fault conditions.

Normal operating conditions are intended to encompass all reasonable combinations of circumstances which might occur in practice in domestic households. Fault conditions are listed in detail and are based on the fact that any single component may fail, that any insulating clearance or material below a certain minimum standard may become short-circuited, that components or leads may

look!



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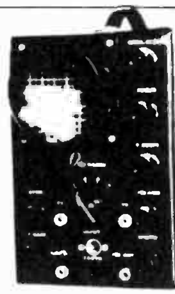

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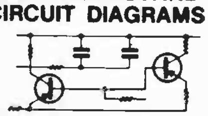

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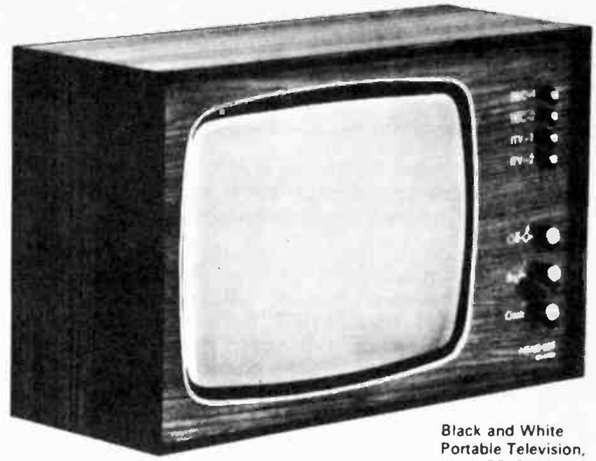

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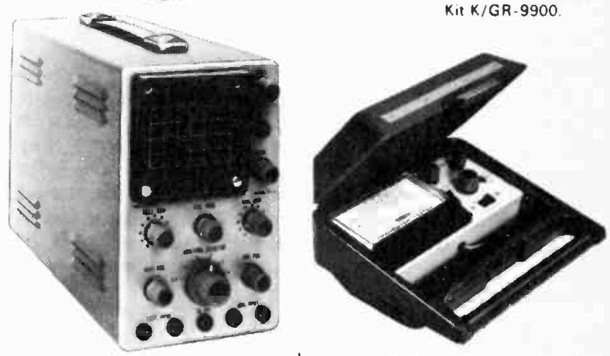

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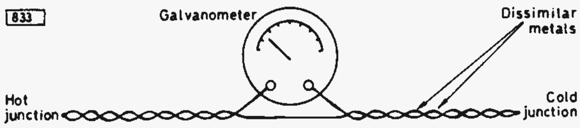


Fig. 1: The galvanometer is calibrated in degrees of temperature difference between the hot and cold junctions. The cold junction is usually at room temperature.

become disconnected and so on.

Perhaps the best way to illustrate the safety requirements of BS415: 1972 is to look at the case of a new design of television receiver. We will consider each aspect of the Standard in turn, see what is required, and then try to assess what precautions have to be taken in order to achieve compliance with each item.

Heating under Normal Conditions

The Standard specifies the order in which the various tests are to be carried out, so we begin with heating under normal operating conditions. The purpose of this part of the test procedure is to ensure that under long term operating conditions no insulating or structural materials suffer deterioration due to excessive temperature; also that no part of the outside of the apparatus gets hot enough to cause pain or injury if touched.

In order to test for compliance with the Standard it is first necessary to establish what are "normal operating conditions."

It is clearly not practicable to quote here all the requirements of BS415: indeed any attempt to do so would raise the point that it would be much better to buy a copy and study the subject in full detail. What we propose to do then is to summarise the main points, providing a guide to the general nature of the requirements so as to illustrate the sort of test procedures involved. For full information there is no alternative but to get hold of a copy of BS415: 1972 itself — it should be possible to get one from any public library by prior request.

Normal operating conditions are listed in the Standard as the worst combination of the following main items: a mains supply of nominal voltage $\pm 10\%$; any setting of the external hand operated controls; the apparatus earthed or not (where relevant); and delivering $\frac{1}{8}$th of its maximum rated output power.

Having established the worst operating conditions — which will normally involve maximum contrast and brightness together with 264V a.c. input (240V + 10%) — the next job is to measure temperatures. This has to be a comprehensive operation because there are so many surfaces to be measured. It is also necessary to have the right kind of equipment. A mercury in glass thermometer is no use at all because it will record the air temperature with only a small contribution from a hot surface with which it is in only partial contact.

The only satisfactory equipment for most purposes is a thermocouple meter as shown in Fig. 1. If two wires of dissimilar material are joined together at each end, and one junction is hotter than the other, a very small current will flow which can be measured on a galvanometer. The meter deflection can be calibrated in terms of the temperature difference between the hot and cold junctions. The virtues of this technique are its accuracy and the fact that the wires can be so thin that very little heat is conducted away from the item being measured. The hot junction can be soldered to metal parts, or secured to insulating materials with a very small patch of adhesive tape.

The temperature of the interior of transformer windings is usually measured by the change in resistance of the copper wire when it is heated up from room temperature to its normal operating temperature. (It is assumed to have reached this state after four hours.) The change in resistance is a direct measure of the change of temperature that has occurred.

Table 1 is a reproduction of Table 3 in BS415 and you will see that it lists all the materials commonly used in the construction of a television receiver. In order to check compliance with the Standard it is necessary to measure all hot surfaces and then compare the results against the figures quoted in the table. The usual procedure is to identify all the hot surfaces first, either by touch or on the basis of experience, and then concentrate the testing on these.

Trouble Spots

The usual trouble spots are to be found amongst the following: the inside of the cabinet or backplate over heat producing sources such as line output transformers and mains dropper resistors; areas of copper clad printed panels near wirewound resistors, heatsinks or valveholders; insulating materials on wound iron-cored components; the windings of line output transformers, chokes and other transformers; and any material situated in a hot air stream. Sometimes the outside of the backplate also gets too hot but in this case the inside will be overheated to an even greater extent.

The cure for these troubles is nearly always pure common sense. To be cured effectively heat problems have to be foreseen at an early stage in the structural design process. If for example you design the layout of a vertical printed panel with the line output transformer, mains droppers and sundry wirewound resistors all in one closely packed cluster then heat problems are inevitable.

A good design is one in which the sources of heat are evenly distributed throughout the cabinet, with no high temperature sources placed close to the cabinet, backplate or other temperature sensitive materials. This approach promotes a good cooling airflow through the cabinet and dilutes any hot airstreams. Bear in mind that heat is transferred by conduction, radiation and convection, and that all three are usually significant. In the case of hot wirewound resistors and similar hot bodies it is sometimes disconcerting to find that instead of spreading out and cooling down as one might expect the stream of

Fig. 2: The hot air stream from say a wirewound resistor does not usually spread out but on the contrary becomes narrow and of high temperature.

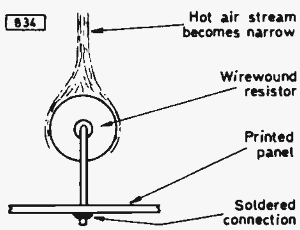


Table 1: Permissible Temperature Rises.

Parts of the apparatus	*Permissible temperature rise*	
	Normal operating conditions	*Fault conditions*
	(Note 1)	(Note 2)
	°C	°C
External Parts		
Metal parts, knobs, handles, etc.	30	65
Enclosures (Note 1)	40	65
Non-metallic parts, knobs, handles, etc. (Note 2)	50	65
Enclosures (Notes 1 and 2)	60	65
Inside of Enclosures, of wood or insulating material	60 (Note 3)	90 (Note 3)
Windings		
Wires insulated with non-impregnated silk, cotton, etc.	55	75
Wires insulated with impregnated silk, cotton, etc.	70	100
Oleoresinous enamelled wires	70	135
Wires enamelled with polyvinylformaldehyde or polyurethane resins	85	150
Core Laminations	As for the relevant windings	
Supply Cords and Wiring		
Insulated with ordinary polyvinylchloride		
not under mechanical stress	60	100
under mechanical stress	45	100
Other Insulations		
Non-impregnated paper	55	70
Non-impregnated cardboard	60	80
Impregnated cotton, silk, paper and textile, urea resins	70	90
Laminates, bonded with phenolformaldehyde resins, phenolformaldehyde mouldings with cellulose fillers	85	110
Phenolformaldehyde mouldings with mineral fillers	95	130
Laminates bonded with epoxy resins	120	150
Natural rubber	45	100

The values of the temperature rises are based upon a maximum ambient temperature of 35°C, but the measurements are made under normal operating conditions.

Note 1: For areas having no dimension exceeding 50mm. and which are not likely to be touched in normal use, temperature rises up to 65°C are allowed under normal operating conditions.

Note 2: If these temperature rises are higher than those allowed by the class of the relevant insulating material, the nature of the material is the governing factor.

Note 3: The permissible temperature rises for the inside of enclosures of insulating material are those indicated for the relevant materials.

(Courtesy: British Standards Institution)

convected hot air tends to form a very thin column of very hot air travelling straight upwards—see Fig. 2. The temperature of the backplate can be surprisingly high over a small area of a square inch or so.

Heating at High Ambient Temperatures

Most of the tests in BS415:1972 are carried out at the equivalent of room temperatures in the range 18-29°C. The maximum ambient temperature at which equipment is expected to operate safely is 35°C however, so a test has to be carried out at this temperature. The receiver is subjected to normal operating conditions as previously defined in an enclosure heated to 35°C and is kept there for four hours. After this the receiver is inspected to see if any damage has occurred that affects its safety within the scope of the Standard. Obvious things to look for are deterioration, distortion or creepage of any insulating materials and impregnating compounds.

Whilst at 35°C the cabinet and backplate are subjected to pressure tests using a standard dummy rigid test finger and a hook. These tests are designed to ensure that no live parts become accessible and that clearances between live parts and metalwork on

Table 2: Minimum Clearances and Creepage Distances in Air.

Peak value of the voltage	Minimum clearance (mm.)	Minimum creepage distance in air (mm.)
Up to and including 34V	2	2
Over 34V up to and including 354V	3	3
Over 354V up to and including 500V	3	4
Over 500V up to and including 630V	3.5	4.5
Over 630V up to and including 800V	3.5	5
Over 800V up to and including 1000V	4	6
Over 1000V up to and including 1100V	4.5	7
Over 1100V up to and including 1250V	4.5	8
Over 1250V up to and including 1400V	5.5	9
Over 1400V up to and including 1600V	7	10
Over 1600V up to and including 1800V	8	11
Over 1800V up to and including 2000V	9	11.5
Over 2000V up to and including 2200V	10	12
Over 2200V up to and including 2500V	11	13
Over 2500V up to and including 2800V	12	14
Over 2800V up to and including 3200V	13	14.5
Over 3200V up to and including 3600V	14	15.5
Over 3600V up to and including 4000V	14.5	16.5
Over 4000V	15.5	17.5

(Courtesy: British Standards Institution)

the outside of the cabinet do not fall below certain specified distances. These clearances are given in Table 2, which is reproduced from BS415. (This table has to be referred to in a number of other tests.)

Electric Shock

Testing for electric shock possibilities is one of the most important of the whole series of tests since it concerns the safety of the average viewer against this danger under normal conditions of use. The test requirements are very detailed and complex, so the following description is only a summary of the main points. It should nevertheless serve to show the kind of precautions that have to be complied with under the BEAB scheme and that home constructors should try to meet to the best of their ability. It is assumed that a.c./d.c. technique is used without a double-wound mains transformer.

The first part of the test procedure consists of applying standard dummy fingers and a test pin to the whole of the outside of the receiver in order to establish whether it is possible to touch a live part. This test is applied both before and after the removal of any parts that can be detached by hand.

First the jointed test finger shown in Fig. 3 is applied with very light pressure in every possible position. Then the test pin shown in Fig. 4 is applied in a similar way to the two sides and the front of the receiver. Finally the rigid test finger shown in Fig. 5 is applied around any opening, with a force of 50N (1N=0·1 kilogram), whilst the jointed test finger is applied without force to see whether any live parts become accessible.

These tests are applied to such places as ventilation slots, recesses for screw heads, gaps between back-plates and cabinets, joints between plastic mouldings, scrim or cloth coverings over loudspeaker apertures, external terminals and so on. No possible means of access to metal parts or to the inside of the cabinet is overlooked. Contact with live parts can be established by applying a voltage to the test finger or pin and attaching a meter to the metal part in question. The receiver is disconnected from the mains of course for this test.

The term "live parts" is clearly defined in the Standard. Aerial and earth terminals are regarded as live if a current of more than 0·7mA a.c. peak or 2·0mA d.c. can be drawn through an impedance of 2kΩ connected to any part and either pole of the

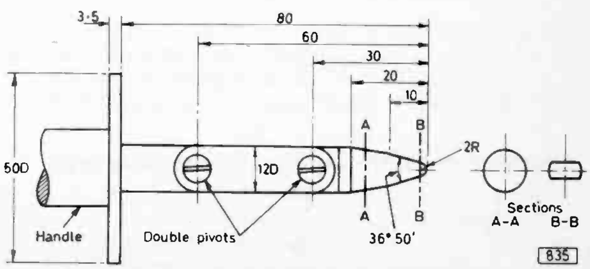


Fig. 3: The jointed test finger - courtesy of the British Standards Institution. Dimensions in mm.

mains supply. For aerial terminals there is the additional requirement that the discharge of electrical energy must not exceed 4·5 microcoulombs.

For other terminals and metal parts the same current limits apply, but the series resistance is increased to 50kΩ. There are further requirements as follows: For peak voltages between 34V and 450V the capacitance connected must not exceed 0·1μF; for peak voltages between 450V and 15kV the discharge energy must not exceed 45 microcoulombs; and for voltages over 15kV peak the discharge energy must not exceed 350mJ. At frequencies above 1kHz the limit of 0·7mA is multiplied by the frequency in kHz with a maximum limit of 70mA.

Knobs and Cabinet Openings

Knobs and the spindles to which they are attached can present special hazards, so the tests on these are stringent. If after removal of the screw(s) or clip securing a knob to a spindle the knob can be pulled off by hand this is first done. The spindle and the surrounding opening is then tested in accordance with the requirements of the previous section. If a knob cannot be removed by hand, access to live spindles or fixing screws etc. is checked by means of a free hanging endless metal test chain of 2·0mm. diameter.

Clearly the best way of complying with this aspect of the safety requirements is to use potentiometers with insulated plastic spindles. Metal spindles should not normally be used. It is also important to make sure that the holes in the cabinet are only just large enough to take the spindles: otherwise there is a danger of access along the spindle to the metal cover of the potentiometer or the wiring behind it. Customer controls get so much use by all manner of unskilled people that it must be regarded as completely irresponsible to take any chances with this aspect of receiver construction. Readers of TELEVISION—please take care.

As we have seen ventilation slots are subjected to standard finger tests (although without enough pressure to cause a wedge action) but other tests are also specified. First a metal test pin of 4·0mm. diameter and 100mm. long is suspended freely from one end through any slots large enough to take it to see whether it can touch any live parts. Next the test is repeated using a free hanging endless flexible metal chain of 2·0mm. diameter suspended for a distance

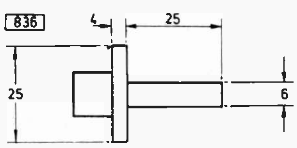


Fig. 4: The rigid test pin—courtesy of the British Standards Institution.

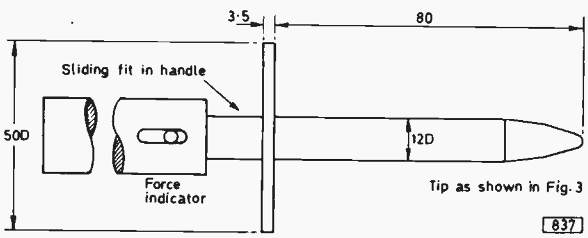


Fig. 5: The rigid test finger—courtesy of the British Standards Institution.

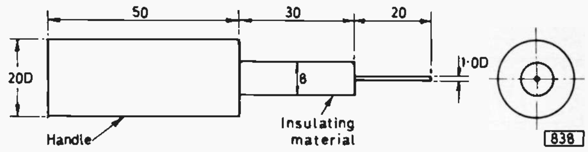


Fig. 6: Test pin — courtesy of the British Standards Institution.

of 100mm. These tests are intended to prevent the danger of necklaces or screwdrivers etc. penetrating the cabinet and causing an electric shock to the user.

It is not always practicable to limit the size of ventilation holes in the top of the cabinet or the backplate to less than 2·0mm. wide since the cooling may then be inadequate. To overcome this problem it is usually necessary to use slots a little narrower than the standard test fingers and then fix a fine mesh plastic netting or scrim over the inside of the slots. Glueing normally secures the netting adequately but must be carefully done. The plastic should be flame retardant of course.

Holes provided in the cabinet for aerial leads, extension leads and so on also present a hazard. Safety is checked by applying the test pin shown in Fig. 6 from all possible angles. A piece of bare wire of 1·0mm. diameter and 100mm. long is also applied to any female socket.

Openings provided for preset controls requiring the use of a tool for adjustment are tested for access to live parts by means of a test pin 100mm. long and of 4·0mm. diameter as used before, applied with a force of 10N within 25mm. of the opening.

Another point to bear in mind is that backplates and any other removable covers must be a good fit. Also, repeated removal and replacement must not invalidate the safety precautions as a result of warping or loosening of the fixing clips or screws. Make a good job of securing these covers.

Internal Construction

There are many cases of accessible metalwork which protrudes through the cabinet or backplate but does not touch any live parts of the set and so will pass the tests applied so far: examples are fixing screws for carrying handles, metal trim, stands, cabinet securing bands and so on. Clearly if these items rest too close to live parts such as soldered connections, bare wires or metal components there is a danger of the space between being bridged and the metalwork concerned becoming live. A further series of tests is essential therefore to establish the long term safety of the equipment and to guard against variations in the assembly methods used that may introduce a hazard.

All accessible parts whether metal or not must be protected from live parts by any one of several specified techniques.

One method of achieving adequate protection is to connect all accessible metalwork to the earth conductor of a three-core mains lead. There must also be an insulating barrier between the metalwork and any live parts and this must comply with the BS415 table of test voltages shown in Table 3. These test voltages have to be applied to the receiver after it has been given a special moisture treatment

Table 3: Test Voltages.

Insulation	*A.C. test voltage*
(1) Between poles of the circuit directly connected to the supply mains (2) Between the mains poles and each accessible part (3) Between the mains poles and each terminal (4) Between live parts and each terminal (5) Between accessible parts and live parts (6) Between terminal devices with a voltage $\hat{U} > 34V$ and each accessible part (7) Between the sound circuit together with its accessible parts and the field energizing circuit of an independent loudspeaker (8) Between the field energizing circuit of an independent loudspeaker together with the sound circuit if the latter is subjected to a voltage $\hat{U} > 34V$ and each accessible part (9) Between any two wires or parts, the short-circuiting of which may cause shock hazard	For all items in the table use: 500V if $\hat{U} < 34V$ or an r.m.s. voltage numerically equal to $2\hat{U} + 1500V$, with a minimum of 2000V if $\hat{U} > 34V$

Note 1: The voltage $\hat{U}$ is the higher value occurring across the insulation under normal or fault conditions, the apparatus being connected to the rated supply voltage.

Note 2: Instead of an a.c. test voltage, a d.c. voltage with a value equal to the a.c. peak value may be used.

(Courtesy: British Standards Institution)

consisting of 48 hours in a chamber of 95% relative humidity at 30°C.

The next method is to use the technique of double insulation. As the term implies, two separate layers of insulation are required: one can be of air, and one must be at least 1·0mm. thick. The test requirements of these two layers are as follows: one layer must pass the voltage test described in the previous paragraph with reference to Table 3; the other layer must withstand a dielectric test of 1kV r.m.s. Also the air creepage and clearance distances must comply with Table 2.

Another approved technique is to use a single barrier of insulating material at least 2·0mm. thick, that passes the moisture and voltage tests already described with the proviso that the minimum test voltage is 4kV r.m.s.

The last choice of method for achieving adequate insulation depends upon a properly controlled air gap of at least 8mm. The air gap must be protected against the deposition of dirt and dust, and must be maintained by some rigid form of construction. There are three further conditions: The area of any accessible metal part that protrudes through to the inside of the cabinet must be less than 500 square mm., and the external part must be unlikely to be gripped by hand, i.e. not a carrying handle. Furthermore any lead which may break away and reduce the clearance below 8mm. must be restrained.

In case there is any confusion over the difference of status between accessible parts in general, and metalwork in particular, a word of explanation may be in order. A wooden cabinet is not regarded as a complete insulator but only as one barrier of a double insulation. A metal chassis cannot therefore be screwed to the cabinet: it has to be screwed to insulating plastic mouldings which are in turn fastened to the cabinet. Fibre backplates constitute only one barrier of a double insulation, so a clearance has to be rigidly maintained between it and the chassis, or another barrier of solid insulation has to be placed in between.

Front control panels also present problems. The easiest way of insulating them from the cabinet is to mount them on a moulded plastic grill which can also carry the loudspeaker. Wires can break at their soldered joints and swing out to touch the cabinet, c.r.t. P band or other metalwork. Any that can do this should be secured close to their point of connection by clips or ties.

In general any live part or wire that can touch the inside of the cabinet or any metalwork connected to it requires safety precautions. Bear in mind the effect of vibration in transport and the possibility of precautions being nullified by routine servicing operations.

Mains leads are a special case of the problems we have been discussing: they should comply with BS6500 in lieu of the other insulation requirements.

Aerial Isolation

Aerial sockets are obviously a potential source of danger (pardon the pun!). If a small lightning discharge or other cause of electrostatic charge breaks down the insulation of the aerial isolator the aerial itself will become live. Anyone plugging a wire into the socket may get a mains shock. Even worse, an aerial rigger on the roof may get electrocuted and thrown to the ground. Clearly no chances can be taken.

Aerial isolators have to be able to withstand discharge tests. These consist of 50 discharges from a 1000pF capacitor charged to 10kV, at the rate of not more than twelve per minute. The resistors and capacitors which form part of the aerial isolator also have to pass separate component approval tests which involve endurance, humidity and high voltages. Probably the most stringent part of the testing involves the application of 4kV r.m.s. after 21 days exposure to damp heat.

CONCLUDED NEXT MONTH

Workshop HINTS

by VIVIAN CAPEL

USING SUBSTITUTE COMPONENTS

BECAUSE of the difficulty in obtaining exact replacements it is often necessary to use near equivalents. It is also the case that a substitute sometimes has certain advantages over the original component. Take for example the lock-fit type of transistor which has found favour with many setmakers. These have three rigid self-locking strips as connectors for insertion into printed-circuit boards with standard grid dimensions. They may well help the setmaker because of the ease with which they can be fitted. For the service engineer however they create problems. For one thing they sit so close to the board that voltage measurements are virtually impossible from the component side—this is especially frustrating when access to the print side is difficult or the transistor connections on this side are hard to identify. Secondly removal is awkward. When a suspect transistor of this type is taken out for testing the short connecting strips rapidly conduct heat from the iron to the transistor: thus if the transistor isn't faulty to start with it probably will be by the time it is freed.

When it is necessary to replace a transistor of this type therefore my practice is to use an equivalent type with conventional wire leads. This makes it easier when servicing is again required and also cuts down on the amount of stock it is necessary to hold. Fitting is straightforward enough, the wires being fed through the appropriate holes in the board and soldered in the normal way.

Direct equivalents for commonly encountered lock-fit transistors (the lock-fit type number is given first in each case) are as follows: BC147=BC107; BC148=BC108; BC149=BC109. The only electrical difference is that the power rating of the wire-ended types is slightly higher than that of the lock-fit types —up from 220mW to 300mW. Other lock-fit transistors having near equivalents that will work satisfactorily in most cases are as follows. The BC158 can be replaced by a BC187 which has a higher power rating and higher frequency limit. The gain too may be a little higher though this will vary from one transistor to the next. The BF194 has a near equivalent in the BF184, the BF195 in the BF185, the BF196 in the BF167 and the BF197 in the BF173. In these latter examples the power ratings of the near equivalents are rather lower than those of the lock-fit types but this should not be a problem if a transistor is being operated well within its maximum voltage and current limits. Note that they have four lead-out wires: the fourth is connected to an internal shield and should if possible be soldered to an adjacent earth point.

To cut stocking down further the following substitutions can be adopted. Use a BC109 whenever it is necessary to replace a BC108. These two transistors are identical except for their noise performance, the BC109 having the lower noise factor and thus providing an overall improvement. Use an AF114 to replace the AF115, AF116 and AF117. The recommended substitutions are slightly dearer than the transistors replaced but this is more than compensated for by the smaller stocks it is necessary to hold.

Valve Substitutions

With valves the use of substitutes often provides considerable economic advantages. In many cases where there is no direct equivalent a near equivalent can be used with very little modification. A slightly different heater voltage rating is of little consequence in a series heater chain since the difference is spread over the whole chain—and in any case is likely to be less than the mains voltage variations. The 30PL14 field timebase valve can sometimes be replaced by the less expensive PCL82: the only modification required is to change the pentode section cathode bias resistor from 470Ω (probably) to 330Ω. As with transistors, a policy of using near equivalent substitute valves avoids tying up money in unnecessary stock.

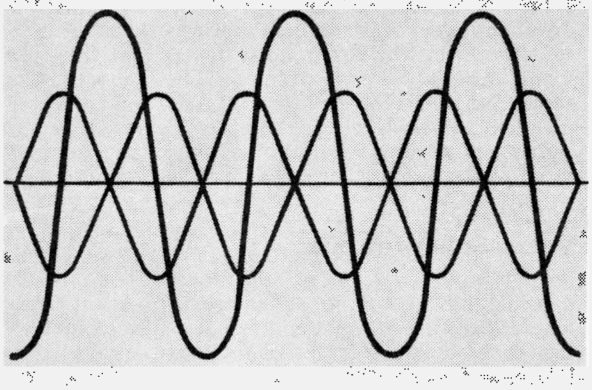
When dealing with an old set where the cost of the repair is a vital consideration a useful dodge is to try swapping over valves of the same type. Where the field and sound output valves are of the same type for example and the field output valve doesn't provide a full scan the sound output valve may do so while the field output valve may be quite satisfactory in the sound output stage. The idea is to use valves which are below par in the least demanding stages. Where the vision gain is low the sound and vision i.f. valves can often be changed over, or the mixer valve in the tuner swapped with one of the same type used as a sync separator or clipper. This doesn't always work of course, but it's worth a try.

To save time in the service department it is a good idea to provide each engineer with a set of commonly used valves. This overcomes the need to draw from stock each time a replacement is tried—the most frequent operation in television servicing since a new valve cures most simple troubles. The valves need not be brand new—a change is often tried because of a suspected intermittent fault in a valve—but must of course be up to standard. To prevent one of the test valves being left by mistake in a repaired set the tops can be painted a bright colour to give immediate identification.

Test Capacitors

Each engineer should also have a supply of substitute capacitors to hook into circuit (often the only certain way of proving a defective capacitor, especially with intermittent faults, is to carry out substitution). They need to be good quality types since some capacitor lead-out wires break off flush with the body of the component after a few flexings. A large-value electrolytic capacitor to test h.t. smoothing is essential: solder its terminal tags to a pair of flexible leads with crocodile clips at the other end.

Phase in



Colour TV

S. GEORGE

PROBABLY the most widely used and important term in colour TV engineering is phase. A nutshell definition is that phase defines the time difference between two usually similar or related signal waveforms. The addition of two identical waveforms with a phase difference of 180° (i.e. in anti-phase) results in zero output since one will be at its maximum positive peak amplitude while the other is at its maximum negative peak amplitude. Subtracting two identical waveforms spaced 180° apart however results in an output waveform which is double the amplitude of the individual waveforms. The addition of two identical in-phase signal waveforms results in an output twice the amplitude of each constituent waveform while their subtraction of course leaves zero output. This is the principle on which the action of the chrominance delay line and its associated add and subtract matrix networks in a PAL decoder is based.

Colour Transmission

The chrominance information transmitted consists of the sidebands of a 4·43MHz subcarrier (its frequency at i.f. therefore is 35·07MHz). This subcarrier is modulated by both the B−Y and R−Y colour-difference signals—*in quadrature*, i.e. there is a 90° phase difference between the B−Y and R−Y signals applied to the subcarrier, enabling them to be separated in the receiver. (The third colour-difference signal required, G−Y, is not transmitted since it can be recreated in the receiver simply by adding set proportions of B−Y and R−Y.) The individual B−Y and R−Y signal components vary in amplitude and polarity, but when they are simultaneously impressed on the subcarrier the result is a signal that varies in amplitude and *phase*, the phase of the resultant signal indicating the particular colour (hue) being transmitted while the amplitude indicates its strength, i.e. the degree of saturation (whether the colour is pale or vivid in other words).

Fig. 1 illustrates these points. Note first that as the colour information transmitted supplements the luminance information transmitted it must be able to indicate either positive or negative values so that in combination with the luminance signal we get a full range of red, green and blue primary-colour signal values—i.e. for a red tone for example we need to increase the output from the c.r.t.'s red gun whilst pulling back the outputs from the blue and green guns to negligible proportions. Thus as Fig. 1(a) shows the possible 360° phase variation of the subcarrier is used to indicate a negative blue colour-difference signal at the reference 0° point (in practice this is the complementary to blue, yellow), a positive red colour colour-difference signal at 90°, a positive blue colour-difference signal at 180° and a negative red colour-difference signal (in practice cyan) at 270°. These are shown superimposed on the standard chromaticity diagram. Now suppose the colour seen by the camera at a particular point is represented by an R−Y signal sinewave of 0·2 amplitude and a B−Y sinewave of 0·4 amplitude in quadrature as shown in Fig. 1(b). The resultant obtained by adding them is a sinewave of 0·45 amplitude 64° behind the R−Y sinewave and 26° in advance of the B−Y sinewave. The equivalent phasor diagram is shown in Fig. 1(c).

Demodulation

The chrominance synchronous demodulators in the receiver decoder are in effect switched on once each subcarrier cycle by the 4·43MHz reference signal generated in the decoder. Each time they are switched on they sample the amplitude and polarity of the chrominance signal at that instant. They operate in quadrature, i.e. the B−Y synchronous demodulator is switched on 90° after the R−Y demodulator, and the reference signal used for this purpose is synchronised to the subcarrier at the transmitter by the burst signal transmitted for that purpose during the sync pulse back porch (more about that later). In the case of the resultant shown in Fig. 1(b) and (c) it can be seen that when the R−Y demodulator switches on at the R−Y axis (90°) it will measure +0·2 while when the B−Y demodulator switches on at 180° it will measure +0·4. The original signal values and polarities are thus recovered.

Phase Shifts

This technique of modulating the chrominance subcarrier phase in order to represent different colours is a neat part of the way in which the colour information is contained within the same channel bandwidth as a monochrome transmission. It has the disadvantage however that phase shifts, which can and do occur in the complex signal path between the camera or videotape recorder and the receiver, will result in incorrect colours being reproduced unless steps are taken to overcome this effect. Correction is not built into the NTSC system, which is thus subject to this trouble. To see what can happen, suppose that in our example there is a phase shift of 20° as shown in Fig. 1(d). Now when the R−Y demodulator switches on it will produce a signal reduced to 0·05 whilst when the B−Y demodulator

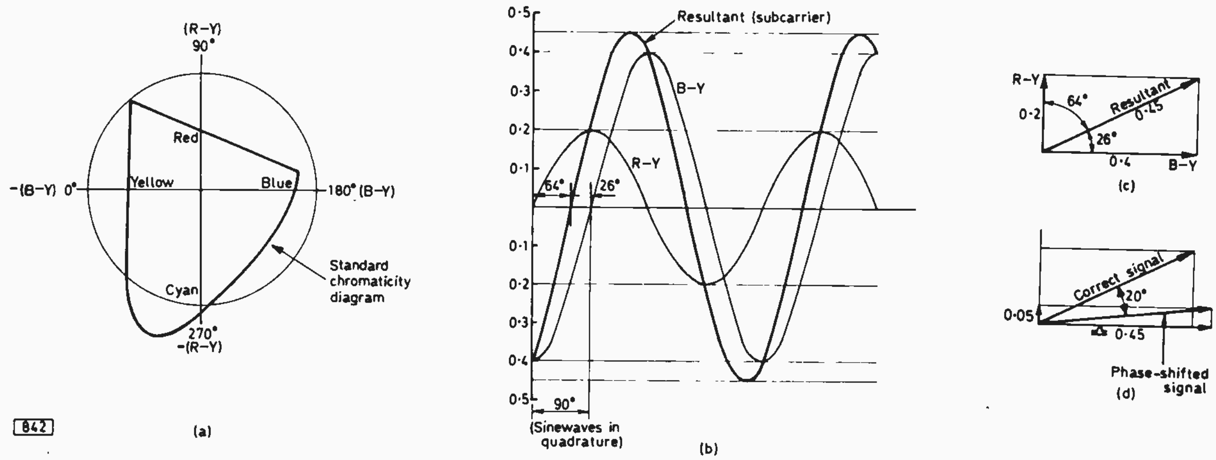


Fig. 1: How the phase of the chroma subcarrier is used to indicate the colour being transmitted. (a) Colour-difference signal phase angles superimposed on the standard chromaticity diagram. (b) Two amplitude-modulated colour-difference signal subcarriers in quadrature add to give a resultant which varies in phase and amplitude. Note that the resultant sinewave passes through the peaks of the constituent sinewaves: thus if the resultant is sampled at the appropriate instants the peak values of the two original sinewaves will be recovered. (c) Vector representation of the sinewaves shown in (b). (d) Effect of a spurious phase shift: unless steps are taken to overcome this the amplitude of one demodulated colour-difference signal will increase while that of the other one will decrease, causing a noticeable change of colour.

switches on it will produce a signal increased to almost 0·45. The effect of a phase shift therefore is that as one colour-difference signal output at the receiver increases the other one decreases: this obviously results in a significant colour change.

PAL System

The problem is overcome almost entirely in the PAL system by reversing the phase of the R−Y component of the chrominance signal on every other line. We say "almost entirely" because the technique does not actually cancel out the phase error. What it does is to alter the *effect* of a phase shift to a proportional reduction of the B−Y and R−Y outputs obtained after signal processing by the chrominance delay line and its associated matrix circuits in the receiver and subsequent demodulation. This slight reduction in saturation is barely noticeable and obviously far less objectionable than the colour change that occurs in the NTSC system.

The basic elements required for delay line PAL decoding are a line period delay line, an add network, and a subtract network (which in practice consists of signal inversion plus addition, giving the effect of subtraction). Fig. 2 shows these elements. First one slight complication here: the line period

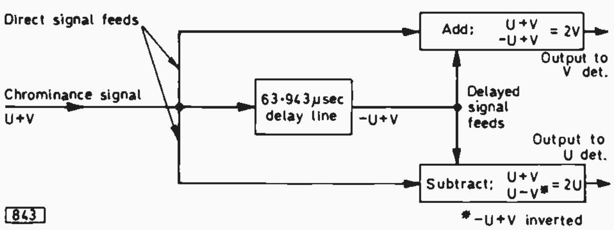


Fig. 2: How the chrominance delay line and its associated add and subtract networks in a PAL decoder separate the two transmitted colour-difference signals prior to demodulation.

(64μsec) of the 625-line system contains 283.75 cycles of the 4·43MHz subcarrier. The odd quarter cycle would make it impossible to carry out the required add and subtract operations. For this reason the delay time of the chrominance delay line is reduced to 63·943μsec which is equivalent to 283·5 cycles of the subcarrier. The odd half cycle is in turn equivalent to a 180° phase shift of the signal obtained at the output of the delay line.

The arrangement shown in Fig. 2 fulfills two operations. It separates the R−Y and B−Y signals, and as already stated changes the effect of a phase shift in the received signal to a slight reduction in saturation after demodulation. We will look at signal separation first. Note that to simplify the diagram we are using U and V rather than B−Y and R−Y. U and V are in practice the correct symbols to use for the signals at this stage, indicating as they do that the signals are weighted ones (the amplitudes of the colour-difference signals are reduced, or "weighted", at the transmitter by set proportions before modulation to avoid the risk of over modulating the subcarrier: the gains of the colour-difference channels in the receiver are adjusted to compensate for this).

Signal Separation

Suppose that the signal being received is part of a line without V signal inversion. This is shown as U+V. The signal at the same point along the previous line would be U−V therefore, but because of the 180° phase shift that occurs in the delay line the output from this is −U+V. Thus the add network receives a direct signal feed of U+V and a delayed signal feed of −U+V, giving an output of 2V, while the subtract network produces from the two inputs 2U. This neatly separates the two colour-difference signals prior to demodulation and makes the design of the demodulators much less critical. It is clearly important that the delayed and direct signal feeds to the add and subtract matrix networks

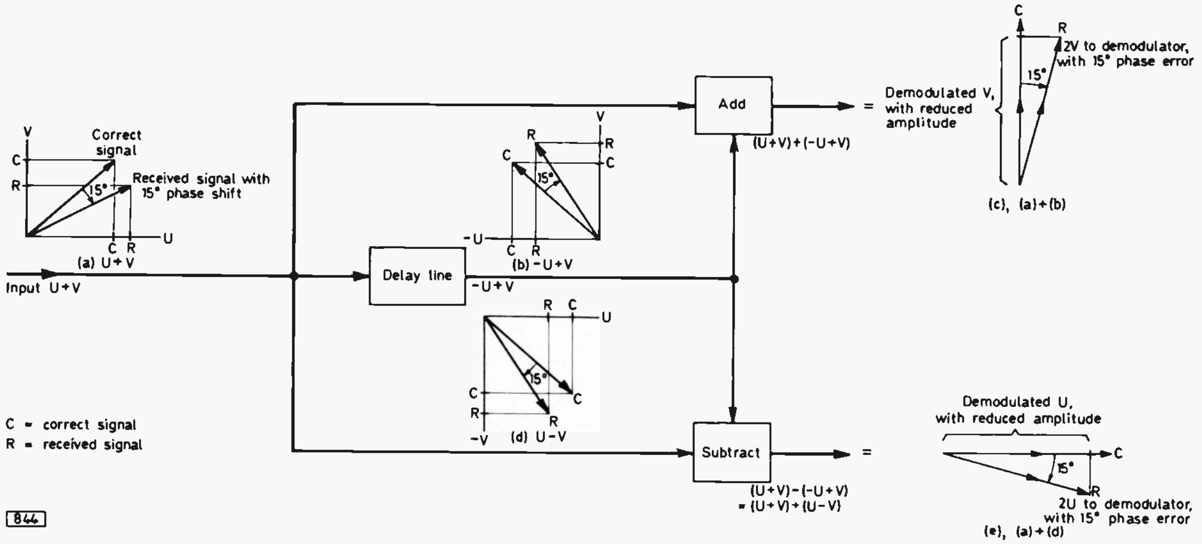


Fig. 3: How the chrominance delay line together with the add and subtract matrixes carry out signal averaging. As a result of the inversion of the V component of the composite chrominance signal on alternate lines the effect of a spurious phase shift becomes a proportional reduction of the amplitude of both the transmitted colour-difference signals after demodulation. The phase error remains but instead of a change in the colour displayed by the receiver the effect of a spurious phase change is converted into a slight loss of saturation which is not noticeable.

are of identical phase and amplitude—otherwise some U signal will appear in the V output and vice versa, causing mild Hanover bars. Note also that as a result of the R−Y signal phase inversion on alternate lines at the transmitter the output from the add network will be +2V on one line and −2V on the next.

Signal Averaging

Fig. 3 shows the effect with this arrangement of a phase error in the received signal. As the input phasors (a) show this, in our example, increases the amplitude of the received U signal and reduces the amplitude of the V signal component. If we add (a) to the appropriate phasors (b) obtained from the delay line we get from the add network the output shown at (c). The phase error is still present, but after demodulation the result is a slight decrease from the correct value in the V signal output obtained. Subtraction consists as we have seen in inversion plus addition. Thus waveform (b) is inverted to give (d) and after addition to (a) the output obtained is as shown at (e). Once again the phase error is still present, but demodulation merely produces a slightly reduced U signal output. The overall effect of this processing then is that instead of a change in the actual colour there is simply reduced saturation.

Let us briefly look at the signal separation process in terms of the type of circuit commonly found. Say in Fig. 4 that the input at the base of the transistor is U+V. This appears at its emitter by emitter-follower action and is fed to the centre tap of transformer T1. Now the previous line was U−V of course. This would become −U+V at the collector of the transistor and U−V again at the delay line output following a further 180° phase shift. The two signals U+V and U−V add across winding 1−2, giving an output of 2U. The output obtained across winding 1−3 is subtractive, i.e. (U+V)−(U−V)=(U+V)+(−U+V), giving the 2V output.

Note that the extra 180° signal inversion introduced between the base and collector of the transistor results in 2V being obtained from the subtract network and 2U from the add network.

Causes of Phase Shifts

Why should phase errors arise? Videotape recorders, transmission lines, bandpass tuned circuits with unsymmetrical susceptance slopes, and amplifiers of all types in which the reactive component of their input impedance varies with signal level are all offenders. Bandpass tuned circuits are purely resistive at their resonant frequency for example, but have reactive components at lower and higher frequencies. This means that the phase of a signal's sidebands will shift with respect to the centre frequency. If the susceptance slope of the bandpass circuit is non-symmetrical, the upper and lower sideband placement will be unequal, introducing a phase shift which varies with modulation depth, i.e. sideband amplitude.

Transistor amplifying stages of all types can cause phase distortion since due to the non-linearity of the base-emitter junction—especially at low signal levels—the input impedance varies with changes in signal amplitude. Also, the input capacitance and resis-

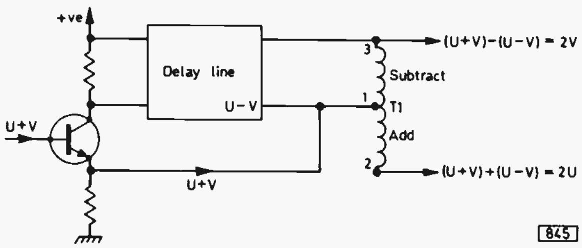


Fig. 4: Typical practical chroma delay line circuit.

tance tend to vary with changes in collector current. The output impedance of the preceding stage and the effect of the coupling capacitor also has an effect.

There are thus many factors than can produce phase shifts. Careful design and the use of negative feedback however can reduce phase distortion to a very small figure. The simplest form of negative feedback is that produced by omitting the decoupling capacitor from a transistor's emitter resistor: this technique is widely used in receiver circuits.

Reference Oscillator Synchronisation

It is sometimes wondered why the burst signal transmitted has its average phase along the −B−Y axis. (It swings ±45° with respect to this axis on alternate lines, but because of the time constants concerned in the reference oscillator phase control loop this circuit responds to the *average* phase of the burst signal.) The reason is that the type of a.p.c. discriminator used locks the reference oscillator in quadrature with the received burst signal. Take for example the circuit shown in Fig. 5. The two discriminator diodes D1 and D2 are fed with antiphase burst signals from the final burst amplifier output transformer and conduct once each cycle, when the burst input to the upper diode D1 is at its maximum positive peak and the burst input to the lower diode D2 is at its maximum negative peak. Zero output from the circuit, i.e. reference oscillator locked, is obtained when the reference signal fed back from the oscillator is passing through zero when the diodes conduct, i.e. this signal is then in quadrature with the burst signal. If the reference signal leads or lags the bursts, the output moves negatively or positively respectively, producing the control action. Thus with an average burst signal along the −B−Y axis the reference oscillator locks along the R−Y axis and its output can be used directly to switch the R−Y synchronous demodulator. As we have seen, the B−Y synchronous demodulator must switch on 90° later, so a 90° phase shift network is incorporated in the reference signal feed to this demodulator.

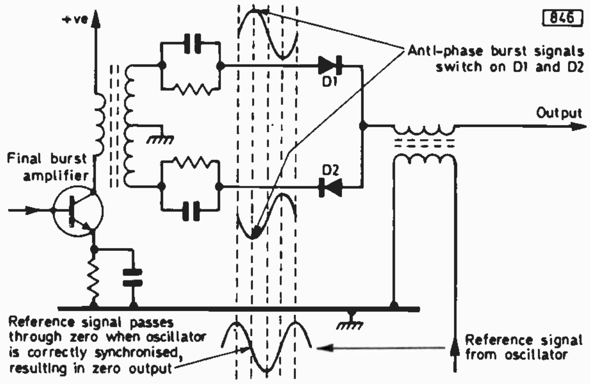


Fig. 5: The type of burst demodulator used locks the reference oscillator in quadrature with the transmitted bursts as shown here.

PAL Switch

The output obtained from one matrix circuit associated with the chrominance delay line is, as we have seen, 2V on one line and −2V on the next. It is necessary therefore in the decoder to reverse the phase of the V signal on alternate lines before it is fed into the R−Y channel. This is done by inverting on alternate lines either the chrominance signal or the reference signal applied to the R−Y synchronous demodulator. The various circuits used for this purpose have been described in detail in these pages before, e.g. in the June and July issues 1972. They must be synchronised to the R−Y signal phase alternations at the transmitter, and for this purpose an ident—line identification—signal is produced from the ±45° burst signal swings on alternate lines. ■

BOOK REVIEWS

INTRODUCTION TO VIDEO RECORDING
By W. Oliver. Published by W. Foulsham & Co. Ltd. 109 pages, 8½x5½ in. Price £1.50.

There is a great need at present for an easy-to-read semi-technical book on video recording systems, both tape and disc, to enable the many potential users of such equipment to understand the problems of video recording and the limitations of each system that has been put forward.

I'm afraid that book is still awaited. Mr. Oliver's opus is packed with publicity photographs which have been seen many times and say very little when they are not supported by the text. We even get the absurdity of photographs of the same equipment in the same situation being reproduced on opposite pages.

The flyleaf of the book says "it tells in simple terms how video recorders and players work". It never does quite get round to doing that and even the little glimpses into operation it does give seem to be incorrect—for example, diagrams of circuits which cannot work or which blandly inform you "A transistor stage", a diagram illustrating scanning with the flyback slower than the scan, and a complete misunderstanding of head angle, tape wrap and head-to-tape speed. These are unfortunately only a few of the deficiencies which make us unable to recommend this book. J.I.S.

TELEVISION ENGINEERS' POCKET BOOK, 6th Edition
Edited by P. J. McGoldrick, C.Eng., M.I.E.E., M.S.M.P.T.E. Published by Newnes-Butterworths, 88 Kingsway, London WC2B 6AB. 372 pages, 7½x5 in., price £2.50.

A new edition of this popular pocket manual which started life back in 1954 has long been overdue. P. J. McGoldrick, Senior Lecturer in the Department of Electrical and Electronic Engineering at Plymouth Polytechnic, has now stepped into the breach and done a thorough job of revision, correction and up-dating. Transistorised circuits and i.c.s are now fully taken into account, with examples from such recent chassis as the BRC 8000. And there is, as you would expect, an extensive chapter on colour television, covering both the basic principles and practical circuits in use. The Trinitron tube is also described in this chapter.

The emphasis throughout is on installing and servicing domestic television equipment and its contents cover very much those subjects of interest to readers of this magazine. T.J.

FAULT FINDING GUIDE

10 John Law

THORN 960 CHASSIS

THE Thorn 960 chassis was developed some eight years ago from the basic Thorn dual-standard chassis (950) of the time for use in a number of dual-standard portable sets fitted with 16in. c.r.t.s. These sets weigh under 30lb. and are of compact dimensions. They make excellent second sets, the 16in. c.r.t. being a convenient compromise between the larger standard 23in. table sets and newer mains-battery portables with tubes as small as 9in. Sets fitted with the chassis include the Ferguson Models 3638 and 3643, HMV Models 2633 and 2638 and Ultra Models 6640 and 6646. All have similar cabinets. The power supply circuitry used differs from that of the basic 950 chassis and in this article we will look at these changes and the faults found in this area and in the line timebase.

Basic 950 Power Supply Circuit

The basic power supply circuit used in the 950 chassis is shown in Fig. 1. The mains is fed through fusible resistor R147 contacts to a solenoid (there is an extra solenoid in plus-f.m. radio versions) which operates the system switch. The solenoid operates only momentarily, throwing the multicontact switch strip into the 405- or 625-line position as selected by the channel change knob. Note that if an overload should result in the fusible resistor spring opening there will be no mains supply to the rest of the receiver. Thus the symptoms of no life, not even a heater glowing, and the mains fuse F1 intact should draw attention to R147: the soldered joint has probably melted and the contacts parted.

From F1 the mains passes to the autotransformer T5 from which a tapping at 205V feeds the BY100/BY105 silicon diode h.t. rectifier via a 12Ω surge limiter resistor (R136). The d.c. output feeds the reservoir capacitor C112 and the smoothing choke L40. Following this a second fusible resistor R138 leads to the smoothing capacitor C113 and the receiver circuits.

The heater chain is fed from another tap on T5. A thermistor (X3, type VA1070) is inserted in the chain between the PCL85 field timebase valve (V8) and the PL500 line output valve (V11) to stabilise the heater current. This component is mounted inside the line output stage screening cage, alongside the PL500.

960 Series Power Supply Circuits

Fig. 2 shows one version of the power supply circuitry used in the 960 chassis. To help reduce the volume and weight of the set to portable proportions the autotransformer and smoothing choke are removed. To reduce the heat level in the confined space of the portable cabinet a completely different and unique heater supply circuit is used. The heater chain is divided into two. V11, V10, V8, V4, the tuner valves, the c.r.t. and V401 heater are connected across the mains supply in series with a 4·33μF capacitor (C121). This capacitor takes the place of a resistor dropper and avoids the heat which a resistor would produce. As in the basic 950 chassis the h.t. supply is obtained from a BY100/BY105 rectifier (W10) with a 100μF reservoir capacitor (C112). The smoothing choke L40 is replaced by two resistors (R138 and R151) connected in series. Additional smoothing is obtained by inserting the second part of the heater chain, V5, V6, V3 and V7 heaters, in parallel with R152 and R153 between the neutral side of the mains supply and chassis. The receiver's h.t. current is some 350mA: R153 is adjustable to absorb the excess 50mA. To check or adjust R153, remove the lead from the junction of V3 and V7 heaters (tag 24A) and connect a meter in series at this point: set the controls for a normal picture with correct test card dimensions and adjust the slider of R153 for a reading of exactly 300mA on the meter.

It will be seen then that whereas in the basic 950 chassis all the heaters are a.c. fed in this circuit seven valves and the c.r.t. heater are fed with a.c. while the other four valves are fed with d.c. An important fact to remember is that if one or more of the four valves in the negative smoothing circuit is removed while the set is operating the entire h.t. current, some 350mA, will flow through R152 and R153, seriously over-running them. Also, an h.t. short-circuit in the set will result in excessive heater current through these valves. If you find that one of them has an open-circuit heater therefore, check the receiver for an h.t. short-circuit before replacing the valve. The receiver can be operated for test purposes if necessary without these valves by connecting a 140Ω 12W resistor between chassis and the negative connection to C112. A raster will appear on the screen but there will be no sound or vision. Intermittent h.t. faults can often be traced under these conditions.

Fig. 3 shows a second power supply circuit used in the portable models. This uses the more commonly found combination of two separate silicon diodes, one feeding the h.t. circuitry and the other the heater chain. As before, the h.t. rectifier is W10, with reservoir capacitor C112. The smoothing choke L40

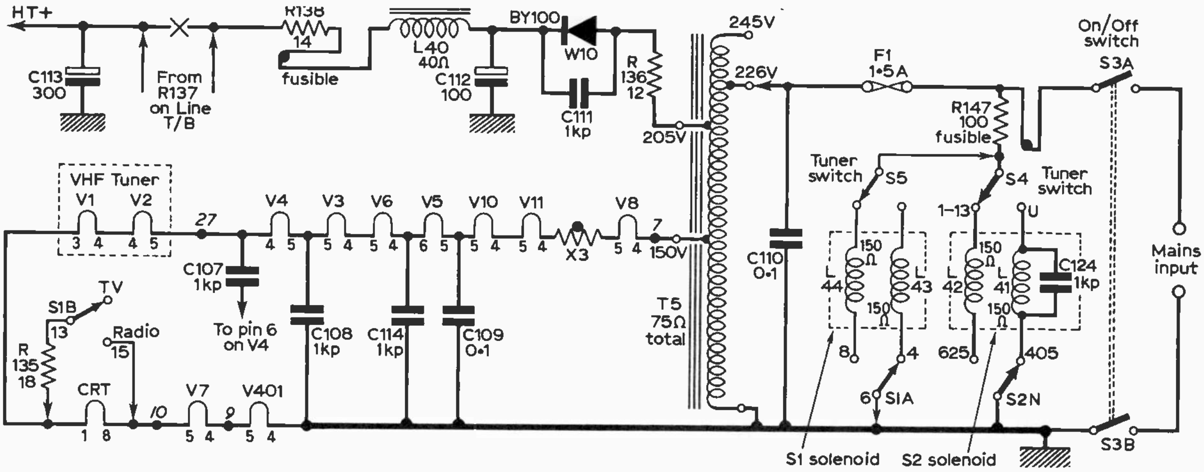


Fig. 1: The power supply circuit used in the basic 950 chassis.

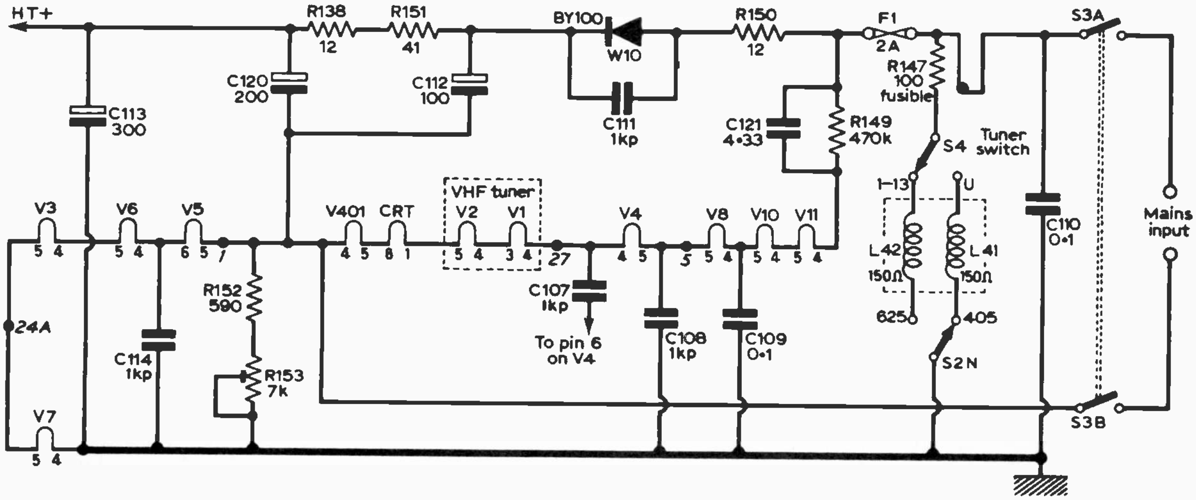


Fig. 2: Power supply circuit with capacitive (C121) heater dropper (early 960 chassis).

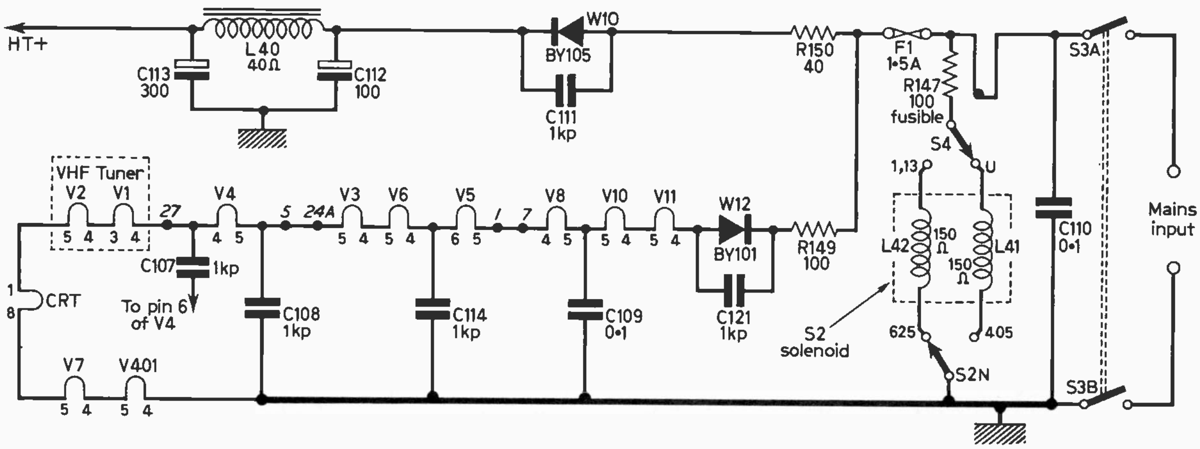


Fig. 3: Power supply circuit used in later versions of the 960 chassis.

is restored, as in the standard 950 chassis, but without the fusible resistor R138. R149 which was a 470kΩ resistor across the dropper capacitor in the previous circuit is a 100Ω surge limiter feeding the heater rectifier W12 in this circuit. The twelve heaters are connected in series to chassis, without a stabilising

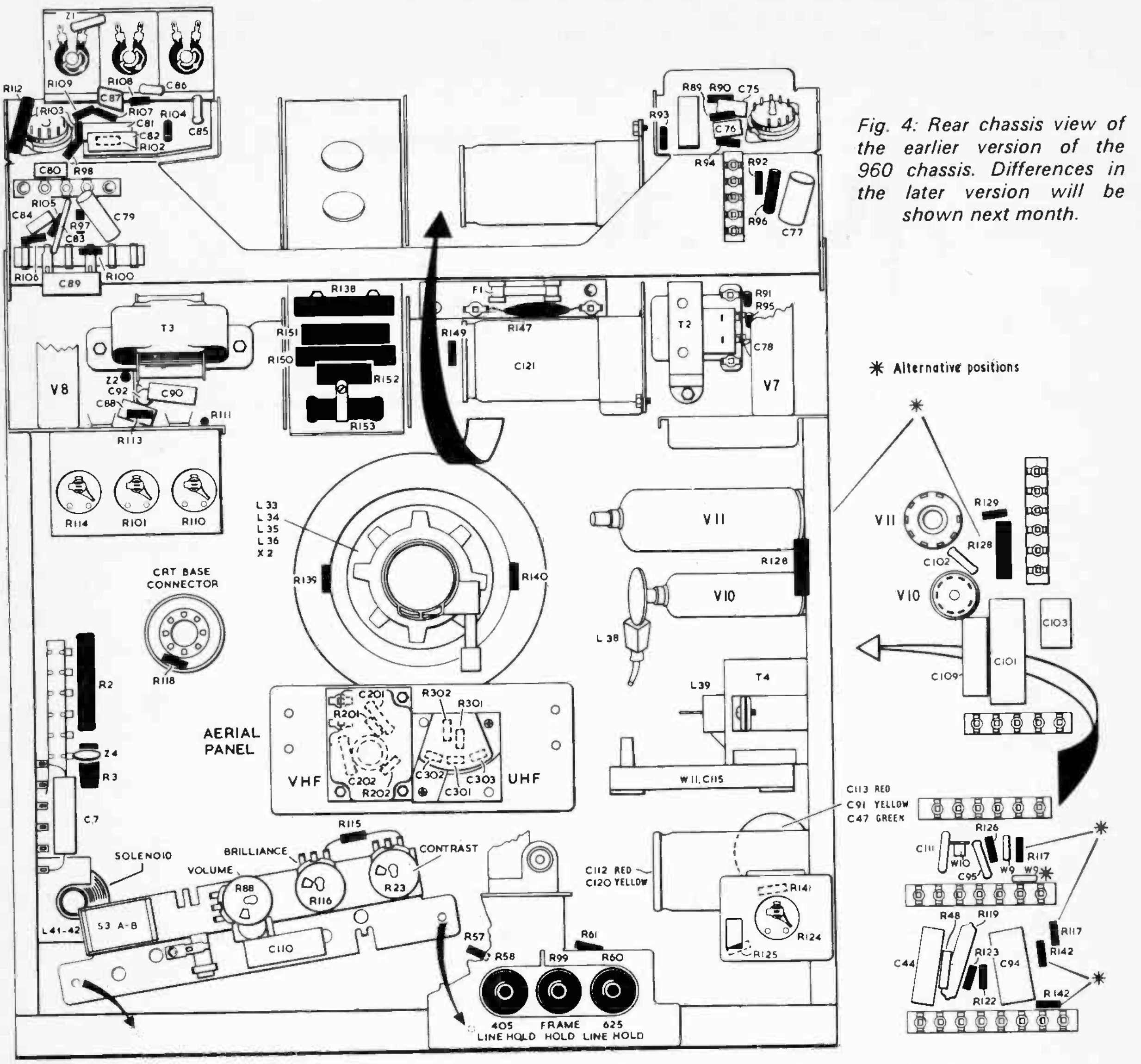


Fig. 4: Rear chassis view of the earlier version of the 960 chassis. Differences in the later version will be shown next month.

thermistor. Note that whereas the output from h.t. rectifier W10 is positive that from the heater rectifier W12 is negative. The surge limiting resistors for the two rectifiers, R149 and R150, are wound on a substantial ceramic former mounted at the top centre of the chassis along with the fusible resistor R147.

The use of a silicon diode to supply valve heater current is common practice in order to reduce heat and power consumption. Since the diode conducts on alternate half cycles it effectively lowers the voltage available for the heater chain, there being no reservoir capacitor to fill in the troughs. Thus a much lower value dropper resistor can be used: in Fig. 3 the 100Ω resistor R149 combines the functions of dropper and surge limiter. Since the resultant heater supply is pulsed d.c. a true voltage reading cannot be obtained using a moving-coil meter. The voltage across the 6V c.r.t. heater in Fig. 3 will show as 4V on an Avo Model 8. The reading obtained at the negative end (anode) of W12 should be −90V though addition of the individual heater voltages comes to 139·2V.

Inserting a diode in series with the heaters effectively lowers the voltage across them. If the diode goes short-circuit however—and this does happen—the full a.c. voltage will be present across the heater chain, resulting in a heavy current flow which will damage the valves. This condition would not necessarily be evident to the viewer. In many chassis using this technique therefore steps are taken to give visual warning of this fault. The device used in this chassis is to connect C107 between the heater and cathode of the second vision i.f. amplifier V4A (30FL14 pentode section). This gives heavy shading on the raster when W12 is short-circuit.

Connecting a meter across the mains plug of the standard 950 chassis will result in a low-resistance reading because of the autotransformer. Checking across the plug in a set fitted with the circuit shown in Fig. 3 however should give a low reading in one direction and a high reading in the other depending on the meter and rectifier polarities: typical figures are 1·2kΩ and 20kΩ.

CONTINUED NEXT MONTH

Assembling a modular colour set

DAVID ROBINSON

PART 1

THE decision to build a colour receiver is not one to be taken without careful thought. If you are thinking of building a set just to save money then think again. It can be cheaper, but this depends on what surplus parts you can obtain and assumes that the time taken over construction is free. My set took nearly a year to complete and I am still tempted to make modifications from time to time. It is my opinion that the only acceptable reasons for building a colour set are that the project is fascinating and challenging and that it is the best way to learn a great deal about colour television, both theory and practice.

Early Decisions

The first decision I took was to use a new 26in. tube. The reason for this was to ensure that the longest tube life was obtained and so that the limiting factor on picture quality would be the circuitry used and the accuracy of the setting up. The next decision that was required concerned the cabinet. It is not easy to build a colour set on a chassis which is then inserted in a cabinet. It is much easier and leads to a more compact receiver if the set is built into its cabinet. A 26in. colour set is a bulky piece of equipment at the best of times, so the more compact it can be made the more likely it is to be acceptable and attractive for domestic use.

I decided to use the conventional front layout: tube on the left, speaker at the top right and control panel at the bottom right. The height of the cabinet is thus fixed by the tube and its magnetic shield and the width by the same plus an additional amount for the speaker. The depth is a compromise. Too deep a cabinet looks rather ugly, especially on a set of this size. It also results in poor ventilation because there is no "chimney" effect in the air flow at the back. Access to the works is also made more difficult. Too slim a cabinet on the other hand means a ridiculous amount of set projecting at the rear. This looks bad and makes it more difficult to support the various units and produce a satisfactory back cover. Another point is that if the set is supported on legs the stability is poor and the set might—heaven forbid—fall forwards.

I finally decided on a depth of 12in. This encloses the tube bulb entirely (the push-through presentation helps here) but leaves the scan coils projecting at the back—with careful layout this is all that need project. One advantage of a larger size tube of course is a roomier cabinet.

The cabinet was simply built using five pieces of $\frac{3}{8}$in. plywood with strips of 1 x 1in. timber in the corners—see Fig. 1. This gives adequate strength with minimum obstruction inside. The tube was fastened to the front with push-through presentation in the usual way.

Cabinet Finish

Some thought was given to decorating the cabinet in an original, easy and attractive way. The main problems occur at the front where we need to fit the cabinet neatly around the tube and also provide a neat speaker grill and control panel. The methods adopted are as follows.

The top and sides of the cabinet are veneered, with the veneers folded over on to the front over a width of about one inch. A similar 1in. wide strip of veneer is applied to the bottom edge of the front. A piece of

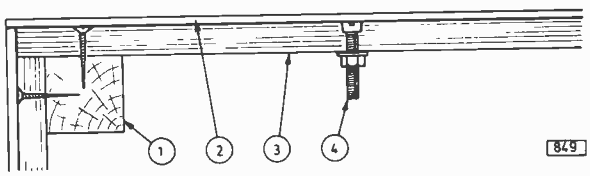


Fig. 1: Cabinet corner joint. (1) 1 x 1in. timber glued and screwed into corner. (2) Veneers fitted with top overlapping side pieces to give a neater joint. (3) Main cabinet consists of $\frac{3}{8}$in. plywood. (4) Bolt and locknut for chassis, transformer, etc., fitted before veneering.

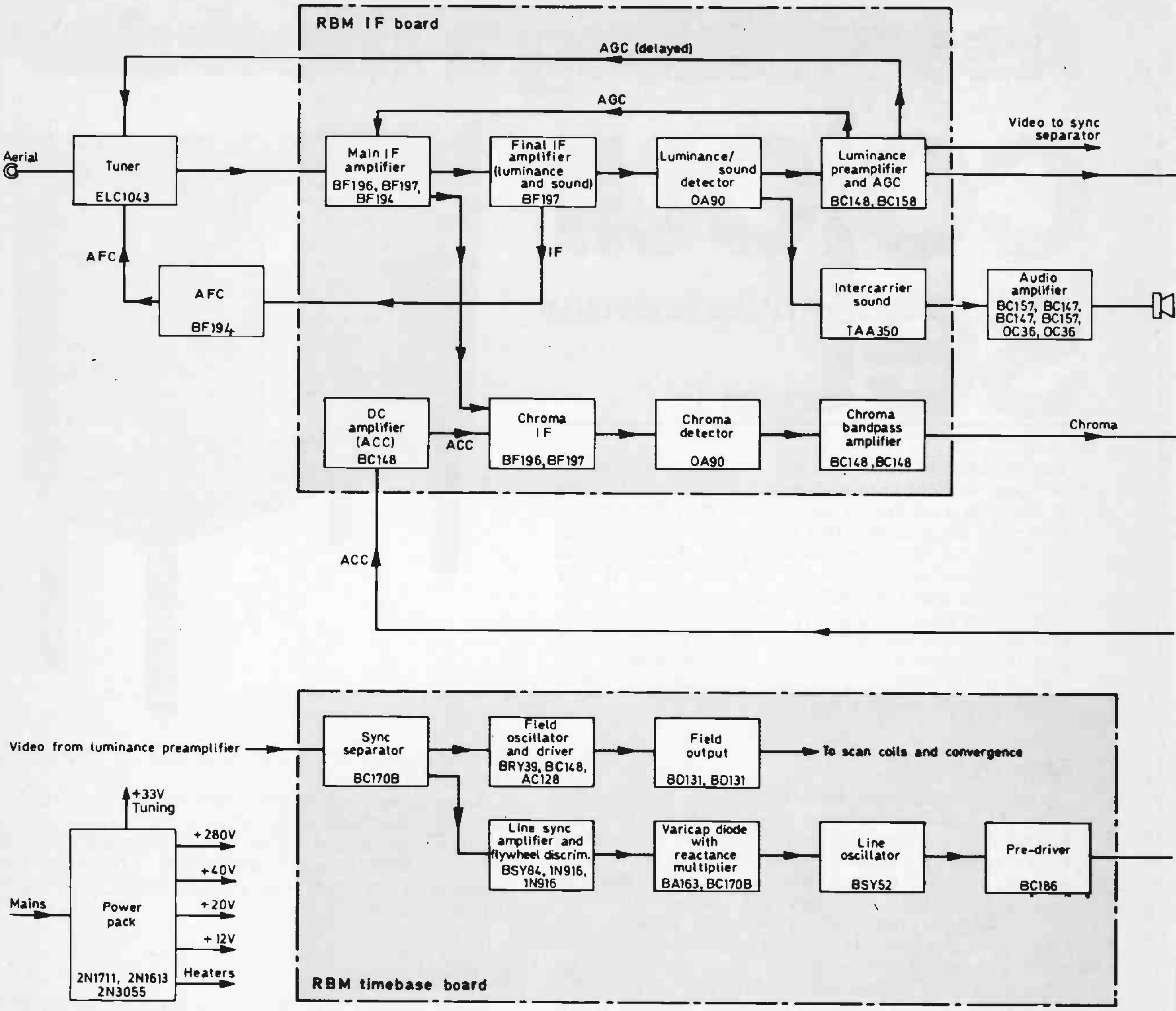


Fig. 2: Block diagram

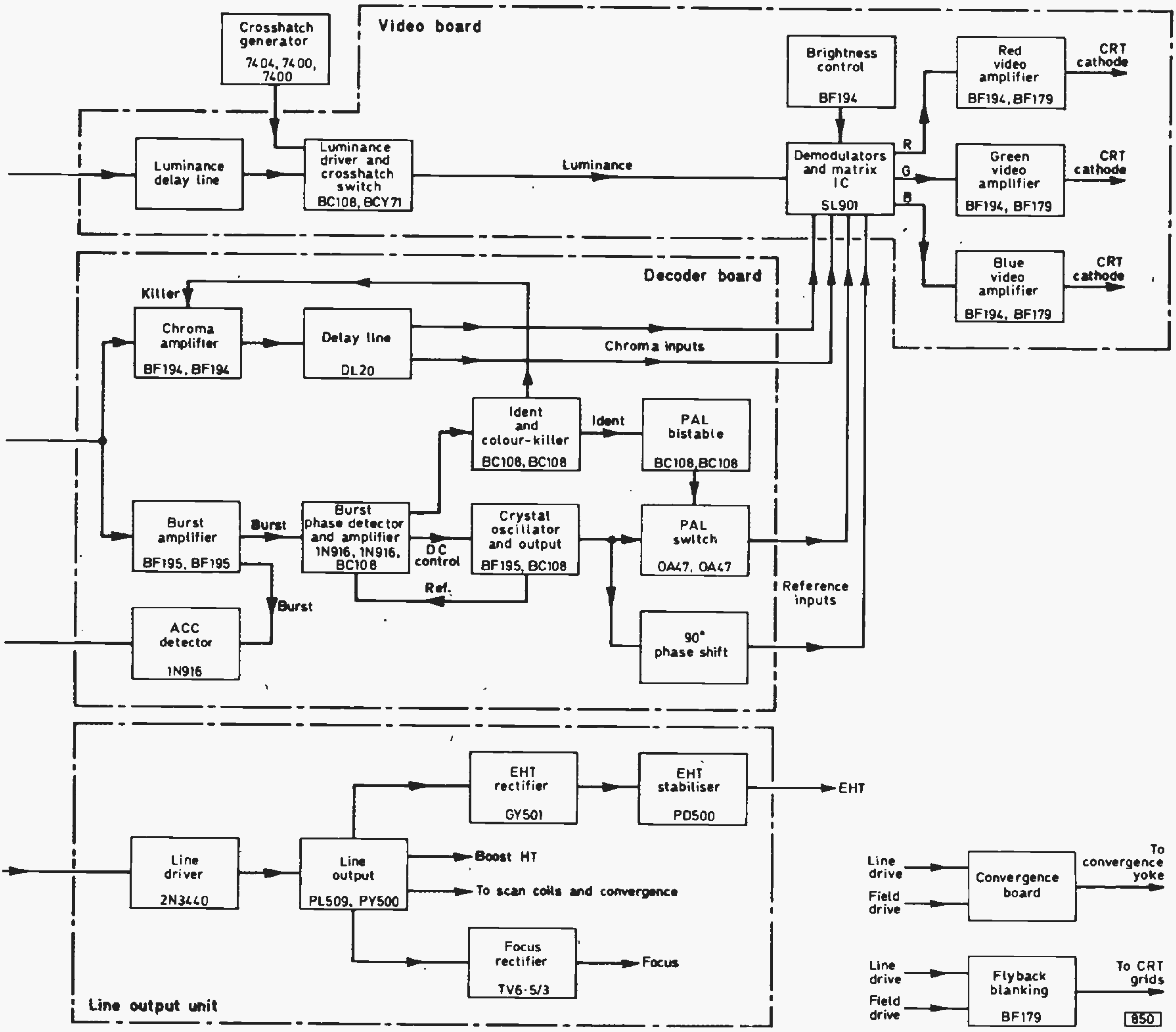
hardboard is then cut so that it is about ½in. smaller all round than the front of the cabinet. Apertures are cut in the hardboard for the tube, the speaker grill and the control panel. The hardboard is then covered with good quality black fabric-backed leatherette as used for upholstering chairs etc. The leatherette is glued on the reverse side of the hardboard only, giving a padded effect. The black speaker grill cloth is glued over the aperture in the hardboard, at the rear.

The control panel is made from matt black Formica with white Letraset for the control identification. This is varnished to protect the letters and is attached to the front of the cabinet. The hardboard-leatherette assembly is then also glued on to the front.

This approach gives a cabinet a more interesting appearance than if it is veneered all over and eases the problem of making a neat control panel. The black leatherette around the screen provides a good "frame" for the picture and improves the apparent contrast. The need to countersink the tube fixing bolts into the cabinet is removed since the heads can be accommodated by making holes in the hardboard before fixing the leatherette.

Using Surplus Units

To keep costs to a reasonable figure a number of surplus components—particularly scan coils, line output transformer, convergence board components and anything else which is available—can be used. An early decision needs to be taken as to whether this policy should be extended to using surplus panels, e.g. an i.f strip. Such panels may well be faulty of course, but the fault generally is a straightforward one—a crack in the board or a faulty transistor for example. The problem is how to test a board before you have a complete receiver. If a 625-line monochrome set which is not in regular use is available it can, with a little ingenuity and provided suitable



of the complete receiver.

power supplies for the boards are available, be used to try out many circuits such as the i.f. strip, field timebase, video output stages and line drive circuit.

The i.f. strip used in my set is a surplus Bush panel. The field timebase, sync separator and line drive circuits are on another panel from the same maker. Both these panels needed repair, but this was straightforward and I found that the use of these saved a good deal of time. They have both been trouble-free so far. Some ingenuity is often necessary when using surplus panels in order to match the inputs and outputs of the various units to each other. Some examples of this are given later. Fig. 2 shows the complete receiver in block diagram form and identifies the panel arrangement.

Tuner Unit

Let us begin at the beginning, with the tuner unit. There is really only one type of tuner worth considering these days, the widely used varicap tuner. Using this with push-button station selection and a.f.c. we have at long last a tuning system that requires absolutely no skill to operate. Ease of operation by non-technical people (and they are the majority!) is a factor all too often overlooked in home-built electronic equipment. A TV set for domestic use must be absolutely foolproof!

AFC

A.F.C. is vital, but many surplus i.f. strips do not have this facility. It can be easily added as Fig. 3 shows. The circuit consists of a limiting amplifier plus discriminator working at i.f. and thus radiates some i.f. harmonics. So don't mount it on the same board as the tuner, otherwise these harmonics will get into the aerial input and cause patterning. Mount it close to the i.f. amplifier stage to which it is connected.

The IF Strip

The i.f. strip I first used was a surplus Pye monochrome one of straightforward design with a single detector output. Despite careful alignment this never proved entirely satisfactory for colour because a strong, noise-free chrominance signal could only be obtained at the expense of objectionable sound-chroma beat patterning. A genuine colour i.f. strip was obviously required. The fault on the surplus RBM colour i.f. strip which I then obtained was easily visible: the audio output transistors had shorted and cooked a few resistors around them. My set already had an audio amplifier however so the offending section was simply cut off! The rest of the board worked perfectly. The circuit is unusual in that a separate chrominance i.f. amplifier is used, its bandpass response being shaped to give minimum distortion of the chroma signal while its gain is controlled by an a.c.c. potential from the decoder. A chroma bandpass amplifier using two transistors is also included.

Automatic Chrominance Control

The first problem was to adapt the a.c.c. input to suit my decoder. This mainly follows the basic Mullard design as used in the *Television* Colour Receiver and gives a negative-going a.c.c. output while on the Bush i.f. panel the a.c.c. input must be positive-going. The original a.c.c. circuit is shown in Fig. 4(a), with forward a.c.c. applied to the BF196 chroma i.f. transistor. The circuit was modified as shown in Fig. 4(b) and works nicely with the Mullard type decoder. With no signal the BC148 is bottomed. As the signal strength rises (increasingly negative-going a.c.c. input) the BC148 conducts less and its collector voltage rises, applying forward a.c.c. to the BF196 to reduce its gain.

Chrominance Channel

I next found that the overall chroma channel gain was excessive with the output of the two-stage chroma

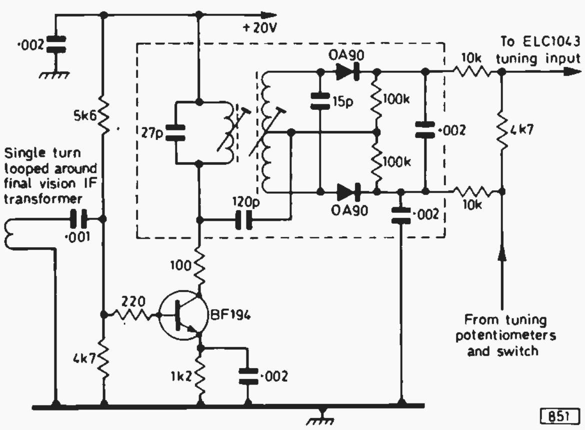


Fig. 3: A.F.C. circuit. The secondary winding consists of 12 turns of 42 s.w.g. wire, bifilar wound with one wire diameter spacing. The primary winding consists of 7 turns of 38 s.w.g. wire wound as a single layer 4.5mm. above the secondary. Use a Neosid 722/4 former and two Neosid 6/900 cores.

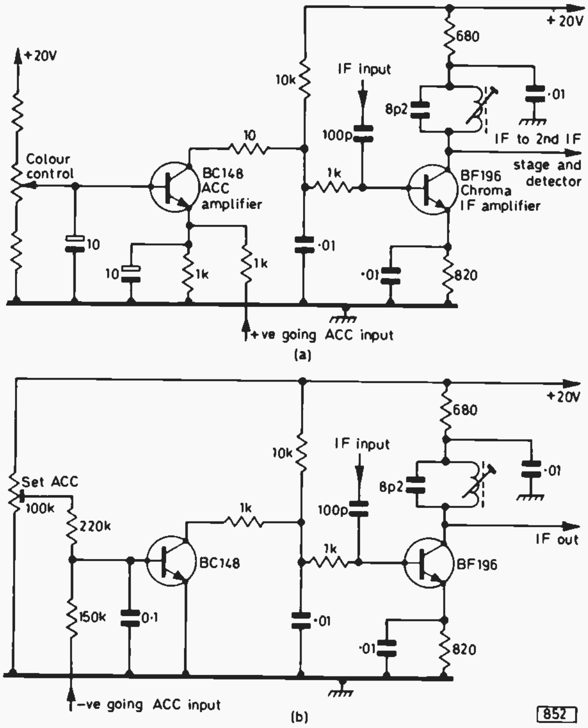


Fig. 4: (a) The original a.c.c. circuit on the RBM i.f. board. (b) Modified a.c.c. circuit to suit the input from the Mullard type decoder.

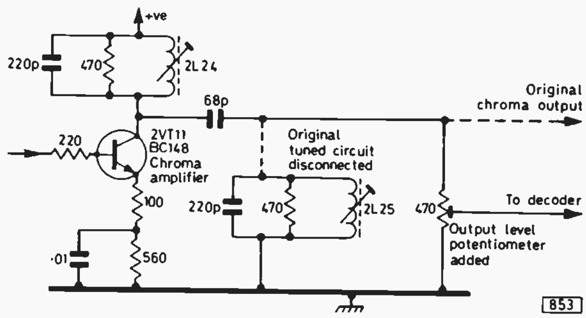


Fig. 5: Modification to the chroma amplifier on the RBM board to make it suitable for feeding the Mullard type decoder circuit.

amplifier on the i.f. strip connected directly to my decoder, this giving altogether four stages of amplification between the chrominance detector on the i.f. board and the chrominance delay line on the decoder board. A simple potentiometer (see Fig. 5) at the chroma output on the i.f. strip overcame this problem. The overall chrominance bandwidth also proved to be too narrow with this arrangement. Disconnecting the final chroma tuned circuit (2L25 etc.) on the i.f. board nicely restored the bandwidth however, giving correct luminance-chrominance registration.

Luminance Side

The i.f. board output circuit on the luminance side is shown in Fig. 6. The OA90 detector provides both

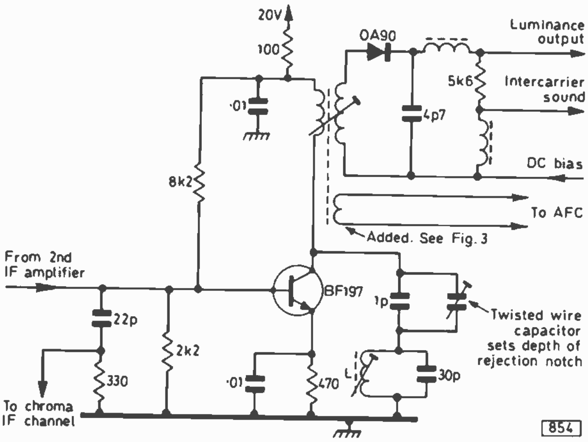


Fig. 6: Luminance i.f. output stage. The rejector L was redeployed as a chroma rejector to delete sound-chroma beat patterning.

the luminance and the 6MHz intercarrier sound outputs. Rejector L operates in the original design as a rejector of spurious signals outside the passband, chroma subcarrier rejection being by means of a tuned circuit in a subsequent luminance stage on a different board.

Results Obtained

On fitting this i.f. strip a much better chroma signal was obtained. Chroma noise was much lower, and the cross-colour performance improved due to the overall response being more symmetrical between the chroma signal upper and lower sidebands. I was still troubled on the luminance side by sound-chroma beat patterns however and found that attempts to reduce these by adjusting the alignment resulted in sound buzz on captions.

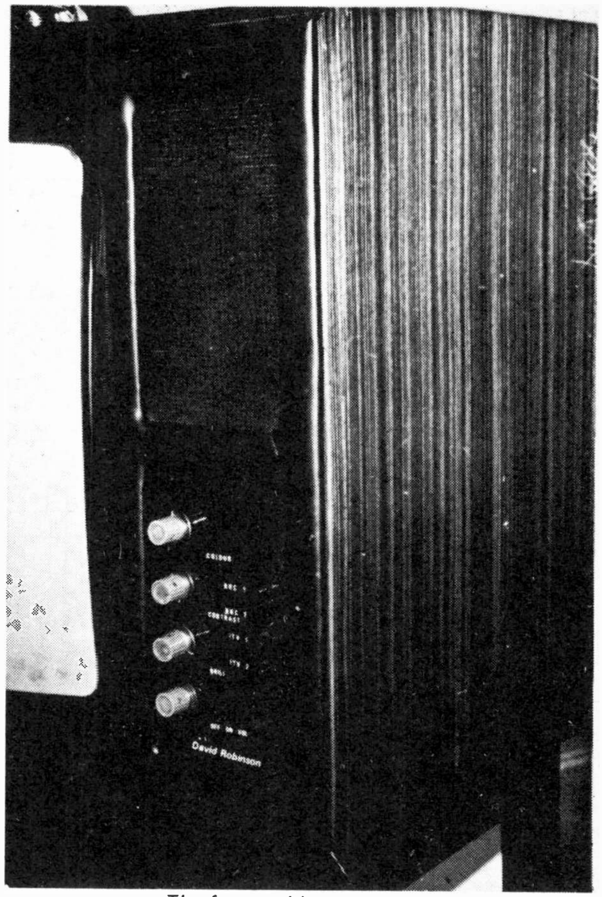
Sound-chroma Beats

The way in which I got around this problem was to remove the chroma subcarrier rejector from the luminance channel and instead adjust L (Fig. 6) to reject the chroma subcarrier at its i.f. (35·07MHz) prior to detection. The use of a.f.c. ensures that the rejection notch always appears at the correct frequency. As the core of this coil (2L12 in the Bush circuit diagram) is slowly unscrewed the notch can be seen running through the 5·25 and 4·5MHz bars on the test card until at one point the chroma pattern is notched out. This not only reduces the 4·43MHz pattern but neatly deletes the 1·57MHz sound-chroma beat as well.

The performance obtained using this strip is now highly satisfactory, with no visible beat patterns, definition such that the 5·25MHz bars on the test card are quite clear, and a good noise-free chroma signal.

The Decoder

The decoder is quite conventional, following the basic Mullard circuit except for the demodulators (see later). I built it on a 5 x 12in. plain Veroboard panel, the component leads being wired together on



The front cabinet treatment.

the reverse side. The layout of the decoder is not very critical and the operating frequency comparatively low: I felt therefore that the time and trouble that would be required to design and make a printed board would not be justified. There are a large number of components in the decoder but construction is quite straightforward. Coil winding can be rather tedious but the tricky part is alignment. More about that later.

Integrated Circuit

I originally intended to use colour-difference tube drive with valve output stages but the Plessey SL901 integrated circuit, the heart of the "I.C. Colour Lock" in RBM single-standard sets, is now fairly readily available. This i.c. provides chroma signal demodulation and RGB matrixing. It accepts the chrominance signals and reference signals from the decoder and the luminance signal from the i.f. board, the RGB outputs provided then being fed to two-transistor video output stages. The i.c. peripheral circuitry is shown in Fig. 7. For brightness control purposes line frequency offset pulses are fed into the i.c. at pin 8 and are added to the RGB output signals: they alter the level at which the black-level clamps in the RGB video output stages operate.

The Mullard chroma delay line circuitry has to be modified to suit the i.c. Fig. 8 shows the revised circuit. The two balance potentiometers are adjusted so that the synchronous demodulators in the i.c. give

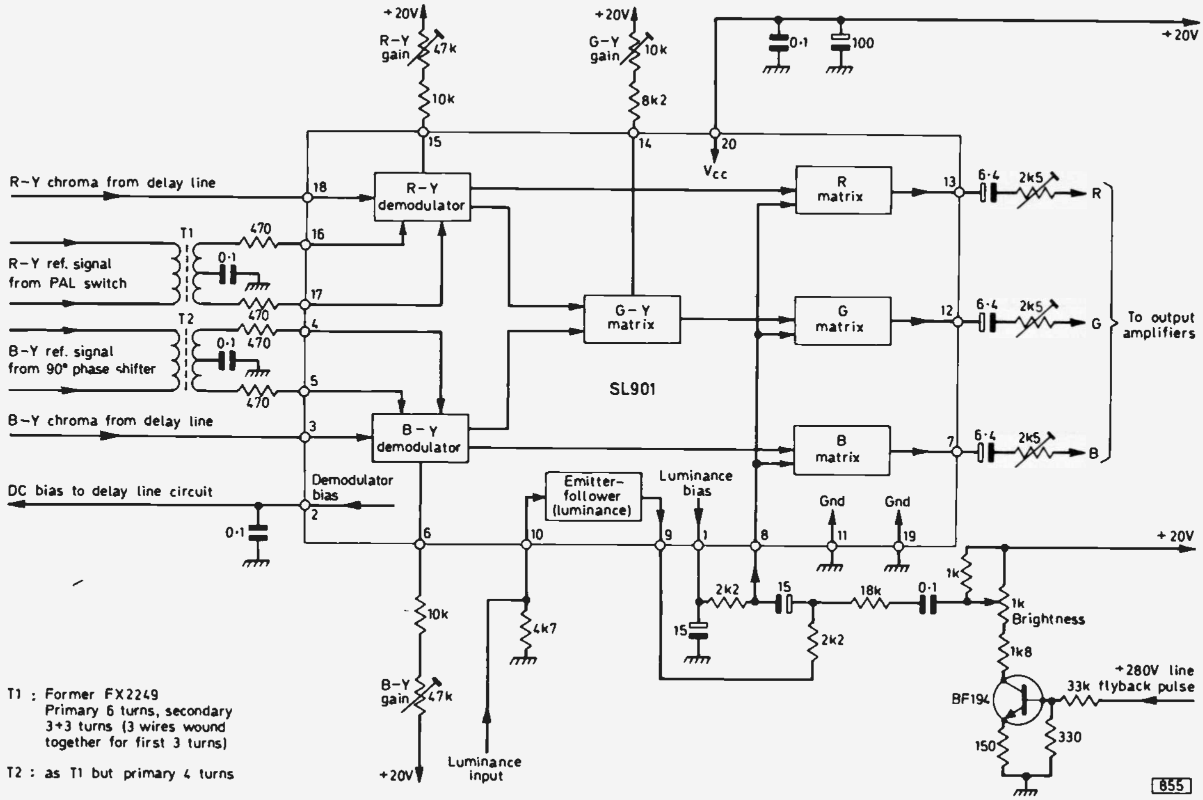


Fig. 7: The peripheral circuitry used with the SL901 chroma demodulator/RGB matrixing i.c. To provide harmonic rejection 33pF capacitors should be shown connected from pins 6, 14 and 15 to chassis. T1 primary consists of 6 turns, secondary of 3 plus 3 turns (three wires wound together for first three turns). Use 38 s.w.g. d.c.c. wire wound on an FX2249 former. T2 as T1 but primary 4 turns. Later versions of the SL901 are encapsulated in a 24-pin pack: the four extra pins—one at each end of each row—are not used.

zero output when no chroma signal is being fed into it. If the demodulators are off balance the reference signal appears at the outputs, giving 4·43MHz patterning all over the screen and also disturbing the black-level clamps.

The reference signals are fed via the usual transformers to obtain the correct phase relationships. The i.c. requires push-pull reference signal inputs however so the secondaries of the transformers (T1 and T2, Fig. 7) are bifilar wound in two halves with the centre taps connected to chassis via 0·1μF capacitors.

The colour-difference signal gain controls in the SL901 peripheral circuitry do not have a very drastic effect on the picture: they are by nature more of a trimming adjustment.

The 6MHz trap in the original decoder design was omitted since there is a trap for this purpose in the chroma amplifier section on the RBM i.f. board.

RGB Channels

The RGB output stages follow the RBM design but some of the resistor values were altered to enable the stages to be operated from a 280V instead of a 200V line—see Fig. 9.

Crosshatch Input

There is a built-in crosshatch generator following a design using three i.c.s originally published in *Wireless World*. The arrangement adopted for feeding the crosshatch signal into the luminance channel is shown in Fig. 10. As can be seen the luminance signal switching is carried out by means of diodes. When the switch in the supply line is switched to "crosshatch" the 20V supply to the luminance emitter-follower (BC108) and the decoder is removed and applied instead to the crosshatch generator circuit and the BCY71 which inverts the crosshatch signal so that it is of the correct polarity for feeding to the SL901. With this arrangement the receiver remains synchronised to the transmitted signal but the crosshatch pattern replaces the picture.

So much then for the signal circuits in the receiver.

Timebase Board

The surplus RBM timebase board used contains the sync separator, the field timebase and the line generator and drive circuits. The only fault present was that the field output transistors had blown so these were replaced. The line drive circuit was intended for use with a transistor line output stage and as my receiver uses a valve line output stage it was necessary to alter this—see Fig. 11—in order to obtain a drive waveform suitable for driving a valve. This arrangement works very well but as it has been tested on a one-off basis only it may not

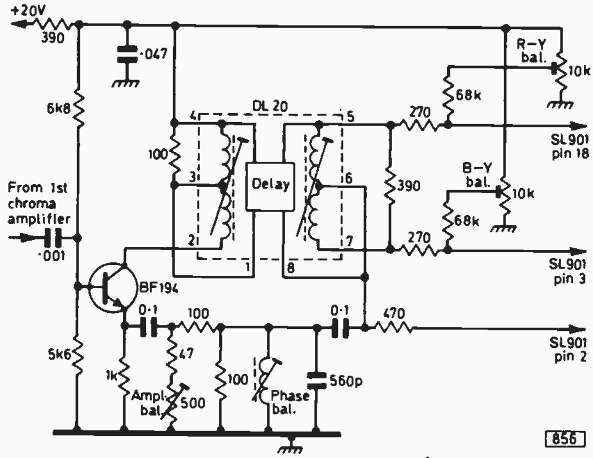


Fig. 8: Chroma delay line circuit, modified to feed the SL901 i.c.

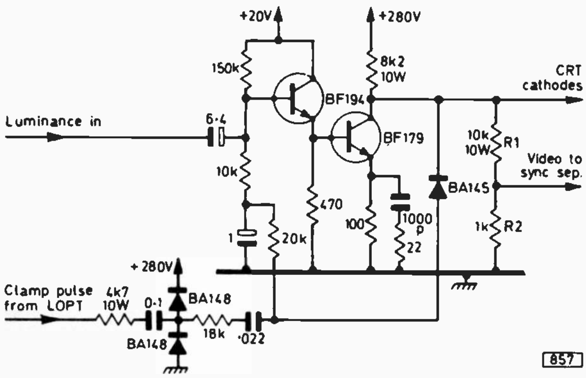


Fig. 9: One of the RGB circuits. One of these was used as shown here for initial testing (see next month), with the luminance signal applied to the input, the output fed to all three c.r.t. cathodes and R1 and R2 used to provide a feed to the sync separator. For RGB use omit R2 and connect R1 to chassis.

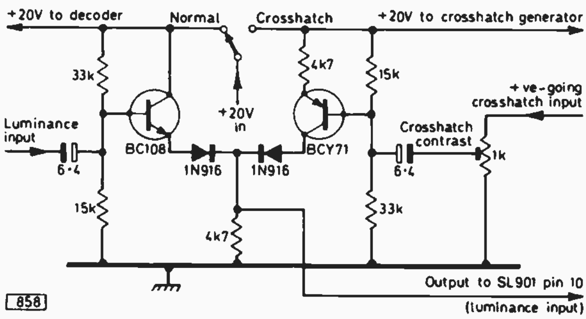


Fig. 10: Crosshatch input and switching circuit.

give the correct drive waveform in all cases where it is tried due to spreads in component values.

Flyback Blanking

The flyback blanking arrangements in a colour receiver can get quite complex. Fig. 12 shows the circuit I used. The purpose of diode D3 is to ensure that the c.r.t. grids are held at a constant voltage in

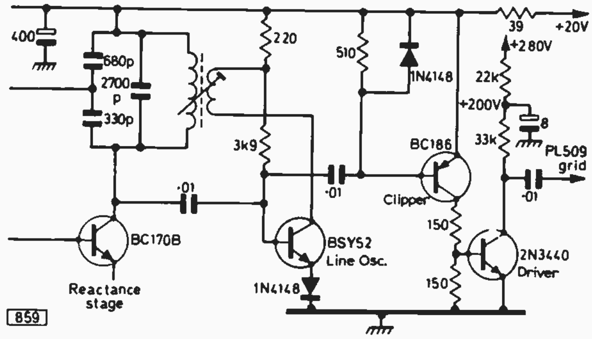


Fig. 11: Modification to the RBM line drive circuit to enable it to drive a valve line output stage.

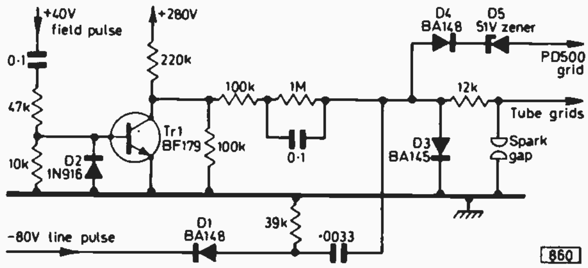


Fig. 12: Blanking and beam limiting circuits.

the absence of the flyback blanking pulses. The line flyback blanking pulses are fed to the tube grids directly, D1 being included to prevent the line flyback blanking input attenuating the field flyback blanking pulses. The field flyback blanking pulses are inverted and clipped by Tr1.

Beam Limiting

The beam limiting circuit is simple but adequate. The anode of the 51V zener diode D5 is connected to the grid of the PD500 e.h.t shunt stabiliser valve, D4 being included to prevent D5 being driven into forward conduction by the blanking pulses—this would impair the blanking of course.

The cathode of the PD500 is connected to chassis via a 1kΩ resistor. Its grid is negative with respect to chassis therefore. As the beam current increases, the PD500 grid becomes more negative until at full beam current (1·2mA) the stabiliser valve is cut off. Its grid voltage will then be at most about −40V. Any further increase in beam current causes the PD500 grid to go rapidly more negative, zener diode D5 then conducting and driving the c.r.t. grids negatively to limit the beam current. Note that both flyback blanking pulse feeds are a.c. coupled to permit this arrangement to be used.

Initially I tried to operate the beam limiter via the a.g.c. circuit as this would have maintained the correct black level. The time-constant of the a.g.c. circuit is long however so the system went into oscillation.

Source of Components: The main items used in this receiver, including the surplus units and panels, were obtained from Manor Supplies, 172 West End Lane, London NW6.

CONTINUED NEXT MONTH

LONG-DISTANCE TELEVISION

ROGER BUNNEY

THERE have been a couple of rather startling news items recently and I feel we must start off this month with these. First there is the prospect of UK DXers receiving a new country during the next Sporadic E season. In the December column I suggested that the reception by Lothar Scholt (GDR) of a 525-line signal on ch. A2 (E3) could originate only from station HZ22, Dhahran, Saudi Arabia. I was mistaken however. Michele Dolci (Italy) reports that a transmitter using ch. A2 (E3) is now in operation on the north coast of Crete. This is an AFRTS (American Forces) outlet operating from the Iraklion base with reasonable power apparently since reception in both Italy and East Germany (GDR) has been confirmed. System M (525 lines, 60 fields) is used on ch. A2 (55.25MHz vision, 59.75MHz sound). Ch. E3 vision is also 55.25MHz so there should be little trouble in locating the channel. The test card used is the RETMA one but with a slanting chequered border. Photographs taken in Italy show an identification slide with "Iraklion", and other programme captions. The caption "AFRIS" mentioned in December can only be "AFRTS". In view of the excellent reception of Albania this past season I feel that Greece will certainly be received this coming year!

Secondly, Garry Smith (Derby) tells us that TSS (USSR) is now using the electronic pattern type CS U 01 —with a slight variation and carrying the identification "UT" at the top.

My log for December is as follows:

1/12/73	DR (Denmark) ch. E4 - MS (Meteor Shower).
2/12/73	DR E4; SR (Sweden) E2, 4 - all MS.
3/12/73	CST (Czechoslovakia) R1; DFF (East Germany) E4; NRK (Norway) E4; SR E4 - all MS.
4/12/73	CST R1; TVP (Poland) R1 - both MS.
5/12/73	NRK E4; ORF (Austria) E2a - both MS; improved u.h.f. tropospherics.
6/12/73	DFF E4; SR E3; CST R1; TVP R1 - all MS.
7/12/73	DR E4; DFF E4; SR E3; NRK E3; JRT (Yugoslavia) E4; RAI (Italy) IB; TVP R1 - all MS.
8/12/73	SR E4 - MS.
9/12/73	SR E4; RAI IB - both MS.
10/12/73	DR E4; SR E4; NRK E2 - all MS.
11/12/73	DR E3; SR E2, 4; NRK E4 - all MS.
12/12/73	CST R1; TVP R1; DR E4; NRK E2 - all MS.
13/12/73	DFF E4; SR E4 - both MS.
14/12/73	DR E3, 4; SR E2, 3, 4; DFF E4 - all MS Geminids meteor shower.
15/12/73	DFF E3, 4; DR E3, 4; TVP R1 - all MS.
16/12/73	Improved tropospherics at u.h.f.
17/12/73	SR E4; ORF E2a - both MS; SR E2, 3; TVP R1 - both SpE.
18/12/73	CST R1; SR E2 - both MS.
19/12/73	SR E2 - MS.
21/12/73	RAI IB; SR E2 - both MS.
23/12/73	WG (West Germany) E2 - MS.
24/12/73	TSS (USSR) R1 - SpE (test card 0249 at 1308).
26/12/73	TVE (Spain) E2 - MS; SR E2 - SpE.

December 1973 was a quiet period with the Geminids MS and a certain amount of Sporadic E activity around the 17th the only significant reception.

Lothar Scholt tells us that DFF - 1 (East Germany) has its test transmissions from 0730-0745. Programmes commence at 0745 until 1230 when further test transmissions continue until programmes recommence at 1500. All times CET. Back in 1971 we briefly mentioned the illegal transmitters operating on the Italian borders, providing various extra programmes on channels other than those officially allocated for television broadcasting (special tuner strips/converters being available). Michele Dolci now tells us that certain JRT Yugoslavian transmissions are now being radiated at around 300MHz.

Extending UHF DX

With our u.h.f. TV - DX horizons now being extended on a more regular basis into Austria and Switzerland during "openings" the time seems appropriate to list the transmitters specifically to "look for".

Switzerland: Rigi ch. E6 30kW; Sankt Chrischona E11 50kW*; Uetliberg (French) E23 160kW; Uetliberg (Italian) E26 160kW; Rigi (Italian) E29 130kW; La Dole (German) E31 400kW*; Rigi (French) E32 130kW; La Dole (Italian) E34 400kW; Bantiger (Italian) E40 300kW; Sankt Chrischona (French) E46 200kW*; Sankt Chrischona (Italian) E49 200kW*.

Italy: All 2nd chain: Torino E30 200kW; Mt. Venda E25 1000kW; Mt. Penice E23 1800kW*; Portofino E29 1000kW*.

East Germany (GDR): All DFF - 2. Dequede E31 500 kW; Schwerin E29 1000kW; Brocken E34 1000kW*; Inselberg E31 500kW*.

Austria (ORF-2): Pfander E24 600kW.

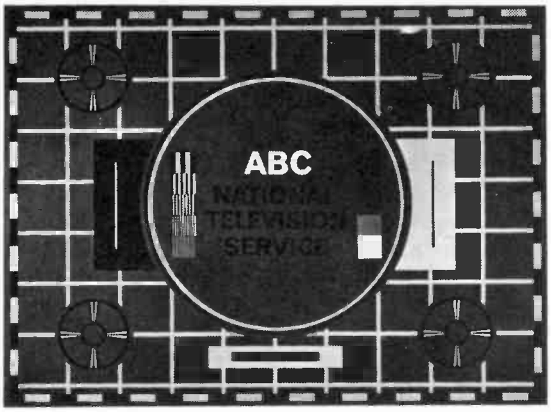
All these stations transmit with horizontal polarisation. Those marked * are the most likely ones to be received —or indeed have been received here in the UK.

Thanks Whitbreads!

As veteran readers of this column will recall I have moved to three different locations during the past two years. Recently I erected a substantial mast at the new location and for a time a problem which caused some head scratching occurred. From about 0715 pulsed ignition interference appeared. This took the form of engine tickover, acceleration and slowing, but on the main road nothing could be seen or heard! The problem was eventually traced to fork-lift trucks operating in the Whitbread-Wessex brewing complex adjacent to my house in Romsey centre - these are silent and operate out of sight in the various buildings! A diplomatic approach was made to the engineering staff at Whitbread's and within a very short time the whole fleet was suppressed, reducing the interference to a very low level—far lower than at the previous two locations! I would like to thank Whitbread-Wessex publicly for their friendly, efficient attention and action.

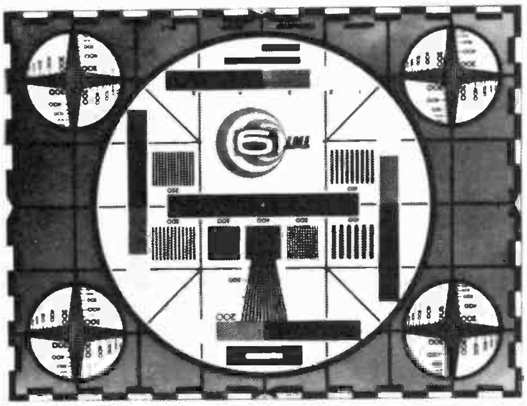
New EBU List

The new EBU transmitter list has just been published. A close examination has brought to light a number of interesting items. In particular Bulgaria is now listed with Band I transmitters as follows: Ruse ch. R1 5kW; Plodviv R2 50W; Arbanasi R3 10W - all horizontal. I feel that the Ruse transmitter is certainly possible—the old ch. R2 5kW outlet was received in the UK. The Egyptian Port Said transmitter is again listed on ch.

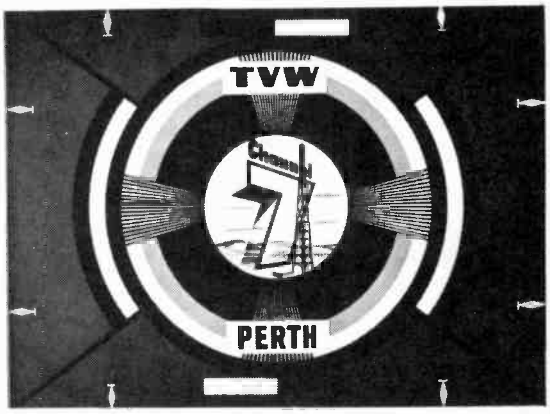


Australian Broadcasting Commission test card.

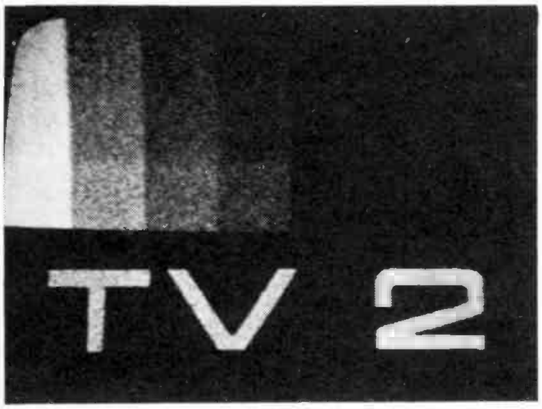
NBN channel 3 test card—Newcastle Broadcasting and Television Corporation Ltd., Australia.



TNT channel 9 test card—Northern TV Ltd., Launceston, Australia.



TVW channel 7 test card — TVW Ltd., Perth, Western Australia.



Belgian BRT-2 test pattern.

Teleac identification slide—Television Academy, Holland.

Photographs courtesy Garry Smith, Ryn Muntjewerff and Peter F. Vaarkamp

E3 - this is *not* in operation however. Welcome news on the Rumanian front, with a number of new transmitter possibilities:

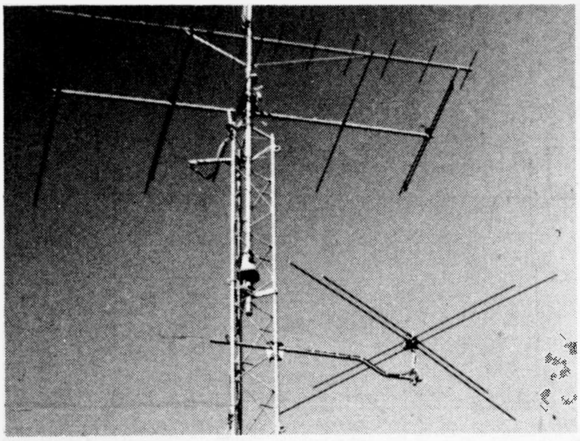
Bucharest ch. R2 100kW horizontal; plus eight cg relays on R2 from 750W downwards.

Oredea R3 120kW horizontal; Semenic R3 15kW vertical; plus 13 relays from 100W down.

Suceava R4 100kW horizontal; Bucharest - 2 R4 75kW horizontal; plus five relays from 400W down.

Birlad R5 50kW vertical; Gheorghieni R5 50kW horizontal; plus five relays from 100W down.

The *List of Television Stations - European Broadcasting Area No.* 18 is available from the European Broad-



The improved Band I omnidirectional array, mounted at 32ft. on Roger's mast to act as a search aerial.

casting Union, Technical Centre, 32 Avenue Albert Lancaster, Bruxelles 18, Belgium for 300 Belgian Francs. This includes six bimonthly supplements and a map. The publication is strongly recommended as the most accurate guide for transmitters in Europe — *all* transmitters are listed within its 316 pages.

News

Monaco: Tele Monte-Carlo is now operating from a u.h.f. transmitting site, suspected to be Mt. Agel, on ch. E35 with partial colour programmes. Transmissions started on December 22nd. At the time of writing it is not known whether these are the long awaited high-power transmissions for Northern Italy.
Qatar, Persian Gulf: Marconi inform us that more colour equipment is being installed at the TV centre at Dohah, Qatar and that Qatar will soon have the most powerful and up-to-date network anywhere in the Gulf States.

Guestworker Programmes

Certain programmes specifically for "gastworkers" are transmitted in West Germany. These are transmitted in various languages for the benefit of foreign labour. Peter Vaarkamp has listed some of these programmes as

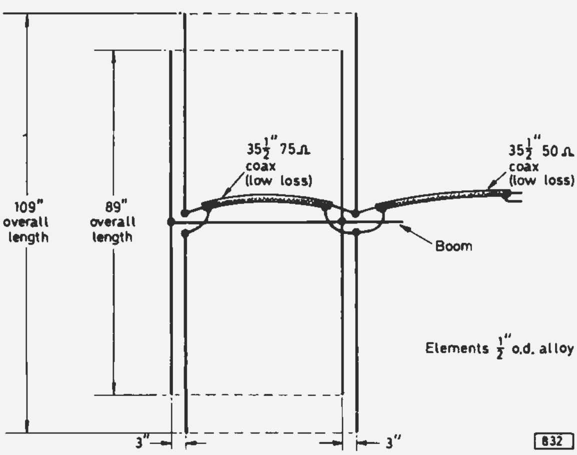


Fig. 1: Exploded view of the improved Band I omnidirectional array. The dipole assemblies are mounted at right angles to each other—see accompanying photograph.

follows: *ZDF*: Sunday "Turkiyo Mektuba" Turkish 0945-1030.
WDR: Monday Italian 1905-1915; Tuesday Greek 1905-1915; Wednesday Spanish 1905-1915; Thursday Turkish 1905-1915; Friday Yugoslavian 1905-1915.
ZDF: Saturday "Cordialmente Dall" Italian 1415-1458.

Peter also mentioned that NOS (Dutch) TV has an equivalent to the UK's Open University. This is called "Teleac" and operates approximately as follows: Saturday a.m. and evening; Sunday 1820-1850 NOS-1; Monday - 1230-1300 NOS-1; evening on NOS-2; Tuesday on both NOS-1 and -2 after programme close; Wednesday 1000-1030 NOS-1. We are featuring the rather distinctive "Teleac" slide this month.

From Our Correspondents . . .

D. McFadyen of Raurimu, North Island, New Zealand has sent us a long account of the DX conditions there during the past few months. Channel 3 seems to be the only clear one. The Aroha ch. 1 relay at 110 miles and Wharite ch. 2 at 90 miles tend to upset Band I but from November 19th Sporadic E opened up (Summer in NZ is during the UK Winter). Good signals arrived from Melbourne ch. 0 and faint signals from CHTV3 Christchurch, South Island followed later by Australian ch. 2 signals (which appear on NZ ch. 3). An interesting weather situation during the season's opening has recurred on each of the past three years. A turbulent front with thunderstorms and severe hail in some areas swept over the South and part of the North Island followed by a cold southerly airstream. This produced many South Island transmitters and Australian transmitters, jamming all the low-band channels. The Keith Cummins' *Practical Television* 625-line receiver is in use and is proving "a most capable receiver". Apparently there have also been signs of F2 reception - we await further news of this with great interest.

Both Clive Athowe (Norwich) and Ryn Muntjewerff (Beemster, Holland) mention reception of the BRT (Belgian) 2nd chain programme. A new pattern with colour bars and the identification "TV2" has been noted. The BRT-2 service is inactive for the time being. We are pleased to feature a shot of the new pattern.

Finally this month John White (Scunthorpe) has written enclosing a quite incredible log of stations received during the excellent November 22nd tropospheric opening. Of particular note was reception of the Berlin SFB transmitter on ch. E39 in colour, using a Bush Model CTV25 Mk 2.

Colour Signal Propagation

The IBA is conducting research into selective fading within a transmitted television signal bandwidth, particularly fading between the luminance and chrominance carriers. If anyone has any information, observations or figures relating to this subject we would be grateful if you could send it in so that all information can be collected for passing on to the IBA. All such information will of course be returned.

Improved Omni-X Aerial

In the beginners' section of this column in June 1973 and also in greater detail in *Practical Television* July, 1969 we featured an omnidirectional Band I array centred on 55MHz. This array is particularly useful for enthusiasts unable to erect a large multielement array for financial and/or domestic reasons. Its advantage is that it responds to horizontally polarised signals from any direction, though it doesn't of course have the gain a multielement array would provide. I have mounted a new version of this type of array at the 32ft. level on my mast, mainly to act as a search array—during good SpE openings in the past I have often missed signals from directions at 90° to the main axis of the main array. One receiver can now be left working from the omnidirectional array while the main array feeds into the other receiver for more selective work.

The modified array uses the "Tru-Match" technique which employs an active dipole (to which the feeder is connected) and a passive dipole mounted in close proximity to the active dipole. For the omnidirectional array two such dipole systems are connected together in X formation, phased and matched into a 75Ω output. The result is a better bandwidth/matching figure. In this particular version the resonant elements are at 51·5MHz and 63MHz whilst the matching/phasing harness is centred around 55MHz.

The passive dipoles are mounted parallel to the active dipoles, spaced some 3in. away. Use of a conventional X insulator is impractical and it is suggested that separate Band I dipole insulators and element mounting clips are used. It is of great importance that the two dipole assemblies are mounted in close proximity and at right angles (90°) to each other.

Since 1969 many enthusiasts have constructed arrays of this type, and have reported excellent results during both the main SpE season and active MS (meteor shower/scatter) periods. The accompanying photograph shows the new array in use here.

LOW MAINS TV FAULTS

STEVEN KNOWLES

When there is a mains voltage reduction during a period of power shortage many people are unable to get satisfactory results from their TV sets because of faults which show up only under low-voltage conditions. Probably the most widely asked question is "why does my set give so much trouble when Harry's next door works perfectly?" The answer is that Harry's set is probably in a much better state of repair generally than the set that shows the fault symptoms.

The maximum permissible voltage drop of 6 per cent represents a drop of approximately 15V. Thus a nominally 240V mains supply will be reduced to roughly 225V, and many potential faults which do not appear at the normal mains voltage will be present with this reduced supply. Let's look at some typical examples.

Line Hold Fault

A Ferguson set fitted with the Thorn 900 chassis was inspected following the complaint of "lines across the screen on all channels—corrects itself late at night". The lines were found to be loss of line hold— the controls were unable to pull the raster into lock on either standard. The owner assumed that the fault was being caused by the voltage reductions but the weak link in the circuit was actually the 30FL14 line oscillator valve which was unable to operate correctly with the reduced supply. A new 30FL14 cured the trouble completely, the set then working normally on both full and reduced mains supplies.

Loss of Signals

Another fault which commonly presents itself under these conditions is lack of vision and sound signals, i.e. a blank raster. In all the cases we have come across a replacement frequency changer valve (or transistor) has restored signals. A variation of this fault is where the frequency changer does oscillate at some frequencies so that maybe only one station is unobtainable whilst the others are normal. Here are a couple of recent examples: a replacement PCF801 frequency changer valve in a Baird model cured the trouble in one case while in a set fitted with the BRC 1580 portable chassis the culprit turned out to be the AF139 transistor in the u.h.f. tuner (incidentally this is a common fault with this chassis under normal conditions as well).

Lack of Height

The picture produced by a Pye Model V830D shrank under low-voltage conditions to approximately one-third of the normal height, with constant field roll which could not be corrected by adjusting the field hold control. A new PCL85 field oscillator/output valve cured the fault, the weak link in this case being the triode section of this valve.

Power Supply Circuits

H.T. rectifiers are a common cause of trouble if not in good heart—valve types should be replaced if they have been in use for any length of time. If a pair is used, replace them both. Metal h.t. rectifiers can be replaced with a BY100 or similar silicon type —connect a 25Ω 10W wire-wound resistor in series to act as a surge limiter.

Another point worth checking is the mains voltage tappings. On many sets even of quite recent design a 250V tap will be found. If a set is found working on this tapping readjustment to the now universal 240V tapping will produce a vast all-round increase in performance. The tappings must **never** be set to a lower voltage than normal to try to improve results however: doing this will knock the life out of the valves and c.r.t. in a very short time.

Action to Take

So if your set is giving trouble when a voltage reduction occurs first determine in which stage the fault lies—by observing the symptoms on the screen —then thoroughly overhaul the stage concerned. If a valve is used in the stage, change it. If any of the resistors appear to be discoloured, replace them. If any of the capacitors seem to be dried up or leaky, fit new ones. If this is methodically done any faults or potential weak links will be eradicated without trouble.

This short guide should enable the best to be got from TV sets during the power reductions that seem to be a feature of our winters nowadays. ■

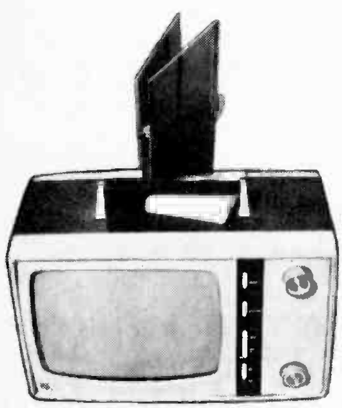
LOG-PERIODIC SET-TOP AERIAL

KEITH PITT B.Sc.

As the coverage of the u.h.f. TV networks rapidly increases more and more people find themselves close to a transmitter and as a result the natural temptation when considering a receiving aerial is to go for a cheap solution and use a set-top one. In practice this is not in most places a good idea because of the nature of u.h.f. signal propagation. It is always wiser to have a properly installed outside aerial, on the wall, guttering, or preferably the roof. Where covenants or structural problems preclude an outside aerial however the viewer is forced to fall back on an indoor one. Previous articles (August 1970 and 1971) have described a variety of set-top aerials, of which the versions of the log-periodic array appear to have been the most successful. This article describes a printed circuit board log-periodic aerial.

Advantages of the Log-periodic

The log-periodic aerial normally looks rather like a standard Yagi array. It has broader bandwidth however, giving even reception of all the channels of a transmitter group. This is very helpful for set-top use as there can be an imbalance between the signal strengths of the different programmes and poor aerial bandwidth only makes this worse. The log-periodic aerial also has very exceptional directional properties, with minimal side and rear lobes. This very effectively removes ghost images and minimises changes due to the movement of people close to a set. The gain of a log-periodic aerial is relatively low but is certainly much superior to that of a bisquare type. Several very good commercial ones are available. These are extremely safe because they are capacitance coupled to ensure that there is no possibility of personal contact with mains potential. *The version described here is not capacitance coupled and must only be used when it has been checked that the aerial socket of the set is safely isolated from the mains supply. This safety aspect is extremely important and must not be overlooked.*



The author's group C version operating with a Philips T-Vette. Mounted for reception of vertically polarised transmissions.

The "upper" aerial group, covering channels 50-68 approximately, lends itself to unconventional forms of construction because of the small physical dimensions of the wavelength. The average value is about 14½in. This enables a four-element aerial to be made that takes up a space of about seven inches square.

Variable Parameters

The log-periodic aerial has a number of parameters that can be altered to vary the size, gain, impedance and bandwidth. Size relative to a normal Yagi can be reduced by converting the aerial from a basically planar form to a three-dimensional arrangement. This is done by putting the booms at a slight angle to each other and has no adverse effect on the performance.

Channel Groups

The model described here was designed for the CD channel group, channels 48-68. A design optimised for group B, 39-51, would be larger in all dimensions by 1·2 times the dimensions given here. This is beginning to be inconveniently large for a home produced printed circuit board. Reasonably good coverage of these lower channels is given by the model described here however. (If large enough vessels are available for the processing, a group A version can be made: multiply the dimensions given by one and a half. The boards will be about 12in. by 6½in.)

Construction

The aerial is made using single-sided copper/fibreglass board. Standard home printed circuit board making techniques can be employed for etching the patterns. We used draughting tape very carefully stuck over the copper laminate, and for etching used ferric chloride solution (which is *corrosive*) contained in a non-metallic photographic developing dish. One for 10 x 8in. prints will be large enough for most of the versions likely to be made, but not

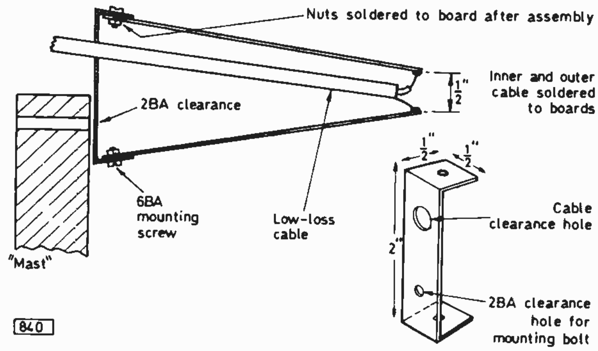


Fig. 1: Cross-section of the assembled aerial, showing the taper. The separation between the insides of the two printed boards at the front is ½in.

Fig. 2 (right): Rear mounting strip details.

for a group A version. Paint or lacquer can also be used as the resist. There are also commercial preparations advertised for home printed circuit board making. Although we used fibreglass board, it would seem that the cheaper phenolic material would also be suitable. Either one or two ounce copper (describing the thickness of the metal layer) is acceptable.

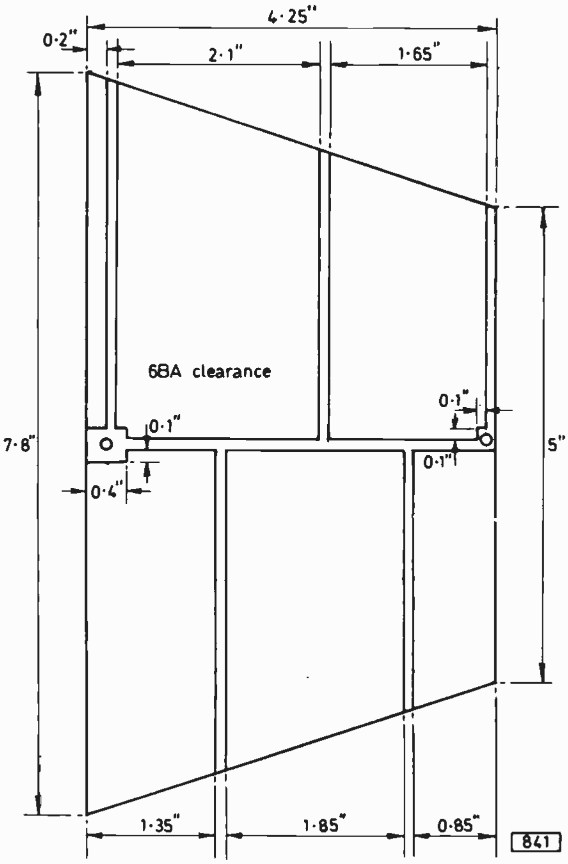


Fig. 3: The printed circuit board pattern. Two boards are required, mounted as shown in Fig. 1. Dimensions given are for a group CD aerial: for group B multiply all dimensions by 1.2 and for group A by 1.5. The width of the conducting strips is 0.1in. Shown half scale.

The stand consists of about 6-7in. of 1in. broom handle nailed or screwed at right angles to a wood or chipboard base which is large enough not to over balance when the aerial is attached. An appropriately sized hole, probably 2BA is best, is drilled near the top of the "mast" to take the aerial mounting bolt. The cable is attached to the front of the boards and brought back to the rear of the mast between the boards (see Fig. 1).

Fig. 3 shows the print pattern and the dimensions. Two identical boards are needed. They are mounted at an angle of 10-15° to each other using a semi-rigid strip of metal (see Fig. 2) which is also used to attach the assembly to the "mast". This half inch wide strip of metal can be of any suitable material and thickness provided it gives adequate support. Aluminium alloy was used for the prototype and as a result the bends are rounded because this metal breaks if right-angle bends are made in it. Two holes must be drilled in the strip before it is bent, one of close clearance for the low-loss cable and the other for the 2BA mast attachment bolt. The position of these should be chosen experimentally, to ensure that the aerial can be mounted with its elements either vertical or horizontal as required for the local transmitters. Dimensions for the strip are shown in Fig. 2.

The two boards are assembled to the strip as shown in Fig. 1, using 6BA nuts and bolts. The copper sides of the boards face inwards and the nuts are soldered down after assembly to give greater rigidity and the necessary electrical short-circuit. The low-loss cable is soldered to the boards at the points shown before they are joined to the mounting strip. There should be no risk of the connections shorting if the assembly is made as shown, but a section of the p.v.c. cable cover can be cut off and used as sleeving if necessary.

Results

It is difficult to generalise about the results obtained but we can say that this model seems quite competitive with most commercial set-top aerials except for one multidirector type which is extremely good. As a result of much experience in installing set-top u.h.f. aerials, the author feels that in most cases they represent a last ditch approach which should be adopted only when circumstances preclude the installation of a correctly mounted, permanent outdoor aerial array. ■

LETTERS

THE SERVICING PROBLEM

As a former TV technician now employed in telecommunications work but still taking an interest in TV servicing on a part-time basis, especially colour servicing having obtained the City and Guilds Colour Principles Certificate by attending evening classes last year, I was particularly interested in your comments under the heading "TV Servicing: Crunch Coming" in the January issue. Taking first the report you mention that during the past five years the number of people employed in domestic radio and TV servicing has declined by 25%, it is interesting that in the department where I work approximately 30% of the technical staff are ex-radio and TV technicians most of whom hold the Final RTEB Servicing Certificate: so the question arises why did they leave the trade?

At the time I left (October 1966) the normal working week was five and a half or six days, including Saturday, and the basic pay in relation to the hours worked was less than could be obtained in a semi-professional occupation (i.e. telecommunications).

A great dislike to many servicemen is having to deal with the grumbling customer who complains for example that the set was not returned the previous night in time for his or her favourite programme. It can so easily dampen the enthusiasm for the job as a technical challenge. I agree fully that customers will have to realise eventually that good servicing costs money and has to be paid for. The customer seems to expect nowadays to pay for good car servicing—and expects to be without the car for two, three or more days. So why not expect to pay for the "box" to be repaired—especially when it is realised that the average colour set probably has more individual components than a car?

Another point is this: when I was employed in TV servicing the company seemed to regard the engineer as the poor relation—a good salesman was worth his salt whereas the engineer was a necessary evil.

It is clear from the advertisements in the press that colour TV engineers are in short supply. So some incentive must be found to attract and keep them. An estate car must help, as will good basic pay—£40 plus and superannuation—and a decent basic set of test gear for each vehicle. Some radio and TV servicing employers should see the equipment we have! Also the general working conditions must be adequate—workshops must be clean, well lit and warm, again with adequate test gear. This costs money of course—but then so does time wasted fumbling around in poor conditions.

The small independent dealer often has more of the test equipment required than many larger dealers and rental concerns and is thus able to give fast, efficient colour servicing for which he charges and, surprisingly, gets paid! Of two large nation-wide rental firms I approached one had a dismal, apathetic approach to test gear while the other had excellent facilities and workshops.

From enquiries I have made I conclude that some small firms have all the basic equipment needed but pay lower wages while some rental firms pay above average wages but, with one or two notable exceptions, have little or no test gear.

Faced with this dilemma, what does the keen engineer do? He either looks for better paid, secure employment, free from customer complaints and, usually, Saturday working or he seeks out one of the better rental firms; or joins the small retailer and earns lower pay; or finally leaves the trade completely. **K. Farrant** (*Preston, Lancs*).

BEAM LIMITING

I was interested in your article on colour receiver beam limiting arrangements. One circuit you omitted to mention was that used in the popular Philips G8 chassis. In this (see Fig. 1) beam current sensing occurs in the emitter circuit of the "lower" of the two BU105 line output transistors. In the event of excessive beam current the emitter voltage of this transistor rises, the beam limiter transistor T5569 conducts more heavily, and its collector voltage falls,

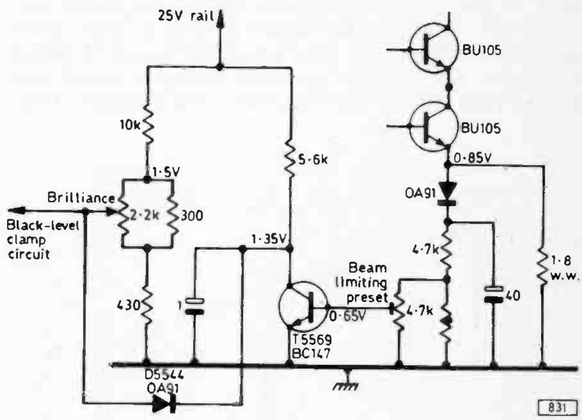


Fig. 1: The beam limiter circuit used in the Philips G8 colour chassis.

carrying the voltage at the slider of the brilliance control with it. A recent case of low brightness in one of these sets—the picture could just be seen at maximum brilliance control setting—was found to be due to the beam limiter transistor going short-circuit. As a result the voltage across the brightness control and the series resistor connected to its earthy end was 0·3V instead of 1·5V.—**J. Thomas** *(Chiswick)*.

RBM STABILISED POWER CIRCUIT

The "fluctuating picture" fault in RBM single-standard colour receivers has come up a couple of times in your columns recently. This circuit seems to have a basic design fault—hence the apparent new appearance of the components and no physical damage. Resistor 8R13 (Fig. 1 page 85 December and Fig. 1 page 125 January) forms a time-constant with the 0·22μF thyristor gate capacitor and as a result of the original resistor value this capacitor does not discharge fully between cycles. In consequence a bias is applied to the diac, it fires late and the h.t. voltage drops. The feedback circuit then over-corrects since it has only a few milliseconds each full a.c. cycle to regulate correctly. The voltage across 8R13 thus tends to shift continually and the effect is instability of about 5-10V amplitude at roughly 10Hz.

The effect is worst under full load when "shocking" the circuit into oscillation can be caused. The cure I have found is to reduce the value of 8R13 to 8·2kΩ or 10kΩ.—**M. J. Shilling** (*Kingston-on-Thames*).

Comment: An official modification suggested by RBM is to reduce 8R13 to 1kΩ. In their latest 110° chassis a similar circuit is used with the resistor value 1·2kΩ. The circuit is of Mullard origin. It is also used in the Philips G8 chassis, but with a 12V zener diode across "8R13". Fig. 2 shows some modifications

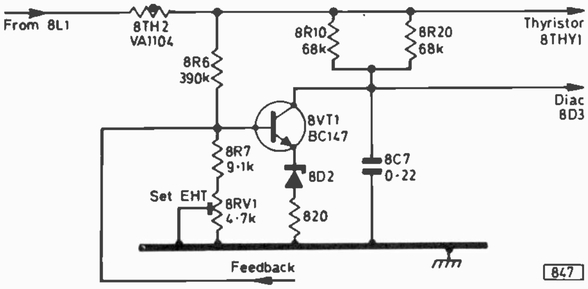


Fig. 2: Modifications introduced in the stabilised power supply circuit used in later versions of the RBM 90° single-standard chassis.

to the circuit in later versions of the RBM 90° chassis in case they may confuse readers without the full circuit.

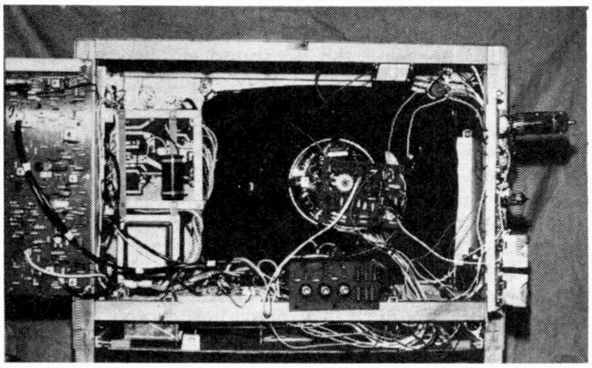
REMOTE CONTROL CIRCUIT

The following notes may be useful in case readers have difficulty in obtaining suitable relays for use in the remote control circuit I described last month.

Reed relays can be obtained from Electrovalue. The encapsulated type LPS12 has a 590Ω coil resistance. R24 should be changed to 330Ω if this type is used. The separate reed type MR1 fits bobbin type MS/12 which has a resistance of 1,040Ω. If this type is used R24 can be omitted from the circuit. The capacitance across an open reed incidentally is less than 1·5pF. The effect of this small amount of extra capacitance can be accommodated by adjusting the a.f.c. transformer tuning slug if necessary.

The Clare-Elliott RP7641-G8 relay can be used for the two changeover contact type required. The coil resistance is 675Ω and the dimensions 22 x 20 x 10mm overall (excluding pins) with 5mm pin spacing. They can be obtained from Service Trading Co., 57 Bridgman Road, London W4 5BB.

The push-button switches I used were obtained from Electrovalue (type 8531). **B. C. James** (*Nottingham*).



Rear view of B. C. James's version of the "Television" Colour Receiver. The decoder and timebase panels are mounted on hinges at the left- and right-hand sides respectively. The i.f. strip is mounted on the left-hand side panel. The mains transformer is on the left, with the power circuit board above. The RGB drive controls are beneath the c.r.t. base panel, with the RGB board behind.

COLOUR RECEIVER SETTING UP

An error occurred in printing the instructions I gave for decoder alignment with a multimeter in the January issue. In the third paragraph of section (13) dealing with the ident circuit, on page 114, the last word of the sentence "If the ident can eventually be made correct by this method then the ident signal itself is adequate" should have been *inadequate*.

Another point is that I am not too happy about the instructions that were added at the end on adjusting the first anode presets for correct grey scale. The method described would be perfectly in order for many receivers (like the one of mine at present being described). But there is one vital difference with the *Television* colour receiver—in this the RGB drive controls are connected in circuit after the black-level clamps. This means that there must be zero voltage across them at black level, otherwise the peak white adjustments will upset the first anode (background) settings. It would be very difficult to set up the grey scale on test card under such conditions. I suggest the following procedure:

(1) Set the first anode controls to minimum and the RGB drive controls to maximum.

(2) Remove all three inputs (Y, R−Y and B−Y) to the decoder board.

(3) Connect a voltmeter across one of the RGB drive controls.

(4) Switch on, and after warm up set the brightness control for zero voltage on the meter.

(5) Remove the meter and advance the red first anode control (in a dimly lit room) until a *very* faint red raster is obtained. Repeat this procedure with the green and blue first anode controls.

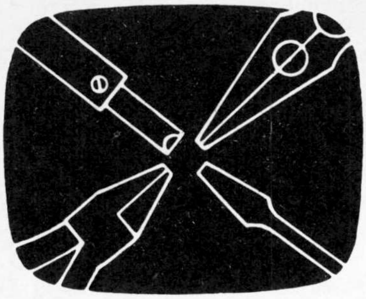
(6) Restore the inputs to the RGB board and check the flesh tone. Reduce the settings of one or two of the drive controls as necessary to give correct flesh colour (leaving the third one at maximum).

(7) Check the dark greys and slightly reset one or two first anode controls if necessary. Then recheck step (6), the RGB drive control settings.

D. Robinson (*Nottingham*).

BRC 1400 CIRCUIT

It has come to our attention that an important resistor was omitted in the circuit for the BRC 1400 chassis (earlier versions) shown on pages 120/1 of the December 1969 issue. R105 (680kΩ) should be shown between V9 and V10 heaters and the junction C95/R110. This resistor provides part of the filtering for the bias applied to the grid of the field output valve from the heater chain. It is present in the circuit shown on pages 120/1 of the January 1974 issue.



SERVICING television receivers

L. LAWRY-JOHNS

DECCA MS2000 & MS2400—cont.

Line Timebase Troubles

In the main however line timebase troubles which cause a no picture condition concern the output stage itself—a shorted boost reservoir capacitor (C134, use a 1kV replacement) or perhaps the DY802 e.h.t. rectifier shorted internally. This latter fault again causes a certain amount of overheating until either the DY802 top cap or the c.r.t. e.h.t. cap is removed to relieve the condition.

If the width is reduced but jumps well out when the "set boost" control VR107 is adjusted, with no proper control action, check the series resistor R170 (1MΩ) before replacing the control as failure to do this may result in the new one burning out in a short time.

If the line hold control is at one end of its travel the ECC82 is most likely to be at fault. If a new ECC82 does not help matters try a new ECL80. If both valves are in order check the electrolytic capacitor C113 in the flywheel sync filter circuit and R117 the anode load resistor of the pentode section of the ECL80.

If the picture hovers about without locking, check the ECL80, R109, C109 and again C113.

Field Timebase Faults

There do not seem to be many common faults in the field timebase circuit and the 30PL14 valve itself wears pretty well. The writer has encountered the following faults at various times however. The cathode decoupling electrolytic capacitor C124 dries up to promote severe loss of height with the lower part of the picture compressed almost to the centre. The value (160μF) is not critical and the more common 250μF 25V value can be used. The boost line decoupler C122 shorts to chassis thus robbing the height control of its supply and producing a nice thin white line across the screen. When this happens it should be borne in mind that R157 is subject to a heavier current flow than normal: it may therefore age toward earlier retirement than would otherwise be the case. The awkward bit about this is that it can go either high resistance to produce loss of height or low resistance which can mean excessive voltage at C122 so that the nice new capacitor you have fitted in this position can come to an explosive end if VDR102 fails to do its job. If VDR102 does do its job a heavy load is imposed on the line output stage and some obvious overheating will take place to call attention to the affliction.

If the trouble is lack of height—an even loss at top and bottom—usually either R157 has gone high resistance resulting in low voltage at the height control or R143 has gone high resistance resulting in low voltage at pin 9 of the 30PL14 valve base.

If the field is rolling with the control at one end of its travel check the valve, R127 and capacitor C115 (this 0·003μF cross-coupler has a high voltage rating which must be observed).

A picture which rolls up or down with little inclination to lock should direct attention to D102 (OA91) in the field sync pulse feed circuit and its bias resistor R116. If these are in order check the PFL200 and its associated components particularly the electrolytics C238 and C240.

Complete Loss of Sync

Complete loss of both line and field sync is most often due to a defective PFL200.

Sound Channel

Probably the most common complaint in the audio output circuit has a mechanical origin. The output transistor TR201 has to be clamped firmly in order to dissipate the heat generated. For this purpose it is laid on its mica insulator and clamped by a nut and bolt or a PK screw. Now this is the edge (what wonderful wit the man has!): the use of a PK screw can cause a sliver of metal to rise, puncturing the mica washer and shorting TR201 collector to chassis. The supply resistor R125 is thus placed across the h.t. line in series with the output transformer (T201) primary winding and a little overheating takes place which together with the no sound symptom tends to suggest that the output transistor has shorted. The answer is to release the transistor, remove the washer and inspect the hole. Carefully smooth the edges, throw away the PK screw, refit the washer and use a nut and bolt to clamp the transistor.

Whilst the writer has not had any trouble with the audio output transistor used in this model similar transistors used in other equipments (one well known record player for example uses an equivalent transistor under much the same conditions) seem to go open-circuit regularly so one should not disregard this possibility.

A high voltage at TR201 collector would suggest either that the transistor itself is faulty or that there is no forward bias at its base. The 1·82V forward base bias is derived from the i.c. so we sincerely hope that any absence here is due to nothing more than absence of supply to the i.c. at its supply pin 14, due say to C227 shorting or R217 being open-circuit. If on the other hand there is a voltage at

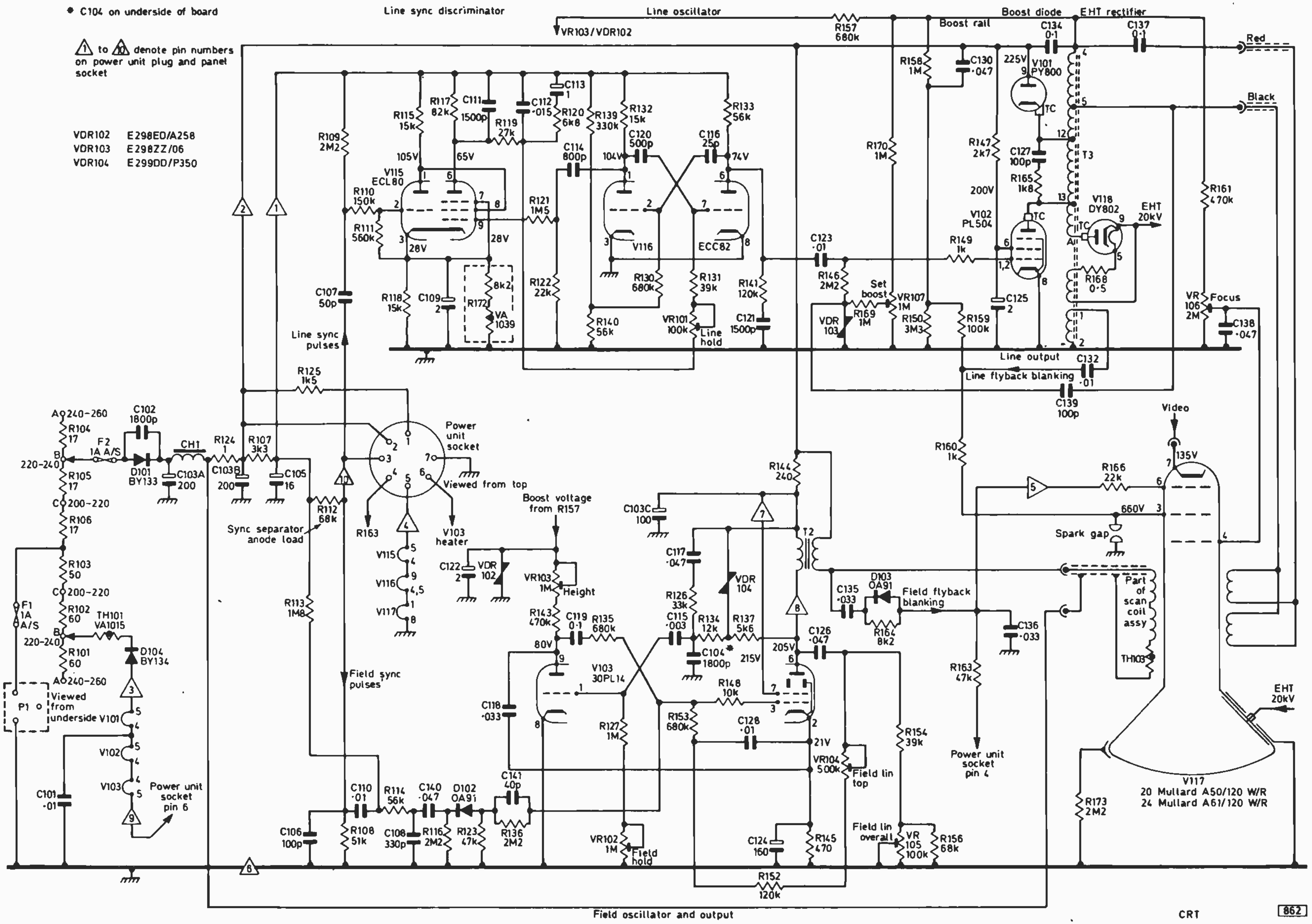


Fig. 4: Circuit of the timebases used in the Decca Models MS2000 and MS2400.

TR201 base but no voltage across its emitted resistor R225 (should be 1·35V) it is more probable that TR201 is faulty.

The MC1351P i.c. presents a bit of a problem if the sound is defective but the output transistor is in order: all one can do is take voltage readings as specified, starting with pin 14 which should be at 11·3V. If this reading is correct the other readings should also be correct provided the i.c. is in order. The only pin with no voltage is pin 7 which is connected to chassis. It is most important to take care with the meter probe when checking i.c. voltages: many a chip has been ruined as a result of adjacent pins being shorted through the careless slip of a blunt probe. A sharp narrow point is less likely to slip.

We are often asked to suggest a cure for vision buzz on sound which cannot be tuned out, coupled with the contrast being weaker than it should be. In the type of circuit used in this chassis, where a.g.c. is applied to the EF183, a weakness in the subsequent EF184 stage will mean that there is little or no a.g.c. action even though the EF183 is being overloaded. If there are signs of weaker than normal contrast and the tuning cannot be accurately set therefore check the EF184 valve before taking any other action.

Tuner Unit

Although the tuner is a little different from those normally encountered the usual remarks still apply. In some areas the most common complaint is reluctance of the mixer transistor TR2 to oscillate. We say in some areas because it is group A channels that are mainly affected, particularly those below 30. The first replacement transistor may be no more lively than the original so one must be prepared to try another (once you have again checked the tuning vanes for foreign bodies and fouling as they are fully meshed).

The first stage TR1 (AF239) can be more easily checked. If reception is poor with the aerial connected to the aerial socket or TR1 emitter remove the plug from the aerial cable and place the wire end near the collector tuned line. If the signal is then better (thus proving that there is no gain in the first stage) it is fair to suspect the transistor especially if there is no voltage across R1. TR3 can be similarly checked—not with the aerial of course but by checking the voltage across R10 or by shorting the emitter to the collector to note the drop or gain produced by so doing.

Plugs and Sockets

Whilst this chassis is not as inclined to exhibit dry-joints as some of the others we have mentioned in recent months nevertheless poor connections still form a goodly quota of the troubles that are likely to be encountered. The sockets are usually well soldered but the plugs may not be so lucky. It is surprising how long an unsoldered lead will continue to make sufficient contact until it is disturbed or the wire loses its fresh surface. When there is a stubborn or intermittent fault or a fault suddenly appears after the set has been disturbed in order to deal with a totally different fault condition always note the effect of gently disturbing plug wiring.

TO FOLLOW: PYE 169 CHASSIS

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INTERFERENCE

I have recently built a colour receiver which is similar in many respects to the design you have published. The set works perfectly except for one problem—the line output stage affects the next door monochrome set (on BBC-1 405-lines only).—T. Prettie (Tonbridge).

If you have not fitted BK chokes at the top caps of the line output valve and boost diode this could well help. Try screening the entire interior of your cabinet with chassis-connected metal foil. In case the trouble is mains borne, fit suppressor chokes in the leads to both sets, as close to the input as possible, with 0·01μF capacitors across the supply. If the interference is by direct radiation and screening the interior of the cabinet fails to provide a complete cure try "earthing" the chassis and all screening by means of a high-voltage capacitor to a separate earth connection. Make sure that all screening is well bonded to chassis. Also ensure that the heater wiring to the line output valve and boost diode is adequately decoupled to chassis.

DEFIANT 2A22

When the set is first switched on two white lines flash down the centre of the screen, a straight one in the centre with a sinewave one superimposed on it. When the set warms up the lines stop and the picture appears but is lacking in height at the top and bottom. Full height is reached after 15-20 minutes and is then maintained, the picture being quite good. The same conditions occur when the set is switched on warm but the set settles down sooner.—T. Swinton (Wigan).

Your troubles are due to ageing valves in this 21in. set which dates from about 1961. The white lines are the result of intermittent line oscillation or output—if you lightly tap the 30P4 line output valve, U191 boost diode and 30FL1 line oscillator when the white lines are present you will probably be able to identify the culprit. Also check the pin connections of these valves, scrape them and apply a little switch cleaner to the valveholders. Another possible cause of this trouble is a dry joint. Having to wait a time for the raster to reach full height indicates that the 30PL13 field timebase valve is low emission.

FERGUSON 3647

White areas of the picture are disturbed by the presence of vivid white lines and greyish blobs. The fault is present on both u.h.f. and v.h.f. and can be partially overcome by adjusting the contrast control to darken the picture.—T. Richardson (Abingdon).

The trouble seems to be a video fault. Try a new 6F28 video amplifier valve and check all the voltages in this stage. Then check that the series peaking coil L22 in the feed to the c.r.t. cathode is not open-circuit. If the brilliance control won't black out the picture or raster check the 220kΩ resistor (R119) in series with it. There is a possibility that the c.r.t. has an internal disconnection or short: does tapping the tube neck lightly momentarily restore the picture to normal? If it does and the base connector is making good contact this could be the cause of the trouble. Check C100 which decouples the c.r.t. first anode (to the h.t. line) and the flyback coupling capacitors C102 and C103: any of these could be breaking down. (BRC 1400 chassis.)

PYE 11U

Both the line and field lock are very easily upset in this receiver. With average picture content hold is just about kept but sync is lost on dark scenes. The hold controls are very critical. Signal strength is no problem and the fault is usually accompanied by a band of line tearing moving slowly upwards on a dark picture and slight bending of the verticals or less serious tearing on an average scene.—S. Potterton (Birmingham).

The part of the set that usually gives rise to this sort of trouble is the video amplifier section (pentode) of the PCL84 V9. Check this valve, also the resistors in this stage, particularly the cathode bias resistor R28, the screen grid feed resistor R26 and the grid stopper R27. Also check the screen grid decoupling electrolytic capacitor C21—if this is faulty it will affect the l.f. response of the stage.

KB VV10 VICTOR

This set worked well for a week or so after we acquired it though the picture took a long while to come on—sometimes about ten minutes, with the sound normal however. Now there is no picture, only flashes across the screen, with smoke coming from the three resistors at the side of the e.h.t. compartment. The e.h.t. rectifier lights up and there is a good spark at the top cap of the valves in the line output section. Everything seems to be working, so some suggestions as to the possible cause of the difficulty would be welcome.—J. Irefield (Scunthorpe).

Smoke coming from the right-hand side width resistors indicates that there is a short somewhere. The most likely suspect is the 4μF electrolytic C125 which decouples the width resistors. Then if necessary check the PY801 and PL36 valves. No picture although the e.h.t. is present suggests trouble in the PCL84 video stage. Check this valve, its screen feed resistor R52 (3·9kΩ) and the other components in the stage. If R52 is charred the PCL84 must be changed.

GEC BT336

The contrast control on this set is inactive. On Band I the picture is not too bad and the contrast control has a little effect but on Band III the picture is weak and the contrast control has no effect whatsoever. The sound is normal on both Bands.—B. White (Peacehaven).

Weak Band III reception with Band I reception more or less normal suggests that the r.f. amplifier valve (B349) in the tuner unit needs replacement. The poor contrast control operation is likely to be due to the 1MΩ resistor (R133 on the timebase board) in series with its slider having changed value. Also check the 1MΩ resistor R30 (i.f. board) in the a.g.c. line.

PAM 5151

This set operates well on v.h.f., and when a u.h.f. aerial is connected to the v.h.f. aerial socket a fair picture is obtained. With the aerial connected to the u.h.f. socket however and a u.h.f. position selected only sound is obtained though there is disturbance to the raster as though a picture is about to appear —the sound is not full volume. The set has not previously been used on u.h.f. but I assume that the tuning coil slugs are set approximately correctly. The signal strength in this area is not too good. All swiches appear to be making good contact.—G. Hitching (Eastbourne).

Some of these Pam receivers had a rotary u.h.f. tuner and some a push-button type. We assume that yours is the latter in which case the set is operating reasonably well but the push-buttons need adjustment. This is done by easing back the depressed button to its full extent then tuning it either way for optimum sound and vision. In addition to the main contrast control at the back these receivers also have an internal preset sensitivity adjustment in the top left-hand corner of the chassis. In some versions one preset control does for both systems but in others there are two separate presets individually marked. This may need advancing—a very small screwdriver is needed. Most of the models in this series were fitted with a valve u.h.f. tuner and though the set has not been used on u.h.f. before the valves will have been operating and could therefore be low-emission. Check that the u.h.f. aerial socket does not have a crack in the printed circuit connection, a common fault. This can be done by waggling the coaxial plug in the socket while the set is on, noting if signal strength rises when the plug is pushed not too hard to one side. If it does, on lowering the chassis you will be able to run some solder over the printed circuit linkage from the centre contact to the aerial isolating capacitor. We take it that the aerial is correctly polarised, of suitable type and properly installed and sited. We do not advise touching any of the slugs on the i.f. panel. (Pye 11U series.)

ALBA T1195

The trouble with this set is insufficient width—in about two inches on each side. The width also fluctuates from time to time. On increasing the brightness control setting the picture balloons, gets duller and finally disappears. The sound is all right.—R. Oakley (Dudley).

The fault conditions are due to inadequate line output and the most likely cause of this is change of value of the two 8·2MΩ resistors in the width circuit—above the preset width controls on the right-hand side (bottom). Replace with large resistors (say 2W rating) of the same value. The PL500/PL504 line output valve may be of low emission but even if this is the prime cause of the condition the resistors are worth changing in the interests of long term reliability. (Philips Style 70 series chassis.)

BUSH T115C

There is sound but no vision. If the brightness control is turned to zero and then rapidly to maximum a brief raster is visible. The heater line seems to be running high as a check on the c.r.t. heater voltage reads 6·9V. The thermistor in the mains input circuit was arcing so I have replaced this with a TH1A but it runs hot. What is the correct thermistor to use and the likely cause of the no vision?—F. Trinder (Eastcote).

The correct type of thermistor to use is the CZ4. If you want to carry on using the TH1A this should be connected in the heater circuit and a separate surge limiter resistor (e.g. RS 66Ω 0·3A section) inserted in the h.t. supply. The loss of vision is due to lack of e.h.t. This could be due to a low-emission PL36 line output valve but there is a strong possibility that the EY86 e.h.t. rectifier base (in the holder) is corroded and requires rewiring.

PYE 20

There is trapezoidal distortion of the raster at the lower left-hand side and I would appreciate instructions on the correct procedure for adjusting the raster correction magnets. The set is fitted with the Pye 169 chassis: is there an easy way to move the chassis panel while the set is working so that these magnets can be reached?—R. Morefield (Llanelli).

There is no specific procedure for adjusting c.r.t. pincushion distortion correction magnets: simply move them to obtain optimum raster shape. You will find that the chassis hinges down sufficiently to enable this to be done.

KB FEATHERLIGHT

There is lack of width on 625 lines, slight cramping to the left of the picture, and the brightness control has to be turned up fully. Full width is obtained on 405 lines. The h.t. and boost line voltages are correct. The line output stage valves have been replaced and the 625-line width control and the resistors between the control grid of the PL81 line output valve and the sliders of the width controls checked and found to be OK. When the line drive is measured the picture fills the screen and the brightness increases, curing the fault! The line drive at the PL81 control grid measures −70V instead of —60V.—T. Williams (Farnborough).

The first suspect must be R161 (680kΩ) which is in series with the 625-line width control. If this has gone high resistance the negative bias produced by the line drive at the PL81 control grid will not be sufficiently offset. Connecting your meter to the PL81 control grid reduces the negative potential there just as increasing the potential tapped from the width control would. Also check R160 (120kΩ) which is in series with both width controls. The slight cramping on the left-hand edge of the screen will probably be cured by readjusting the linearity sleeve under the scan coils. We take it that the resistors between the PL81 control grid and the sliders of the width controls have been carefully checked—they often increase in value after some years' service. (STC/ITT/KB VC11 chassis.)

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TELEVISION MARCH 1974

TEST CASE

135

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

? *A KB Model CK500 fitted with the ITT CVC5 colour chassis was reported as suffering from "yellow tinting". Initial investigation by the field service technician revealed that while the grey-scale tracking appeared to be without fault the red, green and blue drive presets (the chassis uses RGB tube drive) could not be set to eliminate the tinting. Consequently the chassis was brought into the workshop for detailed investigation.*

Three transistors are used in each (RGB) channel in this chassis, the first serving as a matrix stage to obtain a primary-colour signal from the appropriate colour-difference signal applied to its input "electrode" and the luminance signal which is injected into its collector circuit. The resulting primary-colour signal is then capacitively coupled to the final two transistors which are directly coupled to the appropriate tube cathode.

The tube drive from each output transistor's collector is passed through a 5kΩ drive preset control, and it was discovered that by fully advancing the blue drive preset the yellow tinting was reduced but not eliminated. The blue drive circuit was examined and appeared to be in order. The associated transistor voltages were also correct and the BA145 clamp diode connected to the collector of the blue output transistor was without fault.

What was the cause of this symptom, and where in the circuit would the defective component most likely be? See next month's Television *for the solution and for a further item in the Test Case series.*

SOLUTION TO TEST CASE 134

Page 185 (last month)

The causes of sound distortion are sometimes tricky to track down. Misalignment of the 6MHz intercarrier sound channel or of the f.m. detector, failure of a diode in the f.m. detector circuit (though this and misalignment of the intercarrier sound channel are commonly accompanied by the "rough" interchannel sound buzz) and trouble in the audio stages themselves are common causes. A fault in the audio circuits is almost certainly the cause of the trouble when the distortion is present on both v.h.f. and u.h.f. in a dual-standard receiver.

The clue to the cause of the fault in the GEC/Sobell 2020/1020 series receiver was the overheating PCL84. Although the replacement valve tried gave the impression that something was amiss with the original one this notion should have been discounted owing to the abnormal rise in the replacement's temperature and the increasing distortion.

Clearly a circuit fault was under biasing the valve—and fitting a replacement under this condition is not a good thing! Had the technician checked the cathode-to-chassis voltage of the PCL84 he would have found it to be below normal—it was just below 2V in fact instead of 3·4V. Subsequent tests of the 150Ω cathode bias resistor and its 25μF decoupling electrolytic revealed a mild leak in the capacitor. When this was replaced the valve's cathode voltage returned to normal and the sound was free of distortion—even with the original PCL84, which was lucky!

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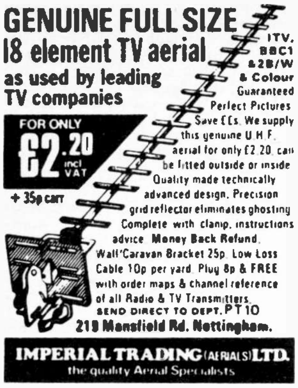

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EH90	46p	PCL84	49p	U191	80p		
EY51	60p	PCL85 } PCL805 }	53p	U193	40p	30P12	84p
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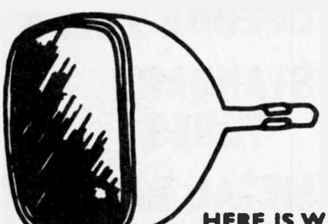

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TV93	TV165
TV94	TV166
TV95 or C	TV171
TV96 or C	TV175
TV97	TV176
TV98C	TV178
TV99 or C	181S
TV100C	183
TV101C	183D
TV102C	183S
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TV123	
TV124	

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.

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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	

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DR23	DM36	DR100	666TV-SRG
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DR30	DM45	DR122	MS1700
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SC24	ST285 or ds	1012	1038
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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

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PHILIPS

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23TG121a	G19T212	G23T212
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23TG131a	G19T214	G24T232
23TG142a	G19T215	G24T236
23TG152a	G20T230	G24T238
23TG153a	G20T232	G24T300
23TG156a	G20T236	G24T301
23TG164a	G20T238	G24T302
23TG170a	G20T300	G24T306
23TG171a	G20T301	G24T307
23TG173a	G20T302	G24T308
23TG175a	G20T306	
23TG176a	G20T307	
23FG632	G20T308	

GEC

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11u Series
12u.
13u
14u
15u
20u

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