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ECC84	0·35	EL84	0·31	KT81	2·00	PENA4	1·00	TP2620	1·00	U191	0·50
ECC85	0·40	EL85	0·44	KTW61	1·50	PEN/DD/		UABC80		U193	0·40
ECC86	0·85	EL86	0·38	KTW62	1·50	4020	2·00		0·40	U251	0·80
ECC88	0·44	EL360	1·20	KTW63	1·00	PFL200	·70	UAF42	0·60	U281	0·90
ECC189	·65	EL506	0·90	M8162	1·00	PL33	0·50	UBC41	0·60	U282	0·55
ECC804	·60	EM80	0·45	MHL4	0·75	PL36	0·60	UBC81	0·45	U301	0·65
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OB2	0·40	6AM8A	0·55	6F14	0·75	7A7	1·00	14H7	0·55	35L6GT	·75	AZ41	0·25
OZ4	0·47	6AN8	0·70	6F15	0·65	7B6	0·75	14S7	0·80	35W4	0·50	BL63	2·00
1A3	0·45	6AQ5	0·45	6F18	0·55	7B7	0·70	19AQ5	0·50	35Z3	0·75	CL33	1·60
1A5GT	0·50	6AR5	0·60	6F23	0·70	7C7	1·00	19G6	6·00	35Z4GT	·70	CV6	0·53
1A7GT	0·65	6AR6	1·00	6F24	0·85	7F8	1·50	19H1	2·00	35Z5GT	·75	CV63	0·75
1B3GT	0·50	6AT6	0·45	6F25	1·00	7H7	0·75	20D1	0·60	42	0·50	CY1C	1·00
1D5	0·60	6AU6	0·30	6F28	0·67	7R7	0·80	20D4	2·00	50B5	0·85	CY31	0·50
1D6	0·80	6AV6	0·45	6F32	0·50	7V7	1·50	20F2	0·75	50C5	0·60	D63	0·25
1G6	1·00	6AW8A	0·95	6G6G	0·50	7Y4	0·75	20L1	1·10	50CD6G		DAF96	0·50
1H5GT	0·60	6AX4	0·75	6GH8A	0·75	7Z4	0·80	20P1	0·55		1·25	DC90	0·60
1L4	0·28	6B8G	0·30	6GK5	0·65	9BW6	0·75	20P3	0·80	50EH5	0·75	DD4	1·00
1LD5	0·60	6BA6	0·35	6GU7	0·75	9D7	0·65	20P4	1·00	50L6GT	·65	DF91	0·30
1LN5	0·60	6BC8	0·60	6H6GT	0·25	10C2	0 65	20P5	1·30	72	0·60	DF96	0·50
1N5GT	0·65	6BE6	0·35	6J5GT	0·45	10DE7	0·75	25A6G	0·60	77	0·53	DH63	0·50
1R5	0·45	6BG6G	1·05	6J6	0·30	10F1	0·75	25L6GT	·60	85A2	0·60	DH77	0·45
1S4	0·33	6BH6	0·60	6J7G	0·30	10F9	0·65	25Y5	0·80	85A3	0·60	DH81	0·75
1S5	0·30	6BJ6	0·55	6J7(M)	0·45	10F18	0·55	25Y5G	0·70	90AG	2·50	DK40	0·70
1U4	0·60	6BK7A	0·60	6JU8A	0·75	10LD11	·70	25Z5	0·80	90CG	2·40	DK92	0·70
1U5	0·75	6BQ5	0·31	6K7G	0·30	10P13	0·75	25Z6GT	·70	90CV	2·40	DK96	0·60
2D21	0·45	6BQ7A	0·55	6K8G	0·45	10P14	2·00	28D7	1·00	90C1	0·75	DL96	0·55
2X2	0·60	6BR7	1·00	6L1	2·00	12A6	1·00	30A5	0·65	150B2	0·75	DM70	0·60
2GK5	0·55	6BR8	1·50	6L6GT	0·58	12AC6	0·70	30C1	0·40	807	1·00	DM71	1·50

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3B7	0·45	6BW6	0·80	6L18	0·55	12AE6	0·65	30C17	0·80	5763	1·50		1·00
3D6	0·40	6BW7	0·70	6L19	2·00	12AT6	0·40	30C18	0·70	6057	1·00	DY87/6	0·35
3Q4	0·60	6BZ6	0·49	6LD20	0·75	12AT7	0·34	30F5	0·75	6060	1·00	DY802	0·35
3Q5GT	0·55	6C4	0·40	6N7GT	0·60	12AU6	0·45	30FL1	0·67	6067	1·00	E80CC	2·20
3S4	0·40	6C5G	0·50	6Q7G	0·50	12AU7	0·33	30FL2	0·67	7193	0·53	E80F	1·40
3V4	0·70	6C6	0·40	6Q7(M)	0·55	12AV6	0·50	30FL12	0·90	7475	1·00	E83F	1·30
4CB6	0·55	6C9	1·00	6Q7GT	0·50	12AX7	0·33	30FL13	·55	9002	0·50	E88CC	0·75
5CG8	0·55	6C17	2·00	6R7	0·75	12BA6	0·45	30FL14	·70	9006	0·30	E92CC	0·60
5R4GY	0·80	6CB6A	0·40	6R7G	0·60	12BE6	0·50	30L1	0·30	A1834	1·00	E180CC	·70
5T4	0·40	6CD6G	1·25	6SA7	0·44	12BH7	0·50	30L15	0·70	A2134	1·00	E180F	1·00
5U4G	0·40	6CG8A	0·75	6SC7GT	·33	12E1	3·00	30L17	0·65	A3042	1·00	E182CC	1·25
5V4G	0·50	6CL6	0·65	6SG7	0·44	12J5GT	·33	30P4MR		AC2/PEN		E1148	0·53
5Y3GT	0·45	6CL8A	0·80	6SH7	0·44	12J7GT	·60		1·00		1·00	EA50	0·27
5Z3	0·75	6CM7	0·75	6SJ7	0·55	12K5	1·00	30P12	0·65	AC6/PEN	60	EA76	1·00
5Z4G	0·45	6CU5	0·75	6SK7GT	·44	12K7GT	·50	30P19/		AC2/PEN/		EABC80	·38
5Z4GT	0·45	6CW4	1·00	6SQ7GT	·45	12Q7GT	·45	30P4	0·75	DD	1·00	EAC91	0·75
6/30L2	0·60	6D3	0·60	6U4GT	0·70	12SA7GT	·55	30PL1	0·85	AC/PEN(7)		EAF42	0·75
6A8G	1·25	6DE7	0·75	6U7G	0·45	12SC7	0·50	30PL12	·38		1·00		
6AC7	0·49	6DT6A	0·75	6V6G	0·17	12SG7	0·40	30PL13	·95	AC/TH1	1·00		
6AG5	0·27	6EW6	0·75	6V6GT	0·45	12SH7	0·35	30PL14	1·10	AL60	1·00		
6AH6	0·60	6E5	1·00	6X4	0·40	12SJ7	0·44	30PL15	0·80	ARP3	0·60		
6AJ5	0·65	6F1	0·75	6X5GT	0·45	12SN7	0·80	35A3	0·65	ATP4	0·50		
6AK5	0·40	6F6G	0·50	6Y6G	0·80	12SQ7GT	·65	35C5	0·75	AZ1	0·25		
6AK6	0·60	6F13	0·70	6Y7G	1·00	12SR7	0·75	35D5	0·75	AZ31	0·60		

ECF80	0·45	EM83	0·55	N339	1·10	PL81A	0·45	UBF89	0·40	U404	0·55
ECF82	0·45	EM84	0·40	P61	0·50	PL82	0·37	UBL21	2·00	U801	0·65
ECF86	0·75	EM85	1·00	PABC80	·38	PL83	0·40	UC92	0·45	VP13C	0·60
ECF804	2·25	EM87	0·70	PC86	0·60	PL84	0·40	UCC84	0·75	VP23	0·75
ECH21	2·00	EMM803		PC88	0·60	PL504/500		UCC85	0·45	VP41	0·75
ECH35	1·25		2·00	PC95	0·60		0·70	UCF80	0·70	VR105	0·50
ECH42	0·70	EY51	0·40	PC97	0·35	PL505	1·45	UCH21	2·00	VT61A	0·65
ECH81	0·33	EY83	0·54	PC900	0·40	PL508	0·90	UCH42	0·75	VU111	0·80
ECH83	0·44	EY84	0·70	PCC84	0·30	PL509	1·45	UCH81	0·40	VU120	£1
ECH84	0·44	EY87	0·33	PCC85	0·44	PL820	1·00	UCL82	0·38	VU120A	£1
ECL80	0·40	EY88	0·40	PCC88	0·60	PM84	0·65	UCL83	0·55	VU133	0·80
ECL82	0·34	EY91	0·58	PCC89	0·45	PY33/2	·45	UF41	0·70	W107	1·00
ECL83	0·70	EZ40	0·50	PCC189	0·48	PY80	0·40	UF42	0·75	W729	1·00
ECL84	0·60	EZ41	0·55	PCC805	0·70	PY81	0·35	UF80	0·35	X41	1·00
ECL85	0·60	EZ80	0·28	PCC806	0·65	PY82	0·30	UF85	0·44	X66	1·25
ECL86	0·40	EZ81	0·29	PCF80	0·40	PY83	0·38	UF89	0·40	X101	2·00
EF22	1·50	FC4	1·00	PCF82	0·40	PY88	0·40	UL41	0·60	XH/1·5	·48
EF40	0·75	FW4/500	£1	PCF84	0·59	PY301	0·50	UL84	0·42	Z759	5·00

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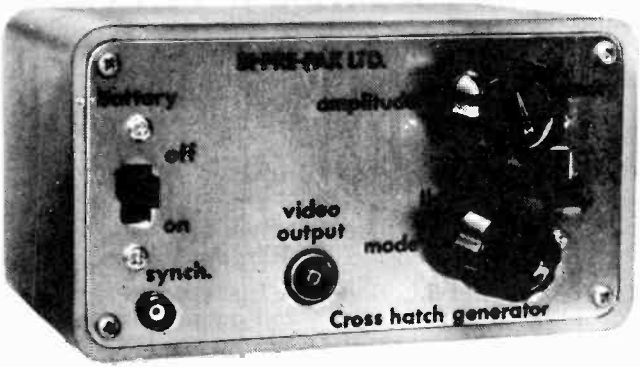

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TELEVISION

SERVICING·CONSTRUCTION·COLOUR·DEVELOPMENTS

VOL 25 No 7
ISSUE 295

MAY 1975

A MAJOR STEP FORWARD

We have become so accustomed in the west to television being a part of our daily lives that it may come as a surprise to some that the next major step forward in the world of television reception is about to occur in India, where regular transmissions direct from satellite are shortly to start.

The satellite involved is the US NASA's ATS-F, which for the last few months has been carrying out experimental transmissions to remote schools in the Rocky Mountains and Appalachians. In July it is to be moved eastwards and parked over equatorial Africa at an altitude of 36,000km. From this height its service area will be enormous, covering almost the entire Indian subcontinent. Programmes will be transmitted up to the satellite from TV centres at Ahmedabad, Bombay and Delhi at 5,950MHz, and retransmitted to earth at 860MHz—with f.m. video modulation.

This development must certainly go down in the records as a major step in the history of television. Satellites have been in use for some time to provide network links, notably in Canada and the USSR, but this is the first attempt to provide a regular service to viewers from a satellite TV transmitter. The experiment is due to last for a year initially, with sets installed in some 2,400 villages. Transmissions will be for four hours a day, in six languages, and will consist of schools programmes, cultural entertainment, and programmes on agriculture, health and family planning.

Why India, you may ask? After all TV started in the developed west—with the first regular transmissions from Alexandra Palace in 1936. Colour and other advances have all made their first appearances in the developed countries. The problem in extending the benefits of TV to the vast numbers of people in land masses such as India and China however is the enormous costs that a system of terrestial transmitters would involve. The answer is transmission via satellite, with a single satellite covering a vast service area.

The developed countries have adopted a system of local programmes and networks not ideally suited to satellite transmissions. There seems little doubt however that satellites will eventually be used, transmitting at s.h.f., to provide additional services everywhere—the service area of a satellite transmitter can after all be narrowed by adjusting its position relative to the area to be served and thus its angle of transmission.

Meanwhile it will be interesting to see how the Indian experiment develops.

L. E. HOWES—*Editor.*

THIS MONTH

THE NEXT ISSUE DATED JUNE WILL BE PUBLISHED ON MAY 19

TELETOPICS

RESULTS FOR 1974

The figures that enable us to get a clear picture of what happened to the UK domestic TV industry in the year 1974 are now out. In comparison to 1973 there was a fall in total colour TV set deliveries of 20%—to 2,209,000. Not a bad figure really: if it hadn't been for the extraordinarily successful trading in 1973 the year would have been considered a good one indeed. Unfortunately however the decline increased towards the end of the year and it is still not easy to see whether the market has stabilised yet. Monochrome set deliveries were substantially down, by 42%, at just 821,000: this however is a corollary of the substantial number of colour sets moved. Imports bore the brunt of the decline—total (colour and monochrome) deliveries of imported sets being down 27% compared to 15% in the case of UK produced sets. In money terms colour receiver imports fell from £103 millions in 1973 to £64 millions in 1974. Exports of colour sets on the other hand rose 227·8% to £16·25 million—not a great amount, but at least things are moving in the right direction.

The Japanese TV industry in 1974 recorded the first ever decrease in colour receiver sales in its home market—down from 6·5 million sets in 1973 to 5·1 million in 1974, a drop of 28%. Exports however increased by 9·3% to 2·29 million. Total production fell by 14·5% to 7·7 million, with stocks increasing substantially.

Meanwhile on the question of reliability Raster, who who writes the "Renter's World" column in *Electrical and Electronic Trader*, has some interesting things to say in summarising his organisation's experiences with colour sets installed during 1974. The reliability of new sets seems to have improved quite noticeably in comparison to 1973's sets. The average call rate (number of calls per year per set out on rental) improved from 1·58 to 0·69, the percentage of sets requiring no calls at all rising from 28% to 52%. This overall improvement applied to both UK produced and imported sets. Once again Japanese colour sets were found to be the most reliable: the annual call rate for the various Japanese makes in the sample was within the range 0·10–0·34, while for UK produced sets the range was 0·78–1·47. Sony's already excellent call rate of 0·41 in 1973 improved to 0·10, which as Raster says is probably about the lowest anyone could reasonably expect. The best rate amongst the UK manufacturers in the sample was Pye, at 0·78: in fact their 713 chassis (the 18in. Model CT200) did even better, with a rate of 0·5. The reliability of sets imported from Europe was much the same as that of UK produced sets. It must be remembered of course that these figures are based on the necessarily limited experience of one organisation. Thorn's 8500 chassis was found to have a "significantly lower call rate" than the 3500 chassis. Substantially more calls were required in the case of models with remote control—compared with equivalent chassis without remote control—generally as a result of defects in the remote control transmitter unit.

It is good to be able to record this general improvement in reliability and interesting to note that it took place during a period when the pressure was off the industry. The Japanese still seem to be ahead in achieving good reliability but it does appear that UK manufacturers are finding ways of getting rid of the bugs. This coincides with the increased use of i.c.s in the latest chassis, a fact that augurs well for the future.

CIRCULAR POLARISATION

Preliminary reports have now been published on the results of tests carried out by RCA in conjunction with WLS-TV Chicago on the advantages of using circular polarisation for TV transmissions. The benefits claimed are substantial reduction in ghosting and co-channel interference without increase in fringe-area interference. Improved discrimination against ghosts results from the fact that while the sense of rotation of the transmitted signal and of the receiving aerial must be identical to give maximum signal pick-up the sense of rotation of a reflected signal is reversed: thus a properly designed receiving aerial for circular polarisation will tend to reject reflected signals. Circularly polarised transmissions apparently give good reception on either vertically or horizontally mounted aerials and generally simplify reception problems.

TED VIDEODISCS LAUNCHED ON GERMAN MARKET

The TED videodisc system has now been launched on the German consumer market: it is the first time that a videodisc system has been introduced on the domestic consumer market anywhere. The system was developed by Telefunken and Decca and a jointly owned subsidiary Teldec. The retail price of the TED videodisc player is under £300—less than half the price of a videotape recorder. The TED discs have a playing time of ten minutes each and are priced from around £2. Some 50 titles are initially available and it is planned to increase this to over 350 by the end of the year. Because the player is a highly complex piece of technology it is being released through specialist retailers of consumer electronics products. User operation is simple however: the disc is inserted in the player, which extracts it from its inner sleeve, plays it and returns it to the sleeve automatically. As a result the disc is protected from manual handling and dust. Any particular scene in a programme can be located within seconds and played as a "still". The TED pickup stylus is automatically cleaned after each disc playing. The output from the player can be fed into the aerial socket of any standard television set: if the set is not equipped to operate with a video system, i.e. provided with an audio-visual push-button switch, the only modification required is a minor one to the line sync circuit.

The system was first announced in this column as long ago as September 1970. The mechanical aspects were described in detail in our December 1971 issue whilst more recently, see this column October 1974, details of the signal processing techniques were given. It has taken a long time to appear on the market, but a great deal of development work has been necessary. Both colour and monochrome signals can be handled, and the demonstrations (in colour) at the last two Berlin radio shows have been impressive. The pickup and tracking system are mechanical, the signal being recorded as frequency modulation in the form of undulations in the groove. The density of the groove is 280 tracks per millimeter, the disc rotating at 1,500 r.p.m. The disc is made from 0·1mm. thick flexible plastic sheet. It rests on an air cushion, the pickup responding to the pressure variations produced by the groove modulation.

There are no definite plans so far for the introduction of the TED system on the UK market.

The latest news about the rival Philips VLP videodisc system is that it is intended to start marketing this next year and to introduce it on the UK consumer market around 1980. The system can provide colour video plus up to eight sound tracks. It is again an f.m. system, but in this case a rigid reflecting disc is scanned by light from a laser, the return beam, carrying the recorded modulation, being detected by a phototransistor. Since there is no physical contact between the disc and the scanning system some novel control arrangements are required. The Philips VLP system was covered in some detail in our June 1974 issue. Philips hint that their system could replace the conventional audio LP disc: after all if you can add video at little extra cost the increase in information value provided would be overwhelmingly worth while.

NEW SEASON'S TV SETS

The new season's TV sets are beginning to be announced by the setmakers. **Pye** have introduced a 26in. set, Model CT216, fitted with the new Mullard 26in. 110° quick-heat colour c.r.t. mentioned in this column last month. The c.r.t., type A66-410X, produces a picture within 3–5 seconds after switch on: Pye refer to this as "Superspeed Colour". The recommended price of the new set is £379 including VAT. It is fitted with the 731 chassis and an AV switch at the back enables it to be used in conjunction with a videocassette recorder.

Three new sets have been announced by **Decca**, an 18in. model (CR301) and two 26in. models (CZ306 and CZ307). The CZ306 features touch tuning and slider controls. It is understood that Decca are to cease production of monochrome sets.

An 18in. 110° model (CT180) has been added to the **Mitsubishi** range. This is the first in their range to feature standard PAL-D decoding. The audio output is 1·5W and as a result of using a double-wound mains transformer two audio jack sockets are available at the front, for headphones or feeding a tape recorder. The c.r.t. heater current can be maintained when the set is switched off, giving "instant on" pictures (this is not the same as fitting a quick-heat c.r.t.)—complete switch off is also provided. The recommended price is £250 plus VAT.

From **Rank** comes a range of models featuring remote control as standard. The single-button ultrasonic remote control unit gives sequential channel changing and sound muting. On the sets themselves there is six channel touch tuning. The remote control unit button operates a spring-loaded switch: depressing this for three seconds mutes the sound which can be brought back by a short press on the switch. The models in this range are as follows: **Bush** BC6111 with 18in. 110° tube at £269 including VAT, BC6318 with 22in. 90° tube at £329 including VAT and BC6418 with 26in. 90° tube at £365 including VAT; **Murphy** MC6309 with 22in. 110° tube at £358 including VAT and MC6409 with 26in. 110° tube at £399 including VAT. There is also the 18in. 110° Murphy Model MC6103 without remote control at £255 including VAT and a new 9in. monochrome portable. Rank have announced that except for a 12in. portable which is to continue in production at Plymouth all their monochrome sets are to be made abroad: the large screen monochrome sets will be made by Bush Ireland while the small screen sets will be purchased from the Far East.

TRANSMITTER OPENINGS

The following relay transmitters are now in operation:

Ashbourne (Derbyshire) BBC-1 (Midland) channel 22, ITV (ATV) channel 25, BBC-2 channel 28. Receiving aerial group A.

Croeserw (Glamorgan) BBC-Wales channel 58, ITV (HTV Wales) channel 61, BBC-2 channel 64. Receiving aerial group C/D.

Leek (Staffordshire) BBC-1 (Midland) channel 22, ITV (ATV) channel 25, BBC-2 channel 28. Receiving aerial group A.

Llanelli, Dyfed (SW Wales) ITV (HTV Wales) channel 49. Receiving aerial group E.

Tideswell Moor (Peak Park area) BBC-1 (North) channel 56, BBC-2 channel 63. Receiving aerial group C/D.

Walsden (W Yorkshire) BBC-1 channel 57, ITV (Granada) channel 60, BBC-2 channel 63. Receiving aerial group C/D.

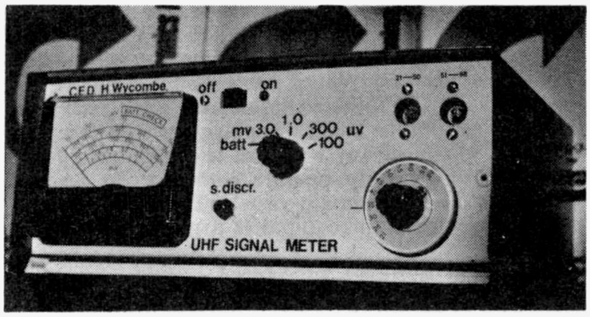
All these relay transmissions are vertically polarised.

INFRA-RED OPTOELECTRONIC LINK

The use of an infra-red optoelectronic link between a television receiver and headphones has been suggested by Siemens. The transmitter would consist of a maximum of eight type LD241 luminescent diodes capable of supplying a total of 120mW, adequate for a large room or small hall. Impedance matching is less complicated using an array of small diodes rather than a single component. The headphones would use a BPW34 photodiode to pick up the f.m. signals. Siemens say that the use of infra-red light is particularly suitable for "flooding" a room since neither dark nor rough areas absorb the radiation or distort the signal. As a result the headphones do not have to be trained in any particular direction.

EQUIPMENT REVIEW: CED SIGNAL STRENGTH METER

I. C. Beckett



THE recently introduced CED signal strength meter is designed for the measurement of u.h.f. signals. It is housed in a strong metal case finished in grey and white, measuring $8\frac{1}{2} \times 3\frac{1}{4} \times 7\frac{1}{4}$in. and weighing $5\frac{1}{4}$lb including batteries. The carrying handle and neck strap are of imitation leather. The instrument is battery operated, being powered by two PP7 batteries which can be easily replaced after removing a plate held by two screws on the side of the case.

On the left of the control panel is the level meter which is calibrated from 25μV to 3mV. The scale corresponds with the five-position range switch, covering 0–100μV, 100μV–300μV, 300μV–1mV and 1mV–3mV. Signals in excess of 3mV require an external attenuator. The fifth range switch position provides a check on the condition of the batteries.

A slide on-off switch and sound discriminator (carrier identification) button are situated to the left of centre while the tuner, covering channels 21–68, and two coaxial input sockets are on the right of the panel. The two input sockets cover channels 21–50 and 51–68.

In addition to the tuner unit the instrument employs four transistors and associated components mounted on two matrix boards. A circuit diagram is not provided however since in the event of repairs being necessary it is recommended that the instrument is returned to the makers for attention.

We put the instrument under stringent tests in the field, in a location where signals in all three groups could be received—channels 23, 26 and 33 (group A) from Crystal Palace, London; channels 24, 27 and 31 (group A again) from Sandy Heath, Anglia; channels 39, 42 and 45 (group B) from Hannington, Southern; and channels 57, 60 and 63 (group C/D) from Beckley, Oxford.

The sound discriminator button was found to be of great help when measuring strong adjacent channels, in this case London channel 23 and Anglia channel 24.

The $3 \times 2\frac{1}{2}$in. level meter has a clear, readable scale which is calibrated in red. The control functions are also clearly marked.

The overall accuracy of the meter was good but, because of slight inherent noise, signals had to be above 30μV before they could be measured.

Larger control knobs would we feel be an advantage for easier operation—especially under cold, wintry conditions on the roof.

To ensure accurate measurements it is as well to switch off adjacent television sets.

In conclusion we feel that with the number of monochrome and colour receiver faults that are due to aerial misalignment the instrument is an indispensible piece of equipment both for the aerial rigger and the field service engineer.

The CED signal strength meter is available from Willow Vale Electronics, 4/5 The Broadway, Hanwell, London, W7 at a trade price of £45, excluding batteries and VAT.

BOOK REVIEW

Videotape Recording, Theory and Practice, by Joseph F. Robinson. Published by Focal Press. Price £4.50. 303 pages.

For those who want a comprehensive work on videotape recording this book is thoroughly recommended. Broadcast quadruplex, helical scan and cassette arrangements are all covered and the requirements of both monochrome and colour signal recording and playback dealt with. One of the most admirable features of the book is that whilst the techniques are gone into in considerable depth the book is nevertheless exceedingly readable. It is suitable therefore for those coming to the subject afresh and for those who require an engineering reference book on the subject. In fact you can read the book through skipping the mathematical bits to get a clear impression of the basic principles and then if necessary go back over the ground in order to investigate particular aspects in greater detail.

Another fact that stands out is that the author is equally at home with the electronic and mechanical aspects of the subject—and manages to make them both equally interesting. Practical points such as the care of tape and deck mechanisms, cleaning and so on are also explained.

The book takes into account as necessary the US 525/60 standard and NTSC colour as well as European and EIAJ standards. It is suitable for readers in almost any part of the globe therefore.

The more detailed mathematical treatments appear in an extensive appendix, which helps to keep the main text clear and practical. A glossary is another helpful feature of this carefully thought out book.

The author has been training manager for Ampex GB Limited and a lecturer at Plymouth Polytechnic. The book demonstrates quite clearly that he is familiar indeed with the needs of the newcomer to the subject.

There is a bibliography at the end of each chapter for those wishing to delve further, but our impression is that almost everything you might need to know is to be found in the book itself. The chapters are as follows: tape recording principles; basic requirements of videotape recording; the broadcast quadruplex format; CCTV formats; f.m. theory; signal systems; servo mechanisms; geometrical errors; timebase error correction; colour correction in CCTV; cassettes and cartridges; editing; magnetic video discs and slow motion techniques. The book is liberally illustrated and the only criticism we have is that the circuits are obviously drawn by someone unfamiliar with electronic circuitry. This is a very minor irritation however.

J.A.R.

BAND I mosfet PREAMPLIFIER

HUGH COCKS

The writer lives in an area covered by extremely high signal strengths on Band III and u.h.f. This effectively prohibits the use of bipolar transistor amplifiers on virtually all the TV bands. Although such amplifiers can just be used at this location on Band I with filters to absorb the Band III and u.h.f. signals, cross- modulation results are not as good as could be expected if a f.e.t. preamplifier was used instead.

Whilst the design in the January, 1974 edition of TELEVISION was very good, high-definition and colour reception proved difficult due to the narrow bandwidth of the amplifier. The writer decided to build an f.e.t. circuit using trimmers instead of varicap diodes to tune the coils. Thus the bandwidth of the preamplifier can be easily altered by stagger-tuning the trimmers for colour and high-definition work, or setting both to the same frequency for meteor shower, tropospheric or low-level SpE reception.

Although at first sight it may seem rather cumbersome using two trimmers for tuning, with practice it proves quite easy to "whip round" from channel E2 to E4. The tuning peak is very sharp when both trimmers are set exactly on the same frequency. This helps a great deal with interference between channels E2 and R1 during high-level SpE openings. In the USA, TV DXers have been using the two tuning capacitor type of f.e.t. preamplifier for some time, due to the rather cramped situation on the v.h.f. bands there.

The unit provides approximately 19–20dB of gain over a 4·5MHz bandwidth and 23–26dB over a 1·5–2MHz bandwidth in the 45–65MHz range. These are only rough estimates and were judged by comparing signal levels from Roger Bunney's excellent four-stage bipolar Band I preamplifier design in the October, 1972 edition of TELEVISION. The preamplifier does not produce any cross-modulated u.h.f./Band III signals from the local TV station.

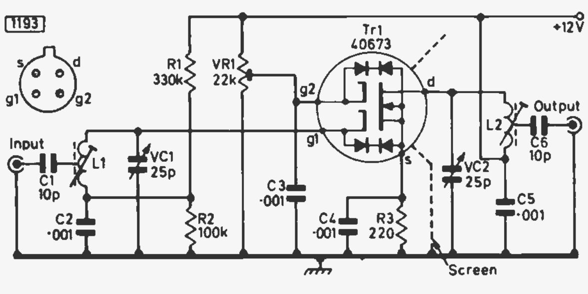


Fig. 1: Circuit of the preamplifier. The back-to-back diodes protect the f.e.t. against static charge build-up.

M.o.s.f.e.t.

The m.o.s.f.e.t. device chosen after some consideration is the dual-gate RCA 40673, which is available for about 60p from several mail order firms. The dual-gate m.o.s.f.e.t. has very low feedback capacitance, which does away with the need for neutralisation to achieve maximum gain.

This particular m.o.s.f.e.t. incorporates back to back gate-protection diodes which short-circuit static that may accumulate on the gates through handling, yet have little effect on the overall gain of the transistor. This makes installation of the 40673 a great deal easier than the unprotected type of m.o.s.f.e.t.

★ Components list

Resistors: (all ± 10%)
R1 330kΩ   R2 100kΩ   R3 220Ω
R4 2·2kΩ   (R1-3 ¼W, R4 ½W)
VR1 22kΩ min. carbon preset

Capacitors:
C1, C6 10pF silvered mica
C2-C5 1nF ceramic
C7 100μF 25V electrolytic
VC1, VC2 25pF Jackson C804

Semiconductors:
Tr1 RCA 40673
D1, D2 BY127 or any diode 50V p.i.v. or greater.

Miscellaneous:
L1, L2 8 turns (centre-tapped) 29 swg space-wound on a 6mm (¼in.) former with dust-iron core.
T1 12-0-12V min. transformer.
LP1 240V neon indicator.
S1 mains toggle switch. Coaxial sockets. Metal box, tinplate etc.

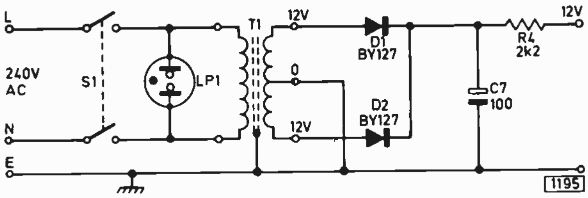


Fig. 2: Circuit diagram of a suitable power supply unit.

Circuit Description

The signal is coupled to gate 1 via C1 and the tuned circuit L1, VC1, the "cold" end of which is earthed through C2. Gate 1 is biased by the potential divider R1, R2 whilst gate 2 is decoupled by C3 and biased from the potentiometer VR1. This allows Vg2s (voltage at gate 2 relative to source) to be adjusted for optimum gain: usually about +4V is required. The drain is connected to the supply through L2. L2, VC2 form the output tuned circuit and C5 decouples the bottom end of the tuned circuit. The source is biased by R3 and decoupled by C4.

Power Supply

A battery power supply could have been used, but a mains supply (Fig. 2) will pay for itself very quickly in these days of high battery prices. No stabilisation of the 12V rail is necessary. The transistor can be run safely from a supply of up to 15–16V, but over 13V slight instability was noted on the prototype.

Construction

The basic layout used in the prototype is given in Fig. 3 for general guidance, though it is not particularly critical. The unit was built in an aluminium box, though any metal container would be suitable. The trimmers are mounted directly through the box lid, all the other components are mounted on a tinplate subchassis which is fixed in place by the nuts and bolts of the coaxial sockets. A large tinplate screen provides isolation between the "input" and "output" components, and the transistor is mounted in a hole in the screen, being held in place by the connections of its lead-out wires.

Allow enough room between the spindles of the trimmers and the coaxial sockets to mount two large knobs for easy tuning. Plenty of space is left in the base of the box for the power supply unit.

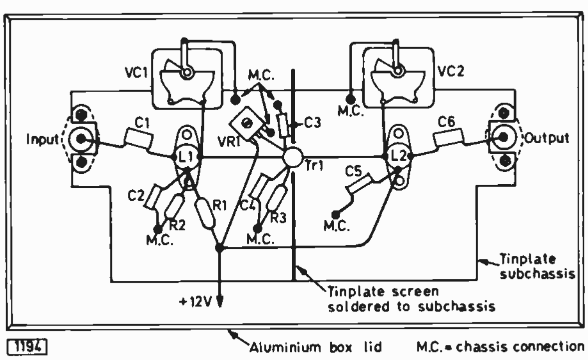


Fig. 3: Layout of the preamplifier. The leads connecting the rotors of the tuning capacitors to the chassis must be of stout tinned copper wire.

Setting Up

Once the unit has been built, set VR1 approximately midway and switch on. Adjust VR1 for a Vg2s of about +4V and check that the total current drawn by the preamplifier is no more than 10mA.

Alignment is extremely simple. With the aerial input unplugged, set VC1 and VC2 to maximum capacitance and adjust L1 and L2 for maximum noise on channel B1 video. Adjust the tuner to channel B5 and ensure that VC1 and VC2 give a good noise peak at almost minimum capacitance. Then, with a signal applied, adjust VR1 for the highest gain. The preamplifier can now be calibrated.

Using the Preamplifier

If a varicap tuner is being used in conjunction with the preamplifier, the gain control has to be reduced below the half-way point to avoid overloading on noise! When a moderate level SpE signal is tuned in, the gain control has to be reduced even further.

In use, it is easiest to peak VC2 first; this results in a noise peak though the signal still remains weak. On bringing VC1 up to the channel, the signal increases greatly, or if no signal is present a high noise peak will be seen. For colour DX, say on channel E2, set VC1 to the E2 vision carrier frequency and VC2 to the colour subcarrier frequency at approximately 52·7MHz. The same technique can be used for channels E3 and E4, and the R channels for the SECAM experts!

With the aerial removed no instability should be seen, but if the trimmers are set at opposite ends of the band and the aerial is unplugged the local transmitters on channels 23 and 26 have been seen. This is not cross modulation but a form of mixing—the 40673 works up to approximately 500MHz. It should be noted that as soon as the aerial is plugged in, this effect should disappear.

The preamplifier also works well on Band II. All that is necessary is to reduce the number of turns on L1 and L2 to six, still centre tapped, and set up in a similar manner.

Conclusion

The preamplifier has been tested successfully in Devon and also in the Dartford area where a very high level channel B1 signal is present. No "B1 spread" was apparent on channel E2, though in the past it has been a great problem at that location. That problem, together with a high level Band II signal, made bipolar transistor preamplifiers almost harder to use than at the writer's location in Devon.

I hope that this design will be of use to other enthusiasts with similar problems of local interference. Finally, my thanks to Charles Oliver for his help in testing and evaluating the performance of the preamplifier. ■

VIDEO CIRCUITS AND FAULTS

PART 4: RGB CIRCUITS

S. GEORGE

WITH the exception of a few imported sets most modern colour receivers employ RGB drive to the c.r.t. cathodes. This aids the design of a solid-state receiver since smaller peak-to-peak c.r.t. drive voltages are required.

In a receiver using colour-difference drive only the luminance channel has to have a bandwidth covering the full video spectrum. With RGB drive however all three video channels must have the full video bandwidth. In addition the phase response, electrical characteristics and thermal tracking of the three channels must be as near identical as possible—to preserve a neutral background over the operating temperature range for example the thermal tracking must be within two per cent.

The use of integrated circuits in the low-level stages helps to meet these requirements. Since the semiconductors and resistors in an i.c. are diffused at the same time their characteristics will be the same and the thermal tracking particularly good. Furthermore since the thermal time-constant of the average i.c. is just slightly more than ninety seconds the major part of the working temperature rise occurs well before the c.r.t. is operational. The temperature change is actually quite large: at switch on the silicon chip temperature will probably be about 15°C, rising to about 80°C after the initial warm-up period and then gradually but very slowly increasing to about 115°C during subsequent use as the cabinet temperature rises, the temperature of the plastic casing remaining at around 50°C.

Many RGB channels employ a.c. coupling at some point, in which case each channel will include a clamp to maintain the correct signal black level. Direct coupled RGB channels are also common however. The luminance channel in a set with RGB drive terminates at the RGB matrix: in all probability a.c. coupling will be used at some point in the luminance circuitry, in which case a clamp or d.c. restorer will be found following the a.c. coupling.

Representative Circuits

Our first example of RGB video circuitry is taken from the Hitachi 110° Model CEP280, see Fig. 1. This employs direct coupled RGB output stages and a five-stage luminance circuit with a.c. coupling between the third and fourth stages. The matrixing of the luminance and colour-difference signals is carried out in the RGB output stages.

The third luminance stage Tr10 consists of an emitter-follower which is a.c. coupled to the fourth luminance stage Tr11 by C51. There is no fixed forward bias to this stage, its base being linked instead to the l.t. rail via the clamp transistor Tr13, diode Cr11 and R61. The collector voltage of Tr13 is set by the brightness controls and the beam limiter circuit. Positive-going line-frequency pulses applied to the base of Tr13 drive it into saturation during the line flyback blanking period, C51 then charging to the potential on C56. Because of its high value (2·2μF) C51 holds this charge with negligible loss until the next clamp pulse arrives.

The output from the fourth luminance amplifier is thus a brightness level controlled signal. This is applied to the base of the fifth luminance amplifier, a pnp transistor which is in series with the emitter circuits of the RGB output transistors. The appropriate colour-difference signals are fed to the bases of the RGB output transistors which thus perform the matrixing process, developing the R, G and B signals across their 8·2k Ω load resistors. The gain of the R output stage is fixed, drive controls in the emitter circuits of the G and B output stages enabling the gain of these to be adjusted to compensate for the differing red, green and blue c.r.t. phosphor efficiencies, the different c.r.t. gun characteristics and the different gain characteristics of the three output transistors.

Since the luminance and colour-difference stages are powered from a stabilised l.t. rail while the output stages are fed from a stabilised 120V rail there is negligible drift and clamping in the output stages is unnecessary.

IC Matrixing

At first glance the video circuitry used in the Thorn 8000/8500 chassis (Fig. 2, earlier versions) appears similar to the Hitachi model just described. Matrixing of the luminance and colour-difference signals in these chassis is carried out in the MC1327PQ integrated circuit IC3 however, the bases of the output transistors thus being fed with R, G and B signals. The pnp transistor VT121 in series with the emitter circuits of the output transistors is used for brightness control purposes, its base being decoupled to chassis by the 1μF electrolytic C170. The brightness controls set the base bias applied to VT121 and in consequence its emitter voltage and in turn the mean collector voltages of the output transistors. The setting of the brightness controls also affects the level of the drive to the bases of the output transistors however since the d.c. restorer (W110) in the base circuit of the final luminance amplifier VT116 is returned to the emitter of VT121. The sync pulse tips drive W110 into conduction, C174 then charging to the potential at VT121 emitter. The comparatively long time-constant of VT116's base circuit ensures that this potential is held with negligible drift throughout the line period. Since d.c. coupling is maintained from VT116 collector through to the c.r.t. cathodes these actions set the picture brightness level and at the same time establish the correct black level. Note that if W110 goes open-circuit VT116's base voltage will rise, being determined d.c. wise by R187 only: its collector voltage will fall therefore and there will be loss of signals from IC3.

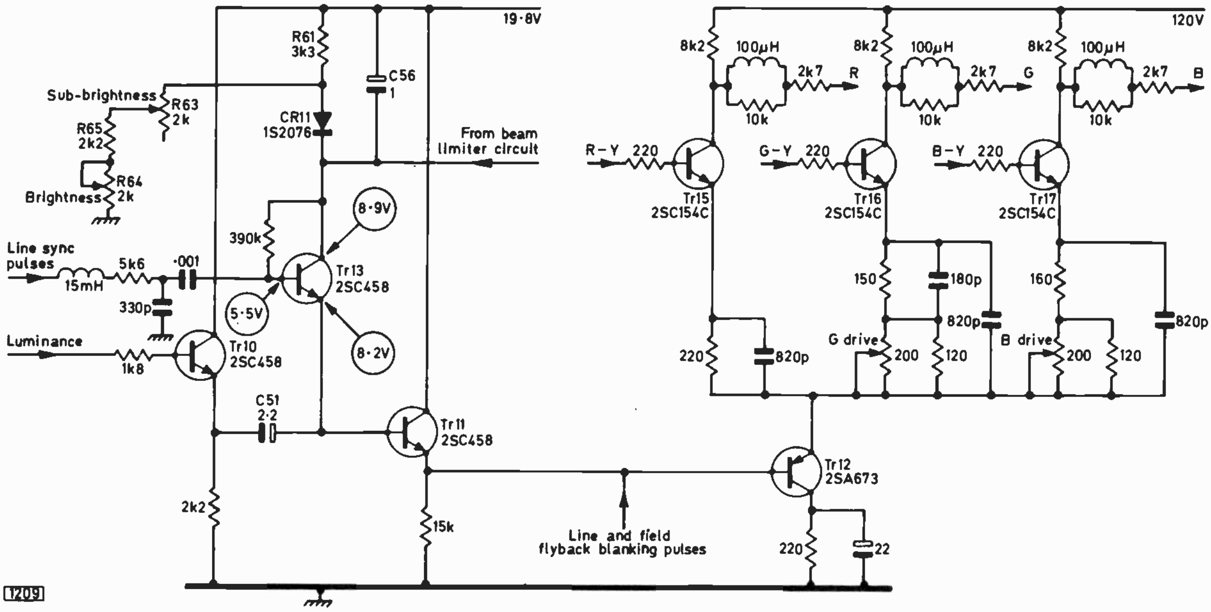


Fig. 1: The latter part of the luminance channel and the RGB output stages used in the 110° Hitachi Model CEP280. The bases of the output transistors are fed with the appropriate colour-difference signals, the luminance signal being applied to the common end of their emitter circuits via Tr12. Thus RGB matrixing is done in the output transistors.

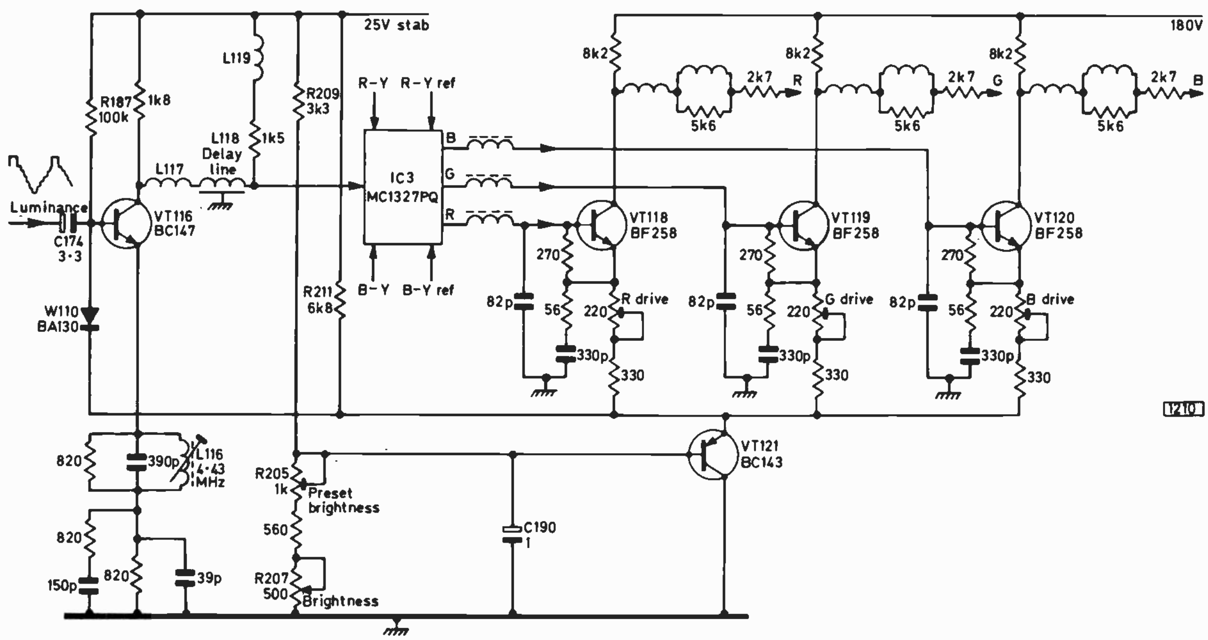


Fig. 2: The final luminance stage (VT116) and the RGB output stages used in the Thorn 8000 chassis. Matrixing to produce the RGB signals is carried out in IC3, these signals being fed to the bases of the appropriate output transistors. Thorn refer to the common emitter circuit transistor VT121 as the brightness voltage source.

The two circuits looked at so far have featured d.c. coupled RGB circuits, with matrixing in the output stages or in an integrated circuit prior to the output stages. With the increasing use of i.c.s the latter arrangement has become very common, the RGB signals from the i.c. driving either single or two transistor output circuits. Two-stage circuits consist of either a cascode arrangement or an emitter-follower plus output transistor, with d.c. coupling maintained from the i.c. through to the c.r.t. cathodes.

AC Coupling

In earlier, discrete component designs it was common to carry out luminance and colour-difference signal matrixing in preamplifier stages from which the RGB

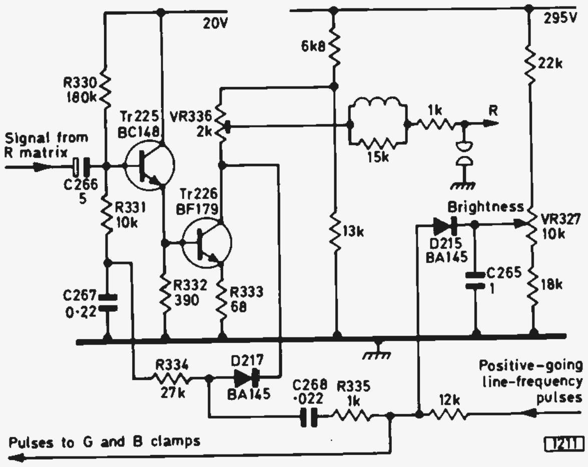


Fig. 3: This type of RGB channel (R one shown here) has been widely used. The primary-colour signal is a.c. coupled to the input, a feedback clamp setting the d.c. conditions in the circuit. The brightness control sets the level of clipping applied to the clamp pulse and thus the black level of the signal.

signals were a.c. coupled to a two-stage circuit consisting of an emitter-follower and output stage. This of course necessitates clamping and the usual system employed consisted of a feedback clamp. The example shown in Fig. 3 is taken from the Decca series 10 chassis.

The base of the emitter-follower TR225 is biased by a potential divider R330/R331 whose earthy end is returned to C267 instead of being taken direct to chassis. The junction of R331/C267 is taken via the feedback loop R334/D217 to the collector of the output transistor. D217 is reverse biased during the line period but is driven during the line flyback period by positive-going pulses which are applied to its anode via C268. If the drive pulses exceed the voltage at the collector of the output transistor the clamp diode will conduct and the coupling capacitor (C268) will acquire a negative charge which is passed via the feedback resistor R334 to the upper plate of C267. As a result TR225 will conduct less, its emitter voltage will fall, the output transistor will also conduct less and its collector voltage will rise. This process will continue until the clamp diode is no longer driven into conduction when the clamp pulse arrives, the d.c. conditions then being stabilised. The tips of the clamp pulses are clipped by D215, the brightness control setting the level at which the clipping occurs and thus the level at which the clamp action takes place and the basic level of the drive signals applied to the c.r.t. cathodes. Note that the decoupler C265 is an important component: if defective, the clamp action and thus the brightness level will be affected.

A slightly more complex brightness control arrangement is used in most chassis which employ this type of circuit. By adding to the signal at an earlier stage a pulse which coincides with the clamp pulse the d.c. conditions in the circuit will be determined by the amplitude of the added pulse. When this technique is used the brightness control sets the amplitude of the added pulse.

In chassis where d.c. coupled RGB output circuits are fed from an integrated circuit in which RGB matrixing is carried out the brightness control may adjust the bias in an i.c. that processes the luminance signal.

Fault Conditions

Since RGB output transistors are d.c. coupled to the c.r.t. cathodes one of the most common faults is complete loss of one signal due to failure of one of the output transistors: sometimes they go open-circuit, sometimes short-circuit. The fault is generally due to a tube flashover, and in circuits such as those shown in Figs. 1 and 2 the common series transistor may also fail, resulting in loss of all c.r.t. drives. Likewise in cascode circuits both transistors may fail together.

Loss of one of the signals with d.c. circuitry will also occur if there is an open-circuit connection or track, bias resistor or emitter-follower transistor. Should R330, R332, R333 or TR225 in Fig. 3 go open-circuit for example there will be no output from this channel.

RGB driver stages are normally emitter-followers. In the Hitachi Model CEP280 however the bases of the output transistors are d.c. coupled to common-emitter colour-difference amplifiers. Failure of one of these stages to pass current for any reason will thus result in the raster being heavily tinted with the relevant colour since there will be excessive forward bias at the base of the output transistor concerned.

An overall red, blue or green picture can be caused by a faulty i.c. in sets using an i.c. for RGB matrixing and preamplification. A check on the voltages around the i.c. will indicate whether the fault is here. With d.c. coupling between the i.c. and the output stages the voltages in the latter will also be incorrect of course.

The feedback clamp type of circuit (Fig. 3) is very common and there are several stock faults. The clamp diodes—D217 in Fig. 3—can become leaky, with the result that there is tinting depending on which diode is leaking. In the case of the clamp diode in the red channel for example the picture will take on a red tint. If the resistor—R334 in Fig. 3—in the feedback loop goes open-circuit the picture will be almost entirely of the colour concerned. Alternatively the resistor may go high-resistance, with the result of tinting of the appropriate primary colour. The input coupling capacitor, generally though not always an electrolytic, can be defective. The result will be tinting and often smears. The trouble can be intermittent, due to a dry-joint.

Returning to the Thorn circuit shown in Fig. 2, complete absence of signals with the c.r.t. cut off would result if R209 went open-circuit, since the common series transistor VT121 would then be without forward bias.

Where one of the output transistors develops a collector-base or collector-emitter short-circuit the resulting low collector voltage will result in maximum beam current from the relevant gun.

A fairly common type of fault in colour receivers of all varieties and in particular sets using RGB drive concerns brightness control: the control may have restricted range, fail to black out the tube at minimum setting or make it impossible for the tube drive to reach peak white. More annoying still, the brightness level may jump up and down in a spasmodic way. Restricted range of the main brightness control is most commonly due to an incorrectly set subsidiary brightness control while failure to reach peak white is often due to a misadjusted beam limiter preset or a defect in the beam limiter circuit. In all such cases the

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LONG-DISTANCE TELEVISION

ROGER BUNNEY

THERE has been some tropospheric reception during February, a welcome sign since the usual September-November tropospheric season just didn't happen this time. The improvement was due to very settled high-pressure systems and at the time of writing (end February) it seems that a second bout of these conditions is imminent. The first period of enhanced tropospheric reception lasted from the 4th through to the 10th of February. From reports coming in it appears that the same conditions were experienced throughout the country and in neighbouring continental areas. Derek Waller (Consett, Co. Durham) contacted us first with a lengthy log of reception at u.h.f. and v.h.f. from France, Holland, Belgium, West and East Germany, Denmark and Scandinavia. Shortly afterwards Clive Athowe (Norwich) reported with an excellent log including East Germany, Sweden and Poland. Clive noted a new GDR (East Germany) test card identification (see later); Sweden on most channels up to ch. E51—including the ch. E28 15kW transmitter at Joenkoeping!; and the Polish ch. R12 (Szczecin) transmitter once again. Ryn Muntjewerff (Holland) received TVP (Poland) on chs. R7, R9 and R12, also the second chain on ch. R25! Conditions seemed to peak on February 9th.

The improved conditions made it possible to examine more closely the new French transmissions—we are hoping to include photographs of the various patterns and identifications next month.

My valley location didn't provide any startling reception. The best day here was the 2nd when many French stations were received, also CLT (Luxembourg) chs. E7 and E21. Because of the amount of material this month I have decided to omit the usual log. Apart from the normal Band I MS reception there was SpE activity on the 13th (Czechoslovakia—CST—ch. R1 at 0755) and again on the 25th when another opening on ch. R1 produced TSS (USSR) with the usual 0249 card and also several unidentified floaters. Sweden was received via SpE on the 11th, with schools' programmes on chs. E2, E3 and E4—and just a hint of TSS on ch. R1.

Summing up then, the month was notable for two excellent tropospheric spells and a trace of Sporadic E.

Current Sun-spot Cycle

An article in the latest technical and news bulletin published by the International Service of East German Radio is of particular interest, especially regarding future hopes (?) of F2 reception. To summarise the points made: We have now reached a very low level of sun-spot figures, indicating low solar activity. The effects of the 11-year cycle are similar in both the northern and southern hemispheres. It was expected that the new solar cycle would start in mid-1974, but high-energy flares on the sun in recent months suggest that the old cycle is being prolonged. This may in turn lead to a comparatively steeper increase in activity during the new cycle. The authors T. J. Cohen and Paul Lintz predict that the end of the current cycle may not occur until the end of 1975 if not later! The bottom peak of the present cycle is expected during 1975. A further prediction is that the next cycle will have a very low maximum peak—no higher than 100. Such predictions are highly speculative however: in fact very long-term predictions tend to be inaccurate because of the capricious behaviour of the sun. Our thanks to Radio Berlin International, DDR-116 Berlin, GDR, East Germany from whom further information on their bulletin can be obtained (no postage required). From my own SpE observations over the past twelve years I have come to the conclusion that there is a negative correlation between SpE reception and sun-spot activity, i.e. with increasing sun-spot activity SpE decreases and vice versa—the low sun-spot activity 1974 season produced quite incredible long-hop SpE reception!

IBA Transmitter List

The IBA has just published the latest edition of its *Pocket Guide to Transmitting Stations*, covering all IBA v.h.f. and BBC/IBA u.h.f. transmitters in the UK. Copies can be obtained free from the Engineering Information Department, IBA, Crawley Court, nr. Winchester, Hants S021 2QA.

News Items

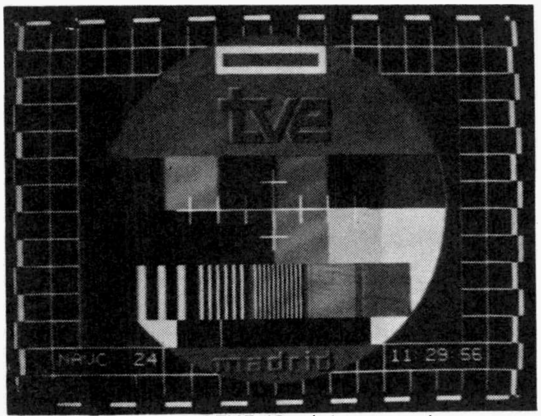
Spain: TVE has changed its name, the new initials being RTVE—"Radio Television Espanola". Although the change took place on February 3rd the "TVE" test card identification is being continued for the time being. A shot of the new test card has been sent to us by TVE/RTVE and is featured this month. It's from a second chain outlet on ch. E24: the identification at bottom left (NAVC 24) is an abbreviation for Navacerranda ch. E24, the transmitter location and channel number respectively. "Madrid", bottom centre, indicates the regional programme while the numbers at bottom right are a digital clock readout. Clive Athowe received the first chain card recently and the identification used with this is also shown. There will be regional identifications at times when such a programme immediately follows. The rectangle on which the centre circle "sits" is at present orange: this is likely to change in due course.

Hungary: Hetesi Laszlo tells us that a new transmitter is in operation on ch. R1 at Nagykanizsa (16·55E, 46·30N). The transmitter power (not e.r.p.) is 4/0·8kW.

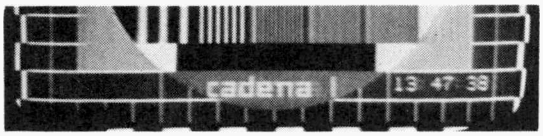
France: It appears that from the end of 1975 TDF (the new French transmitter authority) is to start duplicating the first chain (TF1) at u.h.f. with 625 lines. Paris will be first, followed by Lille. This means that the first chain will then be transmitted in SECAM colour. There is still a vast number of unconvertible 819-line v.h.f. sets in use: consequently TDF has postponed the changeover to 625-line v.h.f. operation.

Monte Carlo: TMC (Tele-Monte-Carlo) has started a service to Italy at u.h.f., using system G but with SECAM colour, for approximately three hours daily.

Egypt: Reports originating from France suggest that Egypt has chosen the SECAM colour system. *Broadcast* magazine for February 17th comments on a report in a French trade paper that the decision to adopt SECAM followed talks between the presidents of the two countries and a deal over the supply of French Mirage IV jet fighters. It is assumed



The new RTVE (Spain) test card.



First channel identification (from C. Athowe).

New DFF-1 identification slide. Photo from Ryn Muntjewerff.

that RTV Tunisie will follow a similar path.

Russia: Clive Athowe recently obtained a copy of a list of TSS TV programmes for a typical week in January. It is interesting to note that a fourth programme is now in operation. Typical programme timings are as follows: first chain 0900–2300; second chain 1825–2255; third chain 0955–1935; fourth chain 1915–2230. In all cases the last time is the commencement of the last programme. There are variations on Sundays.

Holland: NOS is now transmitting the PM5544 test card between twenty and two minutes before the start of programme transmissions. Peter Vaarkamp tells us that the identification is the same as on the previously used type RMA monoscope pattern, i.e. Nederland 1 or 2, and that this appears in the lower centre part of the pattern.

Czechoslovakia: Igor Hajek tells us that the identification "RS-KH" on the electronic test pattern stands for Retranslacni Stanice—Kavci Hory, which translates roughly as Rebroadcasting (or repeater, satellite) Station—Magpie Hills, the latter being the site of a new, large radio and television centre on the outskirts of Prague.

Hungary: Ian Beckett (Buckingham) has provided the following new MT programme timings. Mondays no programmes on either chain. Tuesday first chain 0805–2215, second 2000–2215; Wednesday first chain 0920–2210, second 2000–2110; Thursday first chain 0900–2300, second 2000–2255; Friday first chain 0805–2225, second 2000–2240; Saturday first chain 0820–2330; Sunday first chain 0805–2205. There are no second chain programmes on Saturday and Sunday. The last time given is the start of the final programme. The first chain news "TV Hirado" is at 1930 nightly, the second chain news "TV Hirado 2" at 2100 nightly and the first chain "TV Hirado 3" news at approximately 2215 depending on the length of the last programme.

The Sporadic E Season

The new Sporadic E season will be with us shortly. Experienced DX enthusiasts will know all about this phenomenon of course but for the benefit of newcomers I feel that we should outline the basic details and the characteristics of this mode of signal propagation.

The E layer is present at about 75 miles above the earth's surface. Normally it reflects MW and SW signals, those at higher frequency, i.e. v.h.f. and above, passing straight through into space. At times however parts of the E layer become highly ionised, sufficiently for the m.u.f. (maximum usable frequency) to rise. As a result signals at the lower end of the v.h.f. spectrum are reflected back to earth. The frequencies normally affected in this way are those in Band I, rising through Band II (TV) up to the f.m. Band. The m.u.f. rarely rises sufficiently for Band III signals to be reflected though this does occasionally happen—see later.

The causes of this increased ionisation are not fully understood and there is no definite means of predicting when it will occur—hence the name Sporadic E. From personal observations it seems that SpE declines as sun-spot activity increases while as sun-spot activity decreases so there is a "rise" in SpE—an increase that is in the intensity, frequency and duration of SpE openings. Certainly the possibilities of SpE reception are greater during periods of thundery weather during the summer months. SpE is basically a summer phenomenon, with a low mid-winter peak, but it can occur at any time of the year. The best months for SpE reception are from May to early September.

An SpE opening occurs when a high-intensity cloud of ionisation forms in the E layer, reflecting v.h.f. signals (see Fig. 1). Sometimes the cloud is stationary, at other times it drifts. The result in the latter case is that varying numbers of stations in different locations are received as the cloud approaches or moves away from the reception position. Signals are usually reflected over distances of 500–1,500 miles in the case of a single hop: at times however double hops (reflections) may occur, the range then being up to about 2,500 miles. Short-hop signals tend to be rather dramatic, with multiple images, phase reversal and polarisation shift, the longer-hop—more distant—signals being more stable. Depending on the size of the ionisation cloud, signals may be received from a smaller or larger area—the larger the area the more stations will be received of course. A large cloud will result in several stations being received simultaneously, often from the same network. This produces what we call "floaters", the strongest signal locking in while the other(s) float over it. If a floater increases in strength to become the strongest signal it will then lock in, the other(s) floating.

Sporadic E signals can be extremely strong. Thus even the simplest aerials can be used to receive them. It is a good idea to have several arrays which can be switched in alternately since often a signal present on one aerial is absent on another. If the aerial system cannot be rotated it is best to have the aerials pointing in different directions since SpE signals arrive from many different directions. Switching to another array can then help to reduce co-channel or adjacent-channel interference.

If a low-frequency signal is received very strongly, say CST (Czechoslovakia) channel R1, it will pay to check on channel R2 for signals from the next countries on, i.e. in this case MT (Hungary), TVP (Poland) or TSS (USSR). This is because whilst a sharp reflection angle (short skip) favours lower frequencies a shallower reflection angle from the same ionisation cloud will favour higher frequencies: with a shallower reflection angle a single-hop signal will come from a greater distance of course.

So much then for the basic mechanism of SpE reception at the lower frequencies. Finally a few words about the possibilities of the same type of reception at the dramatically higher Band III frequencies. In passing, it was only a few years ago that Band III MS (Meteor Shower) reception was thought to be impossible, certainly in the case of television signals, but a number of enthusiasts are now regularly receiving distant TV signals via this mode of propagation—the farthest MS distances recorded to date have been the reception of YLE (Finland) in Holland and the reception of TSS (USSR) in Norfolk.

Much of the original work on MS and SpE reception in Band III was done in the USA: some of this has been detailed in the WTFDA bulletin and in articles by Bob Cooper in the November 1958 and June 1967 issues of *QST* magazine (our thanks to Ken Edwards for copies of these). An ionised E layer cloud capable of Band III reflection should be able to reflect a vertically sounded (i.e. the signal is transmitted vertically upwards and reflected back through 180°) signal at 30·5MHz. The cloud would reflect a channel A7 (175·25MHz) signal over 1,200–1,400 miles. A number of reports indicate a tendency for Band III reflections to occur south of latitude 34°.

Such an opening occurred on June 9th 1955. The day's activities started with reception in Texas of east coast stations up to channel A5 (77·25MHz). The signals ceased at 0830 until 1030. Conditions then opened up again with higher frequency channels being received at shortening distances. At 1116 Havana channel A4 (67·25 MHz) was seen in Boston (650 miles) while at 1125 Havana channel A6 (83·25 MHz) was seen at the same location. The m.u.f. then slowly rose. At 1205 Havana ch. A3 (61·25MHz) was observed in Lakeland, Florida (335 miles) while at 1233 Santa Clara ch. A4 (67·25MHz) was seen at the same location (350 miles). At 1300 a Los Angeles ch. A3 outlet

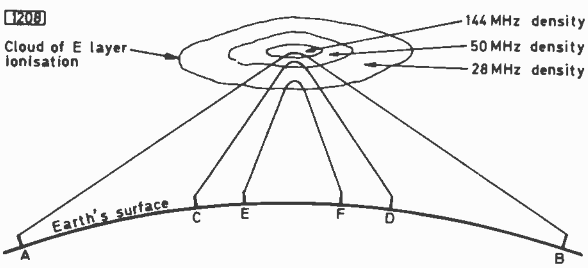
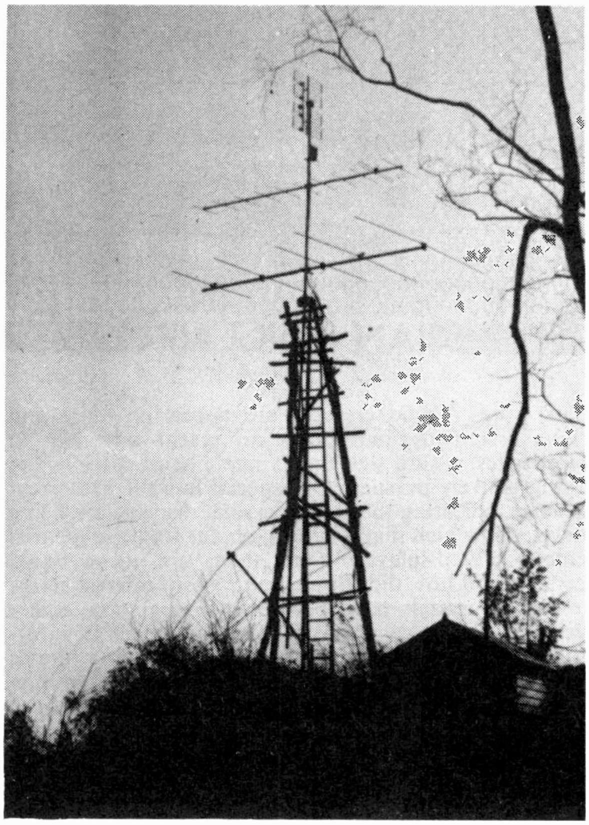


Fig. 1: Comparison of typical skip distances of signals reflected from a cloud of high-density E layer ionisation —the denser the ionisation, the higher the maximum usable frequency. The 28MHz skip path EF might be from 200 miles to essentially local, the 50MHz path CD 400 miles or less and the 144MHz path around 1,200 miles. The shorter the low-frequency skip path the greater the chance of Band I—or III—signal reflections being present over longer hops.



Desert Island DX?—Hugh Cocks' rustic though very efficient receiving arrays and mast.

was received in Temple, Texas. Some minutes later the m.u.f. rose to Band III, strong Cuban signals on chs. A2, A3, A4, A5, A6, A7, A9 and A11 being received in Odessa, Texas. The signals lasted for about fifteen minutes, the distances being 1,400–1,700 miles. At 1413 Cuban Band III signals at 182MHz were received in Temple, Texas. There were numerous other loggings to confirm the exceptionally short-skip activity on that day. The main interest however is the Band III Cuban signals, which considering the distances are virtually the maximum frequencies for single-hop. There was possibly some tropospheric enhancement at each end. It seems that the day featured small, "spotty" E layer patches active for short periods and changing from area to area. The other important fact is the extremely short skip between Cuba and Florida (335 miles) since this indicates that an ionisation density able to give acute-angle signal reflection on ch. A2 is sufficient to provide a Band III E layer signal reflection over the maximum hop distance of about 1,400 miles.

The conclusion to be drawn from this is that the presence of very short skip, i.e. under 500 miles, Band I SpE signals is an indication that conditions may exist for Band III SpE reception. One day during the 1960s I received via SpE Belgium on ch. E3 at only 325 miles: undoubtedly on that day Band III SpE signals may have been present at another location. The two metre band has opened on more than one occasion in recent years to give SpE reception. It does happen, so have a look this season!

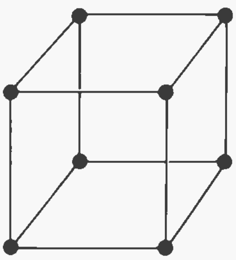
(Note: the American channels A2–A6 lie between 55·25–87·75MHz while channels A7–A13 lie between 175·25–215·75MHz.)

LIQUID CRYSTALS

IAN SINCLAIR

THE words 'liquid crystals' are appearing more and more frequently in reports on recent advances in electronics, a sure sign that a new line of discovery is being actively pursued. Of especial interest are recent reports indicating that liquid crystal displays are being developed which might be suitable for frame sequential colour TV displays. What, then, are these liquid crystals and how did the sudden rush of interest start?

Liquid crystals have been known for some eighty years as a chemical curiosity. The name itself is unfortunate, because the materials are neither true liquids nor true crystals but an inbetween state, sometimes called mesomorphic. A true crystal is a solid, hard material with a definite shape, having precise edge angles and flat sides, see Fig. 1. Crystals are the result of particles of material collecting in a definite arrangement, with enough forces acting between the particles to make sure that the pattern of the arrangement is maintained as other particles are added.



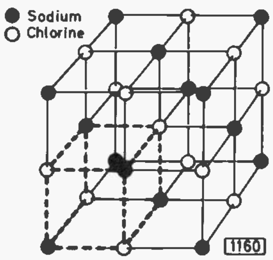


Fig. 1 (left): Simple cubic shape of crystal—one of seven known types of crystal shape.

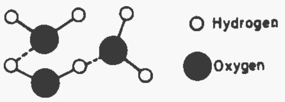
Fig. 2 (right): How a simple cube shape can build up into a crystal lattice—the sodium chloride crystal. Dotted lines show one cubic unit. (The atoms have been shown pulled apart for clarity).

Crystal Structures

Take, for example, the crystal of common salt (Fig. 2). The units which make up the crystal are the ions (charged atoms) of sodium (+) and of chlorine (−). These attract each other strongly, and arrange themselves into a cube shape, packed as closely as they will fit together.

Because each sodium ion attracts not only the chlorine ion immediately next to it but the next one along as well, the cube holds strongly together, and any other sodium and chlorine ions which can be gathered up will add on with no change in the crystal pattern. A crystal of this type is said to have long-range order, meaning that its basic shape will be maintained even when countless millions of ions are bunched together.

Because of the long-range order, the crystal is very hard and requires very large forces or very high temperatures to break up the shape of the crystal. Crystals of this type will, in fact, break only into flat-sided units which are of the same sort of shape as the original crystal.



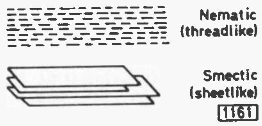


Fig. 3 (left): Short range order in water. Each hydrogen atom attracts the oxygen of another group enough to cause some order so that water boils at a fairly high temperature.

Fig. 4 (right): Long range order in liquid crystals.

Not all crystals are made of such strongly attracting units as the sodium and chlorine ions. Crystals can be built up from atoms (such as the carbon atoms of the diamond crystal, or the more familiar germanium and silicon crystals used in semiconductors) or from groups of atoms (molecules) in which the forces between the units are weaker, the crystals are less perfect and flaws can more easily appear. Nevertheless, the long-range order is still there, which is why the process of epitaxy (addition to a crystal from a vapour) can be used to form junctions on silicon crystals.

Liquids

Liquids have no long-range order, which is why they have no definite shape. The particles which make up liquids attract each other enough to approach fairly close, which is why the material is a liquid and not a gas, but the attraction does not extend to a great enough distance to keep a definite pattern of shape going over more than a few particles (Fig. 3). The substances which we call liquid crystals have some long range order, so that the same structure appears in the whole of the material, but the structure is not the three-dimensional one of the true solid crystal.

Nematic liquid crystals have thread-like structures;

the units join head-to-tail in threads many millions of molecules in length. **Smectic** liquid crystals form sheets of molecules arranged in layers; in neither case is there any further arrangement—the distances between the threads or between the layers are not fixed (Fig. 4). The order, such as it is, is in one (nematic) or two (smectic) dimensions only. The result is that these molecules form materials which look like liquids and take up the shape of their container, but do not flow, pour or stir like true liquids, yet have structures which can be changed by very small forces.

Applications

For eighty years or so, this was of purely academic interest, until it was realised that materials whose structure could be changed by very small forces might be of interest for display systems capable of working at very low voltages. From the electronics point of view, the nematic types of liquid crystal are of most immediate interest.

Nematic materials can be obtained in the form of thin films on glass (films up to 0·5mm thickness) provided that some care is taken over the preparation. For example, particles of dust mixed with the nematic material will cause the pattern to be disturbed over large distances, so that the dust particles appear to be magnified; the preparation of nematic cells therefore needs a dust-free space. It is fairly easy, however, given clean working conditions, to sandwich the nematic materials between glass slides and to seal the whole assembly. It is at this point that the behaviour of different nematic materials starts to become interesting.

Temperature

Temperature sensitivity is one useful feature of some nematic materials. At different temperatures, different colours of light are scattered by the material, so that when a white light is used to illuminate a nematic layer of this type, the colour which is seen by the eye depends on the temperature of the material. The layers can be made very sensitive to temperature, so that a change of a few degrees can cause the cell to go through the whole spectrum from red to violet.

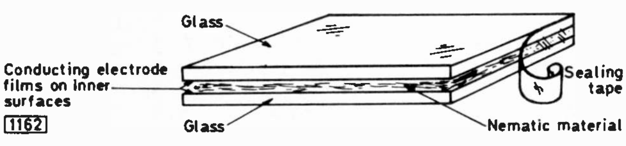


Fig. 5: Construction of a typical nematic cell.

The nematic cell can therefore be used as a temperature change indicator. Even more usefully, the nematic material can be micro-encapsulated (wrapped in tiny plastic spheres so small that the resulting material looks and behaves as a powder) and made into a paint which will then indicate small temperature changes by its colour change. We can, for example, study the pattern of temperature change in the case of a transistor, or locate hot spots on a printed circuit board in this way.

Of even greater interest is the effect of a low voltage applied across a layer of suitable nematic material

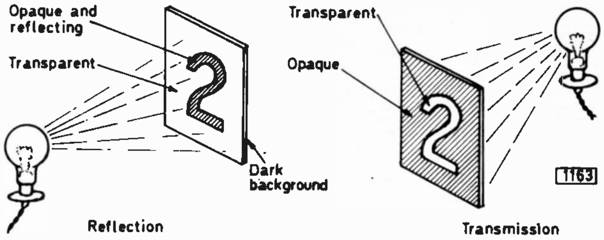


Fig. 6: Two ways of using liquid crystal cells. In each case the shape of the electrodes on the glass decides the figure, letter or symbol seen when the display is activated.

(Fig. 5). The ions present will move through the material causing its structure to break up, so that it changes from transparent to opaque. Light then cannot pass through the material, and is reflected from it in all directions. When the voltage is removed, the nematic material slowly recovers its structure, becoming transparent again in less than a second.

Numerical

This action has made nematic devices of great interest for numerical displays, especially for use in bright conditions. Alphanumeric displays using gas discharge tubes or light-emitting diodes give out light in proportion to the amount of power used, so that a bright display is a high-power consuming display. Nematic displays require very much lower voltages and currents, and are reflecting. They do not have to compete with the light around them, they use it to form their display. For dark conditions, small light sources arranged behind the nematic cells can be used (Fig. 6); when the voltage is applied, the light is blanked off by the nematic cell.

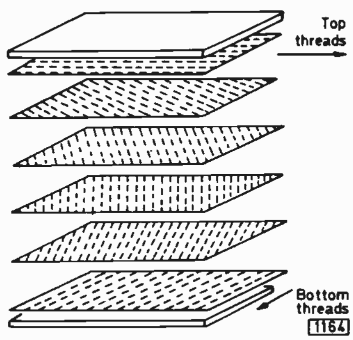


Fig. 7: Exploded view of a twisted nematic cell.

Nematic materials are therefore being investigated for such diverse applications as electronic watch displays (because of the lower power levels) and aircraft cockpit indicators (because they can operate in high light levels). Because the battery of an electronic watch must keep the oscillator and dividers going for a year or more, the display must use very little power. So far this has been difficult to arrange if the display is to be bright enough to be visible in daylight. L.E.D. displays which have been tried have had to be switched, so that the time could be read only when a button was pressed, and the display was turned off to conserve power when not being viewed. The use of liquid crystal displays avoids the need for a display switch.

At the other end of the scale, neither gas discharge nor l.e.d. displays are bright enough for aircraft cockpit use, where the full glare of the sun may strike instrument panels, nor for many other applications where instruments must be read under conditions of high illumination. Reflecting liquid crystal displays are ideal for such circumstances since they merely reflect the surrounding light; the brighter the light the brighter the display.

Flat Screen

Television applications of liquid crystal displays were until recently no more than a distant pipe-dream, but some recent work has brought that flat-panel display a little nearer. The type of liquid crystal which is causing a flurry of interest at the moment is the 'twisted nematic' structure. In a twisted nematic cell, the thread-like structures are not arranged in the same way throughout the thin film in the cell. At one electrode, the threads line up in one direction parallel with the transparent electrode on the glass; at the other electrode the threads are arranged at 90° to the first set, but still parallel to the electrode. This arrangement causes no visible effect when viewed in white light, but it twists the plane of polarised light through 90°.

If we polarise a beam of light by passing it through a polarising material, the beam will also pass through another sheet of polarising material arranged with its plane of polarisation in the same direction (Fig. 8). It will not pass through the second sheet if its plane of polarisation is arranged at 90° to the direction of the first one (Fig. 9). This remarkable effect, known for 150 years or so, is due to the wave nature of light and the way in which it is transmitted.

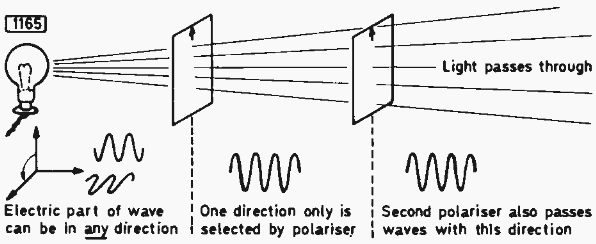


Fig. 8: Polarisation—polarisers in line.

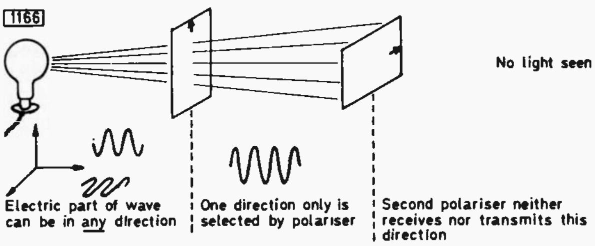


Fig. 9: Polarisation—polarisers at 90°.

Light is radiated when electrons in the atoms of any substance vibrate at frequencies of about 5×10^{14}Hz (five hundred million MHz). Pieces of transparent material, such as glass, act as receivers on one side and as transmitters on the other side. The light does not travel through the glass; the electron vibration in the atoms does, to radiate again on the other side.

When the transparent substance consists of rod-like crystals all pointing in one direction, that direction of electric wave will be preferred for transmission and reception and the light is polarised, just as a radio wave is polarised by being radiated from a dipole arranged in one particular plane. Just as vertical dipoles are unsuitable for picking up broadcasts radiated from horizontal dipoles, the light radiated from a material polarised in one direction does not affect a sheet polarised at 90°, and so is not received nor transmitted.

The twisted nematic cell receives light polarised in one direction, and re-transmits it with its direction of polarisation shifted through 90°. The result is that a twisted nematic cell, viewed through two polarising sheets which would normally transmit light, appears opaque.

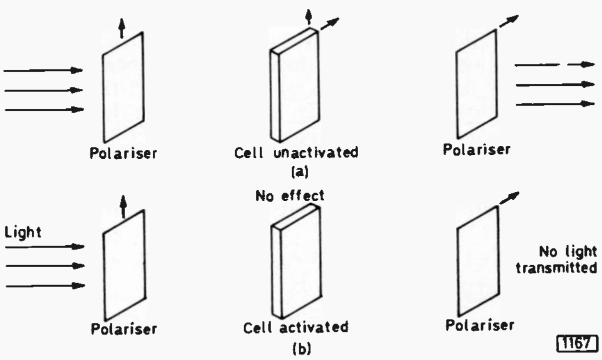


Fig. 10. Using twisted nematic cells:
(a) unactivated—light passes.
(b) activated—light blocked.
The reverse action is possible if the polarisers are lined up instead of being at 90°.

Opaque, that is, until a voltage is applied between the electrodes. In this type of cell there are no ions to conduct current and cause the threads to break up. The electrodes are very close together, and the effect of applying even a small voltage is to cause a large field between them, so making the threads line up with the field and removing the 90° twist. In this condition, the sandwich of polarisers and cell is fairly transparent. When the voltage is removed, the nematic threads go back to their former positions under the influence of the electric charges remaining on the layer immediately next to the electrodes. It is as if they slotted into place and had to slot back in again.

Birefringence

So far, so good; this is another way in which a display can be created using liquid crystal cells, and with practically no dissipation. We can also make use of polarised light to create coloured displays, however.

As long ago as 1935, Dr. E. H. Land, the inventor of "Polaroid" material and later of instant camera fame, took out a patent on a colour display consisting of a film of plastic material held between polarising sheets. The property required in the plastic is called birefringence, meaning that it passes different colours of light according to their polarisation angles. Ordinary Cellophane, for example, is birefringent, and if a piece of Cellophane is held between two polarising sheets, such as the lenses of polarising sun-glasses, and rotated different colours of light will pass through.

The birefringence of plastics makes two-colour liquid crystal displays fairly simple to construct. A four-layer sandwich is needed, with a polarising sheet, a twisted nematic cell, a birefringent layer and a second polariser. When white light falls on this assembly, adjustment of the plastic sheet will produce a coloured light output. When the twisted nematic cell is operated the direction of polarisation of the light reaching the plastic turns through 90°, so that the emerging colour is now different. By using two twisted nematic cells and more layers of birefringent plastic, a greater range of colours has been produced.

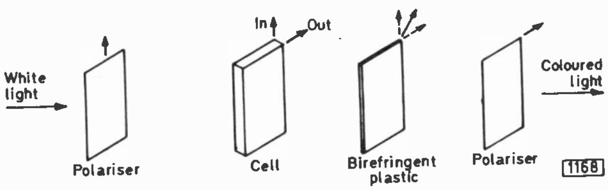


Fig. 11: Colour displays using twisted nematic cells.

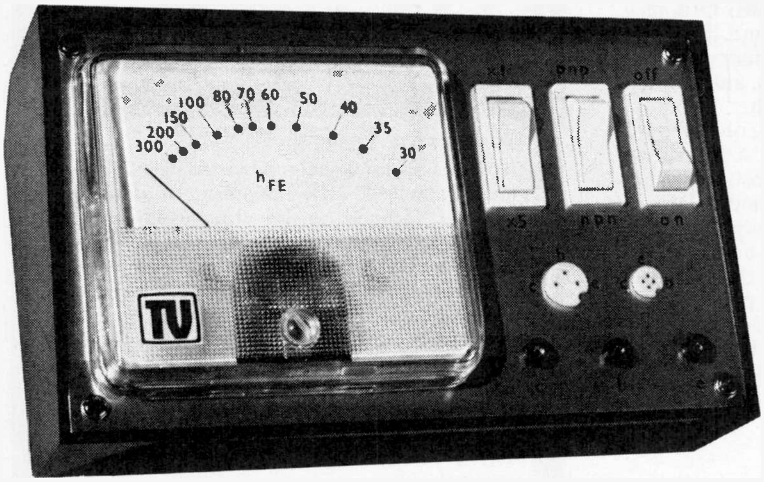
Television applications? Well, the work going on at the moment at the Royal Radar Establishment is not directed at television applications but, of course, to the possibility of radar use (friends in blue, foes in red?). The problem of using twisted nematic cells for television has been their slow response; they untwist fast enough when a field is applied, but return much too slowly for present television field rates. Once again, however, work at RRE has developed faster-switching cells.

Switching

By using a mixture of materials which changes its characteristics at different frequencies, cells have been made which switch on rapidly when a low-frequency (such as 100Hz) voltage is applied, and turn off in a few milliseconds when a high frequency (such as 50kHz) is applied. For such cells, switching at 25Hz with rapid rise and fall rates has become possible for the first time.

We are not, of course, going to see a liquid-crystal TV just yet, not even an experimental model. What is likely is that we shall see the groundwork steadily being laid, and that devices will appear using multicolour fast-switching displays for other purposes such as advertising signs, theatre lighting and colour printing. We shall undoubtedly hear more of liquid crystal displays, at first as colour switching panels in front of c.r.t.s, later perhaps with l.e.d. or other sources. Meantime, I'll design a frame for that flat display; it might take no longer . . . ■

Automatic TRANSISTOR TESTER



TV PROJECT

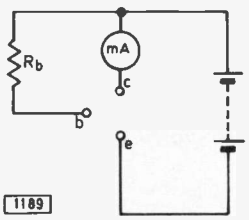
ALAN WILLCOX

SIMPLE transistor testers fall into two main categories—dynamic and static. The former type operate by supplying the transistor under test with an actual signal, and to be truly comprehensive signals should be available at several frequencies. In the case of the static type of tester, the base current is set at some steady value and the resulting steady collector current measured. The ratio of these two currents provides a measurement of the h_{FE} (static forward current transfer ratio) of the transistor.

Because of its simplicity, the static type of transistor tester is the more popular. The circuit of such a tester in its simplest form is shown in Fig. 1. If the battery is 10V and Rb is 1M Ω then (ignoring the small voltage dropped across the base-emitter junction, Vbe) the base current will be 10V÷1M Ω=10μA.

If, as a result, the meter in the collector circuit registered say 1mA, then the h_{FE} of the transistor would be 1mA÷10μA=100. In this case the meter would be marked 100 at that point and 50 at the 0·5mA point and so on. By a suitable choice of meter shunt the measurable range of h_{FE} could be extended.

Perhaps the most important disadvantage of this simple circuit is that the collector current, being dependent on h_{FE}, can be very low or sometimes alarmingly high. Because the h_{FE} of a transistor varies considerably with collector current, it would be more satisfactory to measure h_{FE} at a fixed value of collector current. Another disadvantage is that as the battery ages the base current will fall and calibration would no longer be correct.



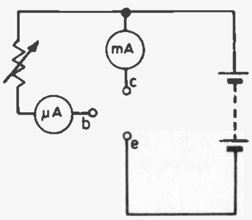


Fig. 1 (left): Circuit of the most basic transistor tester.

Fig. 2 (right): The variable resistor allows the transistor collector current to be set to a predetermined value.

Manual

A better circuit, which overcomes these disadvantages, is shown in Fig. 2. Here the base current is increased by adjusting the potentiometer until a predetermined value of collector current is reached. For a given collector current the base current is inversely proportional to the h_{FE} of the transistor, and so the meter in the base circuit can be calibrated in terms of h_{FE}. In practice a single sensitive meter movement is used. This is switched from the collector circuit (where it is used with a shunt) into the base circuit once the collector current has been set. Although this circuit is simple and effective, anyone who has used such an instrument will know how critical the initial adjustment is, and also how irritating it is to perform this adjustment each time a transistor is to be tested.

In the circuit to be described the potentiometer is dispensed with. Instead the current in the base circuit adjusts itself automatically to provide 1mA of collector current. There is then no longer any need to monitor the collector current, and so the meter movement can be wired permanently in the base circuit.

Automatic

The basic circuit is shown in Fig. 3. Tr1 is switched on by current through R2, thereby providing bias via R1 to the transistor under test. The value of R3 is chosen so that when a current of 1mA is flowing through it, the voltage drop across it is just sufficient to bring Tr2 to the point of conduction. So, when the collector current of the test transistor is 1mA, Tr2 will tend to turn on, shunting some bias current away from Tr1. This in turn will tend to limit the forward bias to the transistor under test and prevent its collector current from rising above 1mA. The current flowing in the base circuit is monitored by measuring the voltage drop across R1. The *V*be of the transistor being tested is "backed off" by the diode in series with the voltmeter.

In the final circuit a 1mA meter movement is used with a 6·8k Ω series multiplier, and so operates as a voltmeter with a f.s.d. of 6·8V. If a more sensitive movement is used it is best to provide a shunt to reduce its sensitivity to 1mA, and to adhere to the associated resistor values shown on the complete circuit diagram, Fig. 4.

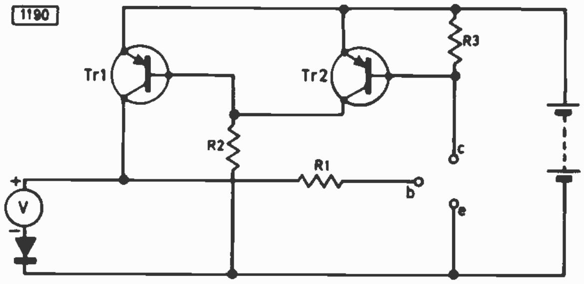


Fig. 3: Basic circuit of a tester which automatically sets the test transistor collector current to the desired value.

Final Circuit

Reference to this circuit will show that the basic circuit of Fig. 3 has been duplicated using complementary transistors, so enabling npn and pnp transistors to be tested. With S2 in the npn position, D1 is reverse biased and Tr1 and Tr2 are effectively out of circuit. D2 is forward biased and so Tr3 and Tr4 are in circuit and function as described above; the meter current flows through R3 and D3. If a pnp transistor is being tested, S2 is switched to the appropriate position and all polarities are reversed. Tr1 and Tr2 now come into action via D1, and the meter current flows through R4 and D4.

The backing-off voltage provided by D3 and D4 is about 0·6V, which is correct when testing silicon transistors. Ideally, germanium diodes should be substituted when testing germanium transistors. However the error resulting from using the same diodes for both types is not significant when compared with the overall absolute accuracy of the instrument. When matching pairs of transistors the error should be similar for the two devices and therefore self-cancelling in this application.

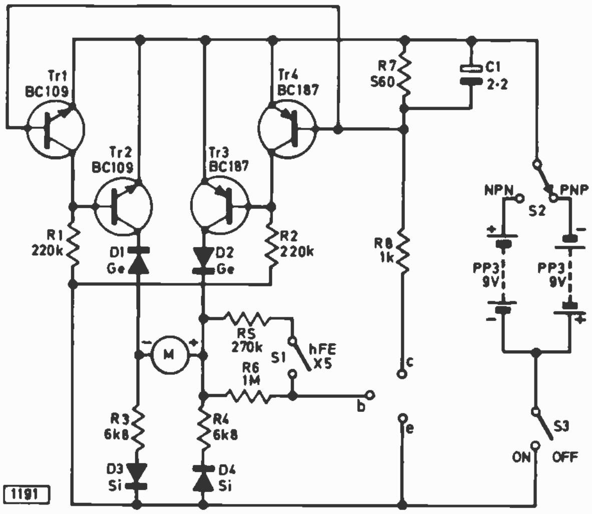
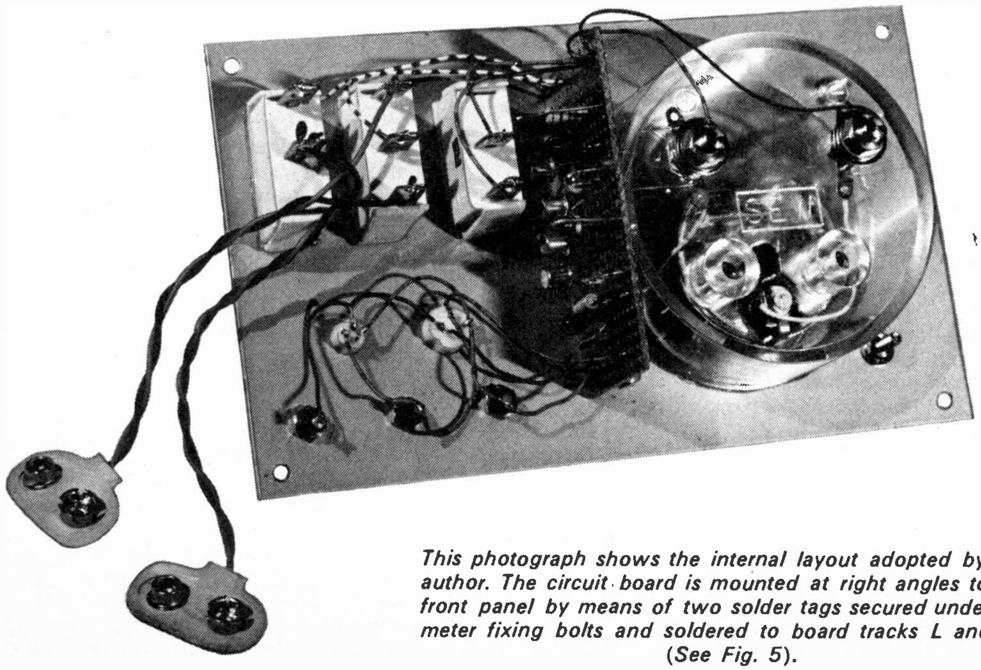


Fig. 4: Circuit diagram of the complete instrument with facilities for testing pnp and npn transistors.



This photograph shows the internal layout adopted by the author. The circuit board is mounted at right angles to the front panel by means of two solder tags secured under the meter fixing bolts and soldered to board tracks L and M. (See Fig. 5).

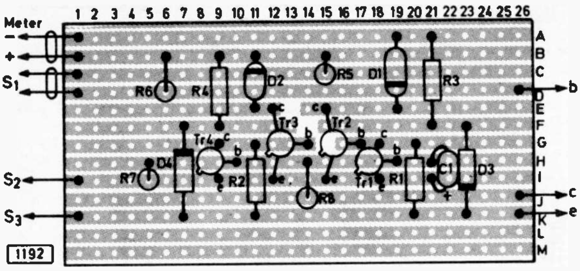


Fig. 5: Component layout and external connections for the circuit board used in the prototype. There are three breaks to be cut in the copper strip pattern. These occur at locations E13, F14 and G15.

h_{FE}	Scale point mA
30	0·98
35	0·84
40	0·73
50	0·58
60	0·49
70	0·42
80	0·37
100	0·29
150	0·2
200	0·15
300	0·1

★ Components list

Resistors: (all ±5%, ¼ or ½W)
R1, R2 220kΩ R5 270kΩ R7 560Ω
R3, R4 6·8kΩ R6 1MΩ R8 1kΩ

Capacitor:
C1 2·2µF 35V tantalum bead

Semi-conductors:
Tr1, Tr2 BC109 Tr3 Tr4 BC187/BC479
D1, D2 OA90, 1GP5 etc. (Germanium)
D3, D4 OA200, 1N4148 etc. (Silicon)

Miscellaneous:
Meter, S.E.W. Model MR65P, 1mA (Laskys)
S1, S3 Rocker switch s.p.s.t.
S2 Rocker switch s.p.d.t.
Transistor holders—
1 Push fit T05 (3L)
1 Push fit T072 (T018) (4L)
3 Miniature sockets
1 Case, Type 21
2 pairs Battery connecting studs
(S1 to battery studs: R.S. Components or Doram)
2 Batteries, PP3
Veroboard, 69 x 36mm (2·7 x 1·4in.), 2·54mm (0·1in.) matrix

The function of C1 is to overcome any tendency for the circuit to become unstable or to oscillate. It is not necessary to use a reversible component here, as the applied voltage should not exceed the safe reverse voltage rating of the specified capacitor.

Power Supply

The reversible power supply was provided in the prototype by having two batteries selected by a s.p.d.t. switch. An alternative and possibly more elegant method would be to use a single battery and a d.p.d.t. switch. In the range of rocker switches fitted in the prototype, the d.p. switch is twice as wide as the s.p. and would not fit into the case used. Hence the adoption of the arrangement shown in Fig. 4.

Calibration

To illustrate the calibration procedure, let us assume that a transistor under test has an h_{FE} of 30. Then for our 1mA of collector current the current flowing in the base circuit is 1mA÷30=33µA. If S1 is in the normal (closed) position the effective base resistor is 200kΩ and so the voltage developed across it is 33µA×200kΩ=6·6V. The current through the meter due to this voltage is 6·6V÷6·8kΩ=0·97mA. Thus, 0·97mA on our 1mA meter corresponds to h_{FE}=30, and is so marked.

Because 0·97mA is near f.s.d., 30 is the minimum h_{FE} that can be measured with a 200kΩ resistor in the base circuit. With a 1MΩ base resistor (S1 open) this point would correspond to an h_{FE} of 150, and so in this position S1 is marked h_{FE}×5. Similarly, were the base resistor 40kΩ this point would signify h_{FE}=6.

The table gives the h_{FE} values marked on the prototype together with the corresponding points on the original meter scale. If the meter scale is first covered with white adhesive plastic ("Fablon", "Contact" or similar) the original scale will show through just sufficiently to enable calibration to be carried out by superposition.

Operation

In the absence of any transistor in the test socket the meter pointer will go hard over, which serves as a useful indication of power on. The inexpensive meter movement specified possesses little or no damping, with the result that upon switch-on the pointer goes over to f.s.d. fairly rapidly. This causes no damage, however, because the maximum current through the meter is limited to 1·2mA.

When a transistor is inserted in the socket, the pointer falls back to indicate the h_{FE} of the device. If it is greater than 200 or so, the ×5 switch should be operated to give a more accurate estimate. If the transistor is open circuit or has an h_{FE} of less than 30 the pointer will remain at f.s.d. If, on the other hand, it is short circuit the pointer will fall to zero.

Diodes are tested by placing them across the collector and emitter test sockets. With a good diode the meter will go from f.s.d. to zero, or vice versa, as the npn/pnp switch is operated.

Battery life is very long, consumption being only a few milliamps. Calibration is unaffected by battery ageing, but when the voltage falls below about 7·5V the lower range of h_{FE} that can be indicated will be reduced. ■

FOREIGN SET FAULTS

DEWI JAMES

TELEFUNKEN

We have had to deal with a number of faults in the **Telefunken 629T, 639T, 719T, 719ST, 719SM, 739T** range of models. As with most sets, irrespective of make or country of origin, the majority of the faults have been in either the power supply section or in the timebase circuits.

Difficulty in controlling, i.e. reducing, the 24V line, with an associated hum bar, has been dealt with by replacing the l.t. bridge rectifier reservoir capacitor C521 (500μF). A low 24V rail, giving the symptom of a small picture, has been remedied by replacing the 24V series regulator transistor T521 (2N5296). Similar symptoms are displayed when T531 (BC213A) in the thyristor h.t. rectifier control circuit is faulty.

Failure of the line output valve (PL509) and boost diode (PY500A) is quite common—and not confined to these particular sets as we are all well aware. No picture has been traced to both C493 (10μF) and R493 (6·8 Ω) in the cathode circuit of the PL509.

Excessive brightness has been traced to R619 being faulty. This is the preset brightness control, or basic brightness control as Telefunken call it.

Field bounce has been cured by replacing the 245V rail (U2) smoothing electrolytic capacitor C547 (200μF).

INTERMITTENT NO SOUND OR VISION

The complaint with a **Hitachi Model P32-311** 12in. monochrome portable (single-standard) was intermittent no sound, no vision, though there was a plain white raster on the screen in the fault condition. After some fruitless searching in the video/i.f. circuitry we decided to concentrate on the a.g.c. circuit and found that when the voltages around the second a.g.c transistor TR552 (see Fig. 1) were measured during the fault condition they read 2·2V at the base, 9·2V at the emitter and 9·3V at the collector. Clearly the transistor was defective, and on replacing it normal operation was obtained. The voltages around this transistor with correct operation and the contrast control set for normal viewing are 4·3V at the base, 3·6V at the emitter and 10V at the collector while the a.g.c. voltage applied to the tuner is 3·6V positive. We did not have an exact replacement transistor (2SC458C) to hand so the old favourite BC108 was used and appears to work satisfactorily. We have encountered this same fault on two subsequent occasions. Because of its intermittent nature it is a little more difficult to track down than would otherwise be the case.

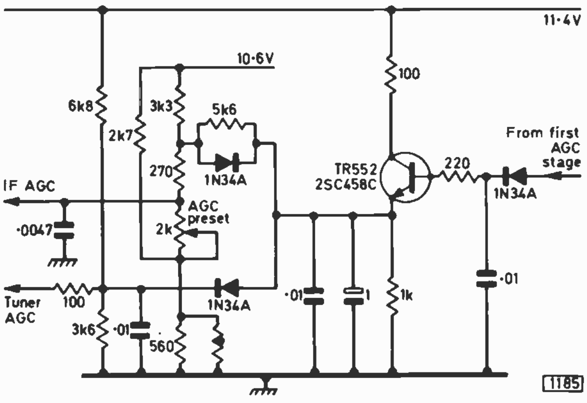


Fig. 1: Circuit of the second a.g.c. amplifier stage in the Hitachi Model P32 12in. monochrome portable set.

COLOUR FADING

Colour fading has been experienced with a **Sharp Model C1831H**. The colour faded gradually, the upper half of the picture being affected first. Sharp say that this effect is usually experienced on one channel only (the weakest) and does not normally happen until the set has been on for at least fifteen minutes. If the fine tuning control is depressed and turned slightly clockwise the colour reappears. On releasing the fine tuner knob however the colour goes again. Although this appears to be an a.f.c. fault this is not so. It can be cleared by readjusting the a.c.c. and colour killer controls as follows.

Allow the receiver to warm up for at least fifteen minutes then turn the contrast and colour controls to maximum. Tune in a colour bar pattern (on any channel) from a generator, or a normal transmission on the channel on which the fault is experienced. Connect a wideband oscilloscope via a 1:1 probe to TP802 adjacent to T803 and i.c. I802 in the decoder section of the main printed board and adjust the amplitude of the displayed burst signal to 0·3V peak-to-peak by means of the a.c.c. preset. Beware: this is shown as R821 on the layout and R827 on the circuit! Disconnect the probe.

Tune in a monochrome signal pattern (e.g. dot or crosshatch), ensure that the colour control is at maximum and turn the colour-killer control R585 fully anticlockwise. This should produce coloured noise on the screen. Adjust R585—while depressing the fine tuning knob and turning this slightly to the h.f. side—

until the coloured noise disappears. Do not turn the control too far clockwise or colour fading will result on broadcast signals.

Finally turn the colour control to minimum: if slight colour remains on the picture turn the colour preset control ("sub-colour", R886) anticlockwise until the colour is fully removed.

If these sets do not operate when the main (with colour control) and instant on (with volume control) switches are set to the on position the manufacturers recommend the following procedure. Set the main switch to on and the instant switch to off; depress the red auto circuit breaker button (at rear of set); then pull the instant switch to on. If the circuit breaker continues to cut out the fault must be traced: leaving the cut-out button depressed will lead to damage in the receiver.

INTERMITTENT LOSS OF SIGNALS

A rather elusive fault was encountered in a **Hitachi Model CSP680** recently. The customer complained that the sound and picture intermittently disappeared, returning when a different channel was selected. On the face of it, a simple case of an intermittent tuner. During a bench examination under the fault condition however it was discovered that the 12V supply to the tuner disappeared, also the 12V supplies to the video circuits and the separate PAL board.

The course taken by the 12V rail is shown in Fig. 1. The 12V supply is obtained from a winding on the line output transformer ("flyback" transformer), via rectifier CR25. Our first step therefore was to measure the voltage at K2 on the K plug. This was correct, but no readings were obtained at B1 or G1. It was then realised that the 12V supply passes through a 2·2Ω resistor (R597) while on the "power" board (this board incorporates the video circuitry and the timebase generators). This resistor was found to be intermittently open-circuit. Quite an easy fault to diagnose when you look at the simplified circuit shown in Fig. 2: not so easy if you try to trace through the convoluted circuit in the service manual.

It appeared that the resistor was susceptible to mechanical vibration and went open-circuit as the tuner was moved. When the fault occurred it looked like a timebase fault since the screen went blank. The raster appeared on advancing the brightness control however. The blank screen was the result of the c.r.t. biasing being altered when the signals from the d.c. coupled RGB output transistors disappeared.

The same circuitry and board arrangements are used in **Model CFP470.**

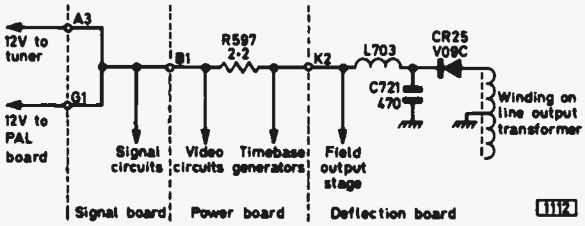


Fig. 2: Path of the 12V supply through the Hitachi Model CSP680. Lack of vision and sound signals was due to R597 going open-circuit. This resistor is mounted on the power board and is decoupled by a 100µF electrolytic capacitor on the signal board.

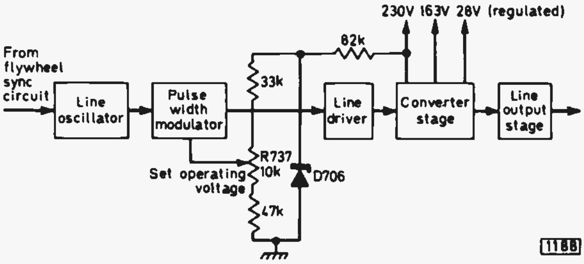


Fig. 3: Block diagram of the combined line timebase and regulated power supply system used in the imported ITT Model FT110.

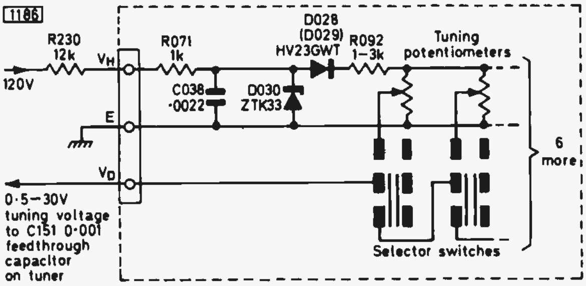


Fig. 4: Circuit of the tuning arrangement used in the Hitachi Model CNP192.

SMALL PICTURE

The 110° ITT colour sets (**Model FT110**) being distributed in the UK are imported from Germany and are entirely different from the UK produced CVC8 chassis. In particular they use a most unusual switched-mode power supply which is actually part of the line timebase. One of these sets displayed the symptom of a small picture and we found that we were unable to set the 163V line (measured across its reservoir capacitor C752) by means of the set operating voltage control R737. The 230V and 163V h.t. lines are derived from a "converter" stage which is included between the line driver stage and the line output stage, while an emitter-coupled monostable multivibrator which is used as a pulse width modulator is included between the line oscillator and line driver stages. The basic scheme is shown in Fig. 3. The voltage applied to the set operating voltage control R737 is stabilised by a zener diode D706 (ZTK33DPD) and this was found to be the cause of the trouble. This imported chassis has not to date turned out to be as reliable as the well known ITT UK produced chassis.

TUNER DRIFT

The 19in. **Hitachi Model CNP192** is possibly the best colour set the company has yet produced. It is similar in design to the CNP190 but the tuner assembly differs somewhat. Unfortunately and uncharacteristically, we have experienced a little difficulty with this unit in that the symptoms of tuner drift have been encountered in a few of these receivers. There are two separate causes of this. First check the voltage on the zener diode D030 in the programme unit (see Fig. 4). It should

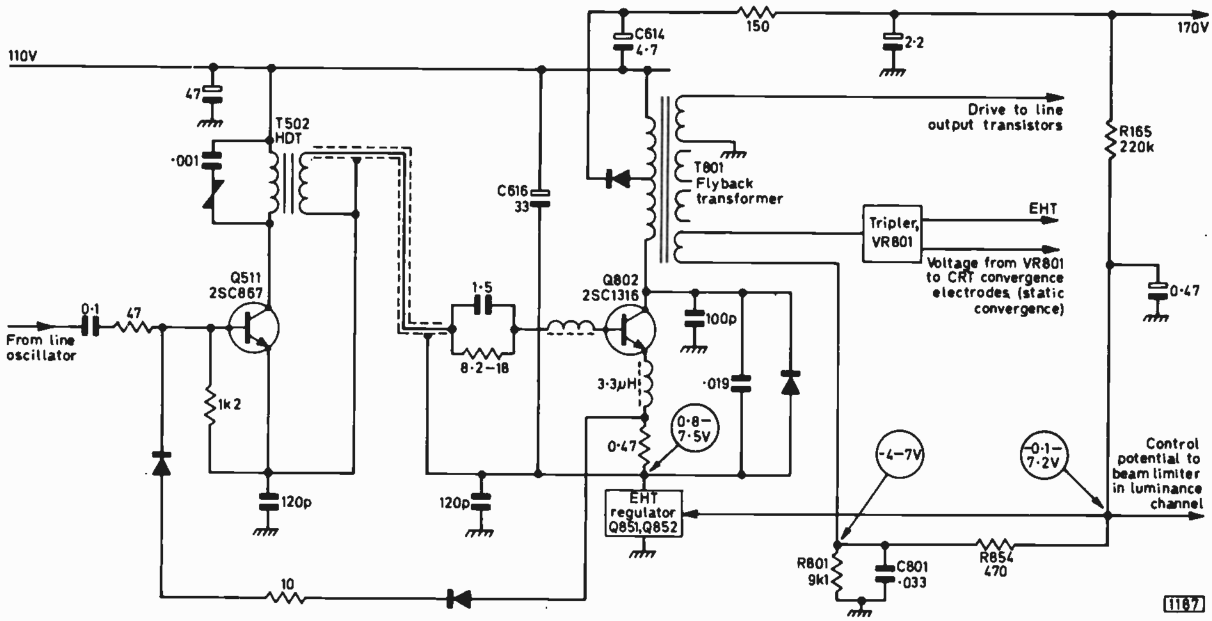


Fig. 5: Horizontal driver and converter stages, Sony Model KV1800UB.

be between 32–36V. If it is between 15-20V drift will occur and the zener should be replaced. If the voltage across the zener is within the prescribed limits the tuner is faulty—probably due to the tuning voltage input feedthrough capacitor C151. Hitachi recommend that the complete tuner is replaced and will accept a category B claim for repairs under guarantee (£4) for replacing the tuner, even in unsold stock receivers—other manufacturers please note. One wonders why it is that only foreign manufacturers such as Sony and Hitachi pay their dealers for under-guarantee repairs.

NARROW RASTER

An eighteen month old **Sony Model KV1800UB** (the 18in set) had normal sound but a raster only five inches wide, i.e. the line oscillator was running at the wrong speed. On examination we found that the transformer (T502, HDT) in the horizontal driver stage was overheating considerably and the cut-out operating intermittently. We assume that the overheating was due to the transformer's effective reactance being reduced as a result of the low oscillator frequency. The fault was cured by replacing both the transistors—Q509 and Q510, both type 2SC1364—in the line oscillator stage: the driver transformer also had to be replaced since it had been badly damaged by the overheating.

The arrangement (see Fig. 5) of the line driver stage Q511 and the following horizontal converter stage Q802, which drives the e.h.t. tripler and the line output stage via its load the flyback transformer T801, is confusing if you are not familiar with the chassis. This is mainly because of the unusual e.h.t. regulation system used. The earth return path for the c.r.t. beam currents is via R801, which also forms part of a potential divider with R854 and R165 across the 170V rail. The e.h.t. regulator controls the impedance between the emitter of Q802 and chassis and is fed from the junction of R854 and R165. As the voltage across R801 varies so the input to the e.h.t. regulator changes, thus altering the emitter circuit impedance and the current flowing in the primary of the flyback transformer T801 in order to compensate for the changed loading. The beam limiter, which is in the luminance channel, is fed from the same point as the e.h.t. regulator.

Flashovers in the c.r.t. can destroy Q802, and the transistors (Q851 and Q852) in the regulator circuit can fail at the same time. If Q802 has to be replaced check the voltages shown in Fig. 3—the lower readings apply with a bright screen, the higher readings with a dark screen.

INTERMITTENT LOSS OF RED

We recently had to deal with a **Hitachi Model CSP680** which would very intermittently "loose its red". The monochrome picture remained unaffected by the fault so we assumed that the trouble was in the decoder section. The fault took some time to trace because of its intermittent nature. We eventually found however that the R−Y chrominance amplifier transistor TR21 (type 2SC460) between the chrominance delay line/matrix circuit and the R−Y synchronous detector was defective.

MITSUBISHI

We have experienced one or two faults on the **Mitsubishi Model CT 200B**, which uses colour-difference c.r.t. drive. First a rather awkward one, the luminance disappearing on colour. Checking voltages through the luminance channel revealed that the second luminance amplifier Q202 (2SC710) was saturated due to a leak in the 4·43MHz notch filter capacitor in its base circuit. The filter is returned to the colour killer circuit so that it is inoperative on monochrome. Reduced luminance but with correct colours was traced to the third luminance amplifier Q204 (2SC711) being short-circuit. The channel selector push-buttons can fail, necessitating replacement of the complete unit.

CCTV

PART 14

Peter Graves

WE have assumed that when a camera is looking at a uniformly illuminated screen its output will also be uniform. In practice however this is not the case—some parts of the final picture may appear to be brighter than others due to a difference in the sensitivity of different parts of the target layer: this is an inherent drawback of many types of camera tube. For many purposes the effect can be ignored but for top quality pictures, or for special applications where a uniform output for a uniform input is essential, some form of compensation must be applied. The phenomenon is known as shading and the correction circuits as a shading generator.

The output from the shading generator is used to modulate the camera tube scanning beam in the same way as the beam in a monitor cathode-ray tube. Thus, while the beam is landing on an area of above average sensitivity the beam current is reduced, when the beam leaves this area the beam current is restored to normal. The areas of different sensitivity are comparatively large (patches rather than points) so that, for instance, the whole of the left-hand side of the picture may be darker than the right-hand side.

Shading Generators

A shading generator develops sawtooth and parabolic waveforms (at both line and field frequencies) which are adjustable for amplitude and polarity. The waveforms are synchronised to the internal line and field pulses in the camera or, if the shading generator is an external unit, to synchronising pulses from the main sync pulse generator. It is found that these waveforms will give a wide range of correction for various positions and degrees of shading on the tube.

With the exception of the time constants the line and field circuits of the shading generator are virtually identical. A typical field frequency sawtooth generator circuit is shown in Fig. 1. Tr1 and Tr2 with their associated components form a discharger type of sawtooth generator—a circuit we have already encountered in scanning discussions. In the absence of an input pulse Tr1 is cut off and C1 charges via R1, the voltage developed across C1 feeding the base of Tr2. The charging curve is the familiar exponential one but only the first part is used, this being almost linear.

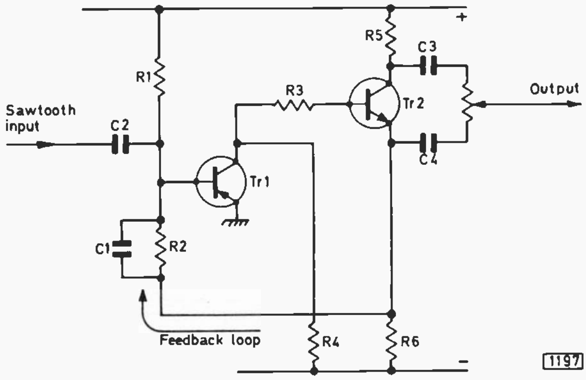


Fig. 2: A parabolic waveform generator using a feedback pair.

When an input pulse at field frequency arrives at Tr1 it turns the transistor hard on, short circuiting C1 which rapidly discharges through it. At the end of the input pulse Tr1 switches off again and C1 recharges for the next cycle of the sawtooth. Tr2 has two outputs, of opposite polarity, which feed the two emitter followers, Tr3 and Tr4. These in turn feed opposite ends of the output potentiometer VR1 which therefore provides both amplitude and polarity adjustment.

Parabola Generators

Parabolic waveforms are developed from a sawtooth waveform (generally the parabolic side of the circuit has its own sawtooth generator) by a circuit similar to the one shown in Fig. 2. Tr1 and Tr2 form a feedback pair but, unlike a straightforward amplifier, a capacitor, C1, is included in the feedback loop. This turns the circuit into an integrator. Without going into a detailed analysis we can say that the circuit carries out the mathematical operation of integration on the

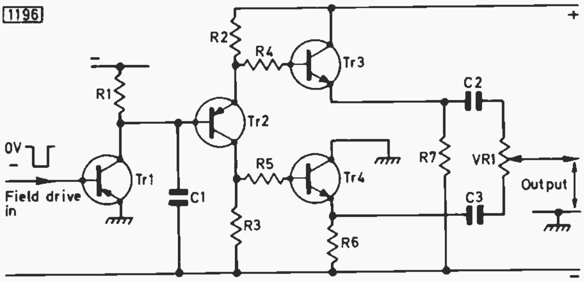


Fig. 1: A simplified sawtooth generator circuit.

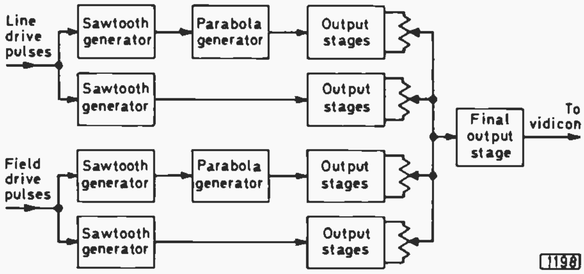


Fig. 3: Block diagram of a complete shading generator.

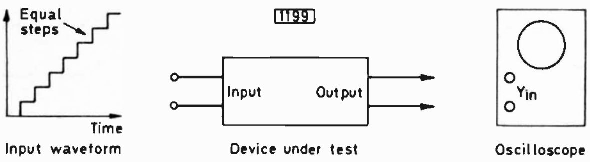


Fig. 4: Finding the transfer characteristic—general case.

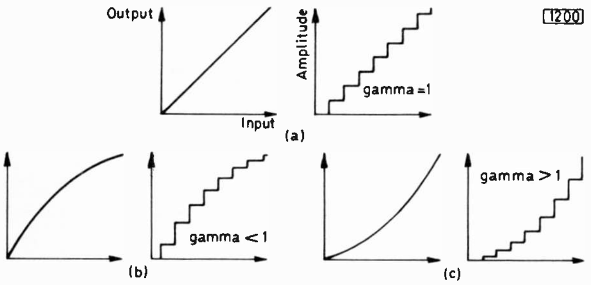


Fig. 5: The effect of different transfer characteristics on a linear staircase input waveform. (a) Gamma=1. (b) Gamma less than 1. (c) Gamma greater than 1.

input signal and it is further possible to show that this will result in a parabolic output from a sawtooth input. Again, Tr2 has two outputs of an opposite polarity feeding a common output control in exactly the same way as the sawtooth circuit.

The block diagram of the complete shading generator is shown in Fig. 3. The various output signals are mixed together and applied to the vidicon cathode or grid. The shading adjustments are quickly set up by pointing the camera at a uniformly illuminated surface, in practice a light box is used with a translucent glass or plastic diffusing screen fitted over the front. The controls are adjusted until the output waveform (on a 'scope) is uniform—that is, flat along the video portion on both line and field.

Gamma

In television use the term gamma refers to the transfer characteristics of the equipment under consideration (which may be c.r.t., camera tube, video amplifier or a combination of these) and must not be confused with the film industry use of the same term in connection with the exposure characteristics of a film. Let's take a general case for a moment and consider a device under test enclosed in a box (black, of course) with only the input and output terminals accessible from the outside (Fig. 4). A linear staircase waveform (which may be voltage, current, illumination, etc., depending on the requirements of device) is applied to the input and the output is displayed on a 'scope. This assumes that there is a voltage output available or that a suitable interface device is fitted to produce this.

Now, a transfer characteristic is simply a description of the relationship that exists between input and output of something. If the transfer characteristic of the device is linear then equal changes at the input will produce equal changes at the output so that the shape of the input and output waveforms are identical (the amplitudes will only be equal if the gain of the device is 1). From the way gamma is defined a device exhibiting a linear transfer characteristic has a gamma of 1. Two differing transfer characteristics and their effect on the output waveform for a linear staircase input are shown in Fig. 5(b) (gamma less than 1) and Fig. 5(c) (gamma greater than 1).

Calculating Gamma Values

Gamma values can be calculated from the transfer curves. If the curves of Fig. 5(a), (b), and (c) are plotted on log/log graph paper, straight lines result as shown in Fig. 6. The slope of the line is the gamma value of that particular characteristic.

It can be shown that the overall gamma of two or more stages is simply the product of the individual gamma values (Fig. 7). This enables us to calculate the gamma of a complete CCTV system once we know the gamma values of the various parts making it up.

Video amplifiers such as those found in cameras and monitors are designed to be linear, i.e. their gamma is 1. A vidicon tube on the other hand has a typical gamma value of about 0·65 so that its signal current output to increasing, linear steps of light input resembles the situation of Fig. 5(b). For equal changes of illumination there is a greater signal current output at the darker end of the staircase than at the brighter. This is an inherent limitation of the tube.

On the other hand, the gamma of the cathode-ray tube of a monitor (or a domestic receiver, for that matter) is generally about 2·2, corresponding to the case of Fig. 5(c). For equal changes of voltage applied to the tube's modulating electrode there are not equal changes in the light output from the screen. The light output increases more at the high (white) end of the scale than at the dark end.

We now have enough information to calculate the overall gamma of a camera plus monitor system by

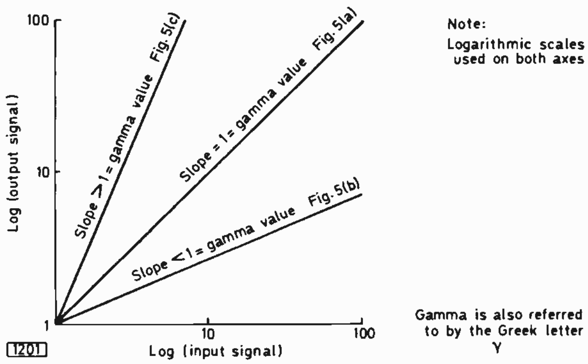


Fig. 6: Idealised transfer characteristics, similar to those shown in Fig. 5 but plotted on logarithmic scales.

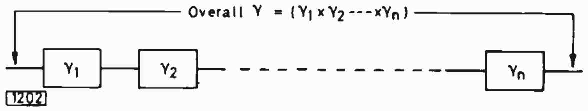


Fig. 7: Finding the overall gamma value of a number of stages.

multiplying together the individual gamma values. Overall system gamma = effective gamma of (camera + camera video amplifier + monitor video amplifier + c.r.t.) $= 0{\cdot}65 \times 1 \times 1 \times 2{\cdot}2 = 1{\cdot}4$ using the values given.

In practice this value is satisfactory for direct viewing by an audience. By a happy accident the mating of the characteristics of the vidicon and the cathode-ray tube means that no gamma correction is necessary. An ordinary film for camera use will also have a gamma of about the same figure (1·4), again in television terms. In this case we are talking about the relationship between a linear staircase of light input photographed by the camera and the amount of light that appears on the cinema screen when the film is projected.

Which leads to the question—why is it sometimes necessary to alter the gamma of a television system? Gamma control circuits are not found on lower grade equipment because for most purposes they are not needed—an adequate picture in terms of tonal values is obtained from the matching between camera and monitor described above. Broadcast standard or other more sophisticated equipment incorporates gamma correction circuits inside the camera video amplifier or as a separate unit following the camera. The example of the cinema film given above is a clue to the question's answer.

Telecine

Suppose a camera is used for telecine operation—viewing a film for subsequent distribution to video monitors. The gamma of the television system, as we have seen, will usually be about 1·4 but so also will the gamma of the film, giving an overall gamma for the complete system (film + TV system) of about 2 ($1{\cdot}4 \times 1{\cdot}4$). This is too high for normal viewing as distortion of the tonal values of the picture will be noticeable. We can electronically change the gamma of the television system (as will be seen later) to give the desirable overall gamma value to the system.

Another example is in the televising of scenes that are mostly dark or mostly light, i.e. without the usual range of tones found in a normal picture. By altering the gamma of the camera video amplifier we can distort the tonal values but improve the picture contrast. Colour cameras of the multi-tube variety must have identical response from each tube and gamma correction circuits (and, for the same reason, shading correction circuits) are fitted in each video amplifier to enable individual tube characteristics to be matched up.

Gamma correction can be achieved by operating one stage of the video amplification in the non-linear part of its operating characteristic. More commonly, because the degree of correction can be more easily controlled, diodes are used to modify the stage characteristics. Sometimes several diodes are fitted, conducting at different voltage levels to tailor the characteristic as desired.

Gamma Correction

A typical gamma correction circuit is shown in Fig. 8(a). The video input (non-composite) is clamped to provide a fixed d.c. reference level for the signal (the details of clamping are covered later in the article). At this point in the circuit the signal is negative-going, peak white corresponds to the most negative part of the signal. The potential at the emitter of Tr1, and hence the cathode of D1, will follow the input signal changes and be of the same polarity. The anode of D1 is held at a d.c. potential determined by the setting of VR1 and the values of the potential divider made up of VR1 and R3. As the signal goes more negative (i.e. whiter) the diode will, at some stage, become forward biased and start to conduct, partly shunting the emitter resistor, R2, and increasing the stage gain. This will introduce a bend into the transfer characteristic of the stage (Fig. 8(a)) which means that a linear staircase waveform applied to the input will come out similar to that shown in Fig. 5(c) meaning that the stage has increased the overall gamma. This is sometimes known as white stretching.

Similarly, we can decrease the gamma with the circuit of Fig. 8(b) where the diode has been reversed compared to Fig. 8(a). As the signal goes less negative —towards the blacks, the diode will begin to conduct (at a level set by the potentiometer) and the stage gain

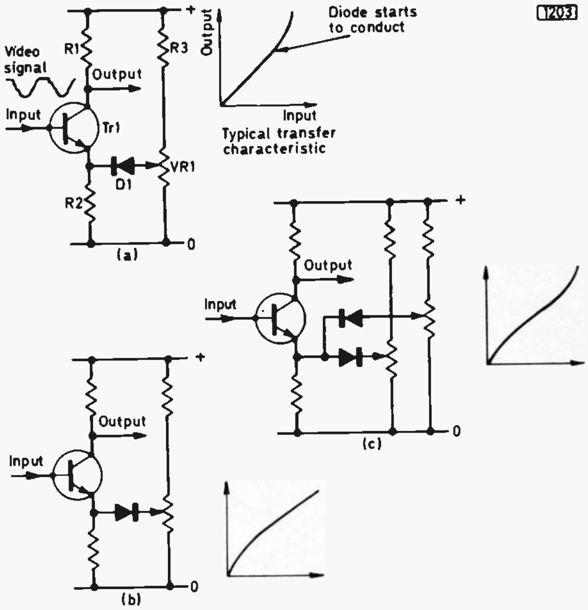


Fig. 8: Three forms of gamma correction circuit:
(a) White stretch.
(b) Black stretch.
(c) Combined black and white stretch.

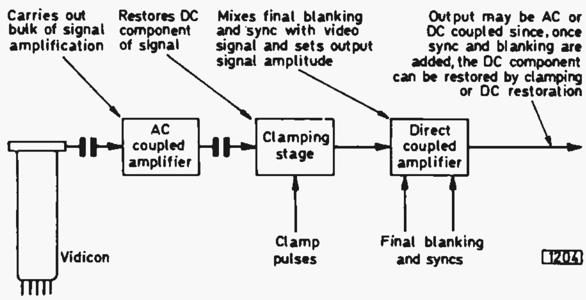


Fig. 9: The video amplifier chain of a typical camera.

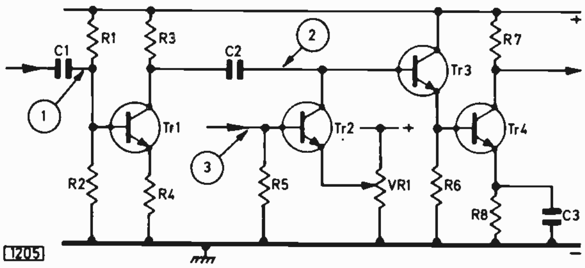


Fig. 10: A clamping circuit using a transistor clamp. The figures in circles refer to the waveforms in Fig. 11.

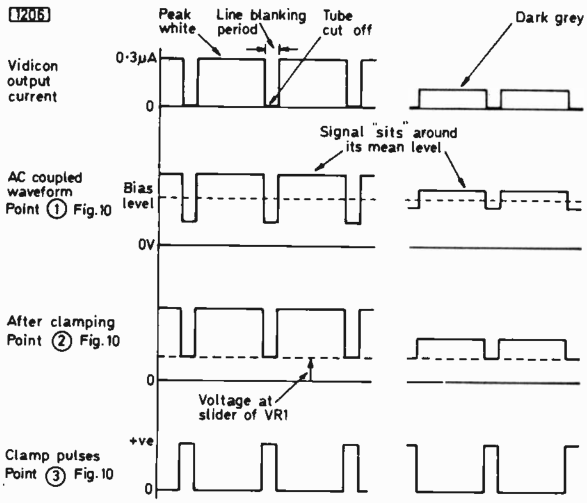
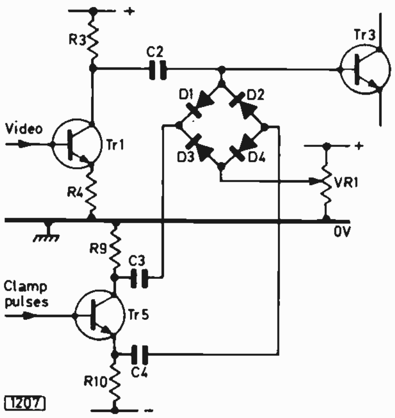


Fig. 11: The effect of a.c. coupling and subsequent clamping on a predominantly white scene and a predominantly dark grey scene. The waveforms are at line frequency.



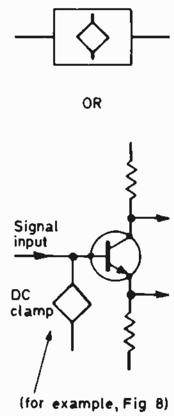


Fig. 12 (left): A clamping circuit using diodes.

Fig. 13 (right): Symbols sometimes used in block (top) and semi-block (bottom) diagrams to denote a clamping stage.

will be increased in the same way as before but this time at the black end of the picture (black stretch). By combining both these circuits, as in Fig. 8(c), we can obtain a wide range of gamma correction. Like many other circuits each manufacturer has his own favourite gamma correction circuit but most modern circuits are based on the examples described above.

The gamma of a camera can be measured by viewing a linear reflectance charts (a grey scale of equal steps, sometimes called a step wedge) and analysing the resulting output waveform on a 'scope. There are more sophisticated techniques available, requiring specialised equipment, but they will not be discussed here. Test charts including a step wedge are often expensive due to the high grade photography and printing necessary to obtain equal steps. A monitor's gamma can be assessed by feeding it with an electronically generated staircase waveform and measuring the screen brightness with a light meter.

Because of the inherent difficulties associated with the design and operation of direct coupled amplifiers it is normal practice in cameras and monitors to do most of the video amplification with a.c. coupled amplifiers. However, the drawback of a.c. coupled amplifiers is the complete loss of d.c. component of the signal and the tendency for the signal to float around its average value. A fixed d.c. reference is necessary for the correct operation of TV equipment.

Clamping

It is necessary therefore to re-insert a predetermined d.c. reference level after the a.c. coupled amplifier, Fig. 9. A few cameras and many monitors use a d.c. restorer circuit identical to those used in domestic receivers for the same purpose. More sophisticated equipment uses clamping circuits which give a more accurately determined d.c. level. A typical circuit is shown in Fig. 10. Tr1 is the last stage of the a.c. coupled amplifier and the signal passes to the clamping stage (Tr2, Tr3) via capacitor C2. The signal at this stage is positive-going and non-composite.

Transistor Tr2 is normally off and is switched hard on by positive-going clamp pulses applied to its base for the duration of the line blanking period. When it is turned on, the base of Tr3 and the right-hand side of C2 are effectively short circuited through Tr2 to a d.c. potential determined by the setting of VR1—the blanking level control. C2 charges and is big enough to maintain its voltage for the duration of the following line period until it is recharged when Tr2 turns on again. Thus, the d.c. level of the signal is set once each line; the waveforms at various parts of the circuit show what is happening (Fig. 11).

Another popular circuit uses diodes instead of transistors as the switching elements (Fig. 12). Tr5 acts as a phase splitting amplifier driven by the clamp pulses. Normally, the diodes are all off (non-conducting) but they are all driven on by the clamp pulse, connecting the d.c. potential on the slider of VR1 to the base of Tr3 when clamping takes place exactly as before. This is a very common circuit and is often used in a diagrammatic form to indicate a clamping stage in block or semi-block diagrams (Fig. 13).

Next month we leave cameras and look instead at monitors and the differences between them and domestic receivers, and also at some of the other equipment associated with CCTV installations.

MILLER'S Miscellany

Chas. E. MILLER

More Thorns in My Flesh

My luck seemed to have been in since I last wrote about strange faults experienced with the Thorn 1500 chassis. Most repairs consisted of valve changes and the occasional tuner trouble. About a couple of months ago however my lucky spell ended, some real stinkers arriving in the workshop.

Number one set had all the symptoms of PCL805 field timebase valve trouble, and indeed replacing the valve did cure the fault for a short while. Then it recurred, with all the bouncing, loss of hold and lack of height which seems to plague the 1500 from time to time. Changing almost any component in the field timebase would restore the picture temporarily to normal, but none of the old favourites (C75, C79, R94, R103, see Fig. 1) would oblige and provide a permanent cure. Finally I got round to checking the resistance between the cross-coupling capacitor C75 and the PCL805 pentode anode. This capacitor is not connected directly to the anode but is taken instead to the junction of two 18kΩ resistors connected across the field output transformer primary. Thus one would expect to obtain a meter reading of some 9kΩ, i.e. the two 18kΩ resistors effectively in parallel. Instead I got 18kΩ on the dial, but it was some time before the penny dropped and I unsoldered the resistors to check them individually. The one nearer the anode (R102) had gone up to over 200kΩ! I suppose that in view of previous experiences with resistors in Thorn chassis I should have cottoned on to the trouble sooner!

The next stinker was brought in by a customer who'd recently moved up from the Winchester area and had tried to retune the push-buttons to our local channels. He could get no trace of picture or sound however, though the raster was normal. A quick check on the transistor i.f. strip produced the surprising discovery that all the voltages were much too high, the rail voltage (HT6) being up from 26V to nearly 50V! My first reaction was to suspect that something had happened to turn off all the transistors, thus reducing the load on the supply. Accordingly I prodded around the a.g.c. amplifier VT3 (see Fig. 2). The collector voltage should be a mere 0·4V but was in fact over 25V! There was also a high reading at the anode of the a.g.c. detector diode W1 and this could be traced back to the emitter of the video driver transistor VT8 where the voltage was far above the correct figure of 5·2V. In fact the collector, base and emitter voltages of this transistor were all roughly the same—but no, it wasn't internally shorted. After much head scratching I went back to first principles and checked the source of the supply.

The 26V rail (HT6) is derived from the heater chain which is not returned directly to chassis but instead via two resistors R79 and R136, the former resistor actually being part of the mains dropper. A heater circuit diode rectifies the supply appearing at R79, C58 acting as the reservoir while R78 and C56 provide smoothing to give the 26V HT6 rail. A standing bias is taken from the junction of R79 and R136 to the base of the video driver. A resistance check showed that there was no d.c. path from the c.r.t. heater to chassis, R79 having gone open-circuit. As this was a rush job (aren't they all?) I made up a replacement from dropper sections and this restored things to normal.

The third 1500 exhibited the same fault as the last one mentioned, good raster but no sound or vision. In this case however the transistor voltages were down. This was traced to C38 (12μF) which decouples the HT2 line to the video output transistor. After this capacitor was replaced the set ran well on test for about an hour. Then it went again, this time due to C32 which decouples the bias applied to the video driver base going dead short. After this fault had been cured the a.g.c. amplifier transistor packed up, followed by the final i.f. transistor! Incidentally the set was not brought in for loss of vision and sound but for alleged roll after twenty minutes viewing, a fault I never saw!

I had made a special journey to the owner's house on a Saturday evening in order to deliver a loan set: the following Monday she rang up in my absence to complain that I'd not brought her set back and that if I really was interested in having her custom . . . .

Which Reminds Me . . .

. . . of the gentleman who phoned up and informed us that he wanted his set back that same evening, repaired or not. This was back in the early days of television when engineers were regarded (if possible) as being even more inferior than they are considered to be today, so his threat was expected to bring immediate grovelling and a plea that one might after all be permitted the privilege of dealing with the fault! Well, about 10.30 that evening we staggered down the customer's garden path with his prized 12in. console and hammered at the door. At length this was opened by a strange figure in vest and long-johns. When he saw the set his face lit up. "Did you manage to repair it then?" "No, but you demanded it back repaired or not so here it is, good night!" Those were the days!

Vintage Spot—EMI—2

When the BBC started TV broadcasting again after the war EMI were ready with some truly prestigious sets for what was clearly assumed to be a good class market. With screen sizes up to 15in., housed in magnificent cabinets proudly bearing the words "By Appointment . . . ", these were true aristocrats. Some models incorporated twin-speaker radios and even radiograms. It's hard to see how these expensively produced masterpieces could have been sold at a profit. At any rate, the next generation of EMI sets were aimed at a wider market. The mass produced series of 10in. models were a radical departure in design, with all the stages mounted on a small chassis

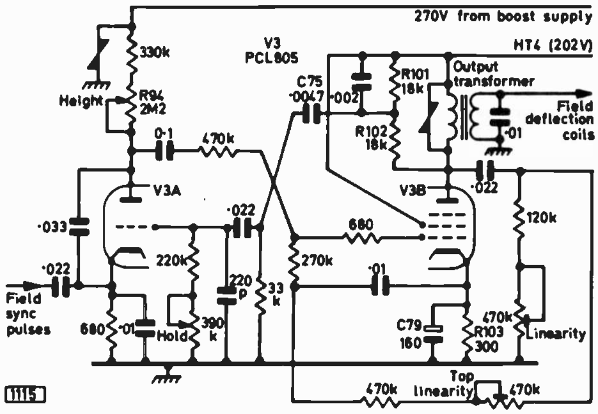


Fig. 1: The field timebase circuit used in the Thorn 1500 chassis. R102 can go high-resistance causing various field faults.

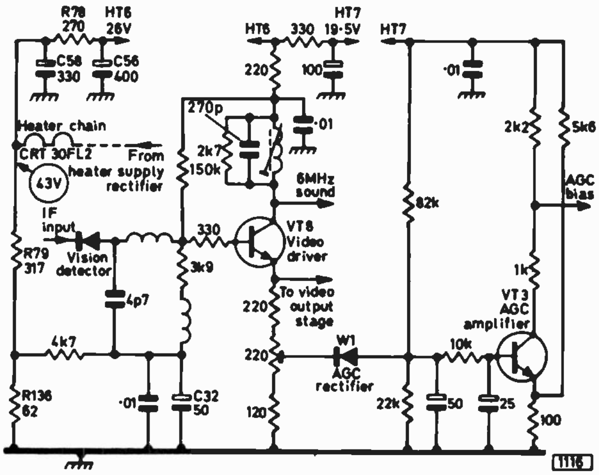


Fig. 2: Another awkward 1500 chassis fault: when R79 goes open-circuit the HT6 and HT7 rails rise dramatically.

frame. They employed 15 valves and a metal rectifier in an a.c./d.c. arrangement. The mains dropper was a most rugged piece of kit, wound with thicker than usual resistance wire and extremely trouble free in use. The line output transformer also rarely needed replacement.

The flies in the ointment were the main presets, of the wirewound slider type and disastrously fragile, and the i.f. strip. To their credit EMI were about the first UK setmaker to use the BREMA recommended i.f.s of 34·65MHz sound and 38·15MHz vision, but the stability of the tuned circuits left something to be desired. In those days I seemed to spend half my time realigning these sets to remove sound-on-vision! Perhaps this explains EMI's brief flirtation with t.r.f. receivers during the production run.

Another unexpected departure from EMI practice was the sound output stage. Instead of a more high-power stage they used a tiny Z77 r.f. pentode as the output valve! Can't help wondering why they didn't use the N37 genuine output pentode which was available in the Marconi range in those days. Their focusing method was the unique variable e.h.t. system which I described in a previous article.

All the sets sold under the HMV label used this chassis but, perhaps a harbinger of things to come, certain Marconiphone and Columbia models had a standard chassis made by Plessey. This practice was continued in the 12 and 14in. era that followed. EMI's own five-channel 12in. chassis had the B9A range of valves, a more conventional focus system—but still an r.f. pentode as sound output valve—and a redesigned i.f. strip. The timebases too were different, but they still had those wirewound, slider presets! Indeed these were to be a feature of EMI sets right up to the end—the final examples were of the multiturn type. Somehow though the EMI chassis didn't seem to live up to expectations: maybe they were over-designed. The simple but robust Plessey chassis was a far better proposition as regards reliability.

As television entered the ITV era EMI went one better than everyone else and produced a 14 channel tuner! They also pioneered the high-level contrast control system with the control in the anode circuit of the video output valve. They were the only firm to my knowledge to fit steering magnets (like a miniature ion trap) on their line output valves, though why they found this necessary is not clear! They also buried their e.h.t. rectifiers in the line output transformer and insulated the assembly with what looked like vaseline. Any overheating here resulted in a gooey mess at the rear of the set! Despite all the design changes however the i.f. strips were still temperamental to a degree. I can well remember going to the length of fitting strips of other makes as a last resort to keep sets going.

Finally, in the late fifties, EMI stopped production of TV sets altogether. All subsequent HMV and Marconiphone sets have been built by Thorn. It seems ironic that the firm which developed high-definition television in Britain should have opted out of domestic TV set manufacture just when the boom years started. We can only conjecture as to what their designers might have come up with had EMI stuck things out until the advent of colour!

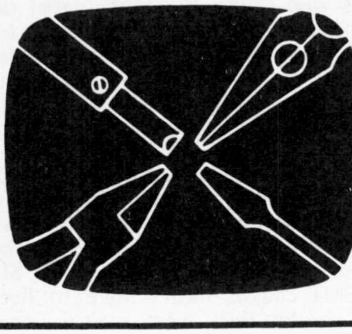
VIDEO CIRCUITS & FAULTS

—continued from page 304

first action should be to run through the brightness level/beam limiting set-up procedure: subsequent inability to obtain correct voltages can then be put down to circuit faults rather than misadjustment. As mentioned previously, incorrect clamp action in sets with a.c. coupling in the RGB channels can affect the brightness level. If the brightness level varies spasmodically check whether it does so under no-signal conditions as well as during signal reception—since clamping circuits operate with respect to black level, variations in signal strength and thus the placement of this level can vary the brightness.

Instances of reduced h.f. response from one channel are generally due to a dry-jointed or open-circuit emitter compensating capacitor or a faulty coupling capacitor—there have also been cases where an output transistor itself has developed reduced bandwidth. A defective coupler can cause smears that look like purity errors.

In older sets the emission from the three c.r.t. guns may be widely dissimilar. This causes complaints of muzzy pictures due to defocusing of the weaker beam(s)—especially towards the picture edges. ■



SERVICING television receivers

L. LAWRY-JOHNS

PYE HYBRID COLOUR CHASSIS —cont.

Weak Line Sync

In the event of weak line hold first try a new PCF802 line oscillator valve, then check the flywheel line sync discriminator diodes D40, D41 (type BA155 in later versions). Check C221 as mentioned last month. Another thing to check if necessary is the resistor (R205 47kΩ in Fig. 1) in the high-voltage reference pulse feedback path to the discriminator.

In the line timebase circuits shown last month the single-standard flywheel sync discriminator circuit was not included since it is basically the same as the dual-standard version. Note however that the feedback capacitor in the low-voltage reference pulse feedback path to the discriminator is 0·0022μF (not 170pF as in the case of the dual-standard circuit shown in Fig. 1). In later chassis the flywheel sync filter resistor (R208 in Fig. 1) is 68kΩ. Also in later dual-standard and in all single-standard chassis the anti-hunt network components in the filter circuit (R210 and C209 in Fig. 1) are 3·3kΩ and 1μF: it is worth making this change in earlier chassis if the picture is bent over at the top.

The Field Timebase

The field timebase does not give much trouble but when a fault does occur confusion can arise due to misleading symptoms. For example, absence of say the 20V positive supply line does not mean that the field will collapse completely. Quite a sizeable band of scan (albeit distorted) will remain. This is due to the 20V negative line (or vice versa) still being present and operating the timebase after a fashion while shifted up or down due to the shift control being connected across the same positive and negative supply lines (via R323 and R324).

Now let us consider a couple of particular cases. Both concern new sets which had been out for only a

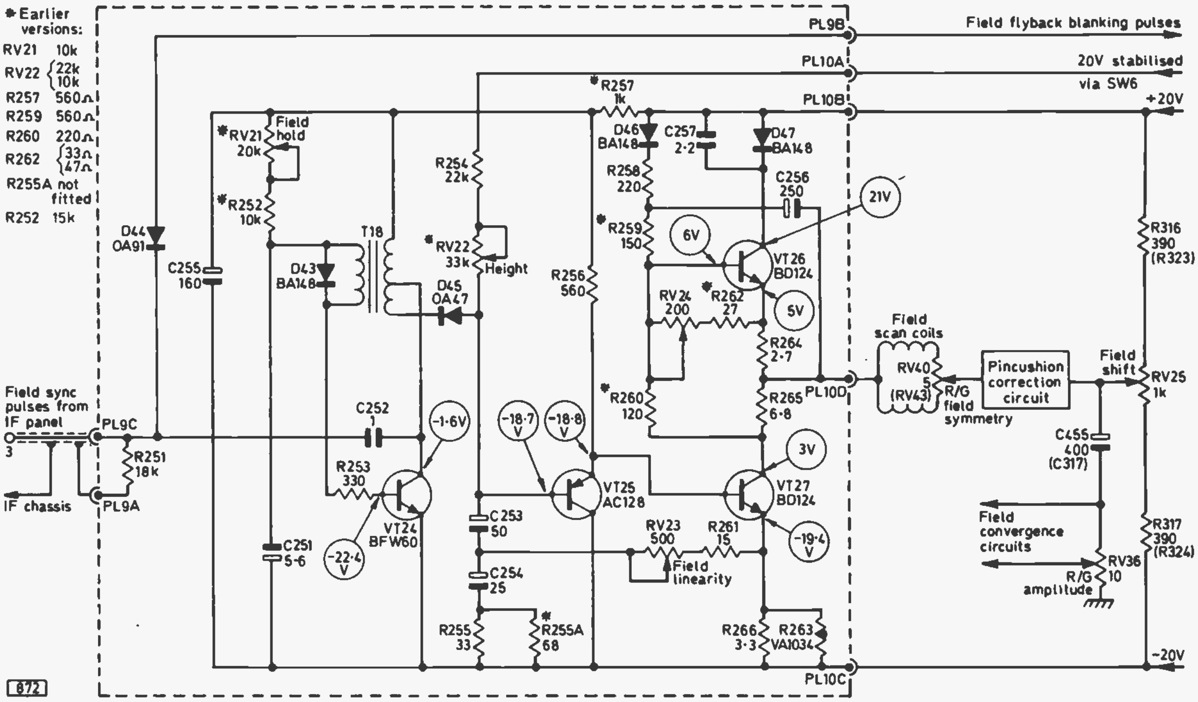


Fig. 4: The field timebase circuit, showing modifications. In the dual-standard version a coil (L49) was incorporated in series with the field shift control slider. Component reference numbers in brackets apply to the dual-standard chassis. For layout see page 261, April 1974.

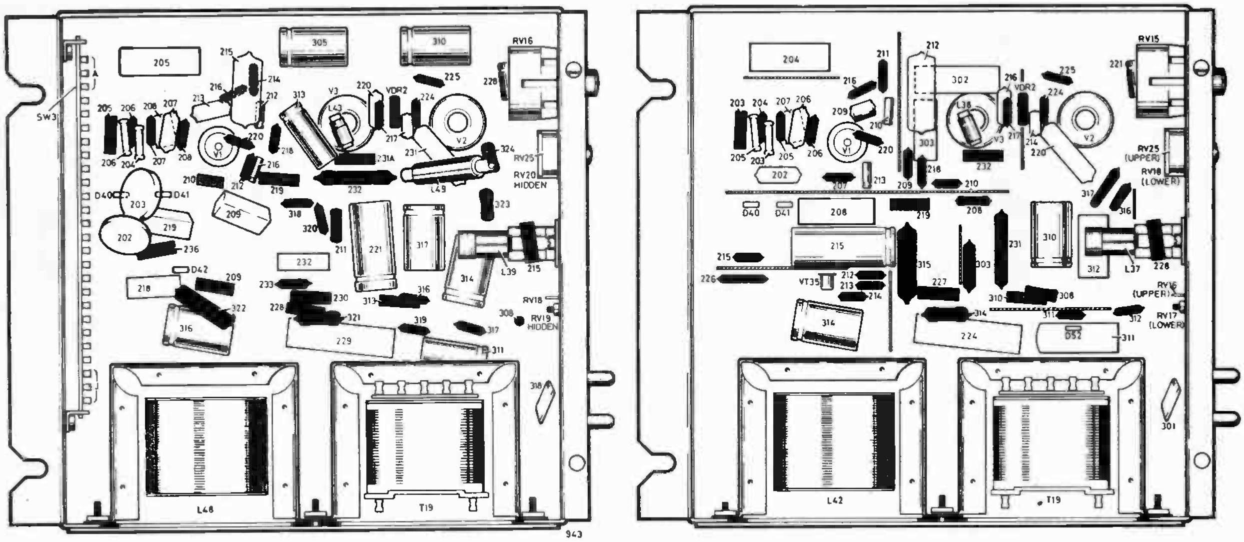


Fig. 5: Underchassis views of the earlier line timebase/power supply unit, dual-standard version left, single-standard version right. Most of the components in the single-standard version were later mounted on two printed boards.

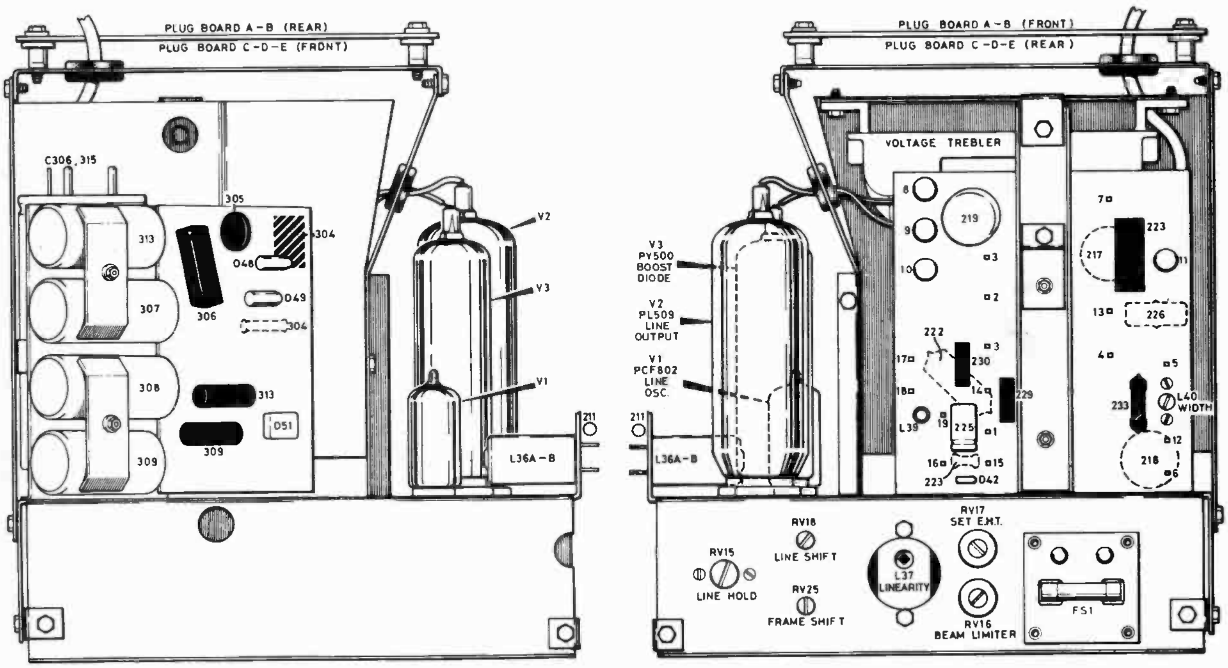


Fig. 6: Views of the line timebase/power supply assembly used in earlier single-standard chassis. These retained the screened compartment but used an e.h.t. tripler in place of the GY501 and PD500 in the dual-standard chassis.

couple of weeks at the most. Both were up-to-date 697 versions, with the right side vertical printed panel.

The first set had a band of about four inches of scan across the lower half of the screen folded up. A meter check on the output transistors showed that they were sharing only 20V and that the 20V positive line was absent, so we said "Ah, must be the bloody edge connector". Having spent some time sorting out which contact was involved we then found the supply absent there as well. The dropper resistor down below was intact so we tediously followed the track up the panel until the voltage was suddenly lost. There visible only when scraped was the finest of cracks. After constructing a suitable bridge the scan opened up to its full glory as it remains to this day. The fact that the line output stage collapses for a split second about once a week (only) is another story which cannot yet be related.

Set number two appeared to function well enough but after it had been in use for a week or so the owner complained of an annoying slight height fluctuation—not enough to switch the set off and go to bed but enough to irritate. We arrived on the scene complete with a replacement field timebase panel just in case the going got rough only to find that the 20V supply to the

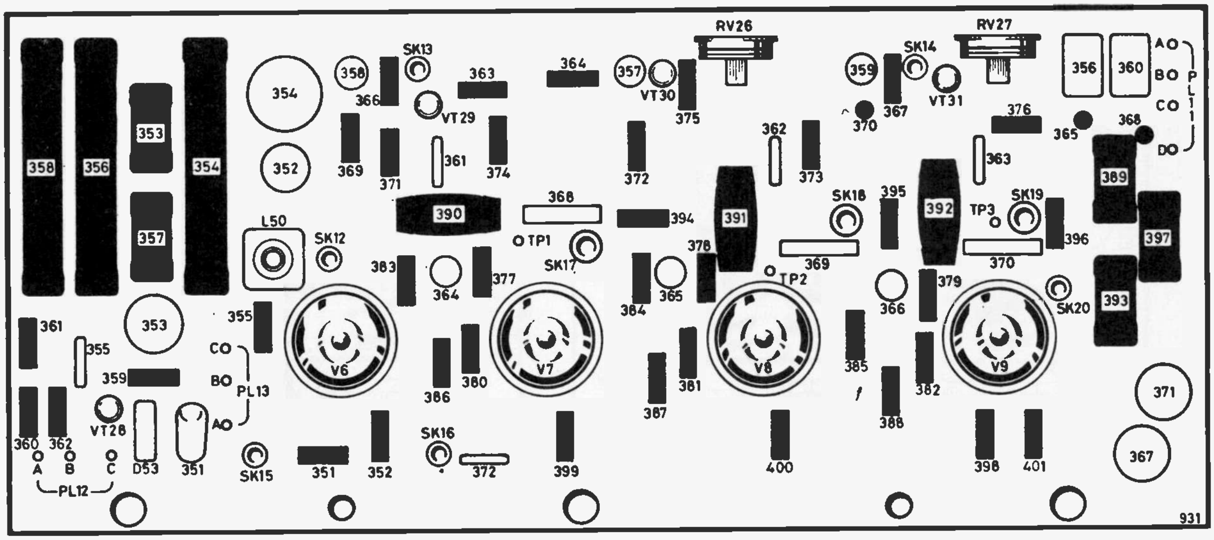


Fig. 7: Layout of the CDA (colour-difference amplifier) panel. The physical shapes of some of the components differ in later versions.

height control was fluctuating. "Bloody zener" we wrongly diagnosed. In fact it turned out to be the 250μF electrolytic (C312) across the zener. It was well nigh open-circuit. When one ponders on this, the zener did do a pretty good job in keeping the voltage as steady as it was.

So there we are: the field timebase panel is more reliable than its power supply. What about the time when one of the output transistors went open-circuit, that wasn't the supply was it? No, but that was a long time ago, about the time when the 160μF smoothing capacitor C255 shorted and collapsed the field. So it doesn't matter what you say, there always seems to be something to jog your memory and prove you wrong. Field hold troubles can be caused by C255 drying up.

The CDA Panel

The luminance output stage and the colour-difference amplifiers are on the left side board: the valves seem to glow brighter than they should. The one with the single heater is the PL802 luminance output valve which can be looked upon as the video amplifier in a monochrome set. It leads a rather arduous life, what with the large signal swings, the brightness control operating on its control grid and its cathode bouncing up and down with the blanking pulses. It's not a life that I would like. When the brightness falls and the control is fully up therefore, spare a thought for the PL802 which may well be failing in emission causing the c.r.t. cathodes to rise in respect of the clamped grids.

With a 285V supply line the anode voltage of the PL802 (pin 7) should be about 215V with about 1·25V on its cathode (pin 9) and 205V on its screen grid (pin 8). If the valve is not at fault and the screen grid voltage is low check the 4μF capacitor (C353) which decouples it. If the screen grid voltage is high check the PL802's cathode components which include VT28 and D53.

If the voltages around the PL802 are correct it is likely that all is not well with the colour-difference output clamps. These consist of the triode sections of the colour-difference amplifiers (V7, V8 and V9), the three PCL84 valves. The cathodes of these three triodes are strapped and held at a constant voltage of something like 105V by the potential divider R393, R397. Obviously these may change value. Say R393 goes high-resistance. The voltages at the anodes will then fall as will the voltages at the c.r.t. grids and in consequence the brightness of the picture will be reduced. The reverse will happen of course if R397 goes high-resistance. The triode cathodes will then rise together with the anode voltages and the c.r.t. grid voltages to produce a brighter picture.

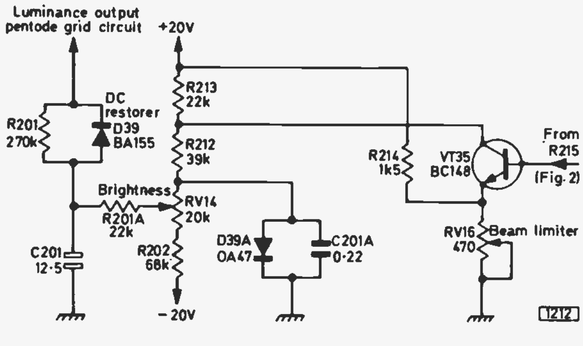


Fig. 8: Beam limiter circuit used in single-standard chassis. In earlier versions D39 was type BA115, R202 82kΩ, R212 and R213 47kΩ with D39A/C201A omitted.

Wrong Colours

All this is fairly obvious. When on the other hand only one clamp varies, the colour of the picture will change. If for example the picture takes on a magenta hue it is likely that the c.r.t. green grid voltage is low and that R395 has gone high-resistance. If the green PCL84 loses emission on the other hand its anode voltage will rise producing excessive green.

We have often been called in because of pretty awful colours to find that one of the PCL84 valves has an excessively bright single heater, one of its heaters having failed leaving the other to receive the full wack.

The rule then is to get the voltages right, starting

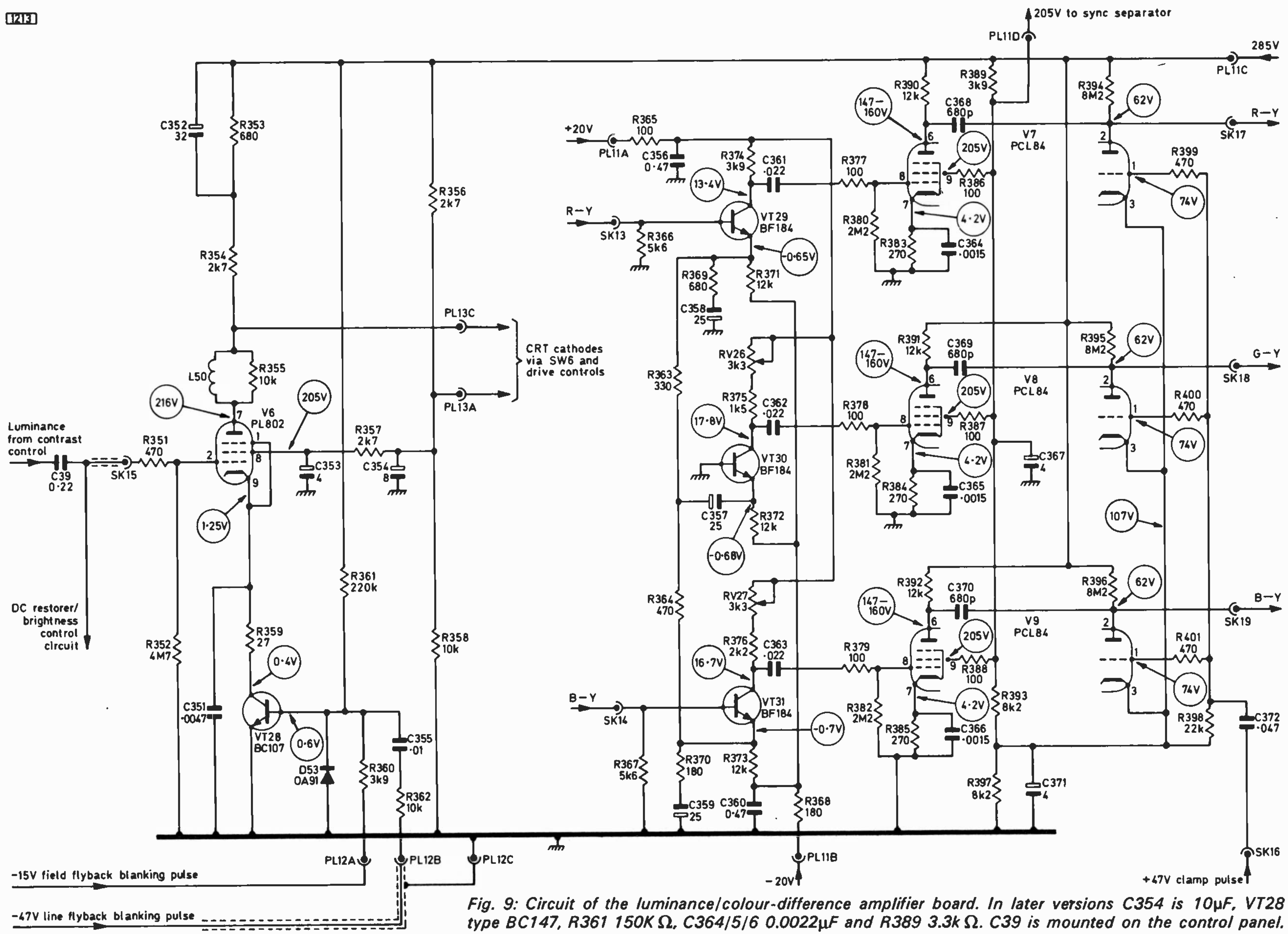


Fig. 9: Circuit of the luminance/colour-difference amplifier board. In later versions C354 is 10μF, VT28 type BC147, R361 150K Ω, C364/5/6 0.0022μF and R389 3.3k Ω. C39 is mounted on the control panel.

from the c.r.t. grids and first anodes and working back to the PCL84 anodes and screen grids: in nine cases out of ten the cause of the trouble will become apparent as an incorrect voltage is found.

Mention of the c.r.t. first anodes draws attention to the presets RV40–RV42 and their 1·5MΩ series resistors R469–R471.

Note that there will be no clamping action if R227 (line output section) goes open-circuit and the result will be weak colours.

IF and Decoder Panels

Believe it or not we have had only two faults (both more than once of course) on the i.f. panel. The first involves replacing the 4·7MΩ resistor to the base of the sync separator: this has already been mentioned. The other and more difficult one is to find the cause of loss of volume, the audio module not being at fault.

By coincidence when this one first turned up we had been spending some time on a Marconiphone Model 4816 portable (Thorn 1590 chassis) which had a similar complaint. We located the cause of the trouble in the Marconiphone set first. The cure consisted of removing the 6MHz quadrature coil can and replacing the small capacitor across the coil. Thus armed we approached the i.f. panel of the colour set (a later version, Invicta Model 7053). This also has an intercarrier sound i.c. and a similar quadrature coil and sure enough the 1,500pF tuning capacitor across the coil was open-circuit.

So all in all we can no more criticise the i.f. panel than we can the decoder, which has proved very reliable indeed.

CONCLUDED NEXT MONTH

ANOTHER COLOUR SYSTEM

The question of which colour system to adopt, PAL or SECAM, has been under consideration now for over eight years in Italy. "Under consideration" is probably a mild way of putting it: the decision is inextricably mixed up with political and financial factors. A new system, ISA, has now been proposed. This is understood to be a variant on PAL developed and patented by the Indesit company of Turin. Whether this will break the deadlock remains to be seen.

TV ICs

Signetics have announced that they are to second-source the TBA120S (see last month) intercarrier sound i.c. and the TBA440 vision i.f./demodulator/a.g.c. i.c. The Signetics TBA440 will be available in two versions depending on whether the a.g.c. output is to be applied to a tuner unit employing pnp or npn transistors. Signetics also intend to introduce a new-generation version of the TBA120S, called the TBA120U, and to second-source the recently announced Motorola range of colour decoder i.c.s—the TBA327, TBA395 and TBA396. The TDA440 was originally introduced by SGS-ATES: it is also produced by Siemens and Telefunken.

Siemens have announced a series of m.o.s. integrated circuits for use in TV receiver remote control systems. The SAB1000 is a transmitter i.c. providing an ultrasonic output at 36 frequencies within the range 33·2–45·8kHz. The associated receiver i.c. is type SAB1001 which operates in conjunction with the SAB1002 memory i.c.

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HMV 2703

The picture collapsed, a smell of burning and smoke coming from the back of the set. The sound remained. On examination we found that R529 had completely burnt out and that the cover of the adjacent electrolytic C530 had melted away. Could you suggert a cause for this failure? Some slight cogging had been noticed prior to the loss of picture but this used to clear up after a very short time.—R. Duncan (Whitwick).

The two components are connected across the 2·2μF line scan correction capacitor C524 which should be checked therefore before R529 and C530 are replaced. Note that C524 must be an exact manufacturer's replacement type. A less likely possibility is a short-circuit in the line deflection coil circuitry. (Thorn 3000 chassis.)

PHILIPS 19TG156A

The trouble with this set is that the picture balloons when the brightness control is advanced. All the line timebase valves, the two boost reservoir capacitors and the resistor in series with the heater of the e.h.t. rectifier have been changed.—K. Darwin (Glossop).

Check for corrosion in the DY86 e.h.t. rectifier valve socket and replace if necessary. Then check the line output valve's screen grid feed resistor R458—this is mounted just beneath the PCL85 on the timebase panel and should be 2·2k Ω. If these points are in order it is likely that the line output transformer is faulty.

KB CK403

The problem with this set is lack of width—the picture is in about 1in. on each side. The PL509 line output valve and PY500 boost diode have been replaced, also the high-value resistors Rh40 and Rh44 in the width circuit, but the width is still in.—G. Kinnear (Chatham).

The usual cause of low width in this chassis is the two resistors you mention. If you are sure that the replacements are up to standard we suggest you check the width controls and the 270pF pulse feedback capacitor Ch23, then make sure that the h.t. voltage is about 290V. If low, replace the 300μF plus 700μF reservoir/smoothing block. Confirm that the drive at the control grid of the PL509 is about −80V, then suspect the line output transformer. (ITT CVC2 chassis.)

EKCO T543

There is an intermittent fault on this set. Sometimes the set works perfectly for hours but at other times the line scan goes out of sync repeatedly, the picture breaking up as the line timebase runs free at high speed. When the fault is present the line hold control has no effect: normally the setting is not very critical. A "jolt" to the line timebase, for example touching the top cap of the PY800 boost diode with an insulated screwdriver, produces lock again.—P. Horne (Oakhampton).

The most likely components to be causing this trouble are the line oscillator feedback capacitor C67 (820pF) and the oscillator coil (L14). (Pye 169 chassis.)

PHILIPS G22K550/01

Frequently when this set is switched on there is no vision modulation on one or more channels, though the sound is o.k. Alternatively, the vision may take several seconds to come in after changing channels—the sound again being normal. The raster is present and the brilliance control operates normally when the vision signal is absent. Occasionally a poor monochrome picture appears. A correct colour picture can be obtained by immobilising the a.f.c., holding in a tuner button, or in stubborn cases by readjusting the tuning preset potentiometers—this tuning appears to have a backlash effect. The 30V tuning voltage is present and correct during the fault symptoms. On at least one occasion we were able to restore the vision by removing and replacing the aerial plug.—T. Anderson (Hull).

The tuner and its immediate circuitry can be discounted since the sound is always present. What you seem to have is a lockout problem, probably originating in the a.g.c. stage which is incorporated in the TAA700 i.c. The i.c. could be defective but if its pin 4 (a.g.c. output) voltage remains at around 2·2V when the fault is present the i.f. transistors should be suspected and checked. Probably the easiest course in this event is to replace the U300 vision gain/detector module. (Philips G8 chassis.)

BUSH TV312

We have come across several cases where the AU113 line output transistor used in this 12in. portable has failed for no apparent reason. Are there any stock reasons for this?—T. Riddley (Folkestone).

The AU113 is protected against transients by means of a 100μF capacitor which is connected between the stabilised 11V line and the base of the regulator sensing transistor (4VT3, BC262B). This capacitor was not fitted on early production models so where the AU113 fails check whether it is there—it can be added on the rear of the panel. Another cause of AU113 failure is when the TV/charge switch has been operated with the set switched on. Customers should be warned about this.

DECCA CTV19

The problem with this set is no e.h.t. The PL509 line output valve gets distressed, glowing red, but the drive from the PCF802 line oscillator seems to be o.k. There are no signs of cooking around the line output transformer.—T. Bennett (London, N2).

We assume you have tried new valves (PL509, PY500, GY501, PD500). If so check the boost capacitor C413 then the d.c. feed coil L408 to the anode of the PL509—this handles large peak voltages which can damage it in time. If necessary check the c.r.t. first anode supply decoupling capacitor C401 and the focus circuit.

MARCONIPHONE 4807

The line and field sync are fairly critical and a dark hum bar moves upwards from the bottom of the screen. When this reaches three inches from the top of the screen the field rolls and the picture pulls over. When the hum bar reaches the top the picture locks correctly for a short time then the whole sequence starts all over again. We have thoroughly checked the sync circuits, the supply line electrolytics and the electrolytic coupler to the video output transistor.—R. Pearson (Manchester).

Check C32 (50μF) which smooths the bias applied to the base of the video driver stage. If this is in order check resistors R136 and R79 from which the bias is derived. Assuming that all relevant supply line smoothing capacitors are in order the fault is in this area. (Thorn 1500 chassis.)

KB KV005

The field output valve cathode decoupling capacitor C84 was found to have burst while its anode feed resistor R101 was found to be charred. The valve and these two components were replaced but the field opens out to only four inches and after about five minutes collapses to a horizontal white line. While the scan is open it is not very bright. The field output transformer and field scan coils seem to be in order.—R. Thomson (Salop).

The fact that C84 was found to have burst means that it had been subject to a high voltage. This could have been due to the valve, which you have replaced. It could also have been due to a leak in C83 which decouples R101 to the cathode (pin 8) of the field output valve. This capacitor (50μF, 275V) should be replaced therefore. Also check the value of the cathode bias resistor R100—it should be 390 Ω. (STC/ITT VC3 chassis.)

ULTRA 6702

The blue amplitude and tilt presets R23 and R27 on the convergence board are burning up while the associated clamp transistor W2 goes open-circuit and its series resistor R22 gets very hot. All these components have been changed but the trouble remains. There seem to be no faults on the convergence board itself while as the picture is of full width and steady the line timebase appears to be in order—there is no excess heat or smell of burning in this area.—G. Sheridan (Warley).

It strikes us that the blue line dynamic convergence coils are open-circuit or dry-jointed. This would divert a heavy current through the components you mention. The coils are connected in series between EC2B/1 and EC2B/2. Before condemning the whole convergence yoke check the joints between the fine coil wire and the leadout tags. (Thorn 2000 chassis.)

KB SV154

The problem on this set is a white flickering which stays on for some time, clears itself, then comes on again. A new e.h.t. rectifier and line timebase valves have been fitted but have made no difference.—T. Armstrong (Malton).

If the "flickering" is less severe when the contrast control is turned down fully the cause of the trouble is probably in the i.f. strip. Faults here are rather common and can be due to cracked print, dry-joints or faulty transistors, especially those of the circular type. The entire i.f. strip can be changed fairly easily on this model. If the fault is not affected by the setting of the contrast control, concentrate on the video amplifier stages. (ITT VC200 chassis.)

BUSH CTV25

After the set has warmed up the picture blurs and dark horizontal lines flickering intermittently develop, accompanied by a buzzing sound which continues unaffected when the volume control is turned down. For short periods the trouble stops, the picture lightening and becoming clear.—H. Paine (Reigate.)

Check the DY86 focus rectifier and 3C21 (270pF) which is connected between its cathode and the focus controls. Also look for signs of charring on 9SG1, the cap-gap (decoupling capacitor with built-in spark gap) associated with the focus electrode (pin 9) of the c.r.t. If the inside of the set is inspected in a darkened room when the fault is present a discharge might be seen at some point in the focus circuit.

PHILIPS G19T210A

The set works normally when first switched on but if the programme is changed the picture and sound disappear, leaving just a blank raster, and remain off no matter which channel is selected. The only way to get the sound and vision back is to switch the set off and on again. Picture and sound are then present and remain until the channel is changed. The transistors in the tuner unit have been replaced but the fault remains.—J. Carson (Romsey).

We suggest you concentrate on the a.g.c. stage. Check the electrolytic (C2074) in the base circuit of the OC44 transistor (T2189), the transistor itself and the OA81 diode. A less likely possibility is one of the transistors in the i.f. strip. (Philips 210 chassis.)

GEC 2034 CONCORDE

On my present u.h.f. aerial I get a good picture but no sound, only a loud hum. The set has been tried on another aerial which again gave a good picture, but as soon as the tuner was tuned for sound the picture went off and the sound came in loud and distorted. On v.h.f. again there is a good picture but the sound is very low even with the volume turned up fully and there is a great deal of hum. On the ITV v.h.f. channel I can't get anything at all unless I hold the channel knob slightly off centre: I then get a decent picture with very low sound and sound-on-vision. There is hum on all channels, both u.h.f. and v.h.f.—R. Brooker (Leicester).

When it is difficult to co-ordinate the sound and vision on these dual-standard receivers the trouble is generally due to C93 (32µF) which decouples the screen grid of the video amplifier section of the PFL200 and the h.t. to anode of the EH90 sound detector/amplifier. We suggest you replace this component therefore. The voltage at pin 6 of the EH90 should be 41V on u.h.f. If this is not so replace the resistors (R92 18kΩ 5W and R93 5·6kΩ 2W) which form a potential divider feeding this pin. They often fall in value.

HMV 2714

The fault on this set is loss of colour—the black and white picture remains however and is good. The colour appears on some occasions and certain programmes, but is then lost again. A new chrominance panel has been tried but the fault remained the same.—D. Rockingham (Bury).

The first, gain-controlled chrominance amplifier is VT110 which is mounted on the i.f. board. Check this transistor—it is usually responsible for the fault. The associated components could also be the cause but this is less likely (Thorn 3500 chassis.)

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TELEVISION MAY 1975

TEST CASE

149

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 single-standard GEC colour receiver tended to change hue somewhat spontaneously. The shift in colour was generally not excessive but was sufficient to be obtrusive. At other times however there would be a more dramatic colour change, with green severely attenuated and red shifting towards magenta. This more markedly faulty display gave a good clue as to the approximate whereabouts of the trouble. Blue was not affected, green which is produced by matrixing red and blue was largely absent, while the red content was changing: something was clearly amiss with the red channel.*

The model in question is a hybrid one with PCL84s acting as the colour-difference output pentodes and triode clamps. Matrixing to produce the green colour-difference signal is carried out in the colour-difference output stages in this chassis. The triode clamps employ a time-constant RC circuit to hold the d.c. level substantially stable during the lines of picture signal. If one clamp—say the red one—fails to work properly the d.c. level of the output from that channel will shift and there will be change in the colours to which the channel contributes. The technician was aware of this basic theory and accordingly concentrated his attention on the red clamp circuit. The anode load of the clamp triode consists of a high-value (8·2MΩ) resistor which is part of the time-constant network previously mentioned. These resistors have a habit of changing value—sometimes drifting as the set warms up—and thus causing hue changes.

The red triode clamp anode load resistor and one or two associated components were found to have altered in value but their replacement made not the slightest difference! What other part of the circuit could be responsible for the symptom described? See next month's TELEVISION *for the solution and for a further item in the Test Case series.*

SOLUTION TO TEST CASE 148

Page 281 (last month)

The technician appeared to pay no attention to the bottom end of the brightness control circuit. It will be recalled he established that the feed from the boost voltage line via a 4·7MΩ resistor to the top of the control was present. In this model the bottom end of the control is connected via a 47kΩ resistor to the mains neutral contact of the on/off switch—a technique used to prevent the switch-off spot lingering on the screen. The 47kΩ resistor forms part of the brightness control potential divider network therefore and was found to be low in value. Thus even with the brightness control set to maximum its slider was at a lower voltage than normal. Replacing the 47kΩ resistor restored normal control of the brightness.

Published on approximately the 22nd of each month by IPC Magazines Limited, Fleetway House, Farringdon Street, London EC4A 4AD. Printed in England by Fleetway Printers, Crete Hall Road, Gravesend. Sole Agents for Australia and New Zealand—Gordon and Gotch (A/sia) Ltd.; South Africa—Central News Agency Ltd. Publisher's subscription rate (including postage): for one year, £3.25 inland rate, £3.85 overseas rate. International Giro facilities Account No. 5122007. Please state reason for payment "message to payee". "Television" is sold subject to the following conditions, namely that it shall not, without the written consent of the Publishers first having been given, be lent, resold, hired out or otherwise disposed of by way of Trade at more than the recommended selling price shown on the cover, excluding Eire where the selling price is subject to VAT, and that it shall not be lent, resold, hired out or otherwise disposed of in a mutilated condition or in any unauthorised cover by way of Trade or affixed to or as part of any publication or advertising, literary or pictorial matter whatsoever.

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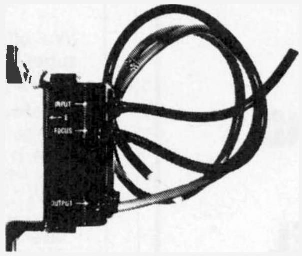
2N1302	0·185	2N4289	0·34	AF240	0·90	BD138	0·63	MPF102	0·39
2N1304	0·26	2N4920	1·10	AF279	0·70	BD139	0·71	MP5A05	0·25
2N1306	0·31	2N4921	0·83	AF280	0·79	BD140	0·87	MP5A06	0·31
2N1308	0·47	2N4923	1·00	AL102	1·00	BF115	0·36	MPSA55	0·31
2N1711	0·45	2N5245	0·47	BC107	0·14	BF117	0·55	MPSA56	0·31
2N2102	0·60	2N5294	0·48	BC108	0·14	BF154	0·20	OC28	0·765
2N2147	0·78	2N5296	0·48	BC109	0·14	BF159	0·27	OC35	0·60
2N2148	0·94	2N5457	0·49	BC147B	0·14	BF180	0·35	OC42	0·50
2N2218A	0·22	2N5458	0·46	BC148B	0·15	BF181	0·36	OC45	0·32
2N2219A	0·26	2N5459	0·49	BC149B	0·15	BF184	0·30	TIP29A	0·49
2N2220	0·25	2N6027	0·45	BC157A	0·16	BF194	0·12	TIP29C	0·58
2N2221	0·18	3N128	0·73	BC158A	0·16	BF195	0·12	TIP31A	0·62
2N2222	0·20	3N140	1·00	BC167B	0·15	BF196	0·13	TIP32A	0·74
2N2369	0·20	3N141	0·81	BC168B	0·15	BF197	0·15	TIP33A	1·01
2N2646	0·55	3N200	2·49	BC169B	0·15	BF198	0·18	TIP34A	1·51
2N2904	0·22	40361	0·40	BC182	0·12	BF244	0·21	TIP35A	2·90
2N2905	0·25	40362	0·45	BC182L	0·12	BF257	0·47	TIP36A	3·70
2N2906	0·19	40406	0·44	BC183	0·12	BF258	0·53	TIP42A	0·90
2N2907	0·22	40407	0·35	BC183L	0·12	BF259	0·55	TIP2955	0·98
SN2924	0·20	40408	0·50	BC184	0·13	BFS61	0·27	TIP3055	0·50
2N2926G	0·12	40409	0·52	BC184L	0·13	BFS98	0·25	TIS43	0·28
2N3053	0·25	40410	0·52	BC212A	0·16	BFR39	0·24	ZTX300	0·13
2N3054	0·60	40411	2·00	BC212LA	0·16	BFR79	0·24	ZTX301	0·13
2N3055	0·75	40594	0·74	BC213LA	0·15	BFX29	0·30	ZTX500	0·15
2N3391	0·28	40595	0·84	BC214LB	0·18	BFX30	0·27	ZTX501	0·13
2N3392	0·15	40636	1·10	BC237B	0·16	BFX84	0·24	ZTX502	0·18
2N3393	0·15	40673	0·73	BC238C	0·15	BFX85	0·30	IN914	0·07
2N3440	0·59	AC126	0·20	BC239C	0·15	BFX88	0·25	IN3754	0·15
2N3442	1·40	AC127	0·20	BC257A	0·16	BFY50	0·225	IN4007	0·10
2N3638	0·15	AC128	0·20	BC258B	0·16	BFY51	0·23	IN4148	0·07
2N3702	0·12	AC151	0·27	BC259B	0·17	BFY52	0·205	IN5404	0·22
2N3703	0·13	AC152	0·49	BC301	0·34	BRY39	0·48	IN5408	0·30
2N3704	0·15	AC153	0·35	BC307B	0·17	ME0402	0·20	AA119	0·08
2N3706	0·15	AC176	0·30	BC308A	0·15	ME0412	0·18	BA102	0·25
2N3708	0·14	AC187K	0·35	BC309C	0·20	ME4102	0·11	BA145	0·18
2N3714	1·38	AC188K	0·40	BC327	0·23	MJ480	0·95	BA154	0·12
2N3716	1·80	AD143	0·68	BC328	0·22	MJ481	1·20	BA155	0·12
2N3771	2·20	AD161	0·50	BCY70	0·17	MJ490	1·05	BB103B	0·23
2N3773	2·65	AD162	0·50	BCY71	0·22	MJ491	1·45	BB104B	0·45
2N3789	2·06	AF106	0·40	BCY72	0·15	MJ2955	1·00	BY126	0·12

Prices correct at April 1975, but all exclusive of V.A.T., postage & package 25p.

COLOUR 25 KV TRIPLERS



£1.70+13p V.A.T.

REPLACEMENT TRIPLERS

TS25, 11TAZ	£3.00+24p V.A.T.
G8 TRIPLERS	£3.00+24p V.A.T.
COLOUR SCAN COIL	£3.00+24p V.A.T.
I.C. SN76544N	£1.00+8p V.A.T.
BU105 Transistors	50p+4p V.A.T.
DECCA CS1730	£1.00+8p V.A.T.
E.H.T. RECTIFIER STICKS X80/150D	10p+1p V.A.T.
PYE TRANSISTOR TUNER UNITS VHF, UHF. *No* push button assembly	£1.50+12p V.A.T.
PHILIPS UHF UNIT	£1.50+12p V.A.T.
6 OR 4 PUSH-BUTTON UHF TUNER UNIT PYE	£3.00+24p V.A.T.
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22 MFD, 315V/W Condensers 25 MFD, 300V/W, 470MFD 35 V/W 10 MFD, 250 V/W 180 PF 8Kv	10p+1p V.A.T.
200+100 MFD, 325 V/W	30p+2p V.A.T.
200+200+100, 325 V/W	40p+3p V.A.T.
200+100+50+100	40p+3p V.A.T.
300+200+100 MFD, 350 V/W	50p+4p V.A.T.
200+200+100 MFD, 350 V/W	50p+4p V.A.T.
100 W/W Resistor	£1.00+8p V.A.T.
300 Mixed Condensers	£1.00+8p V.A.T.
350 Mixed Resistors	£1.00+8p V.A.T.
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COLOUR T/V COMPONENTS
MANUFACTURERS DISCARDED MATERIALS

VHF or UHF Varicap Tuners	£1.20+9p V.A.T.
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Decoder Panels	£1.00+8p V.A.T.
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Money returned if not completely satisfied

SENDZ COMPONENTS

2 WOODGRANGE CLOSE
THORPE BAY, ESSEX

5% P.P. ON ALL ORDERS

Reg Office Only—No Personal Callers Please

130 LOVELACE

TRANSISTORS, ETC.

Type	Price (£)
AC107	0.35
AC117	0.24
AC126	0.25
AC127	0.25
AC128	0.25
AC141	0.26
AC141K	0.27
AC142	0.20
AC142K	0.19
AC151	0.24
AC152	0.25
AC153K	0.28
AC154	0.20
AC176	0.25
AC178	0.27
AC187	0.25
AC187K	0.25
AC188	0.25
AC188K	0.26
AC193K	0.30
AC194K	0.32
ACY28	0.25
ACY39	0.68
AD140	0.50
AD142	0.52
AD143	0.51
AD149	0.50
AD161	0.48
AD162	0.48
AF114	0.25
AF115	0.25
AF116	0.25
AF117	0.20
AF118	0.50
AF121	0.32
AF124	0.25
AF125	0.20
AF126	0.20
AF127	0.20
AF139	0.35
AF147	0.35
AF149	0.45
AF178	0.55
AF179	0.60
AF180	0.55
AF181	0.50
AF186	0.40
AF239	0.40
AF279	0.84
AL100	1.10
AL102	1.10
AL103	1.10
AL113	0.95
AU103	2.10
AU110	1.90
AU113	2.40
BC107	0.12
BC107A	0.13
BC107B	0.14
BC108	0.12
BC108B	0.13
BC109	0.13
BC109C	0.14
BC113	0.13
BC114	0.20
BC115	0.20
BC116	0.20
BC117	0.20
BC119	0.29
BC125	0.22
BC126	0.20
BC132	0.15
BC134	0.20
BC135	0.19
BC136	0.20
BC137	0.20
BC138	0.20
BC142	0.30
BC143	0.35
BC147	0.13
BC148	0.12
BC149	0.14
BC152	0.25
BC153	0.20
BC154	0.20
BC157	0.15
BC158	0.13
BC159	0.15
BC161	0.48
BC167B	0.15
BC168B	0.13
BC169C	0.13
BC170	0.15
BC171	0.15
BC172	0.14
BC173	0.20
BC174	0.26
BC176	0.22

Type	Price (£)
BC177	0.20
BC178	0.22
BC178B	0.22
BC179	0.20
BC179B	0.21
BC182L	0.11
BC183	0.11
BC183K	0.12
BC183L	0.11
BC184L	0.13
BC186	0.25
BC187	0.27
BC208	0.12
BC212L	0.12
BC213L	0.12
BC214L	0.15
BC238	0.10
BC261A	0.28
BC262A	0.18
BC263B	0.25
BC267	0.16
BC268C	0.14
BC294	0.37
BC300	0.60
BC301	0.35
BC303	0.60
BC307B	0.12
BC308A	0.10
BC309	0.15
BC323	0.68
BC377	0.22
BC441	1.10
BC461	1.58
BCY33	0.36
BCY42	0.16
BCY71	0.22
BCY88	2.42
BD115	0.65
BD123	0.98
BD124	0.80
BD130Y	1.42
BD131	0.45
BD132	0.50
BD135	0.40
BD136	0.46
BD137	0.48
BD138	0.50
BD139	0.55
BD140	0.62
BD144	2.19
BD145	0.75
BD163	0.67
BD183	0.56
BD410	1.65
2N1164	3.40
BD234	0.75
BD519	0.76
BD520	0.76
BDX18	1,45
BDX32	2.55
BDY16A	0.38
BDY18	1.78
BDY20	0.99
BF115	0.20
BF117	0.45
BF120	0.55
BF121	0.25
BF123	0.28
BF125	0.25
BF127	0.30
BF158	0.25
BF159	0.27
BF160	0.22
BF161	0.45
BF162	0.45
BF163	0.45
BF167	0.25
BF173	0.25
BF177	0.30
BF178	0.33
BF179	0.33
BF180	0.35
BF181	0.33
BF182	0.44
BF183	0.44
BF184	0.26
BF185	0.26
BF194	0.15
BF195	0.15
BF196	0.15
BF197	0.17
BF198	0.20
BF199	0.25
BF200	0.35
BF218	0.35
BF222	1.08
BF224J	0.15
BF240	0.20

Type	Price (£)
BF241	0.22
BF244	0.18
BF254	0.45
BF255	0.45
BF256	0.45
BF257	0.49
BF258	0.66
BF259	0.93
BF262	0.70
BF263	0.70
BF273	0.16
BF336	0.35
BF337	0.35
BF458	0.60
BF459	0.63
BF596	0.70
BF597	0.15
BFR39	0.24
BFR41	0.30
BFR61	0.30
BFR79	0.24
BFT43	0.55
BFW10	0.55
BFW11	0.55
BFW16A	1.70
BFW30	1.38
BFW59	0.19
BFW60	0.20
BFW90	0.28
BFX16	2.25
BFX29	0.30
BFX30	0.35
BFX84	0.25
BFX85	0.26
BFX86	0.26
BFX87	0.28
BFX88	0.24
BFY18	0.53
BFY40	0.40
BFY41	0.43
BFY50	0.25
BFY51	0.23
BFY52	0.23
BFY57	0.32
BFY64	0.42
BFY72	0.31
BFY90	0.70
BLY15A	0.79
BPX25	1.90
BPX29	1.70
BPX52	1.90
BRC4443	0.68
BRY39	0.47
BRY56	0.40
BR101	0.47
BSW64	0.38
BSX19	0.13
BSX20	0.19
BSX76	0.15
BSX82	0.52
BSY19	0.52
BSY41	0.22
BSY54	0.50
BSY56	0.80
BSY65	0.15
BSY78	0.40
BSY91	0.28
BSY95A	0.27
BT106	1.24
BU105/02	1.95
BU108	3.25
BU126	2.99
BU204	1.98
BU205	1.98
BU207	3.00
BU208	3.15
BU209	2.55
BUY77	2.50
BUY78	2.55
BUY79	2.85
D40N1	0.45
E1222	0.55
E5024	0.20
ME6001	0.16
ME6002	0.17
ME8001	0.18
MJE340	0.68
MJE341	0.72
MJE370	0.65
MJE520	0.85
MJE521	0.95
MJE2955	1.20
MJE3000	1.85
MJE3055	0.74
MPF102	0.40
MPS6566	0.21
MPSA05	0.47
MPSA55	0.50
MPSU05	0.66
MPSU06	0.76

Type	Price (£)
MPSU56	1.26
MPSU55	1.26
OC26	0.38
OC28	0.65
OC35	0.59
OC36	0.64
OC42	0.55
OC44	0.25
OC45	0.32
OC70	0.32
OC71	0.32
OC72	0.32
OC73	0.51
OC75	0.25
OC76	0.35
OC81	0.53
OC81D	0.57
OC139	0.76
OC140	0.80
OC170	0.25
OC171	0.30
OC200	1.30
OCP71	0.53
ON236A	0.65
ORP12	0.55
R2008B	2.05
R2010B	2.95
TIC44	0.29
TIC46	0.44
TIC47	0.58
TIP29A	0.49
TIP30A	0.58
TIP31A	0.65
TIP32A	0.67
TIP33A	0.99
TIP34A	1.73
TIP41A	0.80
TIP42A	0.91
TIS43	0.30
TIS73	1.36
TIS90	0.23
TIS91	0.23
ZTX109	0.12
ZTX300	0.16
ZTX304	0.22
ZTX310	0.10
ZTX313	0.12
ZTX500	0.17
ZTX502	0.17
ZTX504	0.42
ZTX602	0.24
2N525	0.86
2N696	0.23
2N697	0.15
2N706	0.12
2N706A	0.15
2N708	0.35
2N744	0.30
2N914	0.19
2N916	0.20
2N918	0.42
2N930	0.35
2N1164	3.40
2N1304	0.21
2N1305	0.21
2N1306	0.31
2N1307	0.22
2N1308	0.26
2N1309	0.36
2N1613	0.34
2N1711	0.45
2N1890	0.45
2N1893	0.48
2N2102	0.51
2N2217	0.36
2N2218	0.60
2N2219	0.50
2N2221A	0.41
2N2222A	0.50
2N2270	0.41
2N2369A	0.42
2N2401	0.60
2N2484	0.41
2N2570	0.18
2N2646	0.53
2N2712	0.12
2N2894	0.77
2N2904	0.22
2N2904A	0.26
2N2905	0.72
2N2905A	0.73
2N2926G	0.13
2N2926Y	0.12
2N2926O	0.12
2N2955	1.12
2N3012	0.91
2N3019	0.75
2N3053	0.21
2N3054	0.55
2N3055	0.60

Type	Price (£)
2N3133	0.54
2N3134	0.60
2N3232	1.32
2N3235	1.10
2N3250	1.02
2N3254	0.28
2N3323	0.48
2N3391A	0.23
2N3501	6.99
2N3702	0.13
2N3703	0.15
2N3704	0.15
2N3705	0.11
2N3706	0.10
2N3707	0.13
2N3715	2.30
2N3724	0.72
2N3739	1.18
2N3766	0.99
2N3771	1.70
2N3772	1.90
2N3773	2.90
2N3790	4.15
2N3794	0.20
2N3819	0.35
2N3820	0.49
2N3823	1.45
2N3866	1.70
2N3877	0.25
2N3904	0.16
2N3905	0.18
2N3906	0.15
2N4032	0.43
2N4033	0.54
2N4036	0.52
2N4046	0.35
2N4058	0.17
2N4123	0.13
2N4124	0.15
2N4126	0.20
2N4236	1.90
2N4248	0.12
2N4284	0.19
2N4286	0.19
2N4288	0.13
2N4289	0.20
2N4290	0.14
2N4291	0.18
2N4292	0.20
2N4392	2.84
2N4871	0.24
2N4902	1.30
2N5042	1.05
2N5060	0.32
2N5061	0.35
2N5064	0.45
2N5087	0.32
2N5294	0.35
2N5296	0.57
2N5298	0.58
2N5322	0.85
2N5449	1.90
2N5457	0.30
2N5458	0.35
2N5494	0.85
2N5496	1.05
2N6027	0.65
2N6178	0.71
2N6180	0.92
2SC643A	1.36
2SC1172Y	2.80
3N140	1.21
40250	0.60
40327	0.67
40361	0.48
40362	0.50
40429	0.80
40439	2.67

MATCHED PAIRS

Type	Price (£)
AC128/AC176	0.52
AC141K/AC142K	0.56
AC187/AC188	0.60
AC187/AC188K	0.61
AC193K/AC194K	0.71
AD161/AD162	0.95
BC142/BC143	0.70

Any other transistors can be matched at a supplement of 20p per pair

DIODES

Type	Price (£)
AA113	0.15
AA119	0.09
AA129	0.20
AA143	0.10
AAZ13	0.30
AAZ17	0.12
BA100	0.15
BA102	0.25
BA110U	0.30
BA115	0.12
BA141	0.17
BA145	0.17
BA148	0.17
BA154	0.13
BA155	0.16
BA156	0.15
BA157	0.25
BAX13	0.06
BAX16	0.07
BB104	0.52
BB105B	0.52
BB105G	0.45
BR100	0.50
BY100	0.15
BY103	0.22
BY126	0.16
BY127	0.17
BY133	0.23
BY140	1.40
BY164	0.55
BY176	1.68
BY179	0.70
BY206	0.31
BYX10	0.15
BYZ12	0.30
FSY11A	0.45
FSY41A	0.40
OA10	0.20
OA47	0.07
OA81	0.12
OA90	0.08
OA91	0.07
OA95	0.07
OA200	0.10
OA202	0.10
OA210	0.29
OAZ237	0.78
S2M1	0.22
TV20	1.85
IN914	0.07
IN914E	0.06
IN916	0.10
IN1184	0.92
IN1185	1.10
IN4001	0.05
IN4002	0.06
IN4003	0.07
IN4004	0.08
IN4005	0.09
IN4006	0.11
IN4007	0.14
IN4148	0.05
IN4448	0.10
IN5400	0.15
IN5401	0.17
IN5402	0.20
IN5403	0.22
IN5404	0.25
IN5405	0.27
IN5406	0.30
IN5407	0.34
IS44	0.07
IS310	0.45
IS920	0.07
IS923	0.12

Diodes can be supplied balanced at a supplement of 5p per device —e.g. four balanced OA91 would be £0.48 per set.

Variable capacitance diodes can be supplied matched at a supplement of 3p per device.

LINEAR INTEGRATED CIRCUITS

Type	Price (£)
CA3045	1.35
CA3046	0.70
CA3065	1.90
MC1307P	1.19
MC1310P	2.94
MC1327PQ	1.01
MC1330P	0.76
MC1351P	0.75
MC1352P	0.82
MC1358PQ	1.85
MC1496L	0.87
MC3051P	0.58
MFC4000B	0.43
MFC4060A	0.70
MFC6040	0.91
NE555	0.72
NE556	1.34
PA263	1.90
SL414A	1.91
SL901B	3.84
SL917B	5.12
SN76001N	1.45
SN76003N	2.92
SN76013N	1.95
SN76013ND	1.72
SN76023N	1.95
SN76023ND	1.72
SN76033N	2.92
SN76530P	1.05
SN76533N	1.20
SN76227N	1.46
SN76666N	0.90
TAA300	1.76
TAA320	0.94
TAA350A	2.02
TAA435	0.85
TAA450	2.70
TAA550	0.55
TAA570	2.02
TAA611A	1.70
TAA611B	1.85
TAA630Q	4.18
TAA630S	4.18
TAA700	4.18
TAA840	2.02
TAA861A	0.49
TAD100	2.66
TBA120S	0.99
TBA240A	2.97
TBA221	2.28
TBA480Q	1.90
TBA500	1.99
TBA500Q	2.00
TBA510	1.99
TBA520Q	3.34
TBA530	2.71
TBA530Q	2.71
TBA540	3.21
TBA540Q	3.21
TBA550Q	4.10
TBA560C	4.09
TBA560CQ	4.10
TBA570	1.17
TBA641	0.76
TBA673	2.28
TBA700	2.59
TBA720Q	2.45
TBA750Q	2.33
TBA800	1.75
TBA810AS	1.75
TBA920Q	4.23
TBA990	4.10
TBA990Q	4.10
TCA270Q	4.18
ZN414	1.25

Please enquire for linear op. amps, 709, 710, etc.

DIGITAL INTEGRATED CIRCUITS

Type	Price (£)
7400	0.20
7401	0.20
7402	0.20
7404	0.24
7406	0.45
7408	0.25
7410	0.20
7411	0.25
7412	0.28
7413	0.50
7416	0.45
7417	0.30
7420	0.20
7425	0.37
7430	0.20
7440	0.20
7441	0.85
7445	1.95
7447	1.30
7450	0.20
7451	0.20
7454	0.20
7460	0.20
7470	0.33
7472	0.38
7473	0.44
7474	0.48
7475	0.59
7489	4.32
7490	0.65
7491	1.10
7492	0.75
7493	0.65
7494	0.85
7495	0.85
7496	1.00
74100	2.16
74121	0.60
74122	0.80
74150	1.44
74151	1.15
74154	1.66
74164	2.01
74192	2.05
74193	2.30

HARDWARE

BASES

Type	Price (£)
DIL8	0.16
DIL14	0.16
DIL16	0.18

MOUNTING KITS

Type	Price (£)
T0-3	0.06
T0-66	0.06

VALVES

Type	Price (£)
DY87	0.39
EB91	0.30
ECC82	0.41
EF80	0.41
EF183	0.53
EF184	0.53
EH90	0.55
PC86	0.67
PC88	0.76
PCC89	0.58
PCF80	0.47
PCF86	0.58
PCF801	0.58
PCF802	0.63
PCL82	0.50
PCL84	0.54
PCL805/85	0.58
PCL86	0.58
PFL200	0.74
PL36	0.80
PL84	0.61
PL504	0.80
PL508	0.95
PL509	1.44
PY81/800	0.45
PY88	0.52

ZENER DIODES

400mW 3.0-33V 12p each
1.3W 3.3-100V 18p each

VDR'S, PTC & NTC RESISTORS

Type	Price (p)	Type	Price (p)
E295ZZ/01	14	E299DD/P116-P354	all 8
E295ZZ/02	14	VA1015	50
E298CD/A258	7	VA1026	41
E298ED/A258	6	VA1033	8
/A260	6	VA1034	8
/A262	6	VA1040	8
/A265	6	VA1053	8
/P268	6	VA1055S	10
E298ZZ/05	7	VA1077	12
/06	6	VA1104	35
		VA8650	110

RESISTORS

Carbon Film (5%) ea
¼W 5.6 Ω-330k Ω (E12) 1.5p
½W 10 Ω-10M Ω (E24) 1.5p
1W 10 Ω-10M Ω (E12) 3p
2W 10 Ω-10M Ω (E6) 5p

WIREWOUND (5%)
2½W 0.22 Ω-270 Ω 15p ea
5W 10 Ω-8.2k Ω 13p ea
10W 10 Ω-25k Ω 18p ea

CAPACITORS

Full range of C280, C296, tubular ceramic, pin-up ceramic, miniature electrolytics, mica, mixed dielectric and TV electrolytics stocked.—Please see catalogue.

MASTHEAD AMPLIFIERS

Labgear uhf group amplifier complete with mains power unit CM6001/PU.
Groups A, B, or C/D please specify **£9.87**

Labgear CM6030 WB vhf/uhf ultra wideband amplifier (channels 1-68). Complete with mains power unit CM6001/PU **£14.23**

Labgear CM6019 WB uhf wideband amplifier (channels 21-68). Complete with mains power unit CM6020/PU **£7.28**

PATTERN GENERATORS

Labgear CM6004/PG giving crosshatch dots, greyscale and blank raster on 625-lines. Tuning can be preset for anywhere in Bands IV and V as well as Band III (for relays). **£45.39**

Labgear CM6038 DB Pocket size vhf/uhf generator. Outputs as CM6004 PG above but can be used either on mains or battery **£36.00**

COLOUR-BAR GENERATORS

Labgear CM6037/DB: Dual standard band generator gives standard 8 band colour bars + greyscale step wedge + red raster + centre cross + centre dot + crosshatch + dot pattern + blank raster. Sync output also provided **£101.31**

VHF/UHF CONVERTERS

Labgear "Televertas" for DX-ing or single-standard receiver use on relay systems. Type 6022/RA **£12.27**

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