

TELEVISION

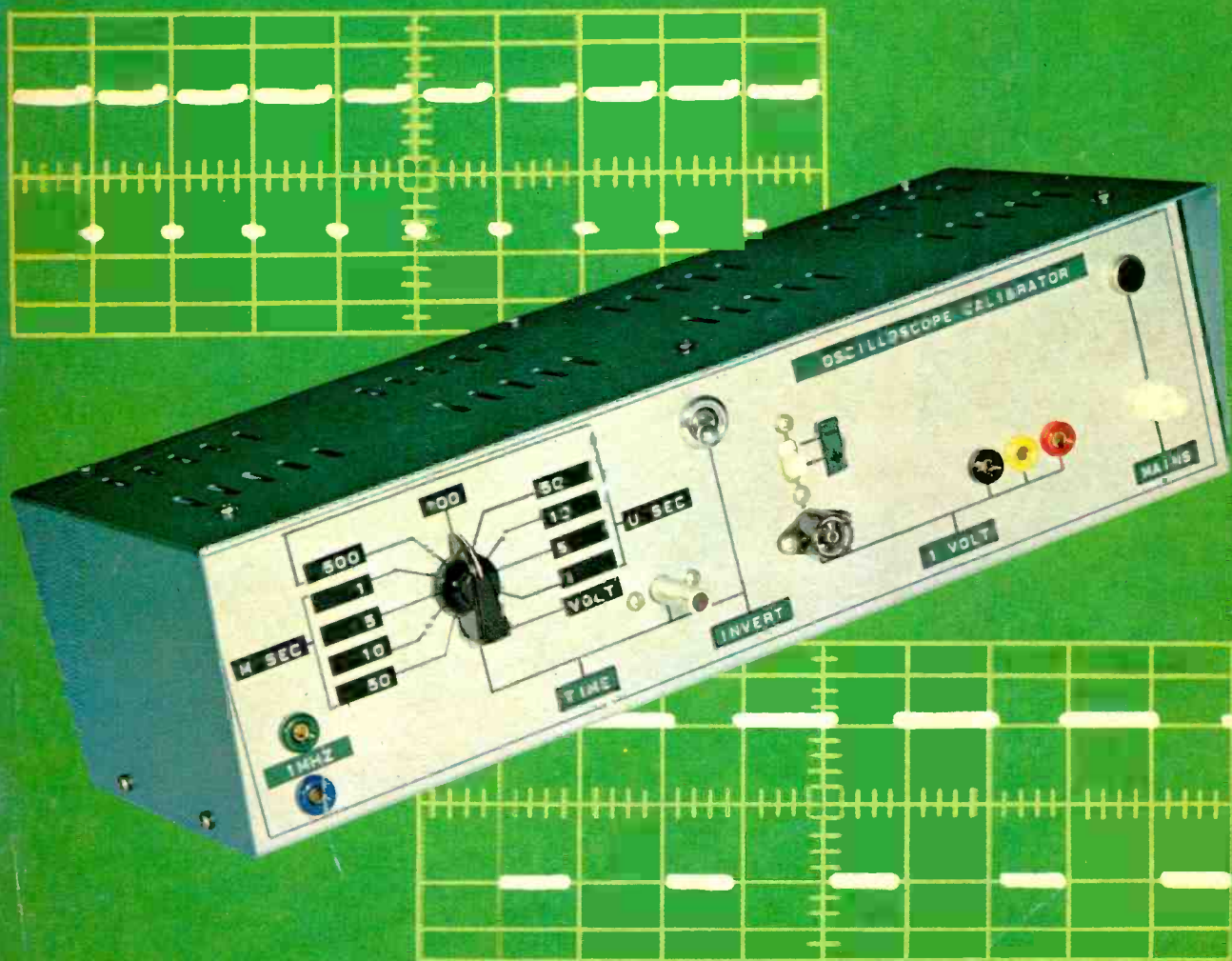
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OZ4	0-47	6AR5	1-55	6F18	0-55	7H7	0-75	20D4	2-00	35Z5GT	1-00	D63	0-25	EC88	0-70	EF90	0-20	HLV22	0-53	PCL86	0-47	R18	0-70	U31	0-33
IA3	0-52	6AR6	1-00	6F23	0-80	7R7	0-80	20F2	0-75	50B5	-85	DAPF91	0-30	EC92	0-45	EH90	0-45	HV22A	+53	PCL88	0-80	R19	0-38	U33	1-50
LA9GT	0-50	6AT6	0-38	6F24	0-85	7V7	1-00	20L1	0-88	50C5	-45	DAPF96	0-44	EC93	1-50	EL32	0-60	IW4 350	1-1	PD500	1-44	R20	0-60	U35	1-78
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IB3GT	0-52	6AV6	0-33	6F28	0-80	7Z4	0-80	20P3	0-80	50EH5	-55	DD4	1-00	EC95	0-95	EL35	0-50	KT2	0-50	PEN44	0-80	RK34	1-00	U45	0-50
1D5	1-00	6AW8A	0-65	6F32	0-65	9BW6	0-65	20P4	1-00	50L6GT	-65	DF91	0-30	EC90	1-00	EL37	2-50	K78	2-00	BEN45	0-80	SP61	0-75	U47	0-80
1D6	0-80	6AX4	0-75	6GH8A	0-75	9D7	0-65	20P5	1-30	72	0-33	DF96	0-44	EC91	0-34	EL41	0-88	KT41	0-98	PEN45D	0-80	TH4B	1-00	U49	0-60
1G6	1-00	6BN4	0-30	6GK5	0-65	10C2	0-65	25A6G	0-38	85A2	0-60	DH63	0-60	EC92	0-28	EL81	0-60	KT44	0-75	PEN46	0-80	TH233	0-98	U50	0-45
1H5GT	0-65	6BA6	0-28	6OU7	0-75	10DE7	0-55	25L6GT	-60	85A3	1-00	DH76	0-45	EC93	0-28	EL83	0-55	KT53	0-50	PEN46	0-80	TP2620	-98	U76	0-55
1L4	0-20	6BC8	0-60	6H6GT	0-25	10F1	0-50	25Y5	0-80	90A4	3-38	DH77	0-38	EC94	0-30	EL84	0-23	KT66	2-40	PEN45D1D	0-80	UABC90	-40	U78	0-40
1LD5	1-00	6BD6	0-32	6J5GT	0-40	10F9	0-65	25Y6G	0-70	90C3	2-40	DH81	0-75	EC96	0-38	EL85	0-44	KT61	2-00	PEN47	2-00	UAF42	-60	U81	0-80
1LN5	1-00	6B6G	1-05	6J6	0-25	10F8	0-55	25Z4G	-33	90CV	-188	DK40	0-70	EC96	0-85	EL86	0-40	KT68	1-00	PEN44	0-98	UBC41	0-53	U91	0-70
1N5GT	0-65	6BH6	0-70	6J7G	0-30	10LD11	-70	25Z5	-80	90C1	-75	DK91	0-45	EC98	0-44	EL91	0-40	KT69	1-00	PEN D/D	0-80	UBC41	0-45	U93	0-35
1R5	0-45	6BJ6	0-55	6J7(M)	0-45	10P13	-70	25Z6GT	-70	150B2	-70	DK92	0-70	EC98	-65	EL95	-39	KT63	1-00	PEN D/D	0-80	UBF80	0-38	U251	0-80
184	0-33	6BK7A	0-60	6J8A	0-75	10P14	2-00	28D7	1-00	807	-58	DK96	0-60	EC90A	-80	EL360	1-00	MH14	0-75	PL33	0-50	UBF89	0-40	U281	0-55
185	0-30	6BQ5	0-23	6K7G	0-25	12A6	-1-00	30A5	-0-65	1821	-1-00	DL33	0-55	EC90B	1-00	ELL80	1-00	MH10B	-1-1	PL36	0-55	UB121	0-77	U282	0-55
1U4	0-65	6BQ7A	0-55	6K8G	0-45	12AC6	0-65	30C1	-0-28	403X3	-1-25	DL92	0-35	EC90	0-34	EM80	0-45	MX40	1-00	PL41	0-44	UC92	0-45	U301	0-58
1U5	0-90	6B3	1-00	6L1	2-00	12AD6	-0-85	30C15	-0-75	5702	-0-80	DL96	-0-55	EC98	-0-38	EM81	-0-65	N308	-1-00	PL81A	-0-55	UC98A	-0-75	U403	-0-75
2D21	0-49	6BR8	1-05	6L6GT	0-58	12AE6	-0-85	30C17	-0-90	6057	-1-00	DM70	-0-54	EC96	-0-75	EM83	-0-65	N399	-2-00	PL82	-0-40	UC983	-0-45	U404	-0-49
2GK5	0-55	6B87	1-40	6L7	2-00	12AT6	-0-38	30C18	-0-73	6090	-1-00	DM71	-2-00	EC90A2	-10	EM84	-0-40	P61	-1-00	PL83	-0-45	UCF80	-0-65	U801	-0-85

VALVES ALSO REQUIRED FOR CASH. LOOSE OR BOXED, BUT MUST BE NEW. OFFERS MADE BY RETURN.

3A4	0-50	6BW6	0-80	6L18	0-48	12AT7	0-34	30F5	0-90	6067	1-00	IW4 500	1-1	EC921	2-00	EM85	1-00	PA8C80	-38	PL84	0-33	UCH21	2-00	U4020	0-55
3B7	1-00	6BVT	0-66	6L19	2-00	12AU6	0-45	30F11	0-75	7192	0-55	DY87	0-30	EC935	1-25	EM87	0-70	PC96	0-60	PL504/500	0-60	VP13C	0-70	VP13C	0-35
3D6	0-40	6BZ6	0-49	6LD20	0-55	12AU7	0-28	30FL2	0-75	7475	-1-00	DY802	-0-33	EC942	-0-70	EM80M83	-0-60	PC88	-0-60	PC88	-0-60	UC981	-0-38	VP23	-0-75
3Q4	0-60	6C4	0-30	6N7GT	0-60	12AV6	0-50	30FL12	-1-00	A1834	-1-00	E80CC	-1-65	EC981	-0-30	2-00	0-00	PC95	-0-75	PL505	-1-15	UC982	-0-38	VP41	-0-75
3Q5GT	0-55	6C6	0-40	6P15	0-23	12AX7	0-28	30FL13	-55	A2134	-0-98	E80F	1-20	EC983	-0-44	EY51	0-40	PC97	-0-38	PL508	-0-90	UC983	-0-55	VT61A	-0-35
384	0-35	6C9	1-25	6Q7G	0-50	12BA6	0-40	30FL14	-70	A3042	-0-75	E83F	1-20	EC984	-0-44	EY81	0-40	PC990	-0-45	PL509	-1-15	UF41	-0-70	U111	-0-44
4CB6	0-55	6C12	0-30	6Q7(M)	0-55	12BBE6	0-50	30L1	0-40	AC2/PEN	-E88CC	1-00	EC980	-0-40	EY83	-0-54	PC984	-0-40	PL802	-0-85	UF42	-0-70	U120	-0-60	
5C98	0-55	6C17	1-00	6Q7GT	0-50	12BH7	0-50	30L15	0-75	0-99	E92CC	1-00	EC982	-0-34	EY84	-0-70	PC985	-0-44	PM84	-0-80	UC980	-0-35	U120A	-60	
6B44Y	0-75	6C18A	0-65	6K7	0-75	12C1	3-00	30L17	0-70	AC2/PEN	-E88F	1-00	EC985	-0-57	EY87	-6	-33	PC988	-0-60	PY337	-6	UF5	-0-44	U113	-0-35
3U40	0-35	6C9D6G	1-00	6R7G	0-60	12J5GT	-33	30P4MR	-1-00	DD	0-98	E118C	-0-00	EC984	-0-50	EY88	-0-40	PC989	-0-50	PY80	-0-38	UF6	-1-00	W76	-0-45
5V4G	0-54	6C98A	0-75	69A7	0-44	12J7GT	-55	1-00	0-00	DD	0-98	E1148	-0-53	EC985	-0-60	EY91	-0-58	PC989	-0-50	PY81	-0-31	UF89	-0-38	W107	-1-00
5Y3GT	0-45	6C98B	0-80	68C7GT	-33	12K5	1-00	30P12	0-80	AC/PEN(7)	-0-98	EASO	0-27	EC986	-0-40	EZ40	-0-55	PC9805	-0-75	PY82	-0-30	UL41	-0-65	W299	1-00
5Z3	0-70	6C96	0-55	68G7	0-44	12K7GT	-45	30P16	0-40	0-98	EAT6	1-00	EP22	-1-50	EZ41	-0-75	PC9806	-0-70	PY83	-0-35	UL84	-0-42	X41	-1-00	
5Z4G	0-35	6C98A	0-80	68H7	0-44	12Q7GT	-45	30P19	-1-00	AC TH11-00	-0-98	EABCO	-38	EP49	-0-75	EZ80	-0-28	PC980	-0-28	PY88	-0-38	UM80	-0-44	X63	-1-25
5Z4GT	0-45	6C97	0-75	68K7GT	-44	128A7GT	-55	30P4	0-75	A160	1-00	EAC91	0-75	EP41	0-70	EZ81	0-27	PC982	0-35	PY901	0-70	UR1C	1-00	X66	1-25
6/3012	0-80	6C97B	0-75	68Q7GT	-45	128C7	-30	30P11	0-68	ARP3	0-35	EAF64	0-60	EP42	-0-55	FW4 500	-0-00	PC984	-0-58	PY900	-0-85	U10	-1-00	XH11-5	-48
6A8G	1-25	6C94	1-00	6U4GT	0-70	128G7	0-40	30P12	-35	ATP4	0-40	EAF801	-0-75	EP73	-1-50	1-00	0-00	PC966	-0-55	PY900A	-85	U9	-0-55	Z349	-0-80
6AC7	0-49	6D3	0-60	6U7G	0-75	128H7	0-35	30P13	-75	AZ1	0-60	EB34	0-25	EP78	0-26	FW4 800	1-1	PC907	-0-67	PY80A	-85	U12	-0-27	Z359	-0-80
6AG5	0-27	6DE7	0-75	6V6GT	0-17	128J7	0-44	30P14	-80	AZ31	0-60	0-00	0-00	0-00	0-00	0-00	0-00	0-00	0-00	0-00	0-00	0-00	0-00	0-00	0-00
6AH6	0-60	6D76A	0-75	6V6GT	0-45	128K7	0-60	30P15	-90	AZ41	-0-65	0-00	0-00	0-00	0-00	0-00	0-00	0-00	0-00	0-00	0-00	0-00	0-00	0-00	0-00
6AJ5	0-75	6WV6	0-75	6X4	0-40	128Q7GT	-65	35A3	-0-65	B36	-0-60	0-00	0-00	0-00	0-00	0-00	0-00	0-00	0-00	0-00	0-00	0-00	0-00	0-00	0-00
6AK5	0-34	6E5	1-00	6X5GT	0-40	14H7	0-55	35A5	-0-80	B43	2-00	0-00	0-00	0-00	0-00	0-00	0-00	0-00	0-00	0-00	0-00	0-00	0-00	0-00	0-00
6AK6	0-60	6F1	0-70	6Y6GT	0-75	1487	1-00	35D5	-0-75	U133	-1-50	0-00	0-00	0-00	0-00	0-00	0-00	0-00	0-00	0-00	0-00	0-00	0-00	0-00	0-00
6AM6	0-37	6F6G	0-50	6Y7G	1-00	19A65	0-50	35L6GT	-55	CV6	-0-53	0-00	0-00	0-00	0-00	0-00	0-00	0-00	0-00	0-00	0-00	0-00	0-00	0-00	0-00
6AM8A	0-55	6F13	0-55	7B6	1-75	19G66	1-40	35W4	-0-40	CV63	-0-53	0-00	0-00	0-00	0-00	0-00	0-00	0-00	0-00	0-00	0-00	0-00	0-00	0-00	0-00

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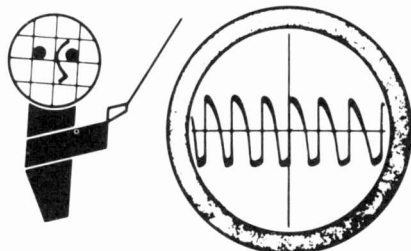
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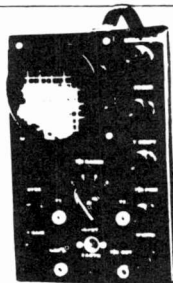
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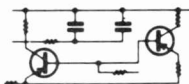
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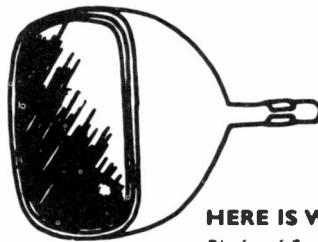
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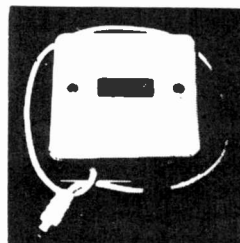
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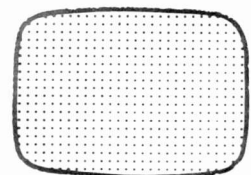
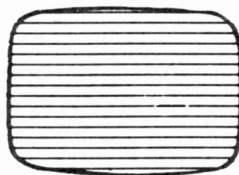
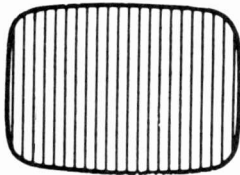
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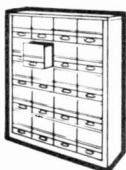
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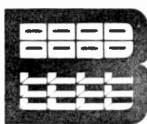
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BRITISH INSTITUTE OF ENGINEERING TECHNOLOGY

TELEVISION

SERVICING · CONSTRUCTION · COLOUR · DEVELOPMENTS

VOL 24 No 7
ISSUE 283

MAY 1974

RATIONALISED TECHNOLOGY

"It's a sellers' market at present—but!" This comment given to us at Seminex just about sums up the present mood in the semiconductor and i.c. market. In spite of current gloomy feelings and concern over the industrial scene generally however we were given encouraging news about the future of the industry. But for those attempting to keep production lines running right now there is still considerable confusion over what is available and when.

Beyond the present component supply problems—with erratic ups and downs that keep distributor sales managers constantly on the 'phone—there are developments in technology that are likely to make a distinct impact on the UK and European consumer electronics industry. In particular a new breed of i.c.s for colour and monochrome set use will result in simpler sets, very simple setting up procedures and simplified servicing. Significant colour tube developments are also on the way.

Just when sets incorporating these new developments will start to appear neither we nor the manufacturers can say. Our guess is mid 1975 however. Development samples of the new i.c.s are already undergoing evaluation and a full production cycle is planned. Development work could be complete by late 1974. Although prices have not been quoted so far we see no reason why future ranges of colour receivers incorporating these new techniques should ultimately sell for more than about £180.

Returning to Seminex, where the development of one family of these new i.c.s was officially revealed, we found at least one answer for the "but" in our opening sentence. One distributor I spoke to commented that while business is still good in one sense in the consumer sector it all comes back to that great imponderable—future consumer demand. A hundred-off orders make for good business amongst distributors—but when the orders begin to soar the real problems arise. Stock lines and production facilities can get tied up for long periods. So the message for the prudent setmaker is clear: although at present faced with near starvation of many items, plan ahead for 1975 now.

An article later in this issue describes the new i.c.s and highlights the all round simplification to TV sets they will bring with them. For consumer and serviceman alike the outlook is good, while the new trends in technology are likely to have far-reaching effects on many of the trading and servicing problems discussed recently in these columns.

M. A. COLWELL—*Editor*

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THE NEXT ISSUE DATED JUNE IS DUE FOR PUBLICATION ON MAY 20. PRINTING ARRANGEMENTS ARE STILL AFFECTED BY THE AFTERMATH OF THREE-DAY WORKING AT THE TIME OF GOING TO PRESS HOWEVER.

TELEVISION Colour Receiver I.F. Alignment Service: The attention of constructors of the TELEVISION colour receiver is drawn to the notice on page 315 terminating the i.f. strip alignment service.

TELETOPICS



COLOUR TV KIT FOR THE CONSTRUCTOR

For those wishing to build their own colour set Forgestone Components (Low Street, Ketteringham, Wymondham, Norfolk) have introduced the first complete colour receiver kit to be offered in the UK, the "Forgestone 400". The kit is to be made available in sections so that constructors can proceed from one panel to the next without having to buy the complete receiver at once. Each panel kit will include everything required for that section of the receiver. The impressive quality of the set can be gauged from the accompanying photograph. The glass epoxy panels come ready drilled, tinned and with the component positions marked. The set is all solid-state except for the two valve (PL509, PY500A) line output stage, a wise precaution that. Extensive use is made of i.c.s, nine in all being employed. The decoder is of the Mullard four-i.c. type while in the i.f. section a TCA270 provides synchronous vision demodulation, video preamplification with noise suppression, plus a.g.c. and a.f.c. outputs. In the timebase section a TBA920 provides sync separation and line generation with flywheel sync control. The main panels are equipped with plugs so that they can be quickly removed for examination. The power supply is fully isolated and the l.t. lines regulated. The i.f. module comes pre-aligned. All in all it looks as if everything possible has been done to make construction trouble free.

MINIATURE SOLID-STATE TV CAMERA

Since our last report on miniature solid-state TV cameras in this column (December 1973) news has come in that the US General Electric Company has successfully developed a camera of this type, wallet-sized and weighing less than a pound. A 10,000 element charge-injection image sensing device is used and the sensitivity of this is such that pictures can be produced at the light level provided by the glow of a candle. Development was undertaken at GE's R and D Centre in Schenectady, New York. Each of the 10,000 pairs of miniature capacitors which cover the face of the imaging chip functions as an individual light-sensing device. As light strikes the chip each capacitor pair collects a charge proportional to the light striking it. To convert these charges into a sequential TV signal each pair of capacitors is individually addressed by scanning circuits to release its charge which is "injected" into the base of the chip. The developers say that the use of the charge-injection principle means that no special structures are required in the chip to

transport the signal charge, almost the entire chip being photosensitive. This is said to give "by far the highest sensitivity yet achieved by a solid-state imager". The developers also point out that the device has high tolerance to defects: if a pair of capacitors fail the result is only one minute dark spot on the screen, whereas in other types of solid-state image sensors where the charge passes from capacitor to capacitor along each line before being "read out" failure of a single element can result in an entire picture line being darkened. Part of the sensitivity achieved is due to the fact that by using the charge-injection principle there is no signal loss incurred in charge transference. The camera's scanning rate can be slowed to increase its low-light sensitivity. Models offering greater resolution are under development.

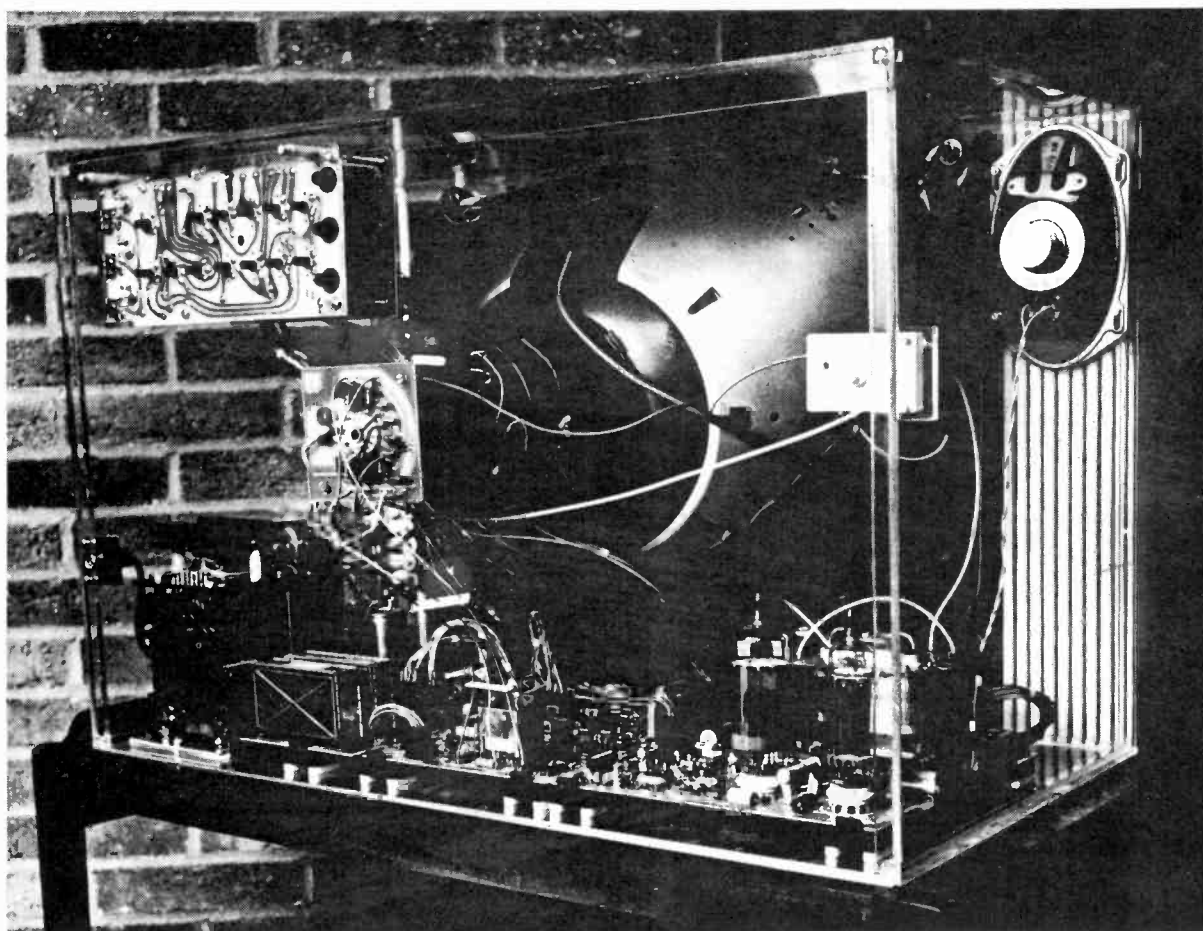
INTEGRATED CIRCUITS FOR TV USE

It looks as if i.c.s are about to take a really firm hold on the TV set scene. In addition to the new range being developed by SGS-Ates—described later in this issue—the last month has seen news of a further three i.c.s developed specifically for use in TV sets.

The latest addition to the Mullard range is the TCA800 for use in colour set decoders. This i.c. incorporates the chrominance demodulators, the RGB matrixes and clamps and provides preamplification of the RGB signals. It thus provides an alternative to using the TBA990 and TBA530, reducing to three the number of i.c.s required for the Mullard type decoder. The RGB outputs are typically 5V peak-to-peak so that simple low-gain RGB output stages can be used. The clamps are claimed to provide signals with d.c. stability such that feedback is not necessary in the RGB output stages, while as they determine the black level at the outputs no d.c. adjustments are necessary. The subcarrier filter capacitors are contained within the i.c.

In the US, ITT are about to launch an i.c. code numbered ITT3701 which provides a complete TV set sound channel, i.e. both the 6MHz intercarrier channel and the audio circuitry. The internally compensated audio amplifier is capable of providing 2W into 16Ω, or up to a maximum of 4W if the case temperature is kept within certain limits. The heatsink required consists of a bracket which can be easily attached to the specially designed 14-pin plastic pack. The i.c. is equally suitable for use in v.h.f./f.m. radio receivers.

The third i.c. which Glenihus are to start producing shortly at their Glenrothes plant is a rather



The Forgestone 400 colour receiver kit on display fully assembled.

different animal, a CMOS (complementary metal oxide silicon transistor) RAM (random access memory) device for use in television receiver ultrasonic remote control systems. The i.c. is intended to act as a memory mounted in the receiver, operating in conjunction with a digital control system which provides three control functions, e.g. volume, brightness and contrast. The memory can retain the information stored at switch-off for between six months and a year, being powered by a single 1.2V rechargeable cell. Emihus say that the i.c. has been designed in conjunction with two major setmakers, one in the UK and one overseas.

THAT WAS THE YEAR THAT WAS !

The year 1973 broke all records for the TV industry: total set deliveries (monochrome and colour) came for the first time to over four million (4,187,000) of which 2,775,000 were colour sets. UK setmakers produced some 2,077,000 colour sets, an increase of 44%, remarkable enough especially when component shortages are taken into account but by no means sufficient to satisfy demand. Colour set sales/rentals for 1974 are now expected to decline by some 28% to around the two million mark. At this level imports could rapidly fade, especially if prices increase—Japanese setmakers, who took 10%

of the 1973 market, are expected to increase their prices between 15-20%.

Mains/battery portables with slightly larger c.r.t.s seem to be the latest trend in setmakers' ranges. **Decca** have added the MS1511, a larger version of the popular Gypsy, to their range: recommended price is £87.75 including VAT. **GEC** are to introduce new 12in. and 15in. versions of the Junior Fineline, featuring new styling, varicap tuners, slider controls and to reduce weight a transistor pump circuit in place of the mains transformer.

New imports include a 110' 18in. colour set, Model CTP5101, from **Sanyo**. This is fitted with a varicap tuner and black matrix c.r.t. and has a recommended price of £259.75. Forward Retailing have introduced the Swedish made **Skantic** range of colour models.

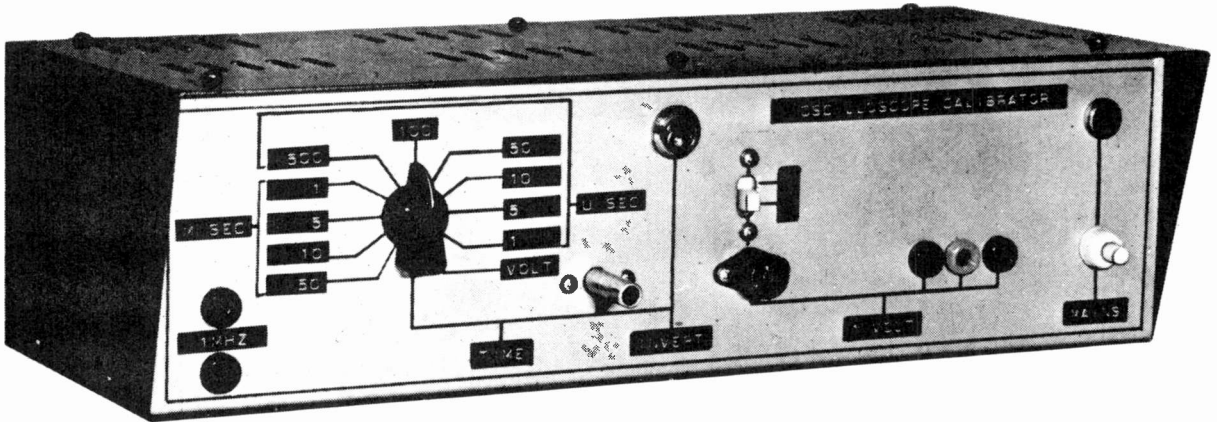
MAIN UHF TRANSMITTER OPENING

The BBC and IBA transmitters at **Bluebell Hill** about three miles north of Maidstone, Kent are now in operation. BBC-1 is on channel 40. ITV (Thames Television and London Weekend Television programmes) on channel 43 and BBC-2 on channel 46. Horizontally mounted group E receiving aerials should be used.

OSCILLOSCOPE CALIBRATOR

ALAN C. AINSLIE

PART 1



The oscilloscope is probably the most widely used single piece of equipment in the analysis of faults or the development of a new circuit or idea. In perhaps 75% of cases it is used merely to display waveforms; the other 25% of the time it is used in its measuring capacity. Manufacturers appreciated this situation and used to find it economic to provide accurate calibration only on top quality laboratory 'scopes.

The situation has now changed and even fairly modest 'scopes have some calibration or measurement facility. It is necessary to keep the calibration up to scratch by periodic recalibration however—with careful attention a 'scope can be expected to hold within 5% of the calibration standard. The better quality laboratory 'scopes ought to be held within 3% at worst, but for this to be realised a reliable standard of time and voltage is required.

The instrument to be described uses a crystal oscillator as the main time reference and is thus capable of good long term accuracy provided a reasonable quality crystal is purchased.

The crystal output is divided by a chain of monostables to give the common 1-5-10 sequence used for

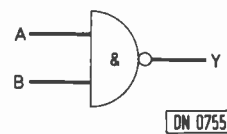
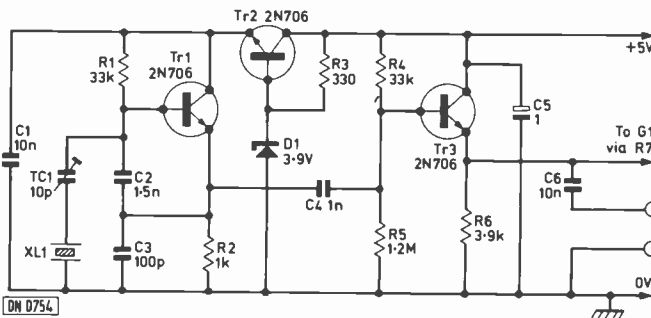
oscilloscope time ranges. With a little judicious fiddling the actual range of calibration can be extended further if desired.

The voltage calibration is provided in a form so that positive or negative excursions of a 1kHz square-wave can be standardised against the laboratory or workshop voltmeter. Here absolute accuracy is perhaps not quite so important as consistency of readings between the two instruments.

The calibrator circuit seems fairly complex on a cursory look but once the principles are understood the whole thing fits together like a jigsaw and is not too difficult to construct.

The Time Standard

Transistor Tr1 (Fig. 1) together with the crystal XL1 form a standard crystal oscillator. This circuit was chosen because the oscillator runs nicely at a supply of 3 or 4 volts and can thus be twice stabilised. Also the circuit oscillates very close to the crystal marked frequency. Capacitor TC1 is provided to adjust the precise operating frequency and



A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

Fig. 2 (above): Symbol (left) and truth table (right) for a single NAND gate.

Fig. 1 (left): Crystal oscillator circuit used.

may be a small 10pF postage stamp trimmer. If a good 1MHz crystal is used (costing £1.50 or so) however TC1 could well be omitted.

The collector supply for Tr1 is stabilised at about 3.5V by Tr2 and D1. Some "low activity" crystals may need a higher voltage or different bias—effected by adjusting R1 over the range 18k Ω to 100k Ω to get a nice undistorted sinewave.

If the circuit still fails to operate, then the power supply can be increased by raising the zener voltage of D1 to perhaps 5 or 6 volts. The supply for the oscillator should then be taken from the point marked A on the power supply (Fig. 6). The author has tried a couple of crystals in the circuit as shown however and has found no difficulty.

The emitter-follower Tr3 drives the divider circuits and presents a high impedance load across R2. This is necessary as C3 forms part of the oscillatory feedback path and is only 100pF.

When the oscillator is powered from the 5V stabilised line the frequency stability is excellent.

★ Components list

Resistors:

R1	33k Ω	R6	3.9k Ω	R11	330 Ω
R2	1k Ω	R7	470 Ω	R12	1.5k Ω
R3	330 Ω	R8	3.3k Ω	R13	8.2k Ω
R4	33k Ω	R9	3.3k Ω	R14	220 Ω
R5	1.2M Ω	R10	3.3k Ω	R15	1.5k Ω

All 5% $\frac{1}{2}$ W carbon film.

VR1—VR12 2.2k Ω min. presets

VR13 1k Ω min. preset

Capacitors:

C1	10nF	C9	47nF	C17	220 μ F
C2	1.5nF	C10	0.1 μ F	C18	500 μ F
C3	100pF	C11	0.47 μ F	C19	100 μ F
C4	1nF	C12	1 μ F	C20	10 μ F
C5	1 μ F	C13	4.7 μ F	C21	1600 μ F
C6	10nF	C14	10 μ F	C22	640 μ F
C7	4.7nF	C15	25 μ F		
C8	15nF	C16	220 μ F		

All electro-lytics
15V working

TC1 10pF trimmer—see text

Semiconductors:

Tr1—Tr5 2N706 Tr6 BC107 Tr7 2N3054

IC1—IC6 SN7400

D1, D15 BZY88-C3V9 (400mW)

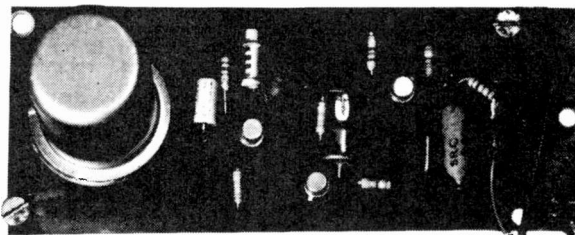
D2—D10 BA154 or OA90 or OA202

D11—D14 1N4002

Miscellaneous:

XL1	1MHz crystal
T1	8V 0.5A transformer, e.g. bell transformer
S1	SPST toggle switch
S2	1 pole, 12 way wafer switch
S3, S4	SPDT toggle switches
SK1	4mm. "1MHz" socket
SK2	4mm. "earth" socket
SK3	Coaxial or MUSA "time output" socket
SK4	Insulated coaxial "volts cal" socket
SK5	4mm. "volts cal" socket
SK6	4mm. "Cal 'O' Ref" socket
SK7	4mm. "Cal '1' Ref" socket

Case, PCB's etc.



The crystal oscillator section of the prototype is mounted on a separate board.

The very small drifts (one part in 10⁶) are mainly due to thermal effects and are insignificant in this application.

The output of the emitter-follower Tr3 is fed to the first i.c. gate (G1). All the i.c.s used are simple NAND gates and need not pose any problems in understanding the circuit operation.

The NAND Gate

Fig. 2 shows the logic symbol (left) for a single NAND gate. There are two inputs, A and B, and one output, Y.

In all logic systems there is one common principle. Signals are not considered in terms of volts above earth but as having a value "0" or "1". In the system used here the 0 level is very nearly ground potential and the 1 level is usually about +4V. The circuits are arranged so that these are the only levels present at the inputs and outputs and no intermediate levels are possible or indeed desirable.

The operation of the NAND gate is that its output rests at 0 or 1 depending on the state of the inputs. When both inputs are at 0 the output is at 1. When A and B are at 1 the output, Y, is at 0. When A or B is at 1, the other being at 0, then the output, Y, is at 1. This is summarised in the truth table shown at the right in Fig. 2. The name NAND arises from the last line of the table: when A and B are at 1 the output is *not* at 1—hence NOT AND and SO NAND.

In practice the gates are simple to use as all the input and output signal levels match up. The matter is made even simpler by the fact that a large "safety" margin has been left by the manufacturer in the definition of the input and output levels.

The output of a gate is specified to be such that 0 is less than 0.4V and 1 is more than 2.7V. The input requirements are that the 0 input be less than 0.8V and the 1 input be more than 2.4V, leaving 0.3V of "noise immunity".

The transition of the output between 0 and 1 is very fast—at worst a few tens of nanoseconds. The gates are thus ideal for the high-speed applications we shall be considering.

If the inputs of a NAND gate are tied together the gate operates as an inverter, i.e. the output is the opposite of the input. This is evident from the truth table where the first and last lines describe these two states.

Pulse Shaping

The two gates G1 and G2 (Fig. 3) both work as inverters and are used to produce nice clean pulses for the following time multipliers. The degree of "straightening" of the leading edge of the sinewave

oscillator output depends on the gain of the transistors in the i.c. but with the two stages of inversion shown a rise time of better than 20ns has been achieved.

Time Multipliers

Gates G3 and G4 form a monostable frequency divider and this is the time multiplication mechanism.

In the equilibrium or rest state the inputs to G4 are at 0 so that G4 output is at 1. This makes one input of G3 1 and if the other input is also 1 the system will be stable.

If the second input of G3 is sent to 0 by the output of G2 however the output of G3 will go to 1. This drags up the inputs of G4 to 1 but they fall again as C7 charges through VR1. Meanwhile the output of G4 is at 0, holding the output of G3 at 1 regardless of the state of the second input.

As C7 charges, the voltage across VR1 falls until it passes the switching point of G4 which then gives an output of 1. This drives the output of G3 to 0, discharging C7 through D2. The system waits in this state until another logic 0 pulse arrives from G2.

Whilst the monostable is "flipped" it is completely uninfluenced by any further pulses coming from G2 and the output pulse obtained from the monostable can be several times longer than the pulses fed in from G2.

The time relationships for the various gates are shown in Fig. 4. The negative spike on the input to G4 is a danger to the i.c. and diode D2 reduces this spike and ensures that C7 discharges as quickly as possible. The monostable is thus "ready" for the next pulse in a few tens of nanoseconds after completion of a cycle. The discharge time of C7 can in practice be a difficulty but is not too important if the discharge diode is carefully chosen and one does not attempt too great a time multiplication in one stage.

The monostable's output could be taken from either G3 or G4. It is taken from the first gate of each monostable circuit however since with successive time multiplications the output from the second gate remains at logic 1 for a progressively smaller fraction of a μ S. This gives a longer mark-to-space ratio as the multiplication progresses down the chain and eventually the timing capacitor will not discharge fast enough, leading to a breakdown of the system.

The principle outlined above can be extended as far as required but the maximum time multiplication for a single stage is by ten. This limit is set by the discharge time of the timing capacitor.

The time multiplications are chosen to give the sequence 1, 5, 10 but this can be changed if required by adjusting the variable charging resistor to give the required multiplication. This versatility is the main reason for adopting the particular form of circuit used.

Output Pulse Shaping

Outputs are taken to the switch S2 and the selected pulse train is passed to G21 which acts as an inverter and, more important, serves to produce clean leading and trailing edges. Gate G22 performs the same function as G21.

The output from G22 is a series of very clean pulses which are also fed to the voltage calibration

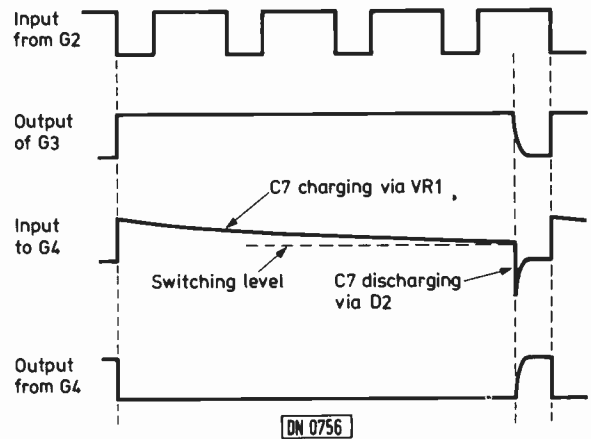


Fig. 4: Input to the first monostable circuit and the outputs available from it.

circuits. The capacitive loading of these circuits degrades the rise time so S3 is used to select the output from G21 on the two shortest ranges. This also inverts the pulses but is of no consequence—calibration is equally simple with either sense of output pulse. The output from S3 is taken directly to the time output for feeding to the oscilloscope.

Voltage Calibration

The pulse rate for voltage calibration is 1kHz. This is low enough not to suffer deformation in even the worst oscilloscopes but fast enough not to cause flicker. As shown in Fig. 5, the lower extremity of the "volts calibration" output waveform is offset about 50mV above earth. In order to overcome this difficulty a reference voltage equal to this offset is provided for connection to the earthy side of the oscilloscope input. A second reference voltage equal in value to the upper extremity of the waveform allows a negative-going pulse output to be obtained.

Gates G23 and G24 provide constant outputs of 1 and 0 respectively because G23 inputs are earthed. A portion of the 0 voltage is tapped from VR11 and adjusted to equal the low level on the "volts calibration" output pulse train. Similarly a portion of the 1 level is used as a reference to provide a 1V negative pulse train—selected by S4.

Capacitors C16, C17 and C18 ensure a low impedance to earth for the oscilloscope earthy input lead—which must not of course contact the chassis or 0V line of the calibrator. For this reason an insulated coaxial socket is used and the metalwork of the calibrator is not taken to mains earth.

Gates G22, G23 and G24 are all in one i.c. so the respective logic levels should track together thermally giving very good long term stability of the calibration pulses.

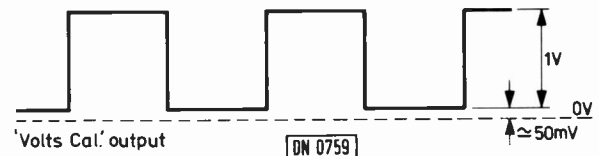
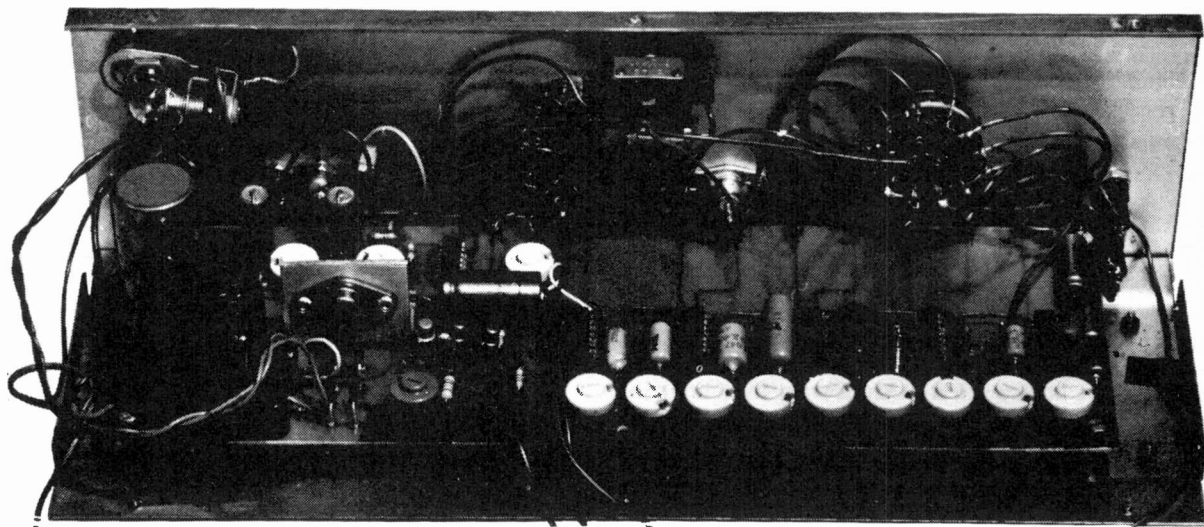


Fig. 5: The positive-going "volts cal" output.



Internal view of the oscilloscope calibrator.

The above description covers the operation of the digital circuits in a fairly thorough way since a full understanding of the operation is needed in the event of any fault finding and also helps in the initial setting up of the instrument.

Power Supply

The timing of the monostables depends to a great extent on the voltage the timing capacitors charge from and hence on the supply voltage. A well stabilised supply is required therefore so that the supply remains constant at any mains voltage or supply load. The mean load is about 100mA but varies by about 15mA in a series of fast pulses as the timing capacitors charge. The power supply circuit shown in Fig. 6 is stabilised against all these variations and in addition is not particularly temperature dependent.

Diodes D11, D12, D13 and D14 provide about 11V across C21 from T1, an 8V bell transformer. Transistor Tr7 is the series regulator element which drops the output to 5V, being controlled by the comparator

circuit Tr4 and Tr5. The base of Tr4 is held at 3.9V by zener diode D15 which is fed from the stabilised line via R11. The base of Tr5 is connected to the potential divider R14, VR13 which samples the output voltage.

If the 5V output falls, the voltage at Tr5 base will fall while that at Tr4 base will remain constant. Tr5 conducts less therefore and Tr6 base voltage rises, in turn making Tr7 base voltage more positive. This restores the balance in the comparator by increasing Tr7 current so that the output voltage rises. The result is that the circuit maintains the output at the same potential over quite large variations in load or mains voltage.

Capacitors C21 and C22 provide the main smoothing but further capacitors are added across the supply lines at various points to suppress switching "spikes". The actual placing of these components will be discussed later as it is dependent on the physical component layout.

TO BE CONCLUDED NEXT MONTH

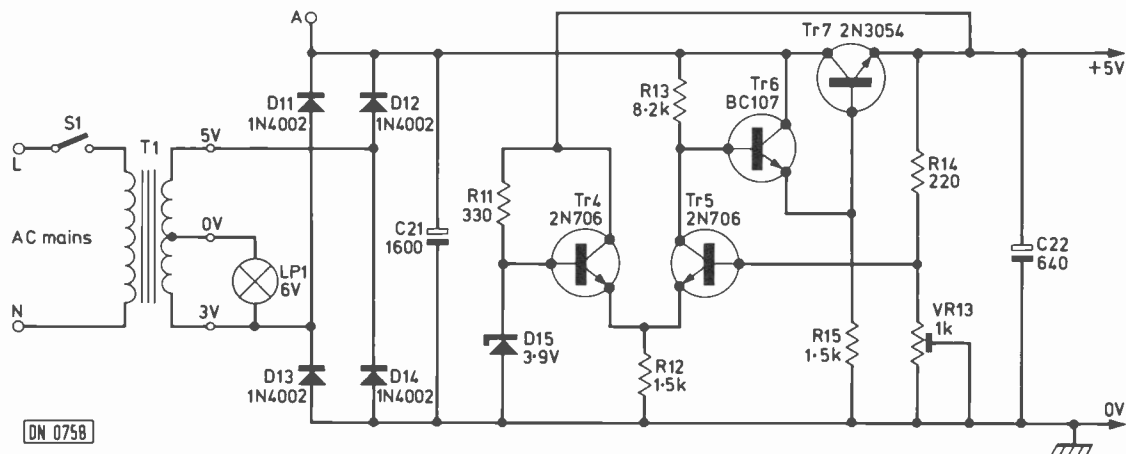


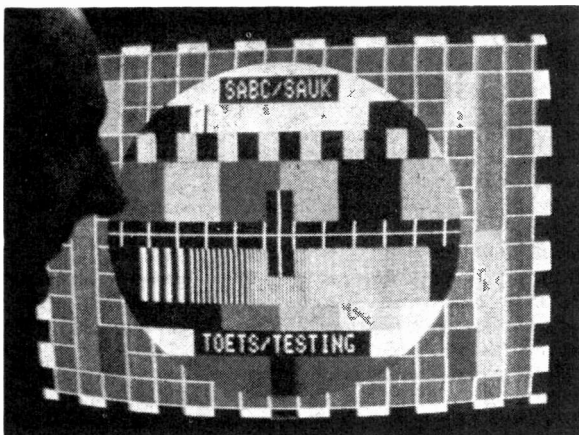
Fig. 6: The stabilised power supply circuit.

LONG-DISTANCE TELEVISION

ROGER BUNNEY

A FEW days before the end of February (when this column was being written) a letter arrived from our South African friend Wally Roane of Pietersburg with the exciting news that he was monitoring some of the first few hours of television in the Republic. True these were test transmissions—vision only—some months ahead of the scheduled start of test transmissions, but it marks an important event in television history. Interesting too that Wally has up to now seen signals only via Sporadic E (Rhodesia) and Trans-Equatorial Skip/F2 from Spain and Italy! His new "local" station at Pretoria (ch.5) is only 130 miles away, with 162kW e.r.p. video. Wally noted signals from February 5th—video only—with some fading though the signal stabilised after sunset. Test transmissions are from 0900-2230 at present: we understand that these signals are for "running up" the transmitter, the official tests commencing next August. The test card being used is of course the Philips PM5544! The identification is "SABC/SAUK" upper and "TOETS/TESTING" lower. We look forward to hearing further from Wally on developments with this new service.

While dwelling on the delights of the PM5544 test card we have received from Pve Unicam of Cambridge a photograph which should delight the philatelists in our midst: this shows a commemorative stamp issued by the Czechoslovakian Post Office in honour of the 20th anniversary of transmissions by the CST. The handout goes on to say "It is this signal that viewers now see on their screens and it has been started in monochrome prior to the introduction of colour transmissions". I can only say that I have not as yet seen this card in use by the 1st Chain in Band I: possibly it is used at u.h.f. for the colour tests(?). One final note is that "an optional plug-in unit extends the versatility of the PM5544 by allowing transmitter and channel identification to be inserted in the test pattern: in Czechoslovakia for example it is used to identify Prague, Bratislava and Brno".



History in the making: the SABC test card being studied as received during an early test transmission.

Following the exciting reception conditions of January, February has in comparison been rather a damp squib! This is to be expected and during such times we must either dwell on past glories or look forward to ever widening the TV horizon during the forthcoming Sporadic E season—more on this later.

My log for the past few weeks is as follows:

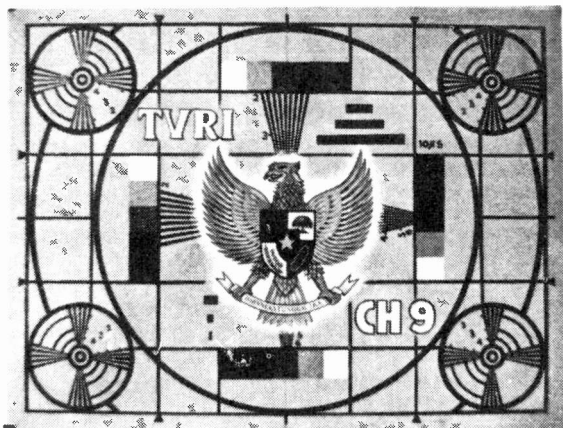
- 2/2/74 TVP (Poland) ch.R1 (MS—meteor scatter).
- 4/2/74 NRK (Norway) E2 MS.
- 5/2/74 TVP R1; SR (Sweden) E2—both MS.
- 6/2/74 TVP R1 (SpE—Sporadic E); CST (Czechoslovakia) R1; DFF (GDR) E4; RAI (Italy) IB—all MS.
- 9/2/74 TSS (USSR) R1; DR (Denmark) E3, 4—all MS.
- 11/2/74 ORF (Austria) E2a—MS.
- 12/2/74 TSS R1—SpE; CST R1; DR E4—all MS.
- 13/2/74 CST R1; TVE (Spain) E2—both MS.
- 14/2/74 CST R1; NRK E2; SR E2—all MS.
- 16/2/74 WG (West Germany) E2—MS.
- 17/2/74 WG E2; SR E4; RAI IB—all MS.
- 18/2/74 TVP R1; WG E2; SR E2; RAI IB—all MS.
- 19/2/74 ORF E2a; WG E2, 4; RAI IB—all MS.
- 20/2/74 WG E4—MS.
- 21/2/74 ORF E2a—MS.
- 22/2/74 TVP R1—MS.
- 23/2/74 CST R1; TVP R1—MS.
- 24/2/74 CST R1; DFF E4; RAI IB—all MS.
- 25/2/74 TVP R1—MS.

Towards the end of the month I spent a period each day on ch.E5 (Band III) in the hope of exotic MS. I was rewarded with several short pings but with my usual luck they were all on programme and consequently could have originated anywhere!

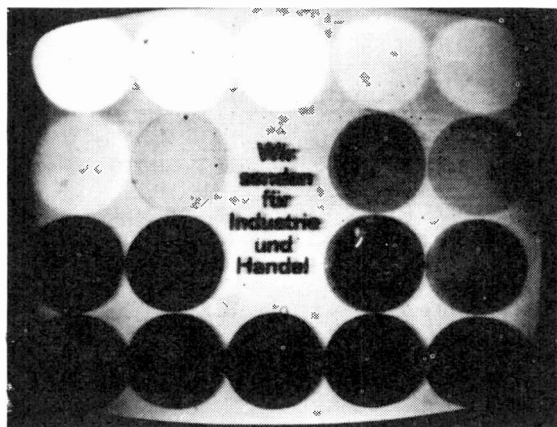
The mystery of the unidentified Fubk test card (with no identification) which I thought may have been originating from Norway is more likely to have been radiating from the Bayerischer Rundfunk. This would tie in with all three Band I channels. Clive Athowe has been



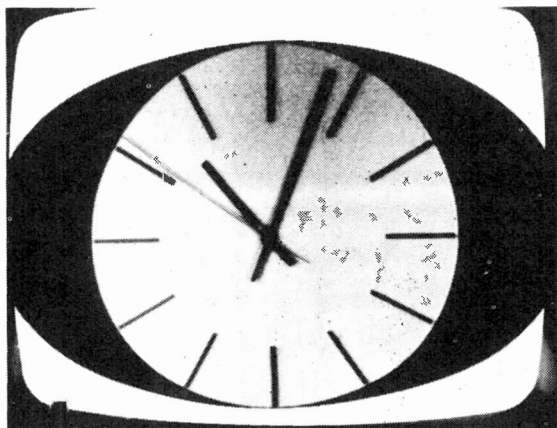
The PM5544 gets everywhere! Here it appears on a commemorative stamp issued by the Czechoslovakian Post Office.



An exotic test card—used by Television Republic Indonesia.
Photograph courtesy Keith Hamer.



DFF-2 colour test transmission caption.
Photograph courtesy Ralf Erler, GDR.



New clock used by RTB (Belgium).
Photograph courtesy Ryn Muntjewerff (Holland).

looking into this problem and has come up with this solution.

The 1974 World Radio TV Handbook recently came to hand and an examination shows that the AFRTS transmitter at Iraklion, Crete is now listed, on ch. A2 with 100 watts only. It has been received with good signals in the GDR and Italy and bearing in mind that

even low-power relays can be received over great distances a close watch must be kept on this channel during forthcoming SpE openings.

A Record Reception

Enthusiasts who do not live in East Anglia often dream about the signals they could receive if they did! To enthuse such dreamers, news has come from Clive Athowe (Norwich) on the good tropospheric conditions back in January. He received, albeit with noisy signals, three transmitters located in the North of Sweden close to the Finnish border. The transmitters—all 1000kW e.r.p. on channels E34, E35, E36—were Pajala, Haparanda and Boden respectively. The signals came in from a heading somewhat more Northerly than the "usual" direction for Swedish stations and since these are the only high-power stations on these channels there seems little doubt as to the origin of the signals. Pajala is the farthest of this trio, at some 1,250 miles! Congratulations, Clive. Clive also noted TVP Wroclaw ch. R25 and Gruentzen ch. E28. On January 15th, Clive noted during the afternoon (1527) the CST type electronic pattern but with the identification "EESTI" to the right-hand side—on ch. R1.

UHF "Exotics"

The following list of OIRT u.h.f "possibles" was held over from the previous column due to (a) excellent conditions and (b) some of them were actually received!

Poland: Katowice ch. R21 500kW; Wroclaw ch. R25 1000kW. Both radiate TVP-2 programmes, with horizontal polarisation.

Czechoslovakia: Praha-Mesto 100kW ch. R24; Kosice 600kW ch. R25; Bratislava 1000kW ch. R27; Ostrava 600kW ch. R31; Liberec 100kW ch. R31; Zilina 1000kW ch. R35; Brno-Mesto 100kW ch. R35. Polarisation is horizontal in every case.

Hungary: Budapest 2 4kW R24; Pecs 2 20kW R32. Both with horizontal polarisation.

News

Spain: Notwithstanding earlier comments about the possibilities (or otherwise) of TVE going colour I am now advised that approximately 12 hours of colour (PAL) are transmitted weekly and that the official start in colour will be in 1975. I noted from the WRTV Handbook 1974 that there are TV transmissions now in the Spanish Sahara: the signals are taken off-air from the Canary Islands (presumably Izana ch. E3) and relayed over several low-power transmitters, unfortunately for us in Band III.

West Germany: The Bayerischer Rundfunk is to change the transmitting polarisation of the Kreuzberg/Rohn outlet from the present vertical to horizontal: until April 30th signals will be radiated in both polarisations. Kreuzberg radiates on ch. E3 with 100kW e.r.p.

Holland: The NOS seems to have settled on a complete PM5544 test card. Initially they commenced transmissions less the side panels; these have been added as indeed has the identification (lower) "PTT-NED 1" or "2". The RMA card is used for fifteen minutes prior to programme commencement.

Belgium: The BRT/RTB have been noted using the PM5544 with alternative identification areas. More recently they were seen to include the identification in the upper black bar instead of the lower one but later still the identification moved back to its former home.

France: The 600ft. mast at the Brest (Brittany) transmitter collapsed recently due to an explosive charge (14/2/74). This had been radiating ORTF-1 on ch. F8 and ORTF-2 on ch. E21.

New TX Listings

Spain: Ares ch. E5 50kW horizontal (NW Spain); Castropodame ch. E7 22kW horizontal (NW central, close to the Portuguese border).

France: Clermont Ferrand ch. E25 1000kW; Lyon Mt. Pilat ch. E43 1000kW; Longwy (near Luxembourg) ch. E44 100kW. These three outlets carry ORTF-3, with horizontal polarisation.

Holland: Roermond ch. E31 has reduced power from 500kW to 250kW (NOS 2).

Sporadic E Propagation

Experienced operators will I trust forgive me using valuable space to cover familiar ground: it is evident that the ranks of DX-TV enthusiasts are rapidly growing however, so the basic theory must be covered occasionally.

Sporadic E propagation is generally regarded as a summer time phenomenon (with often a winter spell of activity as well). During the period May to early September, Band I (up to about 100MHz) signals that would normally pass into space when reaching the radio horizon often encounter intense ionisation within the E Layer (some 70 miles high) and are reflected back to Earth—in a manner similar to short-wave radio signals. The distance between transmitter and receiver (skip distance) usually lies between 450-1,500 miles for a single hop and at times upwards of this if a multiple-hop occurs (signals have been received up to 3,000 miles via triple hop—a very rare phenomenon). The causes of Sporadic E ionisation are unknown and indeed as the name suggests it is completely sporadic in its appearance—suddenly appearing and at times as quickly disappearing. We do know however that it will be most active over the period mentioned above. In consequence this is known as the "Sporadic E Season".

The signals that are received via Sporadic E can be extremely strong—easily reaching the signal levels experienced with the normal local transmitter. For television the lower frequency channels (see DX-TV booklet for channel allocations, pages 4-5) are received best, from ch. E2 through to E4 and the channels within this spectrum. At times signals up to 100MHz will be reflected—strangely the signals between 70-90MHz tend to be more stable and resemble tropospheric signals (i.e. they are very slow fading). Band I signals via SpE often exhibit multiple ghosting effects and phase reversal—especially on the shorter skip signals.

Each year there is usually a tendency for signals from one direction or area to predominate. Signal duration can be from minutes to hours and can occur at any time of the day or evening—the limiting factor is the actual transmission hours. The transmitted polarisation often alters along the path to the receiver and is completely random on arrival though with the really distant signals the polarisation tends to be that of the original transmission. Another characteristic of this propagation mode is that the reflecting sheet often moves: as it shifts so the skip distance changes and stations either nearer or further are brought in.

The newcomer to the hobby is recommended to commence with Sporadic E reception since really spectacular results can be obtained for little outlay using the



*The DFF East Berlin television tower.
Photograph courtesy DFF International Relations.*

most primitive aerial system. This method also helps the DXer to get used to the various transmission standards and frequency allocations.

While browsing through the section in the WRTVHB 1974 on sunspot activity I saw that the coming period compares with that experienced in 1963-65. Those active in the early 1960s will hardly forget the daily SpE openings, with TVE in from programme opening to close down and for the lucky few Cyprus on its old E2 channel with 1.5kW. With luck 1974 will be just like the old days! I feel we should not forget certain "target exotics"—Amman Jordan ch. E3; Iraklion ch. A2; Ruse R1, Plovdiv R2—both Bulgaria; Albania IC; Canary Islands E3. If conditions are really wide open look on ch. E5/R6 (Band III) as there is just the slightest chance that Band III SpE may happen—Band III (or High Band) SpE has happened in the USA!

From our Correspondents . . .

Hugh Cocks has written to tell us that his total TVE Band III catch during the recent (January) tropospheric opening totalled three transmitters—on channels E5, 8, 9. The channel E9 transmitter (90kW e.r.p.) is located at Ciudad Real, south of Madrid! Well done Hugh.

John White (Scunthorpe) has written again with a very long list of trop catches! His colour DX includes many Swedish and West German u.h.f. transmitters. For his photography from the screen John uses a Halina Paullette 35mm camera with HP4 film, using a 1/30th second exposure at f2.8. This seems to give very good results.

FAULT FINDING GUIDE

John Law

PHILIPS FIELD TIMEBASE CIRCUITS

THE field timebase circuits used in the all-valve and hybrid Philips dual-standard and 625-line only chassis have a distinctive factor in common—the use of two valves in the oscillator section. Going back to the 405-line only TG100 series chassis introduced in 1960 we find the triode section of an ECL80 used in conjunction with a PCL82 triode-pentode, the two triodes being operated in a cross-coupled multivibrator circuit. The next series, the TG111, saw the newer PCL85 triode-pentode introduced, operating once again in conjunction with the triode section of an ECL80; this basic circuit continued through the subsequent TG122, TG142, TG152 and TG158 series. The very popular Style 70 chassis (170 series) saw a change to an EF80 coupled to a PCL85, and this basic pattern continued through the hybrid 210, 300 and 310 series—the last to use a valve field timebase. Subsequent Philips field timebases have been completely transistorised.

The earlier series mentioned are of academic interest only now. Models in the TG152/TG158 and 170/210 series are regularly found in workshops however and the field timebase circuits are shown in Figs. 1 and 2. The layout of the 210 chassis field timebase panel is also shown (Fig. 3).

Circuit Operation

The common factor in all these circuits is the use of a cross-coupled multivibrator field oscillator. Fig. 1 shows the two triodes cross-coupled by means of C430 on one side and C432/C431 on the other. The pentode section of the ECL80 is used as the sync separator while the PCL85 pentode is the field out-

put valve. The field charging capacitor C429 charges via R438 and the height control R439 from the boost rail when V402a is non-conducting. The drive waveform thus produced is coupled to the grid (pin 9) of the output valve via C426, C425 and R435, the main linearity control R432 together with R433 forming the pentode grid leak resistance. The hold control R441 is connected in the PCL85 triode section grid circuit: note that it is connected to a potential divider (R440/R442) which is across the h.t. line. The hold control thus selects the bias applied to the PCL85 triode section. The top field linearity control is connected in a feedback loop between the anode and control grid of the PCL85 pentode section. The output pentode feeds the scan coils through a simple transformer. The field sync pulses are integrated by R446 and C433 and applied to the grid of the ECL80 section of the oscillator. Note the use of an anti-parasitic oscillation ferrite bead F402 on the lead from the ECL80 triode anode.

Fig. 2 shows the circuit used in the 210 and later chassis. The 170 series circuit was identical save for the height circuit: a different set of component reference numbers was used however. In these circuits the ECL80 triode is replaced by an EF80 strapped to act as a triode and the output transformer has a tertiary winding to provide the linearity feedback. The oscillator operates in exactly the same manner as in the previous circuit. Typical operating voltages on the EF80 are 40V on the strapped screen grid and anode, with $-1.6V$ on the control grid though this can vary with the setting of the height control. The PCL85 triode should have about 57V at its anode (varies with the height control setting) and $-14.2V$ on its grid; the pentode section should have 205V at its anode, 197V at its screen grid and 15.5V at its cathode.

Drop-off Resistors

In an endeavour to reduce damage in the event for example of a short-circuit in an output valve Philips' receivers are dotted with protective "drop-off" resistors. These 1W carbon resistors are suspended from the underside of stand-off tags and are held in place with solder only. Excessive current—due to a valve interelectrode short for example—results in the solder melting and the resistor dropping to the bottom of the cabinet. Loose resistors in a set suggest therefore that this type of fault has occurred and should lead to a check of all the drop-off resistors shown in the circuit diagram—those in the video amplifier anode and field output valve cathode circuits are mounted in pairs of equal value. Use identical values for replacement purposes and secure them to the underside of the appropriate tags with high-temperature solder. They can then fall away once more should the fault recur.

Hold Troubles

On receiving a complaint of field hold trouble spend a little time deciding that the fault is actually in the field timebase and not for example in the video amplifier/sync separator section. In one case replacing the EF80 appeared to cure a rolling picture fault: some weeks later the fault recurred however and was eventually traced to a changed value resistor

Assembling a modular colour set

DAVID ROBINSON
PART 3

It is often thought that the decoder and the convergence circuits of a colour receiver are the most difficult to build and align since they are "special" to colour sets. In general this is not true, for although these circuits are complex and a little bewildering at first sight they are quite non-critical as regards layout. No, the part which causes all the headaches is the i.f. strip. This is very tricky in monochrome sets and is even more so with colour. The i.f. strip is the heart of the set and unless you are very experienced and have access to all the necessary equipment it would be most unwise to "go it alone" on this. The easiest approach at present is to try to pick up a manufacturer's surplus i.f. strip, preferably one intended for colour use. In general monochrome set i.f. strips are not good enough and more time is needed to make them so than to build your own colour i.f. strip from scratch.

The problem is that the i.f. strip will probably not be intended for use with the ELC1043 varicap tuner. Thus care is needed in coupling them together. Trouble here can result in sound-chroma beat patterns, sound buzz, overshoot, smearing, weak or no chroma—and so on!

Initially it is best to assume that the i.f. strip is correctly aligned—surplus ones nearly always are—and experiment with three variables: the tuning of the tuner i.f. output coil; the damping of the same coil; and of course the ordinary fine tuning of the receiver. This latter adjustment must be exactly right before any other adjustments are attempted, otherwise the results will be misleading. Where a.f.c. is incorporated set the a.f.c. discriminator tuning so that it locks the receiver on to the correct frequency.

AFC Adjustment

To start with the a.f.c. should be disconnected from the tuning line and connected to a voltmeter. On adjusting the tuning potentiometer you will be able to see from the picture when the tuning is approximately right. Now feed the receiver with a weak signal (e.g. by using an indoor aerial) so that some hiss is audible on the sound: on slightly adjusting the tuning again you will be able to hear when the sound carrier passes through the rejection notch—there will be an increase in the hiss. Leave the tuning at this point and do not disturb it.

Restore the normal signal and align the a.f.c. discriminator as follows.

Start with both cores fully out from the former. Screw in the primary core until the first peak in the meter reading is observed (reverse the meter connections if necessary). Now on screwing in the secondary core the reading will at first rise even farther, then as the core approaches the correct setting the reading will drop rapidly and pass through zero. Leave the secondary core just off the zero voltage position so that a small reading is still obtained. Then peak up the reading again with the primary core—due to the interaction between the two cores this will mean unscrewing the primary core slightly. This will increase the reading, so the secondary core must be readjusted again so that the reading is small. Repeat this procedure until no further improvement is being obtained. Then set the secondary core finally to give an exact zero reading.

If the a.f.c. line is now reconnected the receiver should lock correctly. In some cases the a.f.c. circuit is slightly affected by the d.c. passing through it from the tuning potentiometers. To allow for this use the weak signal again and make a small adjustment to the a.f.c. secondary core to once again bring the sound carrier into the notch.

Monochrome Picture Assessment

With a normal signal applied again, carefully examine the displayed test card. Turn off the colour and examine first the luminance signal. The tell-tale areas are the areas of grey bordering the vertical lines of the white square rulings in the background of the test card. These provide an indication of the transient response. Ideally the grey should be perfectly uniform right up to the edge of the white line. In practice however a *slight* overshoot (i.e. a narrow black outline to the right of the white line) provides a subjective improvement in the definition. All too often though receivers have either too much overshoot or the opposite effect—smearing of the white line to the right.

The other important part of the test card for this purpose is the set of frequency gratings to the right of the centre circle. From top to bottom these correspond to 1.5, 2.5, 3.5, 4.0, 4.5 and 5.25 MHz. All colour receivers incorporate a notch filter tuned to 4.43MHz in the luminance channel and since this needs to have a fairly wide bandwidth the 4.5MHz bars will not usually be very clear. If they cannot be seen at all this may indicate that the notch filter is too drastic and needs damping a little. Many receiver designs have a notch filter which provides very high attenuation and completely removes the 4.43-MHz pattern. I have found that this is unwise because it unnecessarily impairs the picture definition. Those who say that the shadowmask tube cannot resolve the extra definition are underestimating the quality of modern tubes. Once again a compromise is necessary. Remember that the system is designed to minimise the visibility of the sub-carrier pattern (for the benefit of those using mono-

chrome sets): small amplitude of patterning is therefore not noticeable. Some attenuation is necessary however since the non-linear c.r.t. characteristics cause an apparent increase in the luminance level of areas where a large subcarrier is present—this of course desaturates the colours. Also interference effects can be generated between the pattern and the array of phosphor dots on the screen.

To return to the test card the first four frequency gratings should be clear and—equally important—should be of similar contrast. The 4.5MHz gratings will be fairly weak, as explained. The 5.25 MHz gratings should be visible but will be fairly weak. Do not worry however if they cannot be seen, provided all is well otherwise. Look out also for sound/chroma beat patterns which take the form of a coarse pattern which dances around in time with the sound and which is noticeable on strongly coloured areas of high luminance such as yellow.

Colour Picture Assessment

Now turn up the colour. The saturation can be correctly set by turning off the green and blue guns and adjusting the saturation (colour) control until the two pairs of red bars at the top of the card are of equal brightness.

No significant grain should be added by turning on the colour. Noisy colour means either a poor aerial or i.f. alignment troubles. Check also the luminance-chrominance registration: the area of red in the centre corresponding to the dress should “fit” perfectly on to the luminance image. Often the colour will be too far to the right, indicating inadequate chroma bandwidth. This is again usually the result of i.f. alignment troubles.

Another useful area to look at is the coloured castellations on the left of the card. These should not smear across to the right.

Tuner/IF Strip Coupling

Having examined these points you will almost certainly have found something wrong. Try adjusting the tuner i.f. output coil. This is easy on the ELC1043/05 tuner but on the original ELC1043 tuner the coil is behind a hole in the metal case which does not line up with it, has a strong core which needs a strange trimming tool and has a thread which strips at the drop of a hat. You have been warned!

Still can't get the right results? Then probably the Q of the tuner output coil is too high for your i.f. strip. This can be put right by fitting a resistor in parallel with the coil. 10k Ω is a good starting point but you may need to go as low as 1k Ω . On the ELC 1043 the resistor is simply connected from the i.f. output point to the i.f. test point—there is no need to open up the tuner. On the ELC1043/05 however the test point is hidden inside and furthermore has a d.c. voltage on it; so the easiest way is to prise off the metal cover—taking *great care* not to disturb any of the u.h.f. circuits or the preset controls—and fit the resistor directly across the i.f. coil itself (see Fig. 16). Replace the cover before retesting the set. Try adjusting the coil again and if results are still not right try the next resistor value down.

The procedure takes less time to do than to write about and should enable a very high standard of

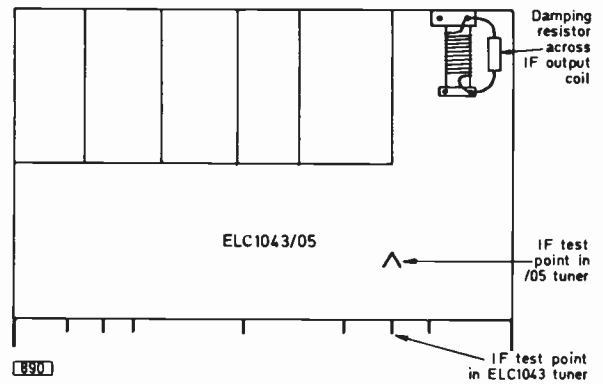


Fig. 16: Damping the tuner i.f. output coil.

results to be achieved. When—and only when—you are satisfied that no further improvement is possible then it may be worthwhile to try a *small* adjustment (not more than a turn or two each way) of the i.f. input coil on the i.f. strip. Make sure you are tweaking the right core (see Fig. 17 for example)—tampering with the rejectors could get you into deep water indeed.

The method described is not a substitute for proper adjustment using a wobulator. Given a ready aligned i.f. strip however it is possible with practice to obtain extremely good results in this way.

Decoder Alignment

There are four basic stages in aligning a decoder. We must first make the reference oscillator lock to the incoming burst signal. Secondly we must bring the reference and chroma signals fed to the synchronous detectors into phase with each other. We must then obtain the correct chroma bandpass response to give optimum luminance-chrominance registration, signal-to-noise and cross-colour performance. Finally we must set up the relative gains of the three colour-difference channels to give the correct RGB signals. Most decoders also have an ident coil to adjust.

Reference Oscillator & Ident Adjustments

Probably to start with you will be getting no colour at all. In this case the first move is to override the colour killer. This should give some sort of colour output from the decoder, consisting no doubt of much patterning with some weak colour flickering across the screen. Adjusting the reference oscillator

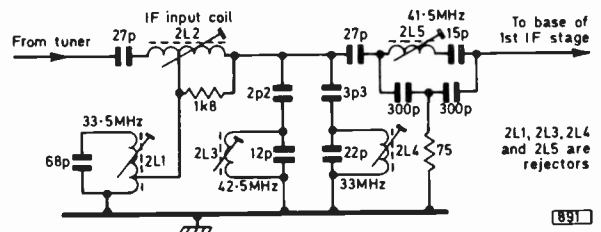


Fig. 17: Bandpass shaping circuits at the i.f. strip input (RBM A809 panel).

frequency control (see Fig. 18) should enable the rolling of the colours to be brought almost to a halt, and unless the alignment is really way out you may be able to get a reasonable colour lock. The ident may well be wrong (green faces) as the ident coil has not yet been adjusted.

The way to obtain an indication of the strength of the received burst signal is to monitor the a.c.c. potential. The burst gating pulse timing coil needs setting first. If you have access to an oscilloscope to look at the gated bursts there is no problem. Otherwise start with the core fully out of the coil and screw it in until you reach the first peak of the a.c.c. voltage. If you now peak up the burst tuning coil for maximum a.c.c. you should have a solid colour lock. Then adjust the reference oscillator output coil for maximum output using either a 'scope or a meter with a simple diode probe.

We next need to adjust the ident coil and here we can make use of the fact that (in the usual decoder circuit) the ident output is also used to work the colour killer. Restoring normal colour killer operation will probably cause the colour to drop out, but adjustment of the ident coil should bring it back again. Reducing the setting of the set a.c.c. control (if present) to give a weaker signal enables a more exact adjustment to be made.

You should now have correct ident as well. If not the chances are that you have a transformer winding in the R-Y reference signal path in the decoder connected the wrong way round. The same thing may well happen of course in the B-Y channel.

Phasing the Signals

The function of the chroma delay line is to counter the adverse effects of phase errors. In order to adjust the phasing of the chrominance and reference signals however we want to show up such errors, so we convert the decoder to simple PAL operation by shorting the input to the delay line. The phase errors are then visible as "Hanover bars" on the coloured areas of the screen.

All the 4.43MHz tuned circuits in the decoder affect both the R-Y and B-Y phasing. In addition however we have in the B-Y channel another variable—the reference signal quadrature trimmer ("set 90°"). We concentrate first therefore on the R-Y signal, by switching off the green and blue guns.

The chroma amplifier input coil has some effect on phasing so the first step is to peak this up for the strongest chroma signal (ignoring the Hanover bars). The coil which has the greatest effect however is the burst amplifier tuning coil. A small adjustment of this nearly always enables the bars on the red signal to be nulled out. The other coil to try is the tuned circuit in the reference feed to the R-Y demodulator.

Remember that with simple PAL there are nearly always some Hanover bars on colour transitions. We are only interested here in removing bars on the larger areas such as the red colour bar or the red dress on the test card. The cyan, green and magenta bars also show up blinds on the red signal.

When—and only when—the red signal is satisfactory switch on the blue gun only and adjust the blue quadrature trimmer for minimum Hanover bars. The green signal contains both R-Y and B-Y components and is therefore not of much use for these adjustments.

Simple PAL operation should give quite an acceptable picture on switching on all three guns, though some slight blinds are nearly always visible if you look closely.

Unfortunately we now need to make the adjustment wrong again! This is because we have to adjust the delay line circuit for optimum phase error correction and for this we need some errors to work with! This can be done by off-tuning one adjustment only, for convenience the burst amplifier tuning, so that fairly bad blinds are visible. Now if we bring back into circuit the delay line (which by the way causes an increase of about 2:1 in the saturation) the delay line phase and amplitude balance controls can be set to eliminate the blinds. Returning briefly to simple PAL again enables the burst tuning coil to be reset correctly.

Chrominance Bandwidth

The overall chrominance channel frequency response is the combined response of the i.f. strip and the actual chrominance amplifier. It is a fact often overlooked that the response must be symmetrical and centred exactly on 4.43MHz for optimum cross-colour performance. Fortunately we have an adjustment for this which is more or less independent of all the others—namely the output coil of the chrominance preamplifier which in my set—as in many—is fitted on the i.f. board.

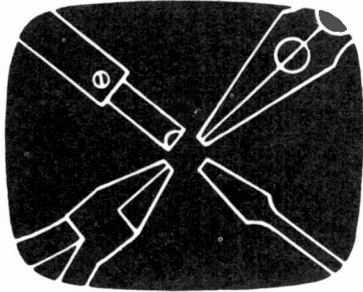
Test Card F is ideal for this purpose as it contains areas with plenty of vertical lines on the luminance image but with no colour on them. The secret is to disconnect the luminance signal—taking care not to remove the input to the sync separator in the process—when on advancing the brightness control a display of just the colour-difference signals can be seen.

The cross-colour will be seen where the vertical lines would be on the luminance signal. Some cross-colour is inevitable of course but on adjusting the aforementioned coil a definite null in the cross-colour will be found. On restoring the luminance signal the cross-colour should be found to have negligible effect on the picture.

Colour-difference & Grey Scale

The tricky part of the alignment has now been finished: on to the easy bits! Many modern RGB drive circuits have no colour-difference drive controls, the matrixing being accurate enough as it is. The SL901 i.c. used in my set does need such controls though they have only a very small range. They can be set up easily on colour bars to give the correct RGB signals, using either a 'scope or the picture tube to look at one output at a time.

The grey-scale controls have a great effect on the colour fidelity of the display. It is not too difficult to set the background (c.r.t. first anode) controls provided the room can be completely blacked out. Attention must obviously be paid to safety when you have a receiver working with the back off under such conditions: it is important that the controls are easily accessible and that there are no exposed live points anywhere near them. From the adjustment point of view large potentiometers and large knobs are helpful; so also is a contrast control which permits the contrast to be reduced to zero without affecting the sync.



SERVICING television receivers

L. LAWRY-JOHNS

PYE 169 CHASSIS—cont.

Line Timebase

The line oscillator and output stages have remained almost unaltered through the series. The boost line smoothing resistor R87 was changed from 820k Ω to 470k Ω along with the height circuit modification mentioned earlier.

The line oscillator is the by now almost standard PCF802 sinewave circuit which gives very little trouble apart from the valve itself and the occasional capacitor breakdown (the electrolytic C66 is the chief suspect).

The shaped waveform from the oscillator is fed to the PL504 line output valve which is self-biased from the transformer. In early models one capacitor (C71) shunted the two 4.7M Ω resistors (R85 and R86) in series in the width circuit. This arrangement was later modified, with each resistor shunted by a separate 220pF 1kV capacitor.

It is in this circuit that trouble is to be expected. The resistors tend to go high value resulting in decreasing width. Intermittent variation in width is often caused by the capacitor/capacitors becoming defective (although they may check well on a bench test). The width control itself (RV6) frequently causes this fault but can be easily checked by rotation. This will immediately show whether there is a dud spot. A faulty control must not be neglected as it can lead to a very expensive repair. A new control can be fitted in minutes and at the cost of a few pence, and may well save a line output transformer at the least.

Striations or vertical rulings down the left side of the screen will be caused by R91 being of higher value than its rated 1.5k Ω or if there is a dry-joint between the resistor and its intended connections.

The writer has not encountered a case of a shorted boost reservoir capacitor (C73) as yet but the fact that from a d.c. point of view it is connected through low-resistance coils to chassis should be kept in mind.

Another point worth remembering is the fact that although the line output stage supply is from the HT1 rail the line oscillator supply is from HT3. Thus failure of R56 will result in overheating in the line output stage due to lack of line drive.

All in all however the line timebase has proved quite reliable in operation—or perhaps we have been lucky in this respect.

Power Supply Circuits

There have been several modifications to the power supply circuits. The obvious differences are the value of R60 (reduced from 156 Ω to 147 Ω) and the position

of the heater circuit diode D5 (moved from midway in the heater chain to the mains side of R60). The heater circuit thermistor may be a VA1075, a VA1070 or (later) a VA1026. A thermal cut-out may also be found although this is not likely in early models.

The transistor supply line was changed from 12V to 11V, with a different regulator (R61A and VDR5 replaced by an 11V zener diode—type BZX70/C11). Varicap tuner models use a supply derived from the HT1 line via a 5%, 2W 20k Ω resistor with a TAA550 stabiliser for the tuner and tuning potentiometers.

The mains supply fuse was changed from 1A to 1.25A delay.

In the majority of cases complete absence of h.t. with the heaters still glowing is due to the fusible resistor R59 being open. Check for shorts before rectifying this. A completely dead condition with the supply fuse blackened is usually due to C55 shorting when subjected to the full a.c. mains (it may not show a short on a meter, but this is no real test). Clip it out, fit a new fuse and if this doesn't blow fit a new capacitor rated at 300V a.c. (or 1kV d.c.).

Video Circuits

A BF178 transistor is used in the video output stage with a 6.8k Ω 5W resistor from HT1 as its load across which the video signals are developed. A control marked RV3A is provided to preset the emitter bias. A roughly correct setting for this is when 85V is recorded at the transistor collector when the test card is being displayed and the contrast is well up. The emitter has a 6MHz rejector in series with its bias whilst the base is fed from the contrast control which is wired between the signal output of the video i.c. and the junction of the voltage divider R26-R27.

On the 169 and 769 chassis the video i.c. was originally type TAA700. This was later changed to a type TBA550Q, with certain component differences.

As mentioned earlier the 569 chassis does not use a video chip but a small panel containing separate transistors and components. In this case the contrast control is fed from the emitter of a BC148 which is d.c. coupled to the preceding BF194 video preamplifier. The detected vision signals are fed to the emitter of this transistor from D1 via the 6MHz sound take-off coil T2.

IF Strip

The i.f. strip consists of a BF196 controlled first i.f. amplifier which is followed by a cascode stage VT2

Chassis variations

Later production:

- C8 147pF
- C18 8.2pF
- C34 0.22μF
- C46 0.22μF
- C81 0.033μF
- R8 390 Ω
- R14A 100 Ω
- R25A 47k Ω—in series with RV2 slider

- R31 220 Ω
- R60 147 Ω
- R65 330 Ω
- R66 330 Ω
- R87 470k Ω
- R87A 1.8k Ω
- RV6 470k Ω
- R85, R86 both shunted by separate 220pF capacitors

- J19 replaced with choke
- Fuse 1.25A delay

With IC2 type TBA550Q:

- C30 0.047μF
- R22A 15 Ω in series with pin 4
- R66A 82 Ω in series with pin 2

See also modified circuitry shown separately and text.

Early production:

- C36 omitted
- R5 220 Ω
- R9 100 Ω
- R65 470 Ω
- R66 470 Ω

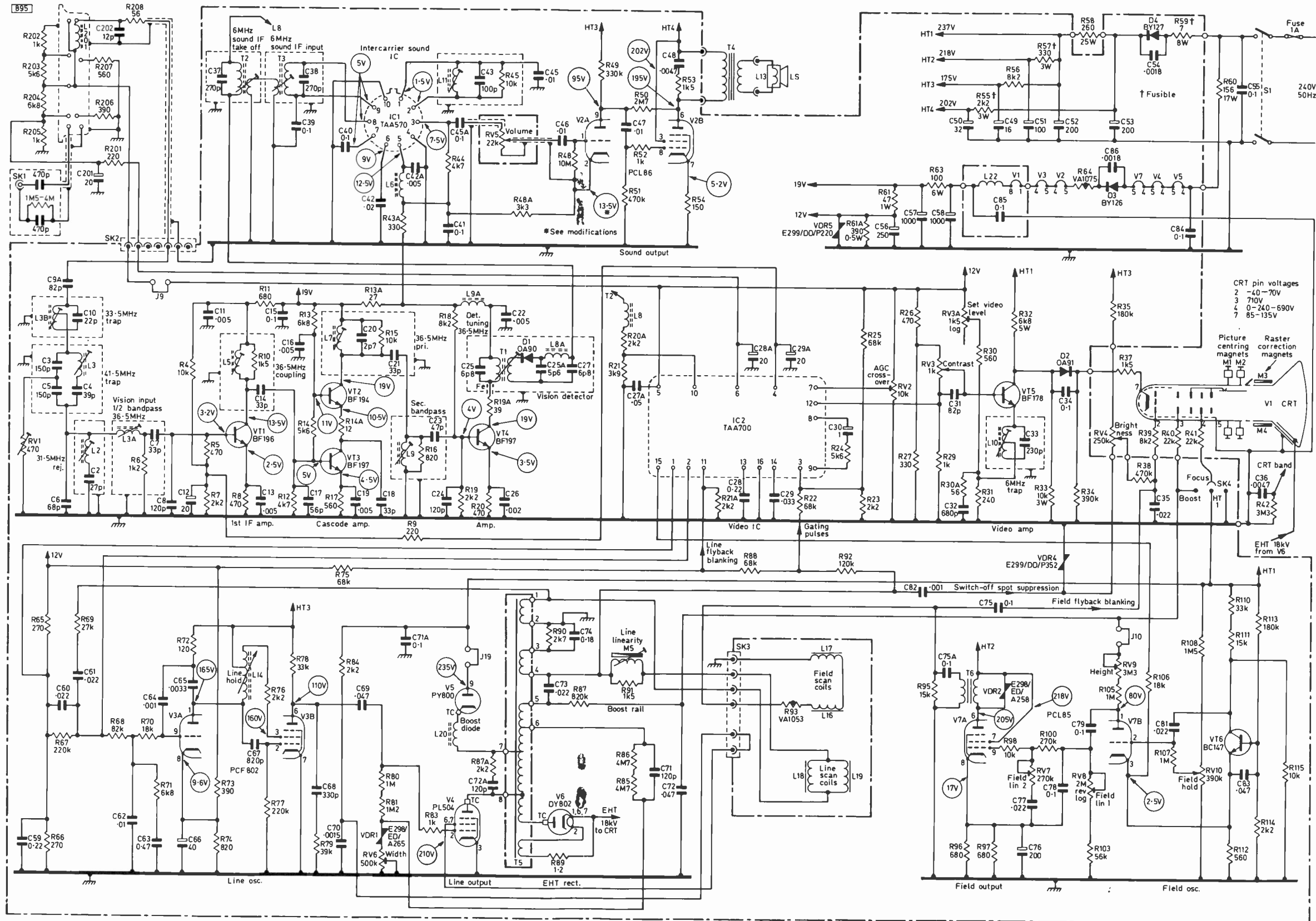


Fig. 9: Circuit of the basic Pye group 169 chassis. See also Figs. 4-8 and 10. Heater rectifier D3 (BY126) should be shown as D5.

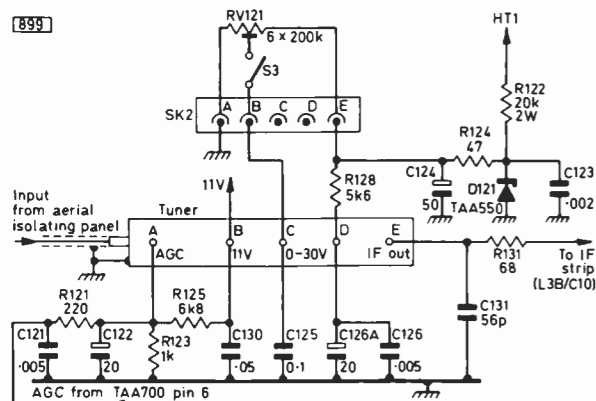
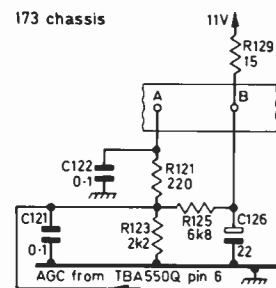


Fig. 10: Circuitry used with the varicap tuner fitted in the 769 chassis (above). In the later 173 chassis four 80kΩ tuning potentiometers (RV121) are used with a 3.9kΩ resistor in series, R128 is 4.7kΩ, C126 and C126A are omitted and the modifications shown on the left incorporated.



4.7kΩ resistor between tags 5 and 6 and a slight clockwise turn to L11 should clear this trouble.

Before suspecting the chip however a wary eye should be cast upon the PCL86 audio valve which tends to run into grid current and produce a croaky sound and an overheated appearance. The pin 7 voltage (pentode cathode) should be a trifle over 5V with nothing on pin 8. If there is a voltage on pin 8 it is nearly always due to the valve, only rarely to a leaky coupling capacitor C47.

The audio output stage is capable of good quality sound (consistent with the loudspeaker used) as a result of the use of both voltage (R50) and current (un-bypassed R54) feedback. The cathode resistor R54 can be damaged by a faulty valve so its appearance should always be checked when the PCL86 has to be replaced. Failure to do this can result in the early failure of a nice new valve, or the

ASSEMBLING A MODULAR COLOUR SET

—continued from page 309

be possible to build a receiver giving just as good results with a fair amount of simplification.

So far as picture quality is concerned the basic limitations are the 625-line PAL transmissions and the shadowmask tube. In practice however the limiting factor is not so much receiver design as the accuracy with which a receiver is set up. This applies particularly to the grey-scale adjustments.

As in all engineering the design of a colour set is a compromise between cost—both in terms of money and time—and performance. It is best for the constructor to avoid complexity for its own sake. It is just not worthwhile for example stabilising all the supply lines, not for a domestic set anyway. And it's not worth making an elaborate array of metalwork with plug-in screened boxes for each module. Too

necessity to replace the resistor at a later date, or both.

Tuner Units

The silicon transistor push-button tuners used in the 169 and 569 chassis have proved fairly reliable in practice—apart from the need to replace the BF181 in the event of a weak and grainy signal (check the aerial, cable, plug and socket first of course) or the BF180 in the event of it being reluctant to oscillate at the lower end of the scale (or at any part when it gets really stropy).

The varicap tuner used in later models is mounted on the lower left side of the main panel, with the control unit behind the push buttons. These tuners are not the easiest to work on as they are very compact. The majority of troubles seem to consist of control voltage variation due to defective resistors (mainly the 33kΩ ones of which there are three inside the tuner) and the very small clearance between some parts and the metal work which can result in the control voltage being shorted to chassis in the event of the slightest vibration (or cleared by vibration or deliberate pressure on the tuner case). So far we have not had to change a transistor in one of these tuners and cannot therefore comment upon the ease or otherwise of this operation. Perhaps the "BF" transistors used are more reliable than the earlier "AF" ones, but this does not seem to extend to those used in mechanically tuned tuners. We may have a very different story to tell say this time next year.

Sync Troubles—569 Chassis

As previously mentioned the 569 chassis has no chip to carry out the video preamplifier, a.g.c. and sync separator functions. A transistor (VT11) of the BC147 type operates as the sync separator in the 569, with a BA154 diode in its emitter return to chassis. The base is biased by a potential divider consisting of a 100kΩ resistor to chassis and a 4.7MΩ resistor to the supply rail. This latter resistor tends to change value resulting in weak sync first and then (as it goes way up) no sync at all. Typical symptoms are poor field sync or intermittent loss of sync after changing channels.

NEXT MONTH: PHILIPS 300 CHASSIS

much circuit pruning should also be avoided however. Why leave out the pincushion correction transducer for example when it costs so little? Once installed it can be forgotten about. And why put up with 10% audio distortion when with a decent circuit this can be reduced to 1%?

The aim of these articles has been to guide those who decide to build a colour set using whatever surplus modules can be obtained. It is an approach that is possible and worthwhile provided you have the time to devote to it; moreover the situation is improving, with circuits becoming simpler and components easier to obtain. If you are prepared to be meticulous at every stage, results can be achieved that are equal to the best ready-made sets on the market—and at the end you will have a receiver capable of giving you and your family entertainment for many years.

Thanks are due to Michael Bajcar for the photography.

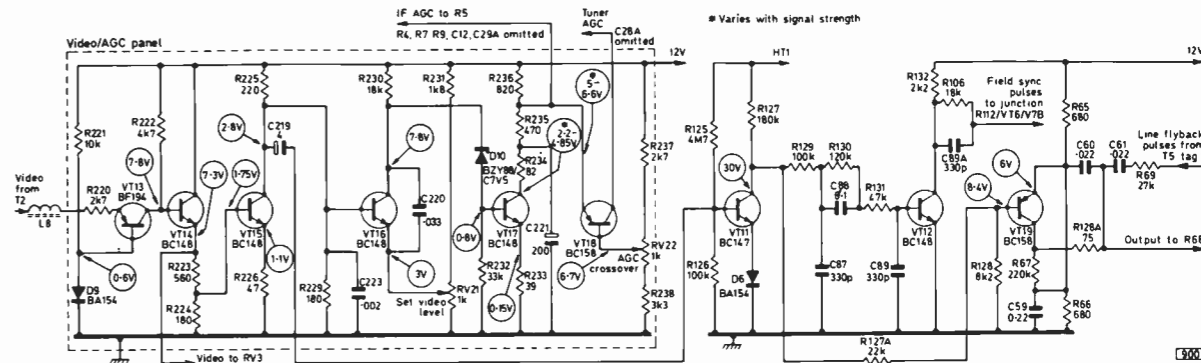
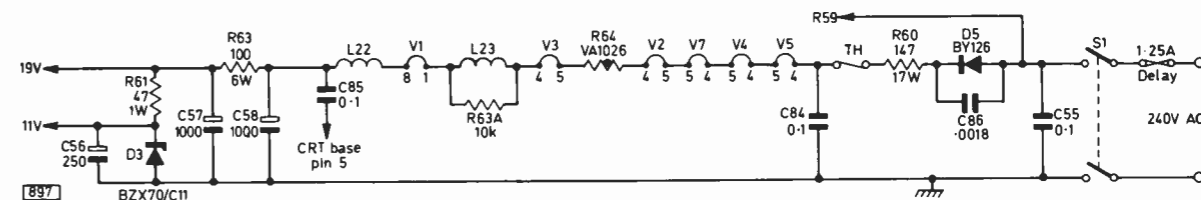
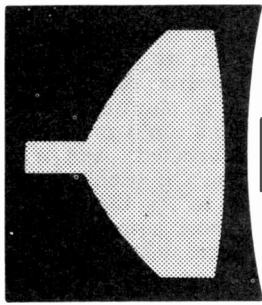


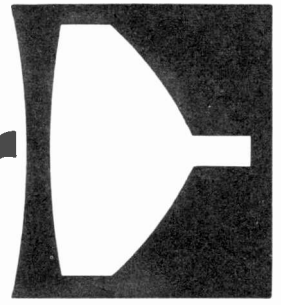
Fig. 4: Circuitry which replaces the TAA700 video i.c. in the 569 chassis. The video output from VT14 is taken to the junction RV3/C31, R29 (the TAA700 video output load resistor) being omitted. Transistor functions: VT13 video amplifier; VT14 video emitter-follower; VT15 inverter; VT16 a.g.c. detector; VT17 a.g.c. amplifier; VT18 tuner a.g.c. delay; VT11 sync separator; VT12 field sync pulse clipper; VT19 flywheel line sync discriminator. In earlier production R65 was 270Ω, R66 270Ω, R236 1.2kΩ and R238 3.9kΩ.





CRT Rejuvenator

FOR MONO OR COLOUR TUBES
W. BELBY



The life of a c.r.t. can be prolonged by improving its cathode emission. Both monochrome and colour tubes can be reactivated using the rejuvenator circuit shown in Fig. 1.

The mains input is applied to the heater of a monochrome c.r.t. (pins 1 and 8 in the case of the usual B8H base) via a 100W bulb. In the case of a colour c.r.t. the heaters are fed from a Philips heater transformer of the type used in the G8 chassis: 1A at 6.3V

not been established and a few more minutes should be allowed for the heater to warm up sufficiently.

For a colour tube the same procedure is adopted but the heaters are fed from the transformer.

Note that the heater(s) can become open-circuit under this treatment: the c.r.t. is then useless of course.

The rejuvenator can be assembled on a piece of wood 18in. long by 6-8in. wide. ■

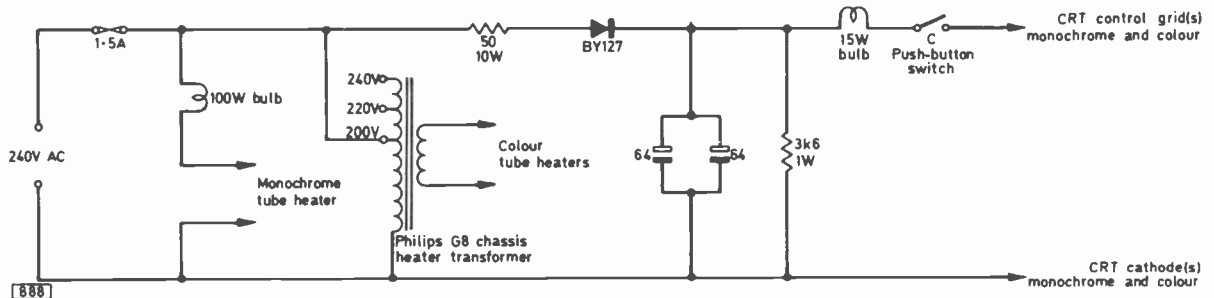


Fig. 1: Circuit of the monochrome/colour c.r.t. rejuvenator.

is applied to the heaters, the 240V input being fed to the 200V tap to obtain increased output. The heater pins on colour c.r.t. bases are usually 1 and 14.

With both monochrome and colour tubes the control grid(s) (all three together with colour tubes) are supplied via a 50Ω resistor, a BY127 rectifier, a 15W bulb (best to have it a different colour from the 100W bulb) and a push switch such as a doorbell switch. The cathode(s) (all three in the case of a colour c.r.t.) are connected to the earthy side of the circuit.

Method of Use

To rejuvenate a monochrome tube connect the heater supply leads to the heater pins and allow the heater to warm up for about ten minutes. Then when push switch C is depressed current will flow from the cathode to grid of the c.r.t. When the cathode is in full emission a blue electron flow will be seen and the 15W bulb will light steadily. The push switch may be operated two or three times briefly (say for two-three seconds). This should result in the tube having a new lease of life.

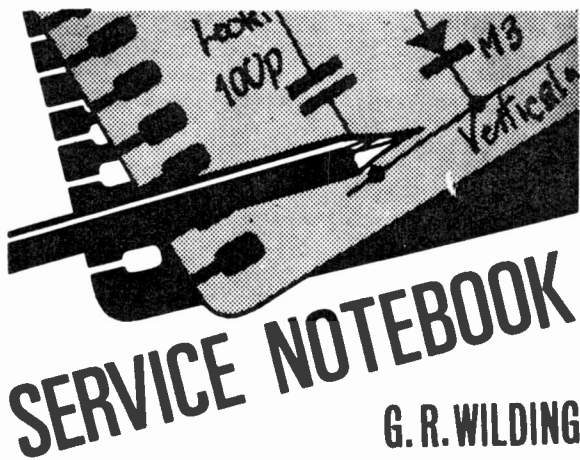
In obstinate cases incline the set slightly backwards after the heater has warmed up and gently tap the tube neck while the push switch is closed.

If the 15W bulb does not light up conduction has

'TELEVISION' COLOUR RECEIVER I.F. ALIGNMENT SERVICE TO CLOSE

Many hundreds of i.f. strips for the *Television* colour receiver have now been aligned and returned to constructors. The call for the i.f. alignment service has declined substantially however and in consequence it is no longer economic to continue with this operation. Bookings will still be accepted provided they are received here by June 14th. After that date no further bookings can be accepted.

We would like to take the opportunity to thank those who have operated this service for us. We regret the necessity to bring the service to a close and hope that all those who have embarked on this project will by now be in a position to make final arrangements for the alignment of their i.f. module if they require this. The need to have expensive equipment continuously available makes it impossible to maintain the service now that the demand for it has fallen to a low level.



Short-circuit Testing

Short-circuits are usually easy enough to trace. If the short is across part of the heater chain the last valve lit will have a heater-cathode short or if not the heater supply lead to that point will be short-circuit. The two valves which most often develop heater-cathode shorts are the line output valve and the boost diode. With an h.t. short, first look for visual evidence—discoloured or burnt resistors, swollen capacitors or electrolytics with bulging end caps—then check whether the short-circuit disappears when one of the valves is removed, indicating the presence of an interelectrode short in that valve. H.F. pentodes of all types and PCL84s in particular are the most frequent offenders in this respect.

To make h.t. short-circuit tracing easier unplug the c.r.t. base—the forward resistance of silicon rectifiers is so low that what appears to be a short-circuit reading between the h.t. rail and chassis can prove on reversing the meter leads to be simply the heater circuit resistance through the h.t. rectifier and if incorporated in the particular model the heater circuit rectifier.

The really time consuming shorts however are those which do not show up on a meter but repeatedly blow the fuse. A Bush Model TV135 was the latest example of this type to come our way. The trouble had started about a month before when the complaint was no sound or picture. The fuse had blown severely but no short could be discovered. Tapping the boost diode, the first suspect in such cases, failed to produce any internal sparking and as the line output valve appeared to be similarly above suspicion and repeated switch-ons failed to make the new fuse fitted blow nothing more could be done other than to give the set another trial. After about a week the fuse blew again and once more no fault could be found. To be on the safe side however we fitted a new boost diode. The fuse next blew after about a fortnight and this time although no short could be found replacements blew immediately on switch-on.

The feed to the h.t. circuit was disconnected and the valves lit up normally. The fault was clearly on the h.t. side therefore and a fault of such severity was likely to be due to a defective main electrolytic, or the silicon rectifier or its shunt transient protec-

tion capacitor breaking down. Silicon rectifiers are very reliable but do occasionally short. We have never known one to read all right on a meter test but break down on switch-on however. Similarly although electrolytics on occasion go short-circuit we have never known one to read o.k. on a meter test but short when the h.t. is connected. And if a small value capacitor breaks down it usually stays that way. Nevertheless we had to try these possibilities. The rectifier was the most suspect device and as it is easily changed a new one was fitted: again the fuse blew. Next the main electrolytics were disconnected, but again we were presented with a blown fuse on switching on. Eventually the cause of the trouble was traced to the tag strip on the main chassis behind the dropper resistor: it seemed that a semiconductive streak had developed in the insulation and that this went very low resistance on applying a high voltage. After fitting a new tag strip no further trouble was experienced.

A rare occurrence but one which must be kept in mind when investigating unaccountable fuse blowing, especially in older receivers. The only comparable fault we can recall happened in a receiver in which a tube aquadag earthing spring had fallen off and caused a heavy short across a tag strip: on replacing all burnt out components and all shorts the fuse blew repeatedly due, it was eventually discovered, to particles of the aquadag adhering to the spring and then being fired into the tag strip insulation, forming a tracking path for high voltages.

Lack of Screen Modulation

Sound but only the slightest suggestion of any screen modulation on either system was the complaint about a set fitted with the BRC 950 chassis. The 6MHz intercarrier sound signal on u.h.f. is taken in this chassis from the anode of the video amplifier section of the PFL200 valve. It seemed therefore that either the PFL200 was hopelessly inefficient or the coupling capacitor to the c.r.t. cathode faulty. A new valve failed to produce any improvement but on checking the video amplifier anode and screen grid voltages zero potential was found at the anode pin. There are several components in the anode circuit and as we were on an outside call the manual was not available. What was the best way of finding the faulty component? The first move was to find the anode load resistor. This is always a high-wattage type, sometimes wire-wound, with a value in the region of 4-5k Ω . Inspection revealed a 3.6k Ω wire-wound resistor which was cold, and on checking with the ohmmeter we found a low-resistance reading from one side of it to the video amplifier anode pin 10 of the PFL200. A replacement resistor restored the picture. The surprising feature was that the u.h.f. sound was well up in spite of the zero video amplifier anode voltage.

If you ever find it difficult to trace the h.t. supply route to a valve electrode when the circuit is not available the best procedure is to place one ohmmeter test prod on the pin in question and run the other prod over the adjacent circuitry. Unless the printed strip leading to the valveholder pin is open-circuit you will soon discover a d.c. connection point after which further voltage and resistance checks will sort out the supply path.

With faults of this nature however always check first for cold wire-wound and discoloured carbon

resistors. Applying a little pressure to any doubtful carbon resistors will show whether they have been over-run by excessive currents since if they have they will readily crumble or split.

Streaks on Raster

Slight but annoying irregular streaks on the left-hand side of the raster, on the v.h.f. BBC channel only, was the fault on a KB model fitted with the ITT VC4 dual-standard chassis. The cause was clearly impaired insulation somewhere in the line output transformer circuit, a frequent place in many receivers being where the heater supply leads enter the e.h.t. rectifier valveholder and get damaged by heat. Inspection showed however that the leads were not at fault, nor was there any sign of corona discharge around the transformer itself or the e.h.t. lead to the c.r.t. anode cap. On removing the chassis it was noticed that the exterior of the high working voltage capacitor mounted at the rear of the line output transformer close to a high-wattage resistor showed signs of being affected by overheating. This

220pF 4kV capacitor feeds line flyback pulses to the width stabilising v.d.r. and on replacing it a completely clean raster was obtained.

Weak Field Lock

Very weak field lock with quite good line lock as a result of zero voltage at the screen grid of the sync separator has been experienced on a number of models fitted with the ITT VC4 chassis. This is caused by the upper resistor of the potential divider which feeds the screen grid going open-circuit. The field lock becomes virtually non-existent because the h.t. feed to the anode of the triode field sync pulse amplifier is taken from the same potential divider network. This triode incidentally is the triode section of the PCL84 video valve: when faced with normal line but weak field lock therefore the PCL84 and the PCF80 (sync separator/half field multivibrator) should be changed as well as the obvious PCL85—nothing is more annoying in servicing TV sets than to start making voltage and component checks only to find that you haven't tried every valve possibility.

FAULT FINDING GUIDE

—continued from page 305

Transformer Troubles

Another fault common to these chassis is failure of the field output transformer. This may consist of an open-circuit winding, giving a collapsed scan. Other internal faults in the transformer can give excessive scan or, more seriously, arcing around the PCL85 base: there will usually be great picture distortion in this case. Another fault caused by a faulty output transformer is top foldover with the flyback lines showing and sometimes with a four inch gap at the bottom. An emergency repair when the tertiary feedback winding on later transformers is open-circuit is to disconnect this winding completely and connect an 0.01 μ F capacitor rated at 1.5kV working between the field output valve anode (pin 6) and R4027.

Fault Summary

The thermistor connected in series with the scan coils and tucked away on the c.r.t. neck in the scan coil assembly can if defective produce reduced field scan.

The system switch contacts in dual-standard sets can cause field troubles: the answer is to clean the switch contacts and coat them with antistatic grease.

Spasmodic height variations are frequently caused by dirty tracks in the height and linearity potentiometers: clean them with methylated spirits and Servisol.

Bottom cramping should direct attention to the output pentode cathode decoupling electrolytic. On the earlier timebases C422 and C426 can also cause this trouble.

Poor field linearity is often due to dead spots or breaks in the tracks of the linearity potentiometers. In stubborn cases it may be necessary to check all components in the linearity networks.

Lack of height, sometimes with reduced brightness,

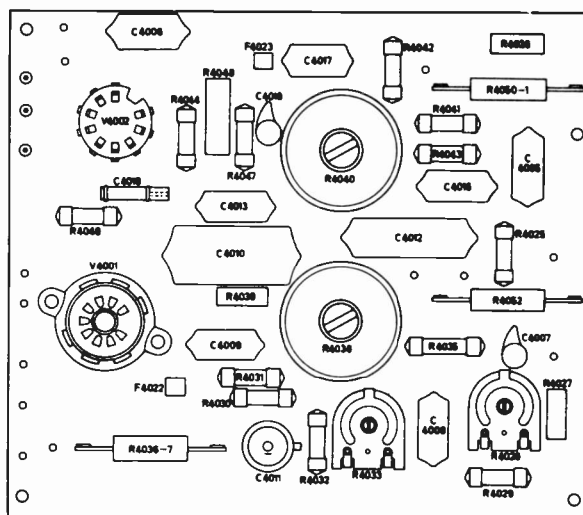


Fig. 3: Layout of the 210 chassis field timebase board.

has been traced to the components which filter the feed from the boost rail to the height control—R2165 and C2067 in Fig. 2. A more common cause of lack of height however is change of value of the resistor in series with the height control (R438 in Fig. 1).

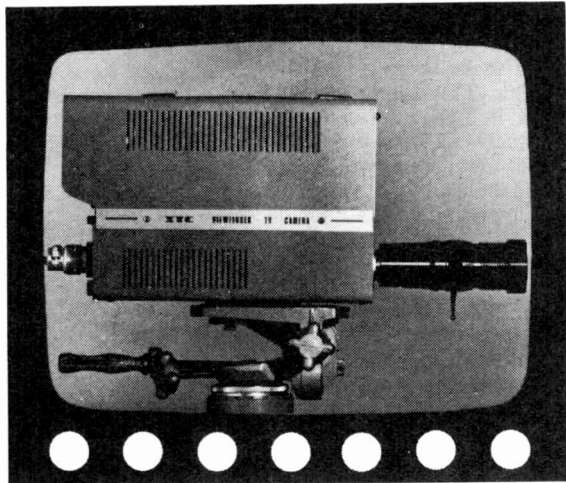
Don't forget that failure of the oscillator section, resulting of course in field collapse, can be caused by a break in the hold control or failure of one of the cross-coupling capacitors.

If the field hold control is at one end of its travel check the value of the 3.3M Ω resistor which is the "upper" of the two resistors in the potential divider network to which the hold control is returned.

The most common cause of field timebase troubles in these chassis however is one or other of the valves—particularly the PCL85 of course.

In addition to Philips models these chassis have been fitted in Cossor, Stella and Peto Scott models.

CCTV



PART 2

Peter Graves

In Part 1 we described the basic operation of the vidicon camera tube. Altering the target voltage alters the tube's sensitivity: as the voltage is increased more current flows in the tube and the external circuit, resulting in a greater voltage drop across the load resistor. The target voltage and beam current cannot be increased indefinitely however since the dark current starts to increase and become non-uniform. A uniformly dark area of the scene may then be interpreted by the tube as black on one side going to a dark grey on the other, a phenomenon known as shading. To an extent we can compensate for not too excessive shading as we shall see in a later article. The dark current also increases with temperature, so ultra stable cameras and cameras working under arduous conditions (say looking into a furnace) have special cooling arrangements for the tube. For optimum pictures the tube manufacturer specifies a maximum beam current (typically 0.3 to 0.4 μA) and a maximum target voltage (typically 100V).

Camera Operating Controls

Figure 1 shows a simplified circuit of the main tube operating controls. This is one common arrangement—there are others which we shall see when we deal with the video amplifier. The *manual target*, or simply *target*, control (RV1) forms part of a potential divider (RV1, R1) across the h.t. line. The target voltage can also be supplied from the auto-target circuit—of which more later. Change over from *manual* to *auto target* operation is done

with a switch or a semi-permanent soldered link.

The *target limit* control (RV2) prevents the target voltage in either condition rising above a preset level. The potentiometer sets the voltage on the cathode of diode D1: if the target voltage rises high enough to forward bias the diode it will conduct and clamp the voltage at that level. Under manual target conditions the target limit is set to prevent the target voltage exceeding the recommended maximum tube voltage. On auto target it is set to prevent the signal level rising too high since this could lead to overloading and distortion in the video amplifier or in following equipment. The input to a videotape recorder for instance must not exceed a certain maximum value.

The target, target limit and beam controls are interdependent. Adjusting one affects the others and setting up is a matter of getting nearer and nearer the optimum setting by adjusting them alternately. You must have sufficient beam current. Too much will shorten the life of the tube however. Too little means that there will not be enough current available for correct operation of the tube in the brightest areas: a bright area that just needs the maximum current will be faithfully reproduced but a brighter area cannot have the extra current it needs and will be interpreted as being of the same brightness. This is known as "white clipping".

Getting a Picture

To obtain pictures from a maladjusted camera (say when someone has adjusted all the controls in sight to "cure" a fault) turn the beam control fully down (to cut off the beam), the target limit control fully up (i.e. no limiting action) and the target control to about three-quarters of its maximum travel. When the camera has warmed up (about a minute) slowly turn up the beam control, watching the monitor. At some point in its travel (hopefully!) a negative picture will appear—black where whites should be and vice versa, like a photographic negative. A further increase in the setting of the beam control should cause the picture to turn "inside out" and become normal. A rule of thumb for setting the beam potentiometer is to advance it to about 20 degrees (estimated rotation) from this point (see Fig. 2). Negative pictures are used for novelty effects or for viewing photographic negatives the right way round: obtaining them by misadjustment of the

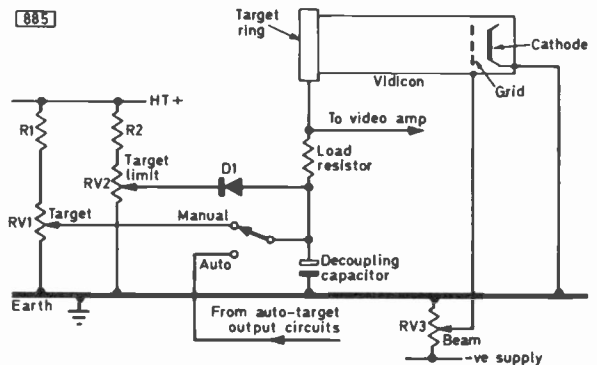


Fig. 1: Simplified circuit of the main vidicon camera operating controls.

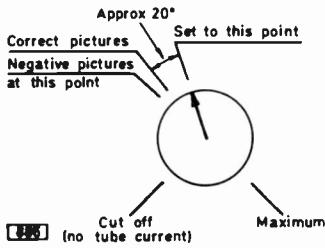


Fig. 2: Method of setting the beam control.

beam control can lead to tube damage however and is not to be recommended. Negative pictures (sometimes called "inverted pictures") need additional circuitry in the video amplifier.

Tube Life

This leads us to the question of tube life. How long does a tube last? What factors affect its life? These are much discussed topics to which there are no cut and dried answers. So much depends on the operating conditions and the type and quality of the tube and camera. A camera working flat out in a poorly illuminated steel works, subjected to extremes of temperature, vibration and electrical surges from the heavy machinery, will not give the same tube life as an identical camera cosseted in a quiet, warm studio. A figure often quoted for average tube life is 2,000 hours but this is sometimes exceeded by a factor of four or five times. There seems to be a considerable element of luck in getting long tube life: two tubes of the same type operated under the same conditions in the same camera may give widely different lives.

This raises another question—how do you recognise a failing tube? Vidicons rarely fail catastrophically unless they are grossly overloaded (particularly the heater). They just slowly fade away. As the tube ages, its cathode—as with all valves—loses emission. Thus each time the camera is set up the beam control has to be advanced a little farther to compensate for the loss of emission. Finally the control will be in its maximum position and no further current will be available. This is the time to think about changing a tube. It will give pictures for a little longer but it is only a matter of time before it fades away completely. Another symptom around this stage is the presence of negative pictures when the camera is first turned on, possibly clearing as the camera warms up. If the beam control is at or near its maximum setting it may be necessary to juggle with the target and target limit controls to get satisfactory pictures. The best way of checking a suspect tube is substitution with a known good tube.

Vidicons and vibrations do not go together, principally because of microphony (modulation of the signal current due to vibration of the tube electrodes). The same effect occurs in the sound output stage of a domestic receiver—a ringing sound is heard from the loudspeaker when the output valve is gently tapped. With a vidicon, microphony produces a "venetian blind" effect on the monitor picture. If the camera has to operate under continuous vibration conditions it should have some form of anti-vibration mounting.

A vidicon camera should never be mounted so that the vidicon faces directly downwards: there is a chance (fortunately minimal due to advances in cathode technology) that flakes of the cathode

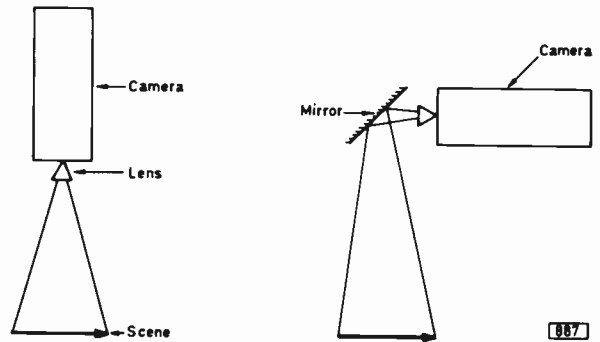


Fig. 3: A vidicon camera should never be mounted so that the tube faces downward as on the left: there is a danger that flakes of the cathode material may fall on to and damage the target layer. If it is necessary to view a scene below the camera use a mirror or prism as shown on the right.

material will fall on to the rear of the target layer and show up on the monitor as white spots. Poor quality tubes—this type in particular—are known colloquially as "spotticons" or "grotticons"! If it is necessary to view a scene directly below the camera a mirror or prism should be used (see Fig. 3).

If the image is the wrong way round reverse the connections to the appropriate scan coils.

Image Sticking

One of the more annoying defects of the vidicon tube is image "sticking" or "burning on". If a camera is focused for any length of time on a bright scene it will still be possible to see the scene faintly when the camera is turned away to look at something else. Images of the sun or bright lights can remain permanently stuck on the target layer. This is inherent in the tube's physical characteristics and is one of its drawbacks that must be lived with. If it is not too severe the unwanted image will normally fade away by itself, the length of time taken depending on all sorts of factors such as scene illumination, target voltage, beam current, type of tube, etc. The process can be accelerated by allowing the camera to look at a plain white sheet of paper that completely fills the field of view. Sticking is more common with new tubes since their target layers are more sensitive. It must be appreciated that this effect occurs whether the camera is on or off, as long as the image is focused on the target layer. Prevention is better than cure and this leads to two important general rules for operating vidicon cameras:

- (1) Never point the camera directly at a light source or the sun.
- (2) Cover the lens or defocus the optical system when the camera is not in use or turned off.

Capping Up

In time these actions become reflexes. Covering the lens is referred to as "capping up" and also protects the lens from dust and damage (a high-quality lens may cost hundreds of pounds). Most lenses are provided with a cap that snaps or screws over the front of the lens (some have another cap for the rear of the lens—where it screws into the cam-

era—which is used when the lens is taken off the camera). Lens caps should be carefully retained.

It is recommended that cameras are turned off rather than being left on but unused for a period of time (say over lunch). Modern vidicon cameras are very stable and will warm up in minutes with no adjustments needed. This is one of their main advantages—compare with an image-orthicon camera that may need an hour to warm up and need setting up at the end of this time.

Capping the lens under auto-target conditions means that the maximum target voltage will be applied to the tube to its ultimate detriment (the video circuits "see" a completely black picture and thus turn up the sensitivity as high as possible by increasing the target voltage to its maximum level).

Lag

Under low light conditions, when the tube is working flat out to produce a picture, "lag" occurs—a progressively fading "tail" appears behind the image of moving objects. How much of this is tolerable depends on the application. The quick cure if possible is to increase the scene illumination by means of auxiliary lighting.

Tubular quartz-iodine lamps in reflectors are efficient and convenient where mains supplies are available. Note that the quartz envelope should not be touched with the fingers—the acids in perspiration attack the quartz, making a potential weak spot in the envelope. Accidental finger marks can be wiped off with alcohol. This type of lamp should not be moved when working since the filament is fragile when hot.

Vignetting

Lack of light shows itself as a noisy, indistinct picture surrounded by a fuzzy halo. The effect is called "vignetting" (pronounced "veen-yetting") or "portholing" since the effect is like looking at the centre of the picture through a porthole.

Under these conditions check that the lens aperture is fully open—depth of focus has to suffer unfortunately. In general the vidicon cameras in common use are less sensitive than the human eye: thus if it appears dim to you the camera is not likely to give very good pictures.

Auto-Target Operation

Let's consider a typical camera application, the security surveillance of a car park or building. The equipment has to operate under all sorts of lighting conditions ranging from the brightest summer sun to dull rainy winter evenings and night time with additional lighting. One target voltage set by the manual target control will clearly not cope with all these conditions: if the camera was set up on a sunny day it would not be sensitive enough in the evening while if it was set up to give good pictures in the evening it would be overloaded at high noon.

To eliminate continual adjustment (and this means in turn that the equipment can be used by unskilled personnel) auto-target circuits are used. Part of the video signal from the video amplifier is fed to a buffer amplifier stage which isolates the auto-target circuits from the main video amplifier and increases the signal level. The output from this stage is recti-

fied and smoothed to give a d.c. voltage of level proportional to the mean video signal level which is itself proportional to the mean level of the scene illumination. This voltage is fed to the auto-target output transistor and subsequently to the tube. The circuit is arranged so that when the scene illumination falls (say the sun goes in) and the mean video signal level falls the target voltage increases. This increases the tube sensitivity so that the tube's output level is brought back up again.

An electrolytic capacitor which must charge or discharge as the target voltage varies is incorporated in the circuit. This delays the auto-target circuit action slightly to prevent the circuit "hunting" or going unstable and oscillating. It can be made to oscillate by pointing the camera at a monitor displaying its own picture: there is then an optical feedback path and if the distance between the camera and the monitor and the video levels are right the system will oscillate, giving weird pictures reminiscent of the opening sequence of "Dr. Who"!

Auto-target circuits are very reliable—the most common cause of trouble is a blown output transistor. The quick check for failed auto target (symptoms: no picture or no change in picture with change in scene brightness, depending on the fault) is to change over to manual target and twiddle the target control to see if you can obtain a picture.

Cameras used out of doors have additional protection from the sun (as well as a cover of some sort as protection against the elements) in the form of a "sun shutter" which is operated remotely, from the viewing point, or automatically by means of a strategically placed photocell feeding an amplifier. Sun shutters are often operated by a rotary solenoid which is arranged to be fail-safe—if the circuit or the supply fails the lens is safely capped. These occasionally fail (mechanical sticking for instance) giving a "no picture" fault whose cause may not be immediately obvious.

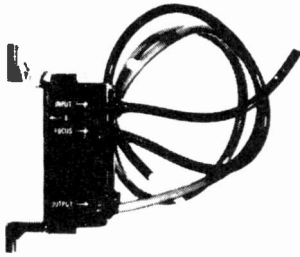
Leaving the lens cap on is not uncommon, usually resulting in nothing worse than a red face on discovery. The author knows of at least one case where a service engineer was called out over 200 miles to a customer with a "no picture fault" only to take off the unnoticed lens cap!

CONTINUED NEXT MONTH

LINE OSCILLATOR FAULTS RRI A774 CHASSIS

The capacitors in the EF184 sinewave line oscillator circuit used in this chassis (Bush TV181S/Murphy V2016 series) cause trouble quite frequently. As mentioned by Les Lawry-Johns the tuning capacitor 3C32 tends to play up, killing the timebase (and thus the signals since the transistor supplies are derived from the line output stage) or causing lack of width (see April/May, 1973). Drift and incorrect speed can be caused by the h.t. supply decoupling electrolytic 3C31 in this stage drying up. Now there are reports that the feedback coupling capacitor 3C34 (470pF) tends to leak or short, burning out the oscillator circuit feed resistors 3R48 (390 Ω) and 3R52 (3.9k Ω) and, since this places h.t. on the grid of the EF184, very often damaging the valve as well. 3C32 and 3C34 (420pF in later production) can also cause line frequency variations.

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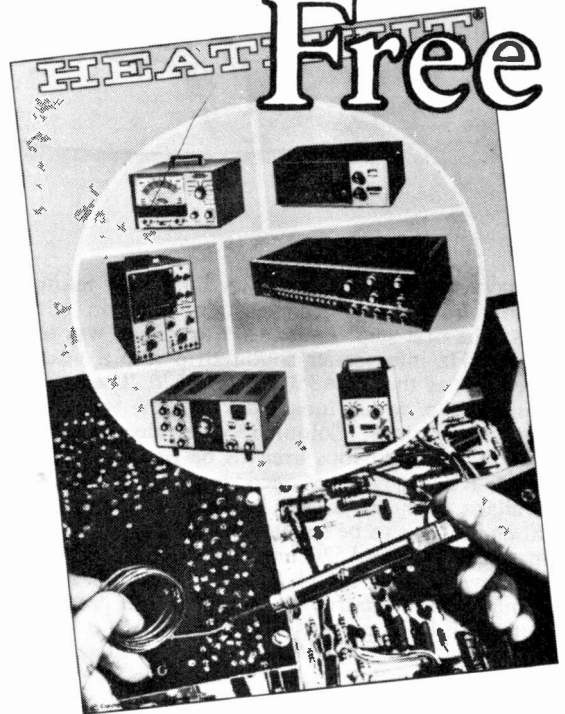
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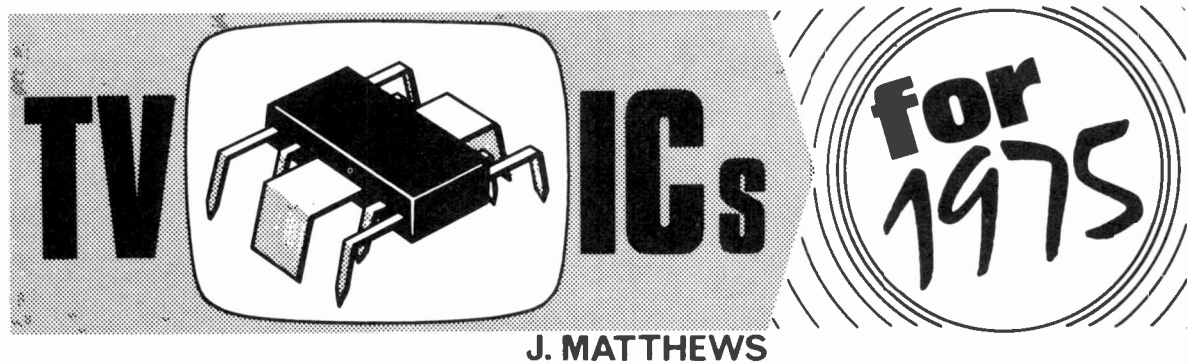
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J. MATTHEWS

INTEGRATED circuits are slowly but surely taking over more and more of the circuitry used in television sets. The first step, some years ago now, was to wrap the 6MHz intercarrier sound strip into a neat package such as the TAA350 or TAA570. Then came the "jungle" i.c. which took over the sync separator and a.g.c. operations. Colour receiver decoder circuitry was the next obvious area to be parcelled up in i.c. form, RBM's two i.c. decoder and the more recent Mullard four i.c. design coming on the scene. The latter is about to be superseded by a three i.c. version in which the TBA530 and TBA990 are replaced by the new TCA800 which provides chrominance signal demodulation, matrixing, clamping and preamplification, with RGB outputs of typically 5V peak-to-peak.

To improve performance a number of sets adopted a synchronous detector i.c.—the MC1330P—for vision demodulation, which of course overcomes the problem of quadrature distortion. In one monochrome chassis this i.c. is partnered by a complete vision i.f. strip i.c., the MC1352P.

In the timebase section the TBA920 sync separator/line generator i.c. has found its way into several chassis and more recently Texas's SN76544N 07 i.c. which wraps up the sync separator and both the field and line timebase generators has come into use. Several monochrome portables now use a high-power audio output i.c. as the field output stage.

Audio i.c.s are of course common, and in several recent chassis the Mullard TCA270 has put in an appearance. This device incorporates a synchronous detector for vision demodulation, a video pre-amplifier with noise inversion and the a.g.c. and a.f.c. circuits. The most recent development to be adopted in a production chassis is that remarkable Plessey i.c., the SL437F, which combines the vision i.f. strip, vision demodulator, a.g.c. system and the intercarrier sound channel.

SGS-Ates Range

Now, from the Italian Development Division of SGS-Ates, comes a new range of i.c.s which SGS hope will set a standard pattern for TV chassis by 1975. How this range combines to provide a complete colour receiver is shown in Fig. 1. The only sections of the receiver left in discrete component form are the video output stages, the tuner, the a.f.c. circuit and of course the line output stage and power supplies.

It will be seen that the colour decoder section is

split up as in the Mullard three i.c. design. The TDA1150 chrominance and burst channel carries out the same functions as the TBA560, the TDA1140 reference section the same functions as the TBA540 and the TDA1160 chrominance demodulator/matrixing i.c. the same functions as Mullard's new TCA800. It looks therefore as if this basic decoder pattern could become widely established.

The other five i.c.s in the range are common to both colour and monochrome receivers. Particularly interesting are the TDA1170 which comprises a complete monochrome receiver field timebase—for colour set use an output stage using discrete components is suggested—and the TDA440 which incorporates the vision i.f. strip, vision detector and a.g.c. circuitry. The intercarrier sound i.f. strip is neatly packed away with the audio circuitry in the TDA1190 while the TDA1180 sync separator/line oscillator i.c. is a very similar animal to the now well known TBA920. The fifth i.c., the TBA271, is a stabiliser for the varicap tuner tuning supply.

The novel i.c.s in this family then are the TDA 440, TDA1170 and the TDA1190 and we shall next take a closer look at each of these.

Vision IF IC

The TDA440 vision i.f. strip i.c. is housed in a 16-pin plastic pack with a copper frame. There is a three-stage vision i.f. amplifier with a.g.c. applied over two stages, synchronous vision demodulator, gated a.g.c. system and a pair of video signal pre-amplifiers which provide either positive- or negative-going outputs. Fig. 2 shows the i.c. in block diagram form.

It is possible to design a very compact i.f. strip using this device and very exact performance is claimed. Note that apart from the tuned circuits which shape the passband at the input the only tuned circuit is the 39.5MHz carrier tank circuit in the limiter/demodulator section. The only other adjustments are the tuner a.g.c. delay potentiometer and a potentiometer (the one shown on the right-hand side) which sets the white level at the demodulator. This of course gives ease of setting up, a help to setmaker and service department alike.

For a sensitivity of 200 μ V the output is 3.3V peak-to-peak, giving an overall gain in the region of 82 to 85dB. The a.g.c. range is 55dB, a further 30 to 40dB being provided at the tuner. The tuner a.g.c. output is intended for use with a pnp transistor or pin diode tuner unit: an external inverter stage is required

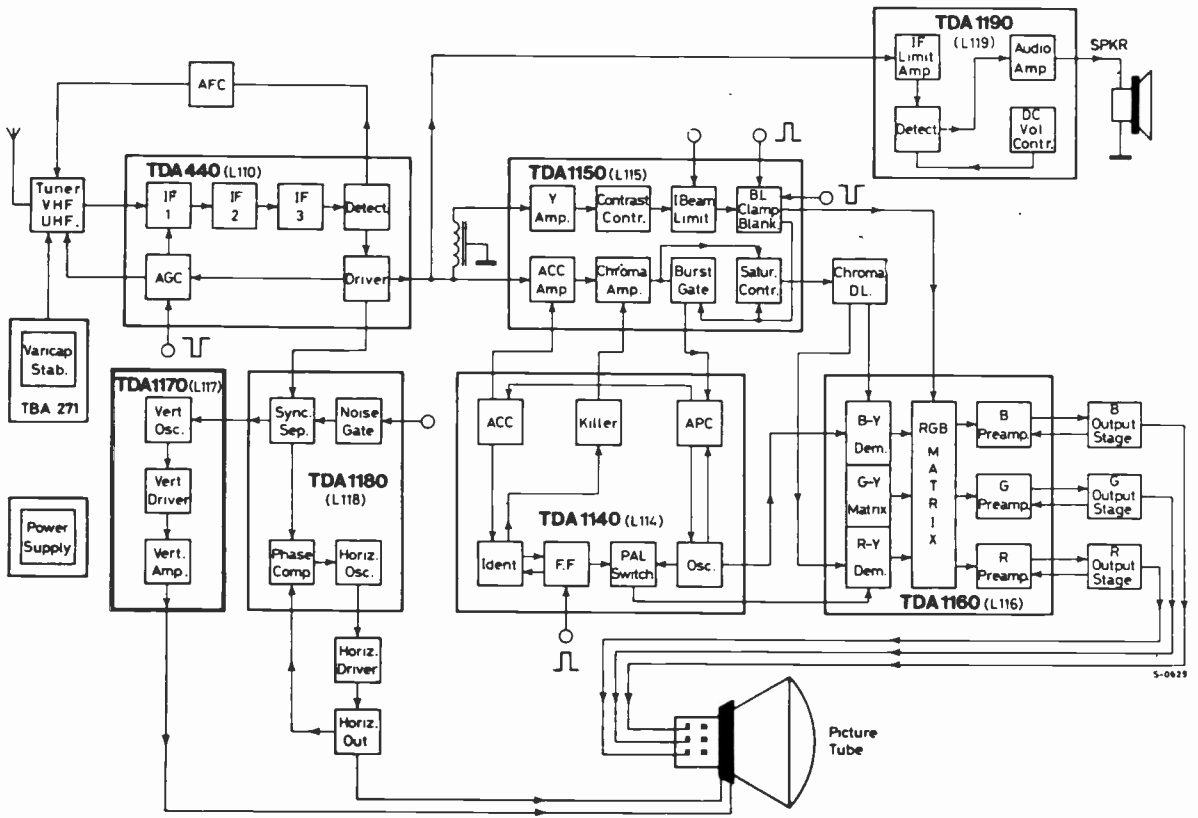


Fig. 1: How the range of i.c.s being developed by SGS-Ates combine to form a PAL colour receiver.

with the npn transistor tuner units generally used. In a monochrome set the output would be fed to a

discrete component video output stage; in a colour design the output is fed to the chrominance section

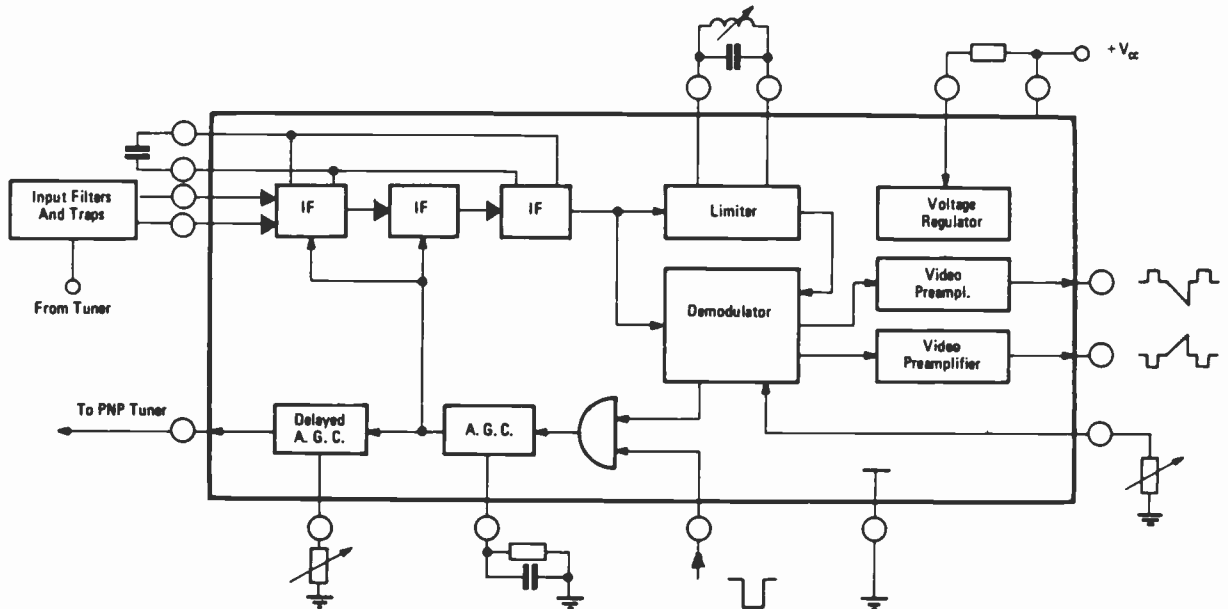


Fig. 2: Block diagram of the TDA440 which provides a complete vision i.f. strip with synchronous demodulation, video preamplifiers providing outputs of either polarity, and gated a.g.c.

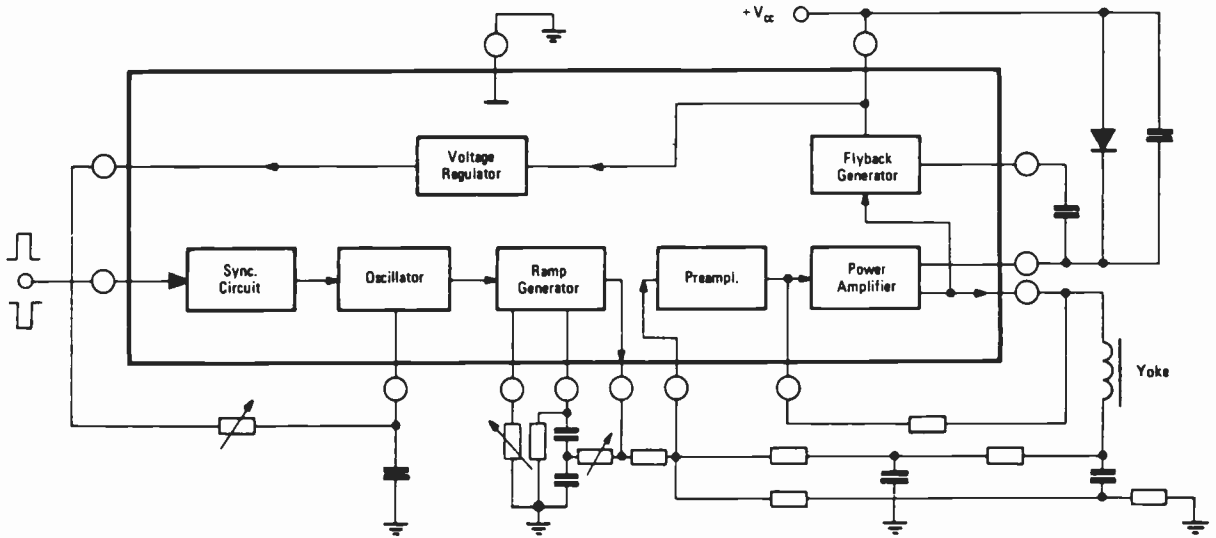


Fig. 3: Block diagram of the TDA1170 field timebase i.c. For colour set use it is recommended that this i.c. is employed as a driver feeding a discrete component output stage coupled to a toroidal deflection yoke.

of the TDA1150 and, via the luminance delay line, to the luminance channel in the TDA1150. Also of course in both cases to the sync separator which in this series of i.c.s is contained in the TDA1180.

Field Timebase IC

The TDA1170 field timebase i.c. is shown in block diagram form in Fig. 3. The i.c. is housed in a 12-pin package with copper frame and heat dissipation tabs. It is capable of supplying up to 1.6A peak-to-peak to drive any type of saddle-wound scanning yoke but for a colour receiver it is suggested that the toroidal deflection coil system developed by RCA is used. In this case the i.c. acts as a driver in conjunction with a complementary pair of output transistors. The yoke current in this case is in the region of 6A.

The TDA1170 is designed for operation with a nominal 22V supply. It can be operated at up to 35V however. A voltage doubler within the i.c. is brought into action during the flyback time to raise the supply to 70V.

Good frequency stability is claimed and the yoke current stability with changes in ambient temperature is such that the usual thermistor in series with the field coils is not required.

For monochrome receiver use the power supplied to the yoke would be 0.83W for a yoke current of 1A peak-to-peak with a 10Ω coil impedance and 20V supply. As the power dissipation rating of the i.c. is 2.2W no further heatsink is required. For use in a colour receiver with a toroidal coil impedance of 1.6Ω the scanning current would be 7A peak-to-peak. The power supplied to the yoke may be as much as 6.5W while the dissipation in the i.c. would be up to 2.3W. In this case a simple heatsink can be formed from a thin copper sheet soldered to the heat fins—an area of about 3.4 sq. in. should be adequate.

The sync circuit at the input gives good noise immunity while the difference between the actual and ideal interlace is less than 0.3% of the field amplitude.

Because of the high output impedance a relatively

low value (1μF or less) output coupling capacitor can be used. This means that mylar types instead of electrolytics can be used, reducing the problems of linearity and amplitude stability with respect to temperature and ageing.

The external controls shown in Fig. 3 are hold, height and linearity (from left to right).

Complete Sound Channel

The TDA1190 sound channel (see Fig. 4) is housed in a 12-pin package. Possible radiation pick-up and thermal feedback risks have been avoided by careful layout of the chip. This pack also has a copper frame, with two cooling tabs which are used as the earthing terminals.

The built-in low-pass filter overcomes radiation problems and with a response 3dB down at 3MHz allows for a flat amplitude response throughout the audio range: this particular feature will appeal to hi-fi enthusiasts as well since it makes the i.c. a good proposition for f.m. radio reception.

The d.c. volume control has a range of 100dB. The external CR circuit (top, Fig. 4) sets the closed-loop gain of the power amplifier. The external feedback capacitor network (right) provides a.f. bandwidth and frequency compensation while the CR circuit across the output limits any r.f. which could cause severe audio distortion.

The TDA1190 does not require an extra heatsink when operating in normal ambient temperatures—up to 55°C—because of the new technique of soldering the chip directly on to the copper frame that forms part of the external tabs. By doing this, SGS-Ates have reduced the thermal resistance of the device to 12°C per watt. The device can dissipate up to 2.2W at 55°C without using an external heatsink other than the printed circuit pad (about 2 sq. in.) which is soldered to the tabs.

The output stages of the TDA1190 are in quasi-complementary mode (with patented features), eliminating the need for bootstrap operation without

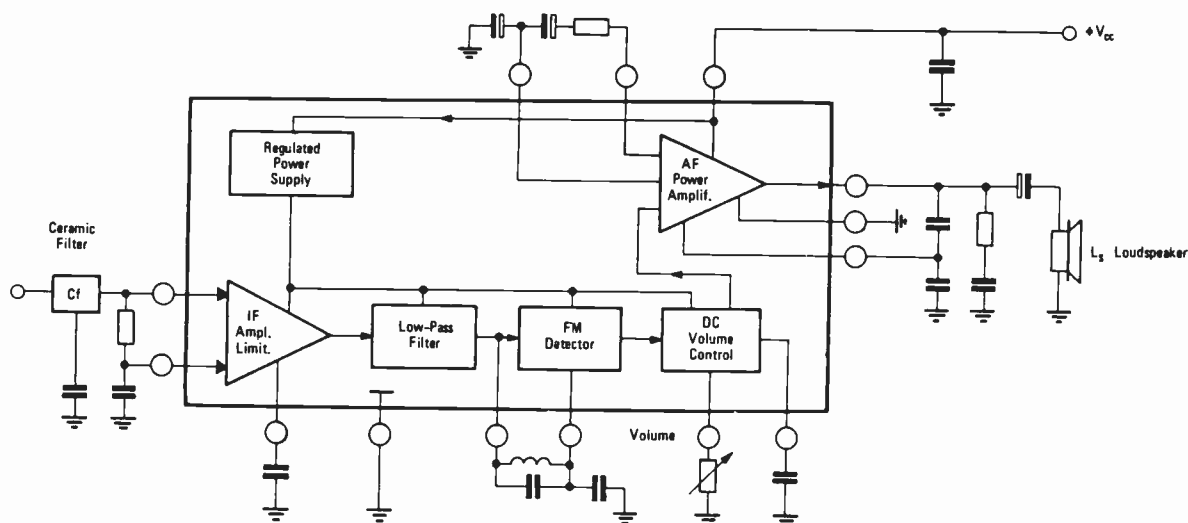


Fig. 4: The TDA1190 i.c. incorporates both the intercarrier sound channel and the audio circuits.

loss of power. The absolute maximum output power is 4.2W with a supply voltage of 24V and a nominal loudspeaker impedance of 16Ω. At 12V and 8Ω an output of 1.8W can be achieved. Total harmonic distortion is 0.5% for 1mV f.m. input and 2W output into 16Ω at 24V.

Satisfactory operation is possible over a voltage supply range of 9 to 28V, making this versatile i.c. suitable for a wide range of applications. The whole audio circuit can be mounted on a p.c.b. 2in. x 2.5in. without a heatsink.

Mounting

The complete family of i.c.s has been designed so that it can be incorporated in very small and simple printed circuit modules. The use of a copper frame assists in improving the thermal stability as well as facilitating the mounting of the i.c.s on the board. Where an extra heatsink is required this can be a

simple fin added to the mounting tabs or a metal clamp on the top of the pack. SGS claim that instability experienced with conventional layouts in colour receivers has been eliminated provided their recommendations are observed.

Power Supplies

A simple power supply circuit without sophisticated stabilisation can be used. The requirements are for outputs ranging between 10V and 35V with adequate decoupling and smoothing. It may be possible to provide only three supply lines to feed the whole receiver system—plus of course the high-voltage supplies required by the c.r.t. The power supply requirements are simplified since the TDA1170 incorporates a voltage regulator for its oscillator, the TDA440 incorporates a regulator for the vision i.f. strip and the TDA1190 a regulator for the low-voltage stages and the d.c. volume control. ■

SERVICE BRIEFS

BRC 1580 Chassis: No or lack of width when the set is first switched on, correcting itself after the set has warmed up, can be caused by leakage between pins 2 (control grid) and 3 (cathode) of the PL81A line output valve valveholder. The leak can be sufficient to stop the ECC82 line oscillator.

Decca CTV25 Series: The manufacturers recommend that the following points should be checked when one of these dual-standard colour sets is being serviced.

(1) Check that the correct types of capacitors are fitted in the following positions: C411 Mullard type C296AA/A470K (0.47μF, 160V) and C412 Mullard type C296AA/A1M (1μF, 160V)—these are the S-correction capacitors; C413 (boost reservoir capacitor) Dubilier type 660F (blue/white body)—0.47μF, 1kV; C417 which decouples the PD500 e.h.t. shunt stabiliser grid should be a Mullard type C296AA/A1M (1μF, 160V). In some sets an 0.22μF capacitor was fitted in this latter position and should be changed—there is the possibility otherwise

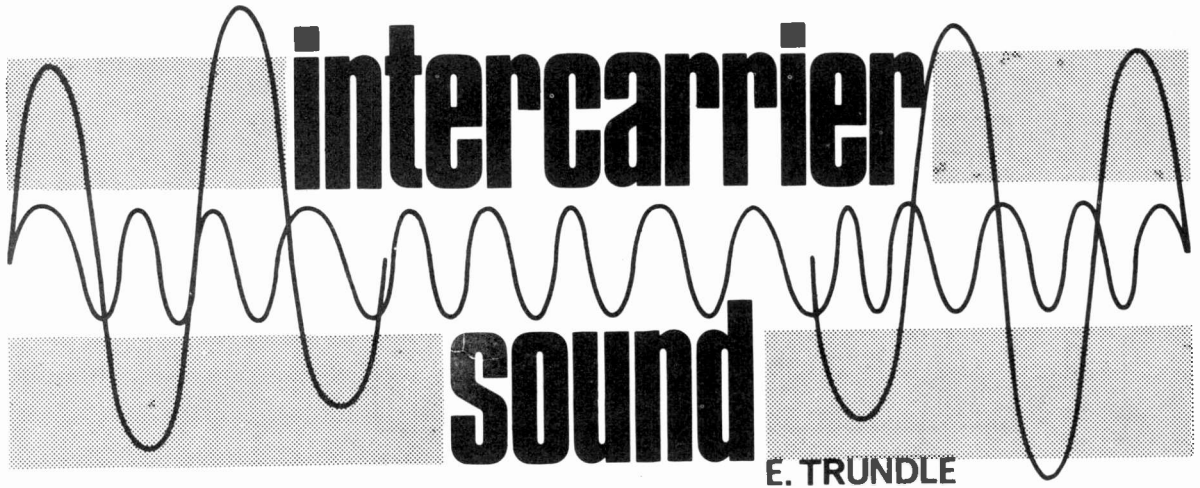
of poor e.h.t. regulation. Where this fault is experienced check the set e.h.t. current control setting and the earth connections to the base of the PD500.

(2) If the line output transformer or its windings have been replaced ensure that the dressing of the leads avoids the possibility of arcing—keep all leads well away from the overwinding and avoid spiky soldering. Do not overlook the ferrite core gapping spacers if a new winding is being fitted (failure to do this can cause excessive current in the PL509 line output valve). Make sure that the d.c. feed coil (L408) to the PL509 anode stands off the paxolin panel with ¼in. spacers.

(3) Set the e.h.t. to 24kV and check the PL509 cathode current (should be approximately 440mA—must not exceed 480mA). Adjust the third harmonic tuning coils (L404/L405) for minimum line ringing consistent with maximum width and make sure that the set e.h.t. current control is correctly set. Recheck the e.h.t. after making these adjustments.

(4) Check that the h.t. voltage is 280V ± 15V.

(5) Ensure that underchassis components do not obstruct the ventilation holes beneath the line output transformer.



So far as we are aware all sets capable of 625-line reception sold in the UK use the intercarrier sound system on u.h.f. It has considerable advantages, but when faults arise diagnosis can be difficult because of the misleading symptoms.

Principles

The tuner on the u.h.f. system presents two basic signals to the i.f. strip, the wideband a.m. vision signal with its carrier at 39.5MHz and a narrowband f.m. sound signal centred on 33.5MHz.

If the 33.5MHz sound signal was separated from the vision signal at the tuner output and then amplified and demodulated any tuner oscillator drift would result in intolerable sound strip "misalignment" due to the relatively narrow bandwidth of the sound signal: in fact to maintain the sound i.f. within 100kHz of its nominal frequency would call for frequency stability approaching one part in 10^3 !

The 6MHz sound-vision spacing is accurately maintained at the transmitter however and the inter-

carrier sound system makes use of this fact by allowing the sound signal in greatly attenuated form to pass through the vision i.f. strip. The vision detector, being a non-linear device, produces a 6MHz intercarrier beat signal ($39.5 - 33.5 = 6\text{MHz}$) at its output. This signal is then fed to the intercarrier sound channel. The scheme is shown in Fig. 1, together with the arrangement used with v.h.f. transmissions for the sake of comparison.

The 33.5MHz sound signal must be reduced to a low level early in the vision i.f. strip. This is done by a trap circuit which acts as an attenuator. If this is not done the sound carrier will be amplitude modulated by the vision signal whenever it swings towards peak white (see Fig. 2)—this is one cause of the well known caption buzz effect.

Depending on receiver design the 6MHz intercarrier sound signal may be extracted either before or after the video output device: where a transistor video output stage is used however it is usual to extract the sound signal before the output stage. Often the sound take-off arrangement forms part of a trap which also prevents the 6MHz signal reaching the c.r.t.

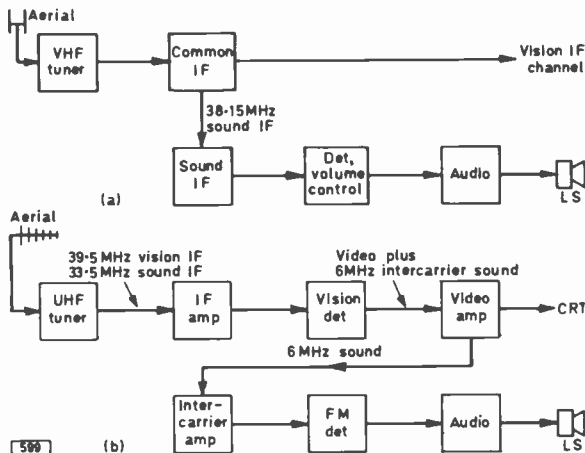


Fig. 1: Block diagrams showing comparison between the path of the sound signal through a 405-line receiver (a) and the intercarrier sound system used in 625-line receivers (b).

Circuits

With discrete components a two-stage intercarrier channel is generally used with a bandwidth of approximately 500kHz: intercarrier sound i.c.s commonly incorporate a four-stage amplifier. A great deal of amplitude limiting is designed into the intercarrier channel in order to "clip-off" any remaining amplitude modulation and interference spikes. The virtually square waveform of the carrier presented to the sound demodulator greatly assists it in its task of producing an audio signal free of interference.

The well tried Foster-Seeley and ratio detector circuits have been very widely used to demodulate the 6MHz f.m. intercarrier sound signal. A completely different arrangement, the "quadrature" or "locked oscillator" circuit, was used in some dual-standard models however (those produced by the Pye and GEC groups). This employs a specially designed heptode valve, the EH90. The circuit used in GEC sets is shown in Fig. 3.

NEXT MONTH IN

TELEVISION

THE VLP SYSTEM

The Philips video long play disc system at present under development offers a reasonable cost home colour video playback system. The discs themselves are similar to conventional gramophone LP records and can be mass-pressed in the same way. The whole system has many ingenious features, from the way in which the full PAL signal plus sound is impressed on the disc as a modulated pattern of pits and scanned for playback by a laser to the signal encoding and automatic control techniques used. A detailed account of the system will be given next month.

PYE COLOUR RECEIVER FAULTS

Paul Soanes describes various fault conditions commonly experienced in the Pye group's 691, 693 and 697 single-standard colour chassis.

IC IF PREAMPLIFIER

Lack of gain in an i.f. strip can be overcome by adding a preamplifier between the tuner unit and the i.f. strip. The problem can occur when a different type of tuner unit to the original is being used or a set is being assembled from various surplus units. The preamplifier to be described uses a $\mu A703C$ i.c. and was designed for use in a colour receiver.

SERVICING TV RECEIVERS

The next chassis to be dealt with by Les Lawry-Johns is the Philips 300 series single-standard monochrome chassis.

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where difficulty is experienced with one of these sets.

The ratio detector provides considerable limiting but a very common cause of vision buzz is imbalance in this type of circuit. Adjustment of the preset balance control generally provided (R121 in Fig. 4 for example) usually provides a cure but the diodes can become faulty (check that they have equal low forward resistance) and more occasionally the reservoir capacitor (C106 in Fig. 4) dries out or develops a leak.

Drift in the alignment of any of the 6MHz tuned circuits can produce vision buzz. Make any adjustments carefully, returning cores to their original positions if no improvement is obtained. The alignment of the 33.5MHz trap at the input of the vision i.f. strip can also be incorrect: great care should be taken in checking this circuit.

Excessive vision signal due to an over-advanced contrast or a.g.c. control is another common cause of vision buzz. In this case however the cause of the trouble is usually obvious from the picture.

It is also possible for a poor aerial installation to cause vision buzz by upsetting the sound-vision ratio.

Distortion

Distortion and "rasping" on sibilants should lead—once it has been proved that the audio amplifier is behaving—to a check on the alignment and bandwidth of the 6MHz sound strip. These symptoms will be present if the sound carrier at maximum deviation falls down the flank of the response of one of the transformers.

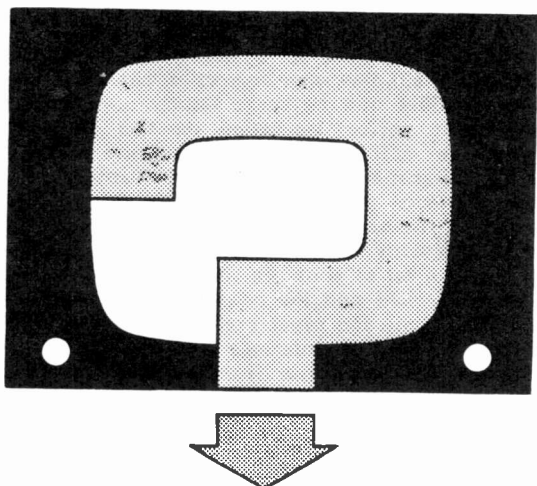
With early types of quadrature detector circuit using the EH90 a "bubbling" sound and distortion were often noticeable on weak signals and/or with low contrast control settings. This was due to the quadrature tuned circuit (L47/C129 in Fig. 3) not locking properly to the weak input signal. The coil can be carefully tuned by ear to minimise these effects.

Modern quadrature detector circuits—including the i.c. variety—are less prone to this trouble although the setting of the quadrature coil is usually very critical. Note that in some recent sets the power supply for the intercarrier sound i.c. is derived from the line output transformer: as a result sound distortion can be experienced if the set boost/width control is incorrectly set thus lowering the supply voltage.

Resistors R92 and R93 in Fig. 3 are very prone to fall in value, causing distortion. If it is necessary to replace them use 2W types. Vision buzz can arise with this circuit when the electrolytic capacitor C93 dries up since this decouples the supply to both the EH90 anode and the screen grid of the video output pentode.

Dead Channel

A completely dead intercarrier channel is a rare bird indeed. The cause will usually be found by making voltage checks. A wideband oscilloscope can be used to trace the intercarrier signal but is rarely sensitive enough to be of use before the final stage of amplification. Even a high-gain oscilloscope applied to the early i.f. stages would not be practical due to confusing displays arising from stray pick-up.



YOUR PROBLEMS SOLVED

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ULTRA 6703

There is sound only on this colour set. The e.h.t. seems to be all right however and the tube heaters are working. But no picture.—G. Hanson (Winchester).

This looks like a beam limiter fault. In this chassis (BRC 3000) the output from the beam limiter circuit is used to alter the bias applied to the luminance emitter-follower if the beam current is excessive. The sensing device is a 1.5Ω resistor between the line output stage earth and chassis—thus the line output current flows through this resistor. Check the voltage at the beam limiter input on the video board—at 13/2. This should be between 4.5V and 5.6V. If this voltage is wrong check back to the beam limiter output connection 22/2. The beam limiter transistor could be faulty, C902 ($4.7\mu\text{F}$) which decouples its output could be short-circuit or the preset brightness control defective. Other things to check are the $100\mu\text{F}$ capacitor (C901) which decouples the beam limiter preset control slider and diode W904 which is in series with the emitter of the beam limiter transistor.

MURPHY V230

We are trying to get this old set to operate properly again. There is good vision and sound on ITV but on BBC there is sound-on-vision, the picture jumping on loud speech or music passages. The attenuators suggested in the manual are no longer available.—A. Warren (Southsea).

We take it that the BBC tuning coil has been adjusted correctly. If so there is either excessive BBC input or an a.g.c. fault which prevents the a.g.c. system reducing the gain sufficiently. Check whether there are any preset gain or a.g.c. controls, and set them for minimum gain. Plug-in attenuators which look very like an ordinary coaxial plug can be obtained: these are adjustable and are simply connected between the download plug and the aerial socket. The simplest solution however is to reduce the aerial input by operating the set from the inner conductor of the coaxial download only. If the picture jumps only when the volume control is advanced and is all right with the sound at a low level the h.t. smoothing is impaired and the electrolytics should be checked.

MARCONIPHONE 4619

There is slight line non-linearity on this set. It starts about two-thirds from the left-hand side and gets worse until at the extreme right there is foldover. A new line output valve has been tried but the fault remains.—J. Cole (Warrington).

Check the line output valve screen feed resistor R128 and its associated decoupler C103, the high voltage capacitor C131 mounted under the line output transformer (if it is slightly warm or tacky on the outside, replace it) and the coupling capacitor C104 to the line output valve (could be leaky). If the picture is not full width check the resistors in the width circuit. There is a chance that the line oscillator (30FL14) or the associated charging capacitor (C51) is faulty. If the problem is on one system only check the appropriate switched capacitors in the line output stage. (BRC 950 chassis.)

FERRANTI TC1122

The trouble with this set is that the e.h.t. is intermittently tracking, with white flecks on the screen. What do you advise?—P. Grant (Tottenham).

It is important to find out where the e.h.t. arc over is occurring. Sometimes it is simply from the e.h.t. lead to chassis, due to the insulation failing. It is a simple matter to renew the lead. The e.h.t. rectifier valveholder insulation could be breaking down. Again this item can be replaced without too much trouble, using a suitable type of course. If the arcing is occurring from one winding to another on the line output transformer or from a winding to the core the only remedy unfortunately is a new transformer. Whether to go to the expense of replacing this in an old set depends on the general condition of the set and the tube. Look around the line output transformer and the scan coils to see where the arcing is taking place therefore.

HMV 2609

The background is very noisy on sound and vision on both systems. The v.h.f. tuner mixer valve which is used on both systems has been replaced, also the first i.f. valve, but there has not been any improvement. Another set has been tried on the same aerial installation and works perfectly.—T. Norman (Leicester).

A noisy background usually indicates that the r.f. amplifier, not the frequency changer, is at fault. It would be worth changing the r.f. amplifier valve in both tuners therefore: if the present ones are old this is sure to give a definite improvement. Make sure that the supply voltages to the tuners are correct: after some years the h.t. feed resistors (R168/R169/R170) tend to increase in value, reducing the h.t. supplies to the tuners with the result that the performance generally is degraded and the grain increased. (BRC 850 chassis.)

BUSH CTV25

A fault in the focus circuit—one of the high-value resistors in the focus potential divider chain going high value—was recently put right but I still find that perfect focus cannot be obtained. Checking the separate rasters I find that the picture can be focused well but that different settings are required for the different guns.—P. Ibbotson (Bury).

The c.r.t. is unfortunately at fault and the only thing you can do other than to replace it is to settle for a compromise focus setting which gives the best average focus on all three guns.

ULTRA 6800

This set is suffering from field slip and jitter. The PCL85 field timebase valve and 30FL2 sync separator have been replaced and the associated components visually checked but the fault persists.—R. Baker (Cheam).

Poor sync troubles on this chassis are generally due to R44 (47k Ω) the upper resistor of the potential divider supplying the sync separator screen grid changing value. If this is in order however check the coupling capacitor to the sync separator (C42, 0.015 μ F), the field sync pulse coupling capacitor C74 (0.022 μ F) and the PCL85 triode cathode bypass capacitor C71 (0.01 μ F). (BRC 1500 chassis.)

MURPHY TV141U

The fault on this set is collapse of the line scan: the set works however if it is tuned off station and/or the line hold control is adjusted away from the lock position. The fault is present on both systems and has been cleared by removing the flywheel sync reservoir capacitor 3C1. The line hold is a little weak however.—L. Chapman (Stourport).

The cause of the fault seems to be in the flywheel sync circuit and the most likely defect is that one or both of the discriminator diodes has gone high-resistance in the forward direction. 3C1 could be leaky of course. Another possibility is that the 47k Ω reference signal integrating resistor 3R2 has changed value. If necessary check the values of the discriminator diode load resistors 3R6 (820k Ω) and 3R7 (1M Ω).

DER 236

This set was obtained as a non-worker but after replacing the 625-line scan correction capacitor C98, the h.t. rectifier and its surge limiter and the line output valve perfect operation on 405 lines was obtained. On 625 lines however there are a couple of faults. First if the aerial is pushed in fully BBC-1 is also received faintly on the BBC-2 and ITV channels. If the aerial is slightly withdrawn, i.e. just the screen making contact, this condition is removed but there is a lot of snow on the picture. The aerial has been checked and the connections between the aerial socket and the tuner are in order. The other problem is lack of interlace and a bit of line tearing on 625.—A. Oliver (London E7).

It seems that the signal strength in your area is excessive. An attenuator at the aerial input should solve the first problem therefore. The second problem could be due to excessive contrast. Check the 625-line anti-lockout diode W3 (BA116), also if necessary the PFL200 and its associated components, especially the electrolytics. (BRC 950 chassis).

PYE 169 CHASSIS

The picture breaks into a fast line slip after the set has been on for about ten minutes. If the line oscillator coil is adjusted the picture reappears but with no line sync. The line timebase valves, the line oscillator coil, the TAA700 i.c. and the resistors feeding the PCF802 line oscillator valve have all been replaced without success.—G. Becker (Preston).

The problem is probably due to one of the polystyrene capacitors C65 (0.0033 μ F) or C67 (820pF) in the line oscillator circuit so these should be checked.

BUSH T100C

We are having difficulty curing a case of no raster on this set. The line timebase valves have all been checked and found to be OK. Line whistle is present but the EY86 e.h.t. rectifier does not light up—there is a slight spark at its anode however. If the line coils are disconnected the EY86 lights up and there is a vertical line on the screen.—O. Pound (Kidderminster).

The trouble seems to be the scan coils and we suggest you try another set—the exact type is not too important so long as they are for the correct scanning angle. There seems to be breakdown of the insulation in the line scan coils.

EKCO CT102

This set has been operating since 1968. There is now a green cast on the screen, but it is red or sometimes blue on the left-hand side and this may extend nearly half way across the screen. The cast sometimes varies but goes back to green.—R. Arthur (Birkenhead).

Unfortunately the c.r.t. could be faulty, especially if the reds are muddy. Another possible cause however is the flyback blanking transistor VT28 (BC107 or BC147) in the cathode circuit of the luminance output valve (PL802). It would also be an idea to check the G — Y output stage/clamp PCL84 and associated components and connections.

KB KV101

On switching to 625 lines the picture at first is fairly good. After about a quarter of an hour however the quality of the picture and sound deteriorates to a point at which it is just as if the aerial had been disconnected. The valves in the u.h.f. tuner have been changed.—R. Chapman (Pontefract).

First try a new PCL84 video valve and check that on system change the voltages in this stage change to the correct figures. If this fails to cure the trouble try shorting the u.h.f. tuner unit a.g.c. tag to chassis: if this restores contrast and ample sound it would appear that excessive bias is being applied in which case the 4.7M Ω resistor connected to the slider of the contrast control and if necessary the high-value resistors in the preset a.g.c. control circuit should be checked—the easiest way is to stab a similar value resistor across each suspect in turn.

Note that the mixer section of the v.h.f. frequency changer valve is used as an additional i.f. amplifier on u.h.f.: it could be faulty. Check that the u.h.f. tuner h.t. supply stays at the correct voltage. If the fade away is accompanied by increasing background noise and hiss on sound, i.e. suggesting a low-gain r.f. amplifier stage, the u.h.f. tuner could be faulty. (KB/STC VC2 chassis.)

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TELEVISION MAY 1974

TEST CASE

137

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.

Q A Decca CS2225 colour receiver (which uses an "interim" single-standard chassis, an updated version of the dual-standard CTV25 series chassis) came in with the complaint of picture roll. Off-air tests in the workshop confirmed this and it was discovered that although the line timebase appeared to lock solidly the field timebase could be locked only temporarily and by very critical adjustment to the vertical hold control.

The chassis employs a transistor sync separator stage and flywheel-controlled line sync. Pulses from the sync separator on the luminance panel pass to the timebase board through screened cable. In the timebase circuitry they are fed to the flywheel circuit through a 100pF capacitor (C312) and to the field oscillator through a 56k Ω resistor (R301) in series with an 0.001 μ F capacitor (C301). R301 in conjunction with an integrating capacitor (C302, 560pF) integrates the field sync pulses which are then passed to the ECC82 field oscillator via a suitably biased OA81 interlace diode which serves to attenuate the line sync pulses so that only the integrated field sync pulses reach the field generator.

Since the line was locking it was concluded that the trouble must lie in the field sync coupling/integrating network. After extracting the timebase board passive tests and measurements were made on

the components in this area. As the diode is vulnerable it was checked first but proved to be in order. Although not of exactly the correct value the remaining components with the exception of the diode cathode upper potential-divider biasing resistor appeared to be perfectly serviceable. This resistor (3.3M Ω R302) was virtually open-circuit however. It was replaced therefore and the board reinstalled. The technician was somewhat surprised when it was then found that the symptom was exactly the same as before!

The symptom was studied in greater detail. At the critical vertical hold setting it was noticed that the picture tended to pull horizontally very slightly with changes in picture information.

What would be a probable cause of this symptom and what steps should next be taken by the technician? See next month's TELEVISION for the solution and for a further item in the Test Case series.

SOLUTION TO TEST CASE 136

Page 283 (last month)

The symptom last month was that of severe overloading in the tuner and/or the i.f. stages, and although the contrast control was able to reduce the gain of the PFL200 video output pentode it was not able to reduce the gain—via the a.g.c. circuit—of the earlier stages.

In this chassis (GEC Series One) the a.g.c. potential is obtained from a peak rectifier diode which conducts on the tips of the sync pulses on the video signal fed to its cathode. Measurements on the following a.g.c. amplifier transistor TR105 indicated that it was incorrectly biased and was not providing an a.g.c. bias potential for the controlled stages. Further tests showed that the resistors in the circuit were reasonably correct in value but that the rectifier diode D102 (type 1N4148) was virtually open-circuit. There was no a.g.c. action therefore which meant that the controlled stages were biased on for full gain irrespective of the setting of the contrast control. Replacing the diode cleared the trouble.

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	2013	2020	2038	2063	2083
	2014	2021	2039		

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

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

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COLOUR TV Line out-put transformers

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8000 Chassis	CTV167 Mk.1 & 2	CT107
8500 Chassis	£10.10 ea.	CT108
All £6.80 ea.	CTV167 Mk.3	CT109
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	CTV182S	CT120
	CTV184S	CT121
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CVC2 "		CT178
CVC5 Chassis		CT179
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		CT153
		CT154
		£8.90 ea.
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		CV2214
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