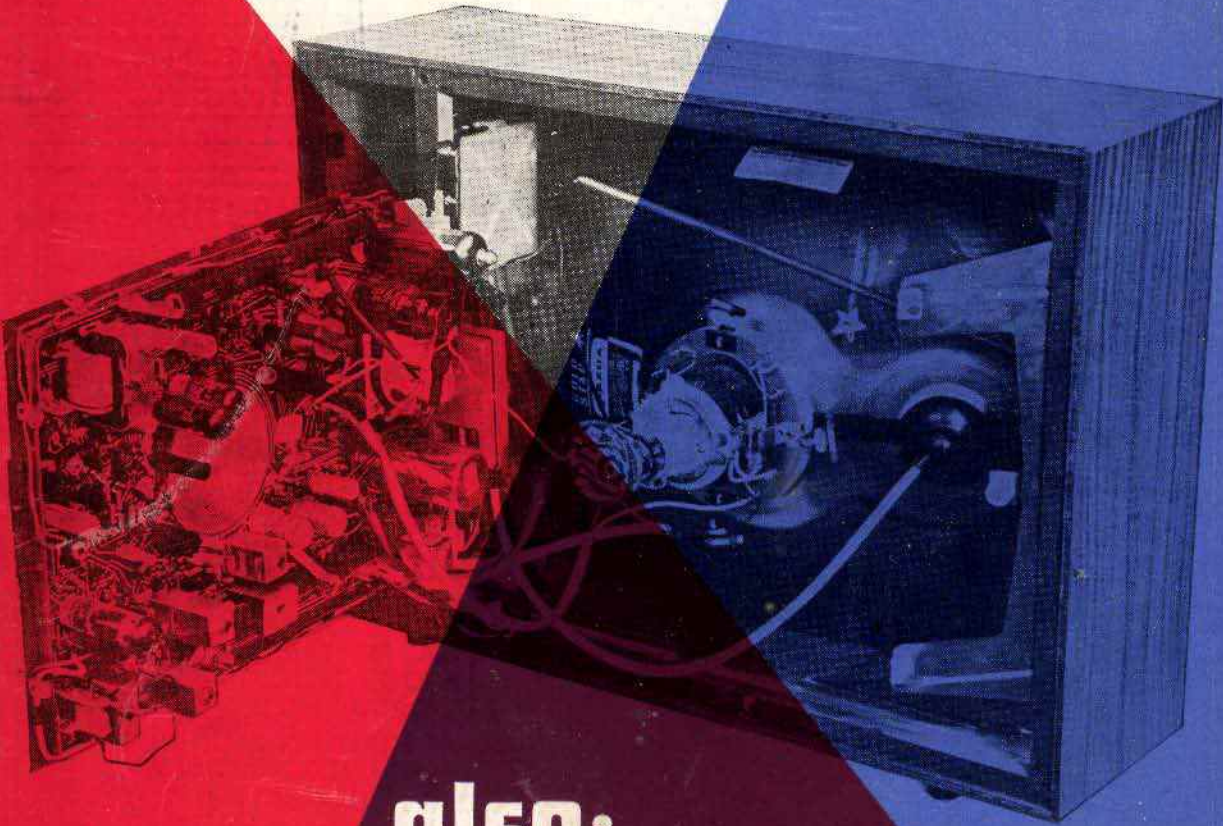
PRACTICAL TELEVISION

3/0

JANUARY 1970

DEVELOPMENTS IN TV RECEIVERS



also:

A CONSTRUCTOR'S 625-LINE RECEIVER

TRANSISTOR LINE DRIVER STAGES

REPAIR SHOP GADGETS

Please note: Components are sold in packs, quantities per pack are shown under each heading. Prices are per piece of each value.

TUBULAR CAPACITORS (3's)

·001	400v.	8d.
·0022	600v.	8d.
·0033	600/1500v.	8d.
·0047	600/1500v.	8d.
·01	400v.	8d.
·022	600v.	8d.
·033	600v.	9d.
·047	600v.	9d.
·1	600v.	10d.
·22	600v.	1/8d.
·47	600v.	2/3d.
·01	1000v.	1/1d.
·022	1000v.	1/1d.
·047	1000v.	1/6d.
·1	1000v.	1/6d.
·22	1000v.	2/3d.
·47	1000v.	3/3d.
·001	1500v.	1/6d.

WIRE-WOUND RESISTORS (3's)

10 watt rating, suitable for mains dropper sections.

1	Ohm	1/9d.
10	Ohms	1/9d.
13	,,	1/9d.
25	,,	1/9d.
33	,,	1/9d.
50	,,	1/9d.
87	,,	1/9d.
100	,,	1/9d.
150	,,	1/9d.
220	,,	1/9d.
330	,,	1/9d.
1K	,,	1/9d.
2·2K	,,	1/9d.
3·3K	,,	1/9d.
4·7K	,,	1/9d.

PULSE CERAMICS (3's) 12KV

100pf	22pf	1/1d.
120pf	47pf	1/1d.
180pf	68pf	1/1d.
250pf		1/1d.

Tubular type for use in Scan correction circuits and Line Outputs.

CERAMICS (6's)

500pf	8d.
680pf	8d.
820pf	8d.
1000pf	8d.
1500pf	8d.
3000pf	8d.
5000pf	8d.

RECTIFIERS

Silicon Mains (3's)

Westinghouse S10AR2	6/6d.
BY127 Mullard	5/3d.
BY105 Mazda	7/0d.
BY327	5/6d.

CONTACT COOLED FULL WAVE

75ma	12/8d.
100ma	13/8d.
150ma	16/8d.

CO-AXIAL PLUGS

Bakelite top	10d.
Egen metal	1/4d.
Single point (car radio)	2/0d.

SLIDER PRE-SETS (3's)

100K	1/6d.
1 Meg	1/6d.
2·2 Meg	1/6d.

JACK PLUGS

Chrome standard	4/0d.
Standard	3/0d.
3·5mm. metal	3/0d.

DIN PLUGS (3's)

3-pin	1/10d.
5-pin	2/2d.
Sockets	1/0d.

BIAS ELECTROLYTICS (3's)

25mfd	25v.	1/4d.
50mfd	25v.	1/6d.
100mfd	25v.	1/9d.
250mfd	25v.	2/8d.
500mfd	25v.	2/8d.
1000mfd	12v.	5/0d.
1000mfd	30v.	4/9d.
2000mfd	25v.	6/0d.
2500mfd	30v.	8/0d.
3000mfd	30v.	8/6d.
5000mfd	30v.	9/3d.
25mfd	50v.	1/7d.
50mfd	50v.	1/10d.
100mfd	50v.	2/3d.
250mfd	50v.	3/4d.
500mfd	50v.	4/0d.
2000mfd	50v.	8/0d.
2500mfd	50v.	9/6d.

SMOOTHING ELECTROLYTICS

Wire ended, 450v. working.

1mfd	1/3d.
2mfd	1/4d.
4mfd	2/0d.
8mfd	2/4d.
16mfd	3/0d.
32mfd	4/2d.
50mfd	4/8d.
8/8mfd	3/6d.
8/16mfd	4/8d.
16/16mfd	4/6d.
16/32mfd	5/0d.
32/32mfd	4/9d.
50/50mfd	7/0d.
50/50/50mfd	8/0d.

CANNED ELECTROLYTICS

100/200mfd	10/6d.
100/400mfd	14/0d.
200/200mfd	15/0d.
200/200/100mfd	18/6d.
200/400/32mfd	15/6d.
100/300/100/16	16/6d.
100/400/32mfd	15/6d.
100/400/64/16	18/6d.

SKELETON PRE-SETS (3's)

25K	Vertical	1/4d.
50K	,,	1/4d.
100K	,,	1/4d.
250K	,,	1/4d.
500K	,,	1/4d.
1 meg	,,	1/4d.
2 meg	,,	1/4d.
500K	Horizontal	1/4d.
680K	,,	1/4d.
1 meg	,,	1/4d.

CARBON FILM RESISTORS

½ watt and 1 watt.

The following values are packed in cartons of *six of each value.* Price 2/6d. per carton.

10	ohm	1·2K	150K
12	,,	1·5K	180K
15	,,	1·8K	220K
18	,,	2·2K	270K
22	,,	2·7K	330K
27	,,	3·3K	390K
33	,,	3·9K	430K
39	,,	4·3K	470K
43	,,	4·7K	560K
47	,,	5·6K	680K
56	,,	6·8K	820K
68	,,	8·2K	1M
82	,,	10K	1·2M
100	,,	12K	1·5M
120	,,	15K	1·8M
150	,,	18K	2·2M
180	,,	22K	2·7M
220	,,	27K	3·3M
270	,,	33K	3·9M
330	,,	39K	4·3M
390	,,	43K	4·7M
430	,,	47K	5·6M
470	,,	56K	6·8M
560	,,	68K	8·2M
680	,,	82K	10M
820	,,	100K	12M
1K		120K	15M

All the above values are available in both ½ watt and 1 watt versions.

***Special for Philips TV's:** 8·2M 2-watt, 4/6d. per pack.

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Remember . . . WE ONLY SUPPLY SERVICE DEPTS. and can therefore carry large stocks, and also we know and understand your problems regarding getting the right spares QUICKLY and the RIGHT PRICE. HOT-LINE ORDERS: 01/567 5400.

SUB-MINIATURE ELECTROLYTICS (3's)

1mfd	18v.	1/6d.
2mfd	18v.	1/6d.
4mfd	18v.	1/6d.
5mfd	18v.	1/6d.
8mfd	18v.	1/6d.
10mfd	18v.	1/6d.
16mfd	18v.	1/6d.
25mfd	18v.	1/6d.
32mfd	18v.	1/6d.
50mfd	18v.	1/8d.
100mfd	18v.	1/8d.
200mfd	18v.	2/0d.

THERMISTORS (3's)

Miniature	1/6d.
TH1	2/4d.

RADIO/TV GLASS FUSES

1 amp, 1·5 amp, 2 amp, 3 amp. Per dozen 3/0d.

MAINS FUSES

2 amp, 3 amp, 5 amp, 13 amp. Per dozen 5/0d.

TERMINAL STRIPS

2 amp	2/3d.
5 amp	2/10d.
15 amp	5/9d.

DOUBLE DIODE RECTIFIERS (3's)

Bush/Murphy/BRC etc.
Line/frame timebases etc.

3 leg	6/3d.
4 leg	6/3d.
5 leg	6/3d.

VOLUME CONTROLS

Standard spindle with flat.

Double pole switch	4/0d.
Without switch	3/0d.

(One per pack)
5K, 10K, 25K, 50K, 100K, 250K, 500K, 1 meg, 2 meg.

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HOT-LINE ORDERS

RECORD PLAYER CARTRIDGES

ACOS: GP67/2g. High gain general purpose Mono	16/8d.
GP91/SC. Stereo-compatible replacement	22/0d.
GP91/3SC. High gain version of above	22/0d.
GP94/1SS. Stereo cartridge	37/9d.
GENERAL PURPOSE REPLACEMENT FOR TC8's etc.	
High gain, plenty of output (Jap.)	19/10d.
Stereo version	37/9d.

SERVISOL AND ELECTROLUBE PRODUCTS (Nett trade)

Servisol aerosol can	12/6d. nett
Electrolube 2AX aerosol	14/0d. nett
Servisol Freezit	9/6d. nett
Electrolube No. 1 Snorkel	18/0d. nett
Electrolube 2GX Grease	8/4d. nett
Servisol Aero-Clene for tape heads	10/6d. nett
Servisol Aero-Duster	10/6d. nett

REPLACEMENT STYLI

TC8	4/6d.
GC8	4/6d.

RADIO AND TELEVISION VALVES

British made valves normally supplied.

DY86/7	9/1	EY86/7	9/1	PCL86	11/4
DY802	9/1	EZ80	10/10	PD500	31/7
EABC80	12/8	EZ81	8/2	PFL200	15/9
EB91	8/2	EZ90	9/3	PL36	13/7
EBC90	10/10	GZ34	13/7	PL81	11/4
EBF80	10/10	GY501	15/9	PL81A	14/6
EBF89	10/10	PC86	12/6	PL82	10/10
ECC81	10/0	PC88	12/8	PL83	13/8
ECC82	10/0	PC97	9/1	PL84	8/7
ECC83	10/0	PC900	12/8	PL302	13/7
ECC804	15/4	PCC84	10/0	PL504	18/1
ECH81	14/6	PCC88	16/8	PL508	20/4
ECH84	12/8	PCC89	13/7	PL509	31/7
ECL80	9/6	PCC189	13/7	PY33	12/2
ECL82	12/8	PCC806	15/9	PY81	9/0
ECL83	13/4	PCF80	11/4	PY800	9/0
ECL84	11/4	PCF86	13/7	PY801	9/0
ECL86	12/8	PCF87	18/1	PY82	8/4
EF80	9/6	PCF801	13/7	PY83	13/7
EF85	12/8	PCF802	13/7	PY500	20/4
EF86	16/4	PCF805	14/11	UABC80	13/7
EF89	10/10	PCF806	13/7	UCH81	13/7
EF183	12/8	PCF808	14/11	UCL82	12/8
EF184	12/8	PCL82	11/4	UCL83	14/6
EH90	13/7	PCL83	13/4	UL41	14/6
EL34	10/0	PCL84	11/4	UL84	12/8
EY51	13/7	PCL85	11/4	UY85	9/0

ALL MAZDA/BRIMAR TYPES IN STOCK.

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All orders must exceed 50/0d. in value otherwise postage and packing will be charged at 5/0d. per invoice. Components must be ordered in multiples as packed.

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Send 1/6d in loose stamps for our comprehensive catalogues listing valves, components, tubes, transistors, mikes, aerials, Line output transformers. BY RETURN SERVICE ANYWHERE.

PRACTICAL TELEVISION

VOL 20 No 4
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JANUARY 1970

BACK AT THE TOP

WELL, it's been a long time on the way, and no one can say we've not been patient, but colour is *really* here at last. Since the time of Baird's ingenious but crude pioneering colour TV transmissions in the late-1920s it has taken forty years for the realisation of a nationwide practical colour TV service.

During the post-war years there were many false alarms, hesitations and similar frustrations. At many a radio show colour sets were demonstrated, serving only to whet the appetite and showing that while colour was tantalisingly near it was at the same time elusively out of reach.

After spasmodic BBC experiments with the NTSC system in the late 1950s however the UK adopted the PAL system and this was the green light everyone had been waiting for. Following a run-in period from July 1967, a limited colour service began in the following December on the BBC-2 u.h.f. channels and was progressively expanded. And then, on November 15th of last year, came the big switch-over with BBC-1, BBC-2 and ITV colour on u.h.f.

So colour is really here at last. It will present problems and challenges to everyone in the industry (makers, designers, retailers, salesmen), to studio production staff, to the engineers of the broadcasting organisations, to the service engineers and—let us not forget—to the viewers who have to find ways of affording their receivers!

Nevertheless at the very outset of the service around 50% of the population are within reach of a colour signal and the gap will rapidly narrow over the next year or so. There are over 100 hours of colour a week, an output bigger than anything in Europe. And the technical quality of broadcast signal and receiver performance is unequalled anywhere in the world.

So, thanks to the tremendous achievements of the BBC and ITA engineers, the GPO, the receiver manufacturers and the countless backroom boys, it should be a matter of some pride that, after years of heel-dragging, we once again boast a status worthy of the country that was foremost in the pioneering days of television.

W. N. STEVENS, *Editor*

COVER: The photo used on our cover this month was kindly supplied by the British Radio Corporation and shows their latest 1500 single-standard chassis.

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THE NEXT ISSUE DATED FEBRUARY WILL BE PUBLISHED JANUARY 23

TELETOPICS

BBC-1 AND ITV COLOUR

The BBC-1 u.h.f., including colour, services from Crystal Palace, Sutton Coldfield, Winter Hill and Emley Moor started on November 15th. The Crystal Palace transmissions are on channel 26, horizontally polarised (group A aerial); Sutton Coldfield channel 46, horizontally polarised (group B aerial); Winter Hill channel 55, horizontally polarised (group C aerial); and Emley Moor channel 44, horizontally polarised (group B aerial).

The ITA u.h.f. transmissions are on channel 23 for Crystal Palace, channel 59 for Winter Hill, channel 43 for Sutton Coldfield and channel 47 for Emley Moor, aerial groups and polarisation as for the BBC transmissions.

MULTI-SCREEN TV SET

The first multi-screen TV set in the UK is being shown by British Relay. The four-channel receiver has a 25in. colour main display and ranged below this three 5½in. monochrome monitor screens. The receivers are NordMende models produced in Germany and are intended primarily as professional studio units. However they can be made available for the domestic market at a price of around £850.

BUSH-MURPHY COLOUR DEVELOPMENT

A new circuit technique of considerable interest is used in the single-standard Bush-Murphy colour chassis. This technique avoids the need for a crystal-controlled reference oscillator with a.p.c. loop in the decoder. Instead, subcarrier regeneration is achieved by the use of a narrowband crystal filter with very high Q. The burst signal is applied to this, causing the filter to ring with constant phase throughout the line period. On black-and-white when there is no burst signal there is thus no reference signal applied to the colour demodulators so that colour interference is avoided, while the absence of an a.p.c. loop simplifies setting-up.

VIDICORD REPRODUCER

A new piece of equipment has been introduced by Vidicord Holdings Ltd. to enable normal Super-8mm. film to be reproduced on a television set. The equipment consists of a small low-wattage projector and image converter and is priced at £370 for single orders. A full colour/black-and-white version is proposed for about a year's time at about £250, using a flying-spot scanner.

LABGEAR COLOURMATCH RANGE

Labgear Ltd. (Cromwell Road, Cambridge) have released a brochure illustrating and describing their "second generation" range of u.h.f. aerials and amplifiers. This is called the *Colourmatch* range since particular attention has been paid to impedance matching to ensure faithful reproduction of colour programmes. The range includes three basic u.h.f. aerials (CM11, CM14 and CM18) which feature a new dipole matching arrangement, a series of single-stage high-gain boosters intended for mast-head mounting, a three-outlet amplifier covering frequencies from 40-860MHz designed to cater for the second TV receiver market, u.h.f. distribution amplifiers, a signal-strength meter and compact pattern generator providing adjustable crosshatch, dot and line patterns as well as grey-scale and blank raster waveforms on the 625-line standard.

DEVELOPMENTS IN INDUSTRIAL CRTs

Westinghouse have introduced a 4in. split-screen tube which combines the features of normal c.r.t. operation and storage tube display so that information fed to it can be compared visually with information presented on the storage screen, a separate internal storage screen being used.

RCA have developed a tube whose image can be displayed in either of two chosen colours. The colour of the light emitted by the phosphor screen depends on the velocity of the beam so that by changing the anode voltage the colour can be altered to any within the specified colour range. The 12in. tube is a development type with a high-voltage electrostatically-focused gun.

NEW UHF SIGNAL BOOSTER

Transpeaters Ltd. (56, Station Road, Worthing) have introduced a new u.h.f. signal booster. The high-gain low-noise circuit uses two transistors in cascade to provide a nominal gain of 16dB (minimum 12dB). The booster runs from the receiver's h.t. supply, covers the whole of Bands IV and V and is housed in a canister of 40mm. diameter and 55mm. length. Supply is at present restricted to the Trade at £4 17s 6d net trade.

FAULTY SETS TO BE INVESTIGATED

The RTRA and TV manufacturers are co-operating in a campaign to reduce the number of faulty sets delivered. RTRA and EAA members have been asked to supply full details of sets received for a month and their condition. The results are to be analysed to devise ways of cutting down and eventually eliminating the incidence of faulty sets delivered.

LATEST BBC STATIONS

The BBC-2 service from the **Fenton** relay station started on November 3rd on channel 27 with vertical polarisation. A group A receiving aerial should be used and the other channels assigned to the station are 21, 24 and 31. The station serves Stoke-on-Trent and those parts of the potteries not adequately covered by Sutton Coldfield and Winter Hill.

The BBC-2 service from **Craigkelly** started on October 27th on channel 27 with horizontal polarisation. Use a group A receiving aerial.

The BBC's TV and v.h.f. radio relay station at **Whitby,** Yorkshire came into operation on November 10th. BBC-1 is transmitted on channel 4 with vertical polarisation. The radio services, horizontally polarised, are as follows: Radio 2 89·6MHz; Radio 3 91·8MHz; Radio 4 94MHz.

NEW INSULATION METER

Comark Electronics Ltd. (Brookside Avenue, Rustington, Littlehampton, Sussex) have introduced a new insulation meter, type 1905, which provides six test voltages from 25V to 1kV and can measure leakage resistances from 0·1MΩ to 10,000MΩ to $\pm 5\%$. The test voltages of the battery-operated 1905 are generated by a transistor converter and the output is electronically stabilised to limit the maximum current to 10μA: semiconductor diodes and rectifiers can be safely checked for leakage.

LOWEST YET COLOUR RENTAL

Granada have introduced a new colour TV rental scheme at under £1 a week in conjunction with a German-made 11in. single-standard mains-operated portable set called the Colourette. The set is made in the W. German factory of the US General Electric Co.

NEW SOUND-ON-SYNC SYSTEM

Northern Electric Laboratories in Ottawa have announced the development of a sound-on-sync system for transmitting the sound and vision portions of a programme within a single satellite channel. The basic sound-on-sync system was described in our January 1969 issue. Northern Electric Laboratories claim that by using delta modulation instead of conventional pulse code modulation the design of the audio receiving equipment is simplified.

PRESENT RENTAL POSITION

More than 80% of the colour sets now in use in the UK are rented, according to the Electronic Rental Association which represents all the major TV rental companies and most of the smaller ones. And of the just over sixteen million TV sets installed in homes and offices in the UK slightly more than half —8½ million—are rented. These figures are given in a report entitled *The Case for Rentals* issued by the association showing that the present restrictions on the industry discriminate against the rental organisations.

COLOUR TV REFERENCE SOURCE

Fisher Controls Ltd. (Brearly Works, Luddenden Foot, Halifax, Yorks) have developed in conjunction with the BBC Research Department a new colour TV reference source designed to meet the need for a low-cost, accurate, portable instrument for use by both broadcasters in setting up monitors and retailers' service departments.

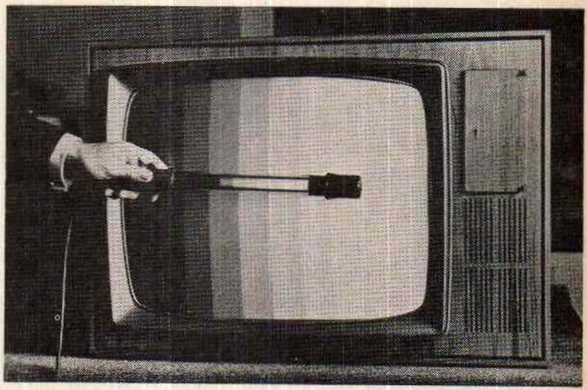


Photo by courtesy of the BBC

The Fisher/BBC colour TV reference source has a colour temperature of 6,500°K (Illuminant D) which is maintained in spite of voltage and ambient temperature fluctuations. The display (see photo) is in the form of a four-step wedge and the instrument is contained in a thick acryllic tube with moulded rubber grip and end cap. The replaceable light source has a rated life of 5,000 hours. Price is £10 plus 5s post and packing.

TV DELIVERIES

Despite the expected upswing in colour television sales with the advent of BBC-1 and ITV colour programmes the figures for radio and television deliveries to the home trade continue to show a fall for the January to August period in comparison to 1968, according to the Economic and Statistical Division of the British Radio Equipment Manufacturers' Association. Deliveries of colour receivers for August 1969 were 1,000 higher than for the same month of 1968 but are still 18,000 lower than for the same period of 1968. Monochrome sets at 92,000 are lower by 15,000 on a monthly basis compared with 1968, giving a figure of 39,000 lower than for the same total period of 1968.

NEW TV STUDIO LAMP

To meet the requirements of colour TV studios Osram (GEC) Ltd., Wembley, Middlesex, has developed a 2½/2½kW halogen-filled version of the twin-filament colour studio lamp. The new lamp does not require a collector grid and gives almost 100% lumen maintenance so that there is more uniform lighting on the reflector. A bromine filling has been adopted in preference to iodine as this has no effect on the lamp's spectral characteristics.

DEVELOPMENTS IN TV RECEIVERS

K. Royal

ONE of the most outstanding circuit developments of recent times is the integration of solid-state devices with thermionic valves to give the so-called hybrid receiver. Indeed virtually all sets currently being produced are hybrid, the transistors serving in the small-signal circuits and the valves in the timebase, video and sometimes audio circuits which are more concerned with power.

While the valve has been ousted almost completely in other spheres of domestic electronics, including radios and audio equipment, and indeed in the vast majority of commercial applications, it seems likely that the hybrid television set will continue to be made for some years to come yet. However this must not be taken to imply that the all-transistor television set is a non-starter. Several makers have already produced all-transistor monochrome sets during the last three or four years, while two British manufacturers, the British Radio Corporation and Rank-Bush-Murphy, have produced all-transistor colour models. BRC has two chassis, series 2000 and 3000, the first dual-standard and the second 625-only, while the RBM chassis is called the A823 series and uses integrated circuits as well as conventional and high-voltage transistors.

Using Valves or Transistors?

At the present time transistors capable of handling the high powers and large pulse voltages of the timebases and the large signal swings of the video amplifier are just emerging and are consequently more costly than the valves which have been doing these jobs very successfully for several decades. It is noteworthy that the power requirements of valved monochrome line and field timebases are about 35W and 12W. The improved efficiency of transistors, with the lack of heater power and so forth, diminishes the total powers respectively to about 24W and 9W, and while these orders of power are not excessive for transistors in general problems arise from the very high volt-ampere products of the scanning circuits and the peak retrace potentials. For example the line scanning circuit runs up to about 3,500 volt-amperes, with a pulse of some 6kV occurring on the valve anode due to the retrace. In these circuits the circulating current is kept in bounds (to provide the 3,500VA requirement) by running the valve anode from the boosted h.t. line. Sadly the transistor counterpart will not play in this way since the collector potential is limited to about 150V, with a pulse voltage rating of little more than 1·5kV. Hence the sets that do use transistors in the line timebase have to be specially tailored to take into account the existing limitations of the available transistors—and this sort of tailoring can be more costly than using the valves which satisfy the problems with ease.

In colour sets the problems differ a little; for one thing the large number of valves required in the overall circuit complex adds up to a lot of heat, so transistors solve the difficult ventilation problem. Moreover the cost of the transistors (even when relatively expensive power ones are adopted in the timebases and video circuits of all-transistor models) in ratio to the overall cost of the set is less for colour (owing to the high cost of the colour picture tube and the chroma circuits) than for monochrome which, in the current state of the art, tends to make the all-transistor colour set a more viable proposition than its monochrome counterpart.

Colour set volt-ampere scanning requirements are about double the figures earlier mentioned for monochrome sets, and the high current at the relatively low transistor voltages is supplied by a mains transformer, efficient rectifier and complex stabilising circuit. The e.h.t. system may be separate from the line output stage—i.e. using its own transistors—as in the BRC 2000 chassis—but is commonly triggered from the line timebase signal. The required 25kV e.h.t. supply is obtained from the limited pulse potential delivered by the transistors via a step-up transformer and voltage multiplying circuits. The e.h.t. voltage can be maintained at a constant value over the wide range of beam currents by an internal feedback circuit as distinct from the control provided by the more conventional shunt regulating valve mostly found in hybrid colour sets.

Voltage triplers are also being used in 625-only models. These are activated by pulses from the line output transformer and take the place of the e.h.t. rectifier valve.

Another difficult area of the all-transistor set is the video amplifier which has to deliver up to 120V of picture signal drive to the thermionic picture tube over the full contrast range within a luminance bandwidth of some 5MHz. High-slope valves running from a little above 200V h.t. yield this wide bandwidth swing without too much trouble, but the limited voltage that the collectors of transistors can withstand makes it difficult to secure the required swing (how can 120V of video possibly be obtained from the collector of a transistor with a maximum Vc of say 90V?). Actually, recent years have seen the advent of high switching speeds (necessary for wideband operation) and of Vc ratings comparable to the anode voltages of video output valves. Such transistors are found in the latest all-transistor sets.

Placing transistors in the audio section gives few troubles and some hybrid models (notably colour ones) feature transistor audio modules or printed circuit boards. However, many hybrid monochrome sets still favour the well tried triode-pentode valve audio section, the triode audio amplifier receiving detector signal direct and delivering it to the pentode for driving the loudspeaker. It would seem that this scheme is still more economical than a pair of class B transistors driven from a couple

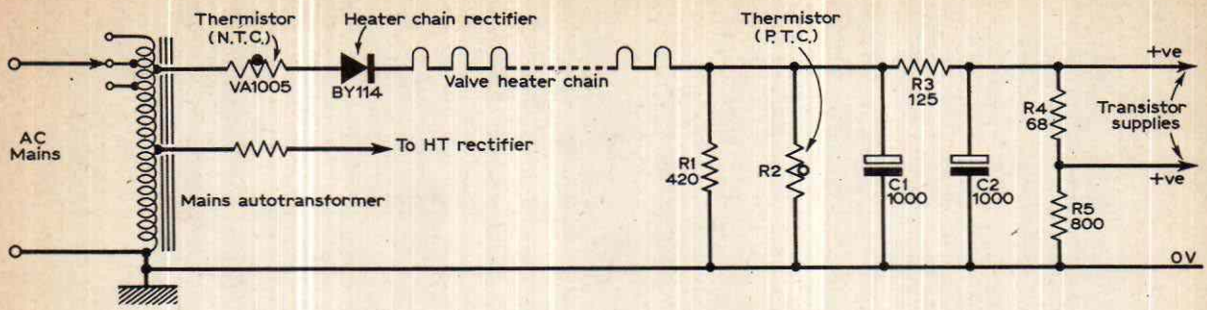


Fig. 1: A heater chain rectifier not only reduces the power dissipation involved in the use of a mains dropper resistor but also provides a source of d.c. for the transistors.

of transistors and a transformer or, for better quality, a complementary-mode circuit.

Transistor Powering in Hybrid Sets

The few watts of power required by the small-signal transistors of hybrid sets is not difficult to obtain and a number of circuits have been evolved for this purpose. The supply is commonly obtained by resistive dropping from the main h.t. line or from a potential created by rectification of the line scan signal (see Fig. 7 later). Another arrangement (used in Pye/Ekco sets) makes use of the silicon rectifier in series with the heater chain as shown in Fig. 1. The rectifier here constitutes a recent development in itself, for it was introduced originally to reduce the heater circuit power and heat dissipation. Heater current was previously dropped to the value required by the valves (commonly 0·3A) by the mains dropping resistor, which got very hot and thus produced a complicated ventilation problem in hybrid sets with heat-sensitive transistors. The solution was given by the series rectifier since this allows only half-cycle pulses of current to flow through the heaters, the root mean square (r.m.s.) value of which, being below that of the complete mains cycles, gave the required dropping effect without the need for the power-consuming mains dropper.

In Fig. 1 the heater circuit is loaded by R1 and shunted by the positive-temperature coefficient thermistor R2 to keep the output voltage within the limits required by the transistors during switch-on surges. The voltage appearing across the load is smoothed by C1, C2 and R3 and adjusted in level by the potential-divider R4, R5.

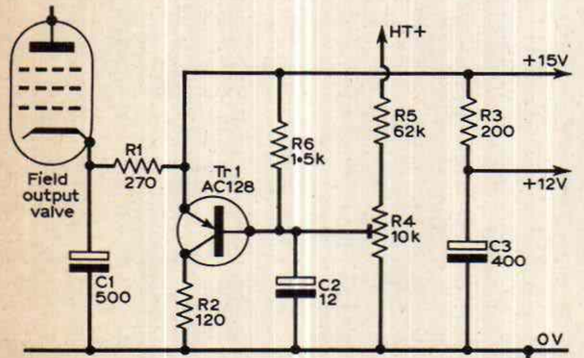


Fig. 2: In one Bush-Murphy chassis the transistor d.c. supply was obtained from the cathode circuit of the field output valve as shown here. The transistor Tr1 acts as a shunt stabiliser.

Sometimes, such as in certain GEC and Sobell models, protection other than that given by the p.t.c. thermistor R2 in Fig. 1 is provided. There must be some sort of protection for the transistors against the high switch-on current. In Fig. 1 R2 is of very low value when cold so that only a very limited voltage is developed across it (and R1 in parallel) when the set is first switched on, but as the heater current stabilises so R2 warms up and increases in value substantially and at that time has virtually no shunting effect on the real load R1 thus ensuring that the transistor supply voltage is ultimately of the correct value.

The GEC/Sobell sets secure the same net result by an extra OA81 diode connected in series with the cathode of the field output valve and the load end of the heater chain. It is connected in such a way that prior to conduction of the field output valve (i.e. as it is warming up after the set is switched on) the cathode resistor of the valve appears in parallel with the heater chain load, thereby inhibiting voltage rise across the load due to the high heater current. When however the field output valve warms up and takes current, indicating that the heater chain current has also stabilised, the shunting effect on the load by the cathode resistor is removed as the diode is then reverse biased.

Some Bush/Murphy hybrid sets get the transistor supply from the cathode circuit of the field output valve direct, with stabilisation provided by an AC128 transistor as shown in Fig. 2. With the transistor conducting the cathode circuit of the field output valve consists of R1, R2 and the collector/emitter conduction of Tr1, this producing a potential of 12V at the emitter (due to the drop across R2 and the transistor).

The supplies are held constant by the transistor acting as a shunt stabiliser, its initial conduction, and hence the supply voltage obtained, being adjusted by the preset R4 and the feed resistor R5 fed from the h.t. line. The base samples the supply potential via R6, smoothed by C2, and as this varies so does the transistor conduction in a way to keep the supply constant.

Tuners

The majority of hybrid sets have transistors in the tuner and i.f. channel and also in the intercarrier sound channel. The latest single-standard (625-line

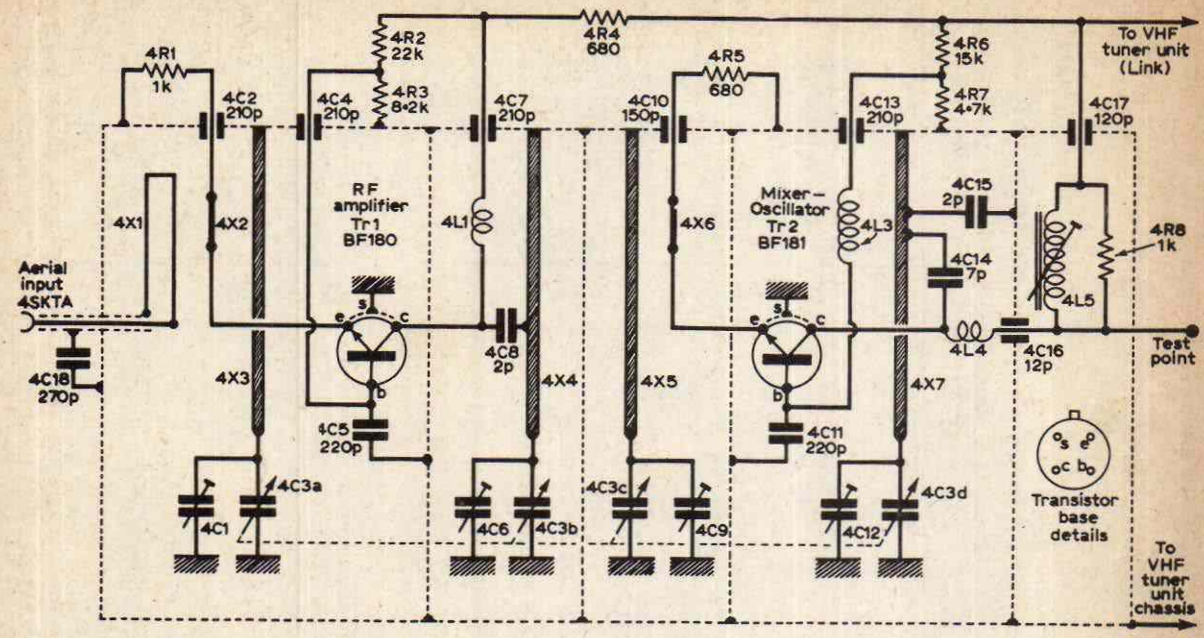


Fig. 3: U.H.F. tuner unit using silicon planar transistors and quarter-wave line tuned circuits.

only) sets of course have only a u.h.f. tuner, while quite a few of the dual-standard models employ an integrated or "all-channel" tuner working both on the v.h.f. and u.h.f. channels. Some earlier models have separate tuners for v.h.f. and u.h.f. The latest developments in the u.h.f. tuner are shown in the complete circuit in Fig. 3, from a Bush set. Here the first transistor is a low-noise r.f. amplifier and the second a self-oscillating frequency changer. Quarter-wave tuned lines or "cavities" are used at the r.f. input (at Tr1 emitter), at the r.f. output (Tr1 collector), at the mixer input (Tr2 emitter) and for local oscillator tuning (4 X 7). Bandpass coupling is secured between lines 4 X 4 and 4 X 5. Input matching to the 75-ohm coaxial line is provided by 4 X 1 and 4 X 2 in conjunction with 4 X 3, and the four major lines are tuned over Bands IV and V by a four-gang capacitor assembly (4C3). The four tuned sections are used to obtain adequate image rejection. The four transmissions which will eventually be available in each area in an 88MHz spectrum require an image rejection ratio of 53dB, which is the recommended figure. 4L5 is the i.f. coil and the output is fed to the v.h.f. tuner via 4C17 and the tuner link which also supplies power to the u.h.f. tuner.

Electronic Tuning

Variable capacitance diodes, often called varicaps, are already being used in European tuners instead of the gangs for tuning over the channels. These are also being investigated in the UK for television tuning (they are in common use on the v.h.f. radio channels) and it is likely that we shall shortly see, the first u.h.f. tuner with varicaps in British sets.

Any junction diode in reverse conduction exhibits a value of capacitance across its two terminals and the value depends on the amount of bias, decreasing as the reverse bias is increased. Varicaps take advantage of this effect and species have been tailored to give a swing of all the Band IV and Band V channels in conjunction with quarter-wave tuning lines. Figure 4 shows the first-stage circuits of a u.h.f. varicap tuner, where diodes D1, D2 and D3 replace capacitors 4C3a, b and c in Fig. 3. A similar diode is also incorporated in the local oscillator tuning circuit.

In each case the diode anode is connected to chassis and the cathode to the tuning line. A d.c. potential from R1 is applied via R2 to D1, via R3 to D2 and via R4 to D3. A similar feed is applied to the oscillator tuning diode. It will be seen that the potential is obtained from a 250V+ source stabilised by zener diode ZD1, R5, R6 and the negative temperature coefficient resistor R7, is taken via R8 and adjusted by the switched preset R9 or R10. The switches selecting R9 or R10 are the station selector switches.

The potential given by the slider setting of R9 or R10 thus reverse-biases all the diodes together and the selected preset is adjusted to give the capacitance necessary to tune the required station. This arrangement gives two-station selection and as will be appreciated it would be a very simple matter to arrange two additional presets to provide four-station selection for the UK system.

A major advantage of this electronic tuning is that the tuner can be located almost anywhere in the receiver without being tied to mechanical levers and couplings. A disadvantage—in the UK that is—which is now being overcome is that varicaps reflect a lower Q factor to the tuned lines, thereby impairing the selectivity somewhat and making it difficult to achieve the necessary 53dB rejection ratio.

It is essential for the control potential to be stabilised and the control circuit compensated for temperature change to avoid severe mistuning on changes of mains potential and/or temperature. The zener diode in Fig. 4 takes care of voltage variation while the thermistor looks after tempera-

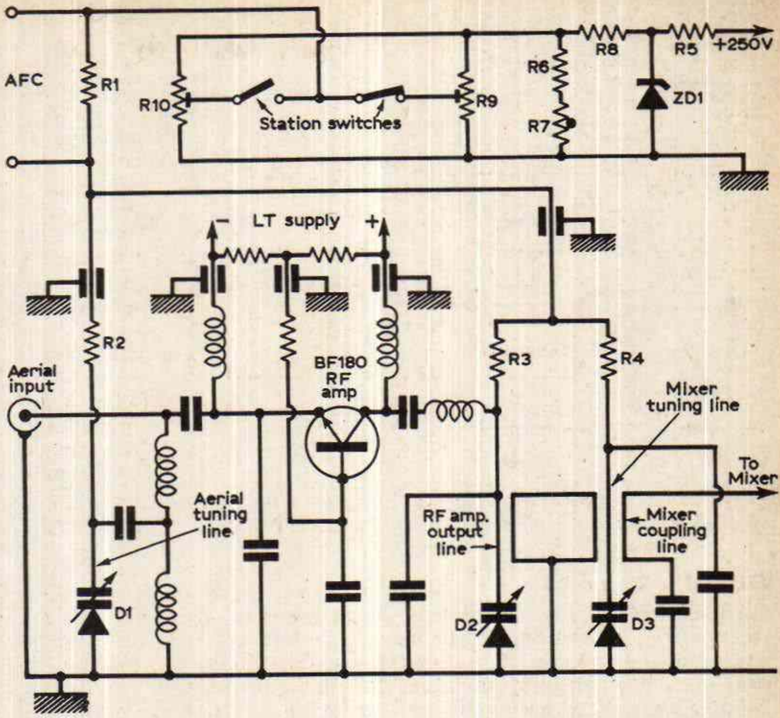


Fig. 4 (right): R.F. stage of a u.h.f. tuner using varicap tuning.

ture change, within the limits 250kHz tuning swing for a 10% mains voltage variation and 500kHz for a 20 deg. C temperature change.

Another advantage of the scheme lies in the relative ease of introducing automatic frequency correction (a.f.c.). The a.f.c. potential is obtained from a discriminator fed from a separate stage in the vision i.f. channel and is applied across the two terminals labelled a.f.c. in Fig. 4. The control thus acts on all the varicaps. The i.f. stage feeding the discriminator is given amplitude-limiting characteristics to prevent impulsive interference affecting the tuner, and both this stage and the discriminator transformer are tuned to the vision carrier (at i.f. of course).

To avoid chroma-sound beats (patterns on the picture) arising from user mistuning some colour sets with tuners using mechanical ganged capacitors—as distinct from varicaps—also employ a.f.c. This is applied solely to the local oscillator tuning, and the varicap is sometimes inductively coupled to the oscillator tuning line for ease of application.

Broadband UHF Preamplifier

Front-end amplifiers also come under the category of fairly recent developments and Fig. 5 shows such an amplifier using two transistors and quarter-wave tuning lines capable of providing a gain of at least 20dB over a whole group of u.h.f. channels. The response curve at (b) reveals that the bandwidth is some 110MHz between the −3dB points and that the response is virtually flat over 90MHz at full gain. Power requirement is 7mA at 15V, and properly designed the amplifier should be perfectly stable with the input and output open- or short-circuit.

Design is based on the Texas Instrument type 2N3570 planar transistor but it would be possible to use a similar kind of u.h.f. transistor such as the Texas 2N5180 which is an epitaxial silicon planar npn device. Readers interested in making a low-noise u.h.f. preamplifier of this kind should refer to the article entitled *Coaxial Resonators* which appeared in the June 1967 issue of PRACTICAL TELEVISION. This detailed the design parameters and characteristics of quarter-wave tuning lines, with notes on construction.

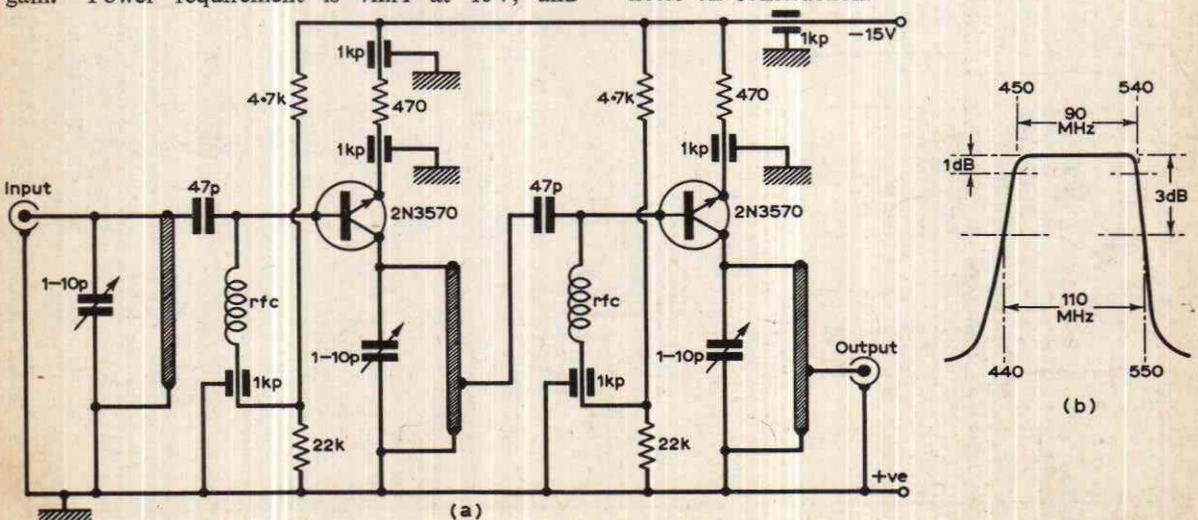


Fig. 5: Broadband u.h.f. preamplifier providing a midband gain of about 20dB. The circuit (a) is based on the use of quarter-wave lines. The frequency response is shown at (b).

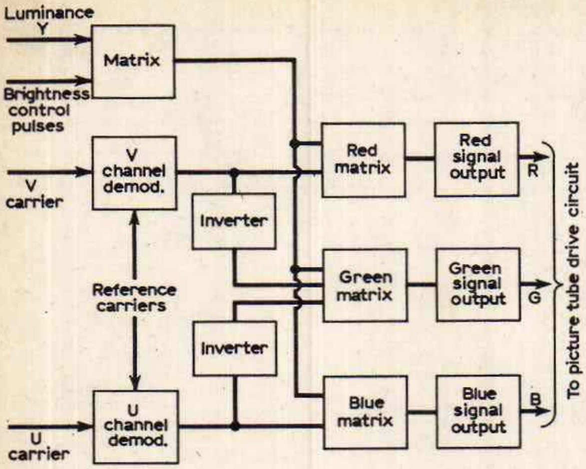


Fig. 6: Block diagram showing the functions carried out by the i.c. used in the latest Bush-Murphy colour chassis.

Advent of ICs in TV

Integrated circuits are already being featured in many items of domestic electronics, including portable radios (Roberts), f.m. tuners (Truvox), tuner-amplifiers (Fisher) and the like and it is already feasible to replace about 70 semiconductors in the small-power sections of contemporary colour sets. Indeed some colour models are already using i.c.s. Such a device in the Bush CTV174D gives the so-called "colour lock" while in the Murphy CV2210D the device gives what the makers call a "constant colour circuit".

This i.c. in Rank-Bush-Murphy sets consists of a multiplicity of transistors, diodes, resistors and capacitors formed by a photo/chemical process of etching on a very small silicon chip of only one-twentieth of an inch square. Even when it is encapsulated, rather like an over-sized transistor but with many more lead-out wires, it is not much bigger than a postage stamp and yet embodies the equivalent of 65 conventional components.

The i.c. operates between the chroma detectors and the red, green and blue drive stages to the colour picture tube as shown in Fig. 6. It will be seen that separate matrices are used to derive the red, green and blue signals and that each of these matrices also receives the luminance or Y signal. This technique gives rise to separate red, green and blue primary-colour signals which are fed through pre-amplifiers in the i.c. and subsequently drive separate amplifiers with very heavy negative feedback. These raise the primary-colour outputs from the i.c. to levels suitable for applying to the colour picture tube.

Mullard are also making i.c.s for domestic television sets—for further details see *Teletopics*, July 1969—and some of these are beginning to appear in the new single-standard chassis. An example is shown in Fig. 7. Here a TAA570 i.c. provides the 6MHz intercarrier i.f. amplification, sound demodulation (f.m. of course) and low-level a.f. amplification. As can be seen a separate intercarrier detector D1 is driven from the collector of the final vision i.f. amplifier, and this in turn feeds the i.c. via the tuned circuits L1, L2. A quadrature detector is used in the i.c., the tuned circuit L3 and associated capacitor providing the local quadrature signal. The demodulated and amplified output is *RC* coupled via C1 to the volume control the slider of which is taken to the grid of the triode section of a PCL86 audio amplifier/output valve.

An interesting feature of this circuit, used in the GEC 2047 and 2048, is the derivation of the l.t. supply for the transistor stages and i.c. from the line output stage. The l.t. rectifier D2 is fed from a tapping on the line output transformer and rectifies the scanning current, smoothing being provided by the filter C2, R1, C3.

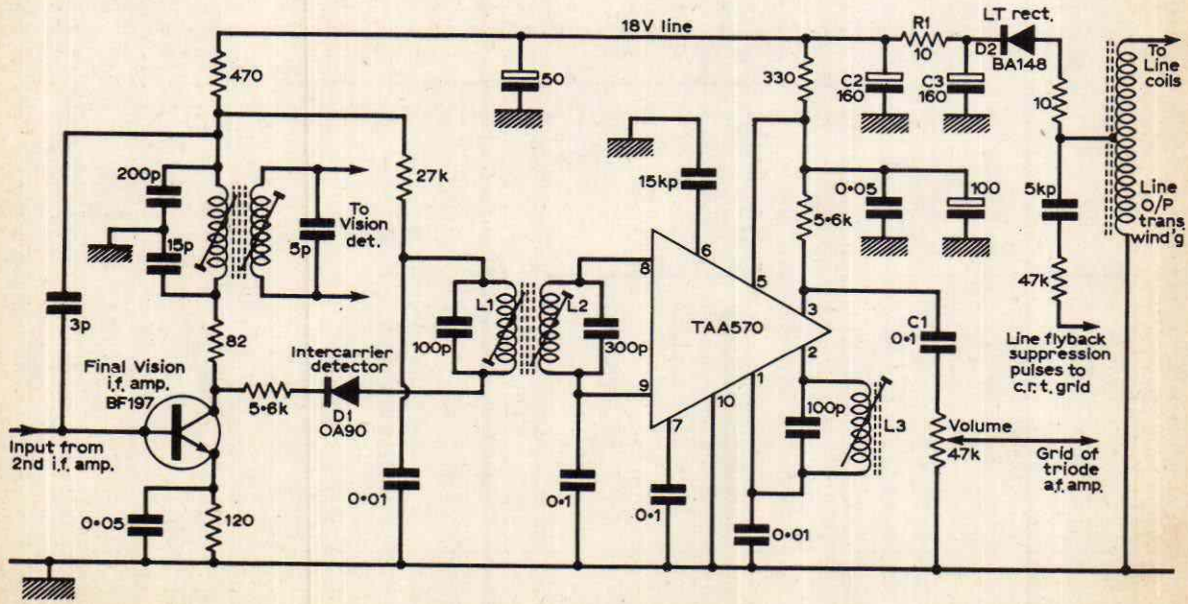


Fig. 7: Use of an i.c. to provide intercarrier i.f. amplification, demodulation and low-level a.f. amplification.

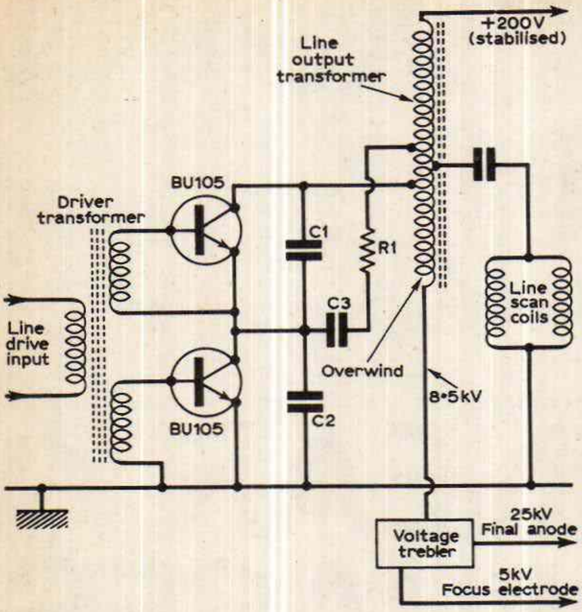


Fig. 8: Basic Mullard transistor line output circuit.

With the advent of single-standard working many designers have adopted a rather different approach to the design of the i.f. strip. This is to use an elaborate response-shaping filter at the input to the strip but to give the individual stages a broadband response. The individual stages are designed for high gain, high *LC* ratios are used, and heavy resistive damping is applied to broaden the response. This technique enables the effects of variations in component tolerances and transistor spreads to be overcome. Printed-circuit i.f. coils are sometimes used.

Transistor Line Output Circuit

Notwithstanding what has been said earlier about the all-transistor set Mullard have produced a line output transistor with a peak *V*c rating of 1·5kV and a peak current of 2·5A, type BU105. By employing a pair of these in the line output stage as shown in Fig. 8 it is possible to achieve the required high volt-ampere product for colour picture tubes and to obtain both the 5kV focus potential and the 25kV e.h.t. for the final anode, the latter by means of a voltage trebling circuit. With this arrangement—and indeed with any transistor line output stage—it is not possible to use the feedback technique common in valve sets to stabilise the e.h.t. and line scanning current. It will be recalled that a kind of a.g.c. is adopted in valve line output stages, sample pulses from the line output transformer being rectified by a voltage-dependent resistor element and the resultant d.c. potential applied to the control grid of the valve as a controlling bias. This method of stabilisation is only possible when the valve is arranged to operate above-the-knee of its anode current/anode voltage characteristic. Line output stages operating below-the-knee are effectively switched on and off by the line drive signal, and the same applies to transistors, so with these circuits it is necessary to stabilise the actual supply voltage. For this purpose, and also for providing a stabilised supply for the video stages in all-transistor sets, Mullard have recently introduced a thyristor h.t. unit.

One important consideration when using a pair of line output transistors as in Fig. 8 is to ensure that they are matched so that they share the flyback pulse equally between them. C1 and C2 tune the circuit and in combination with R1 and C3 which are returned to a centre-tap on the line output transformer primary winding act to avoid the inevitable mismatch between the transistors.

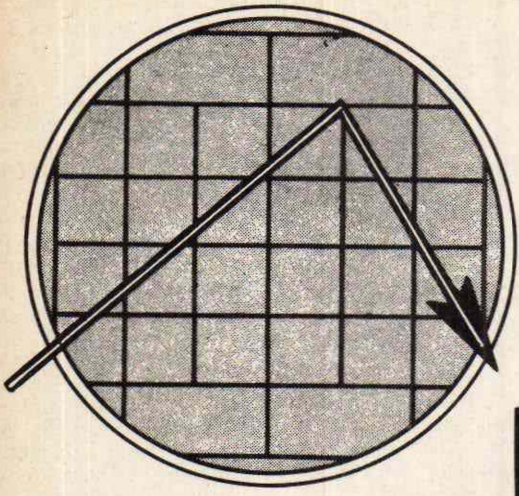
Miscellaneous Developments

A major hazard to the transistors and other semiconductors in all-transistor and hybrid sets is the flashover or transient energy which occurs at the tube cathode as the result of internal flashovers, and such happenings are not as uncommon as might be thought. The flashover current flowing through the tube can rise to a peak of some 700A for a very short period of time. This very heavy current can inject sympathetic currents into the chassis and associated wiring and thus produce high transient voltages across the semiconductor junctions, which can easily precipitate their failure.

There have recently been developments to afford significant protection against this hazard, especially so far as flashover in colour picture tubes is concerned, as the higher e.h.t. voltage makes these more vulnerable to flashover and because colour sets usually have more solid state components than monochrome ones (even so some of the latest monochrome tubes are equipped with comparable protective devices). The protection takes the form of sparkgaps and resistive feed circuits at the tube terminals. The sparkgaps liberate the discharge energy and pass it back to the external conductive coating of the tube via a low inductance link while the resistors serve to hold off any spurious energy from the electrode feed circuits. The net result is that almost all the transient energy is bypassed from the semiconductors.

Finally a word about recent picture tube developments. Tubes are now being made with built-in screen protection which apart from making a protective glass screen in front of the cabinet unnecessary allows the tube to project beyond the front of the cabinet, thereby presenting the biggest possible screen area to the viewer. The design is based on a metal reinforcing band round the screen flare, examples being the Mullard P-type tubes and Mazda Rimband and Rimguard tubes. It is of course most important not to replace these with unprotected types. Also the width-to-height dimensions of the screens of the latest tube types match the picture aspect ratio exactly making it possible to get a correctly "centred-up" Test Card which is not possible with the older style tubes.

On the colour side it is interesting to note that BRC now mount the Shadowmask tubes in their sets "blue down", i.e. with the blue gun at the bottom and the red and green ones at the top, the reverse of normal practice. This is done to reduce pin-cushion distortion, BRC not using pin-cushion correction on their sets. By mounting the tubes this way, and with the tube viewed from above the centre line as is normally the case, the electrical and optical distortion cancel. ■



LINEAR TIMEBASES Part 2

K. T. WILSON

LAST month basic timebase parameters, simple timebase circuits and bootstrap timebases were described. It is now time to look at the Miller timebase in its several forms.

The Miller Integrator

The bootstrap principle was developed in the USA for radar use while in this country the Miller integrator was being developed at the same time for the same purposes. To understand the principle of the Miller integrator, we must go back to the simple circuit shown in Fig. 3. The shape of the graph of voltage against time is exponential but if a very small portion only is taken the difference between that portion and a straight line is very small. If we are charging from a 300V line and use only the first 3V of the waveform then the linearity of the trace is almost perfect. To make use of such a small waveform we need an amplifier (Fig. 11) and what converts such an arrangement into a Miller integrator is to arrange negative feedback from the output of the amplifier back to the capacitor.

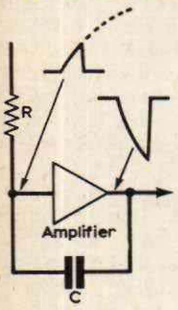


Fig. 11 (left): Amplifying a small portion of the charging voltage—this can be made more linear by negative feedback to the other side of the capacitor. This scheme is the basis of the Miller integrator.

Figure 12 shows a practical Miller integrator and its waveforms. In this type of circuit capacitor C *discharges* through the resistor R to provide the linear sweep. The resultant change of voltage is applied to the grid of the valve (V1B) whose anode is connected to the other plate of the capacitor thus providing the negative feedback. The operation of the integrator is as follows. In the rest position the switching valve V1A is conducting so that the anode of V1B is at line voltage. C charges via V1A and V1B grid current. When V1A is cut off by a negative pulse applied to its grid V1B anode voltage drops. This drop is communicated by C to V1B grid so that V1B is almost cut off. C then begins to discharge via R and R1, carrying V1B grid positive so that negative feedback starts, V1B anode voltage falling. C continues to discharge until the switch valve V1A turns on again or until grid current is drawn by V1B and its anode voltage bottoms. Thus at the end of the sweep, which is negative going at the anode of V1B, capacitor C is almost *discharged* and when the switch valve operates the capacitor charges again.

This arrangement of the Miller integrator, used extensively in much wartime radar equipment, showed many of the advantages and disadvantages of Miller integrator circuits. The linearity is excellent and a large amplitude of trace is obtainable. The circuit is fairly economical in components and the output is at low impedance so that other circuits can be driven easily. There is one main disadvantage, the voltage step at the start of the timebase.

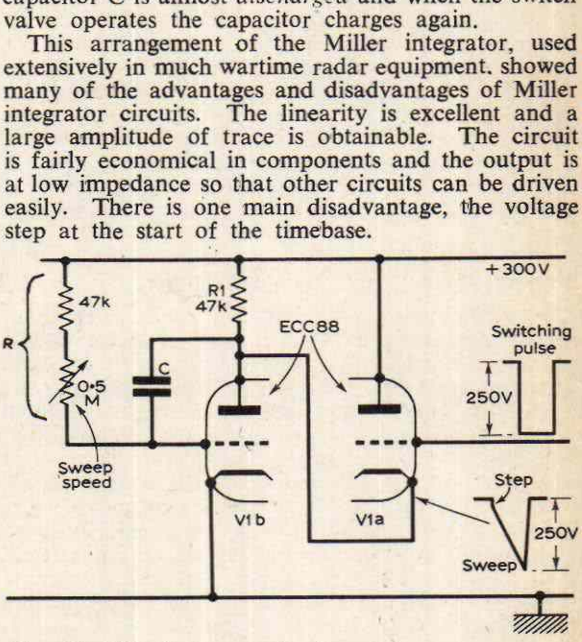


Fig. 12: Miller integrator circuit.

Like the bootstrap timebase, the Miller integrator has been greatly elaborated and developed so as to remove its disadvantages and extend its range of sweep to shorter periods of time. Many oscilloscopes use a Miller integrator in which a cathode-follower is used in the feedback circuit (Fig. 13) so that the anode of the Miller valve (V2) drives the low input capacitance of the cathode-follower (V1) and the low output impedance of the cathode-follower is used to drive the Miller capacitor C.

The step of voltage at the beginning of the sweep

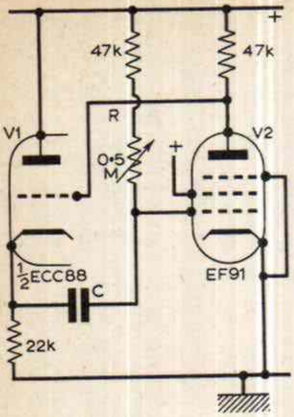


Fig. 13 (left): There are many elaborations on the basic Miller circuit. Here a cathode-follower is used between the anode of the integrator valve V2 and the charging capacitor C. Note the use of a pentode as the Miller valve—the greater gain of a pentode gives more feedback and thus better linearity.

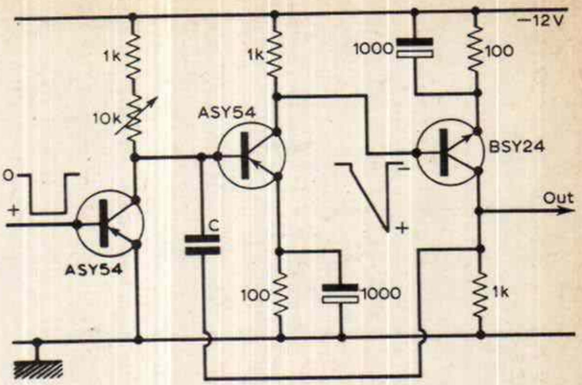


Fig. 16: Transistor Miller integrator, using a compound amplifier.

may be eliminated by gating this portion out with a diode or by switching the integrator at the grid instead of at the anode. The transfer of the switching to the grid means that the flyback becomes much slower, as the capacitor must recharge through the anode load of the Miller valve instead of through a switch unless a switch valve is included in the circuit to short out the anode load during flyback. A more elaborate Miller circuit of this type is shown in Fig. 14.

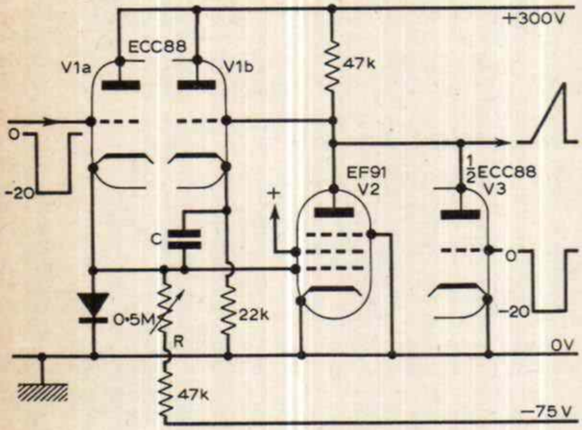


Fig. 14: A more elaborate Miller circuit. Note that the grid switching valve V1a and the flyback valve V3 are fed with the same switching waveform.

The switching of Miller integrators can be carried out particularly economically using a multigrid valve. For example a pentode with a short suppressor-grid base can be connected with the usual Miller capacitor between its anode and control grid and the switching waveform applied to its suppressor grid. When the suppressor grid of a pentode is negative with respect to its cathode the current is switched from the anode to the screen grid so that in the circuit shown in Fig. 15 the rest position is with the control grid drawing current, the screen grid bottomed and no current reaching the anode which is at line voltage. When the suppressor grid is switched on the flow of current to the anode causes a drop in anode voltage which reaches the grid through C and is enough almost to cut off the valve. The Miller linear sweep then takes place until the anode bottoms or until the suppressor grid is switched off again.

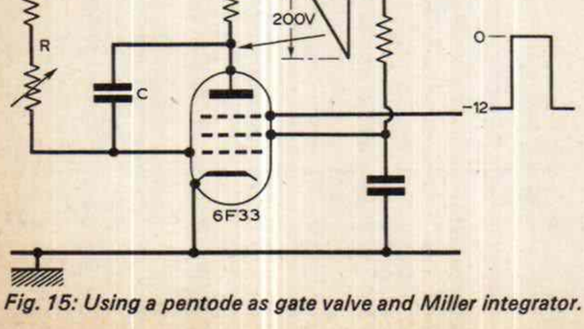


Fig. 15: Using a pentode as gate valve and Miller integrator.

Miller integrators are especially adaptable to transistorised designs because there are no restrictions on impedance as are found with the bootstrap. The greater the gain of the amplifier used the more linear is the output waveform and it is particularly easy with transistors to construct high-gain d.c. amplifiers. A cascade circuit is particularly suitable, and a Miller circuit using such an amplifier is shown in Fig. 16.

The Miller Transitron

Certainly the most popular timebase among amateur constructors of oscilloscopes in the past has been the Miller transitron shown in Fig. 17. This is an economical design but suffers from some severe drawbacks, notably changes of amplitude with frequency, slow flyback and difficulty of precise synchronisation when used free-running.

The action is as follows. Imagine the circuit in the state where the suppressor is cut-off so that all the cathode current flows to the screen which is consequently at low voltage. The control grid is drawing some grid current and the anode is at line voltage. Of all these voltages that at the suppressor grid is the only one which is not fixed since the suppressor is returned to earth via R2 and has been switched negative only by the capacitor (C2) connection to the screen. This capacitor now discharges so that the voltage on the suppressor grid rises exponentially. During this time there is no waveform at the anode. Eventually, due either to the rising voltage at the suppressor grid or to a sync pulse applied to it, the voltage at the suppressor grid will reach cut-on and anode current will start to flow. This has two effects. One is that less

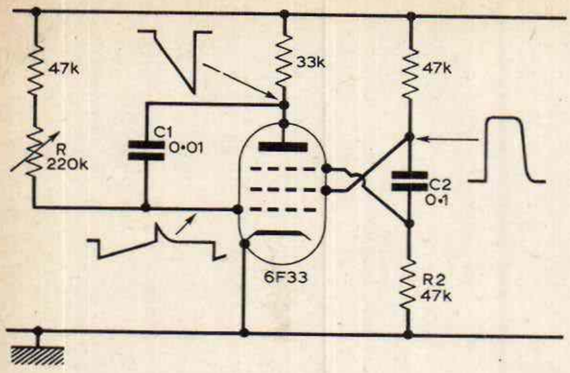


Fig. 17: The Miller transitron circuit.

current flows to the screen grid which rises in voltage and forces (by means of C2) the suppressor voltage higher and the other is that the anode voltage drops until the control grid (through C1) is close to cut-off and the Miller sweep begins.

The screen-suppressor grid action is the switching operation and it causes the screen and suppressor grid voltages to increase very rapidly until the suppressor grid is draining current and the screen grid is almost cut-off. The Miller sweep causes the anode voltage to decrease steadily, and eventually the anode voltage becomes so low that some current starts to flow to the screen grid which is at a much higher voltage. When this current causes the screen grid voltage to drop the switching action takes place again, with the suppressor grid being switched negative through C2 until the circuit is once again in its original state. The circuit can be modified for triggered operation by biasing the suppressor grid to cut-off and applying sync pulses to it, and a bright-up voltage for the grid of the c.r.t. can be obtained from the screen grid which is positive during the time of the sweep.

The choice of value of C2 is critical, and for wide ranges of sweep time it is preferable to switch C2 as well as C1, making C2=10×C1 in value.

Cathode-coupled Phantastron

This is a very old circuit which is still widely used. It is shown in Fig. 18. In the absence of a trigger pulse the control grid is drawing current, the screen grid is bottomed and the voltage at the cathode due to the current in R2 holds the suppressor grid negative to cathode so that the anode takes no current. The voltage at the anode is held fixed by the diode D1. When a positive-going trigger pulse is applied to the suppressor grid anode current flows starting the Miller sweep and reducing the amount of current flowing to the screen grid. Since the first step of the Miller sweep drives the control grid negative by means of C1 the cathode current is greatly reduced so that the suppressor grid holds the potential relative to cathode which it was given by the trigger pulse. At the end of the sweep the anode voltage is low, the grid starts taking current and the cathode current eventually rises sufficiently to cut the suppressor grid off again until the next trigger pulse is received.

This circuit, which is a direct-coupled (cathode-coupled) version of the Miller transitron, has been used with great success as a time-delay generator but is not so often found as an oscilloscope timebase. Sweep times of 0·1μsec or less are readily obtainable.

The odd name derives from the feelings of an RAF radar engineer who thought the working of the timebase "phantastic"! RAF slang also named the next timebase, whose performance was thought very clean or "sanitary". The sanatron uses a Miller integrator coupled to another valve which is used for switching. This is a timebase admirably suited for amateur constructors but which is seldom seen (Fig. 19).

Sanatron

The suppressor grid of the Miller valve V2 is normally held at cut-off by its connection to the negative line and because V1 is bottomed due to its control grid connection to the positive line. A negative trigger pulse at the suppressor grid of V1 shuts off current to the anode whose voltage rises rapidly, taking with it the voltage of V2 suppressor grid. This starts the Miller sweep in V2, and the drop in voltage at V2 anode is communicated via C1 to the control grid of V1 holding this valve cut-off after the trigger pulse has ceased. Providing C1 is greater than the charging capacitor C V1 will be held cut-off at the voltage limited by the zener diode Z1 until the anode of V2 has bottomed. When this happens V1 control grid is rapidly raised in voltage by the connection to the positive line and V1 conducts again, shutting off the suppressor grid of V2 and restoring the original conditions.

Automatic Triggering

Many timebases in modern oscilloscopes offer the facility of automatic triggering. When the timebase is switched to "auto" any waveform will give a steady synchronised display regardless of frequency; though of course the speed of the sweep will have to be adjusted so that a definite number of cycles of waveform can be seen.

In such circuits the trigger pulse, taken from an external socket or from the internal Y-amplifier, is amplified and applied to a multivibrator which normally free runs at a very low speed of between ten and twenty-five Hz.

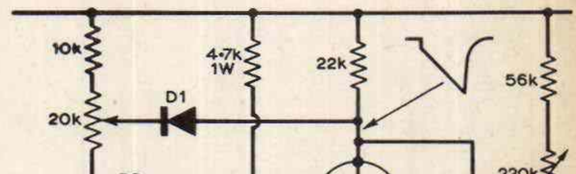


Fig. 18: The cathode-coupled phantastron (C-Phant) circuit. Note that this is a triggered circuit which gives one sweep for each trigger pulse received and does not free-run.

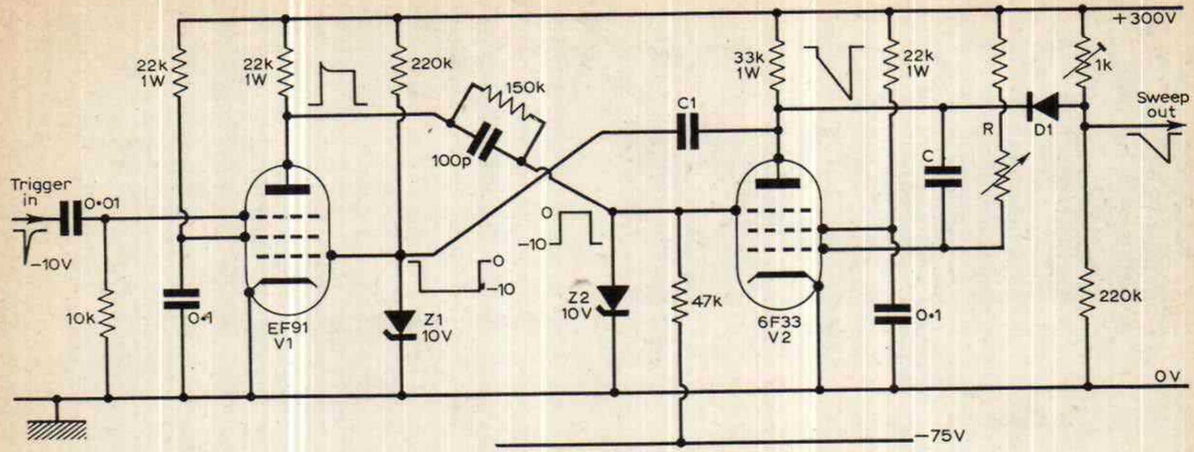


Fig. 19: The sanatron sweep circuit. Note the use of zener diodes Z1 and Z2 to prevent grid voltages rising above earth potential or below the zener voltage, in this case −10V. The clipping circuit at the output removes the step on the waveform, but has the effect of delaying the sweep relative to the trigger pulse.

The arrival of the trigger waveform forces this multivibrator to generate a squarewave which rises and falls in voltage in sympathy with the waveform received (Fig. 20). The edge of this squarewave is then used as the trigger for the timebase. Note that the squarewave itself cannot be integrated into a sweep waveform since this would only ever show one half cycle of a waveform. The use of the squarewave to trigger the timebase accurately enables us to show as many cycles or as small a portion as can be made visible and the lock is perfect due to the sharp pulse received from the multivibrator. Automatic circuitry of this type usually operates with input repetition rates up to 1MHz; at higher speeds the large time-constants of the multivibrator, necessary to ensure free-running at a low speed, prevent satisfactory operation. At such frequencies however it is usually easy to obtain a good trigger pulse from the input waveform itself.

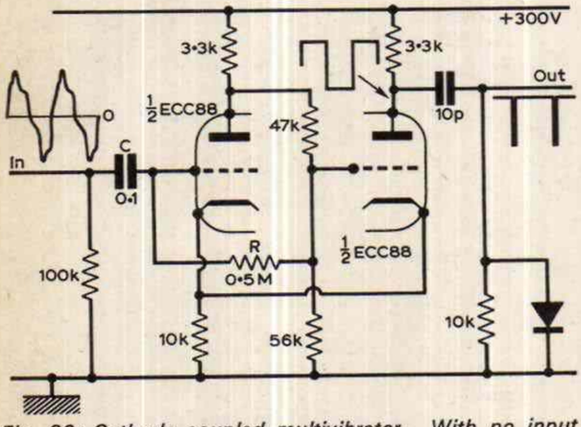


Fig. 20: Cathode-coupled multivibrator. With no input signal the circuit oscillates at a low frequency determined by the time-constant CR. With an input signal applied a squarewave is generated whose sides occur at the same time as the voltage of the applied waveform crosses the zero voltage line.

Non-scanning Uses of Timebases

Although timebases are always found associated with the scanning of cathode-ray tubes several other applications for timebases exist which are of considerable importance. In these other applications are also found many transistorised timebases which can be used at low-voltage levels; transistor timebases are not just now in general use in oscilloscopes because so many instrument tubes still require fairly high deflection voltages.

One very widespread use of timebases is for time delay. This circuit is triggered by a pulse and produces another trigger pulse after a time delay (usually 0·05 – 5μsec) which is adjustable and exact. The addition of a time delay to the triggering of an oscilloscope greatly increases the scope of its use. For example if a trace is being examined and the timebase is being triggered from the leading edge of the received waveform, then speeding up the timebase can only have the effect of presenting the first portion of the waveform. If, now, the trigger pulse to the timebase is increasingly delayed with respect to the leading edge of the waveform, the portion which can be seen on the oscilloscope will shift gradually over the whole waveform (providing the delay is sufficient). This facility was used in the old Solartron D300 oscilloscope, and in conjunction with the automatic timebase which used a scale-of-two counter to present a trigger pulse to the timebase on every second trigger this made for most effective operation. At the prices now current second-hand this superbly designed (both electrically *and* mechanically) instrument is a real bargain to the serious user. A study of the circuitry alone is an object lesson in good design.

Phantastron valve circuits have for a long time been very popular for time delays, as the step at each end of the sweep provides excellent timing marks; the last step can be amplified, differentiated and used as the output trigger. Transistorised time delays usually use Miller integrator circuits which at

—continued on page 164

Workshop HINTS

by VIVIAN CAPEL

SOME SIMPLE GADGETS

QUITE SIMPLE gadgets can sometimes be obtained or made up that result in saving of time and effort that are out of all proportion to the time originally spent in making them. It is true that some gadgets can be "white elephants", rarely if ever used after being made. The ones described here this month are those that have proved particularly useful and are in continual use.

Instability Chaser

Instability of either sound or vision circuits is quite a common fault especially with older receivers. In many cases the cause of the trouble can be traced to one of the decoupling capacitors in the i.f. circuits. Usually one of the screen decouplers is the culprit, the value being anywhere between 1000pF and 3000pF.

The most effective way of tracking down the defective capacitor is by bridging it with a replacement. It is important that the wires of the replacement are kept as short as possible, otherwise its efficiency as a decoupler bypassing high frequencies is impaired. Also if the component is held in the hand hand-capacitance will certainly have an effect. Thus the substitute should have its leads cut short and then be soldered into place. As there may be quite a number of decoupling capacitors, bridging each one in this manner will take some time as the set must be switched on and off again on each occasion.

The instability chaser here described does away with this and enables capacitors to be bridged quickly and easily without affecting performance and without the need for switching the receiver off and on. In essence it consists of a capacitor mounted on a tag strip which also forms the probe. This in turn is fixed to the end of an insulated handle

Fig. 1: Simple instability chaser.

(see Fig. 1). The two tags of the section of tag strip are cut to form points and the capacitor is soldered directly between them with the wires cut as short as possible. The handle may be formed by a length of Tufnol rod which has an internal screw thread at one end. Any convenient material could of course be used for this purpose.

In use the chaser is merely bridged across a suspected capacitor. The spacing between the pointed tags will in most cases be found to be just about right.

Replacing Decoupling Capacitors

When tackling any service job a supply of spares that are most likely to be needed should be at hand. There may be times though, particularly on outside service calls, when for one reason or another the exact spare needed is not available. Where a case of instability has been traced to an open-circuit decoupling capacitor and it is found that there is not one in the spares kit, there is a way around the problem.

It will be found that the majority of TV receivers include a number of r.f. bypass capacitors in the heater circuit. These are to prevent r.f. currents from entering the heater circuit and thereby being passed on from one stage to another. This provision is mainly preventive as it is not often that trouble arises from this source. Removing one of these capacitors then will in most cases have no bad effects. They are usually of the same type and values as the h.t. decouplers, so a capacitor can be removed from the heater circuit and used as a decoupler.

With most components the physical position of the replacement does not affect performance so that if some other position should prove more convenient it can be mounted there. This is not so with r.f. decoupling capacitors. Replacements should be mounted in the same position as the original, the wires kept as short as possible and particularly the earthing wire should be soldered to the same point. R.F. currents may well be flowing and circulating in the chassis and earthing to a different point could actually give a degree of coupling to some other circuit.

Sometimes it is found that replacing a decoupling capacitor brings an improvement but that some instability still remains. In such cases do not overlook the possibility of more than one decoupler being defective. It is not uncommon, especially with older sets, for two decoupling capacitors to be defective at the same time and replacing any one will not completely restore stability.

On some rare occasions it has been found that bridging the defective capacitor with the instability chaser has cured the instability and yet when a replacement has been permanently wired in traces of instability remain. Checking decouplers in other stages fails to bring to light any trouble there. Sometimes it has been found that the original capacitor was not wired in the most effective position, and experimenting, particularly with different earthing points, has produced a cure. Sometimes an additional capacitor is needed wired to a different earth point. It must be noted though that this is the exception, and that in general the original position and earthing point should be adhered to.

Fitting Awkward Screws

Introducing a screw into an awkward position on a chassis is one of the difficulties that the service engineer encounters from time to time. What is needed is a device to retain the screw firmly on the screwdriver blade until after it is fitted when the screwdriver can be detached easily. Various gadgets have been produced and tried over the years, some using a claw grip which holds the head of the screw from the outside. These are quite effective, but often take up too much room when trying to insert the screw in a confined space. The device here described grips the screw from inside the slot in the head and thus takes up no more room than a normal screwdriver. It has been in use for some years since it was first made and has proved invaluable.

First a normal screwdriver of fairly small blade width but with a long shank is needed. Next obtain a piece of tubing or a bush which forms a good fit over the shank of the screwdriver. As this will be subject to some wear a hard metal such as steel should be chosen in preference to brass or one of the softer metals.

Then grind or file the tube down on either side of one end leaving two prongs of metal remaining. For maximum effectiveness these prongs need care in shaping. They should be tapered so that they are wider at the base in order to give them extra strength, but they should not be pointed at the end. A small slot is now cut at the other end of the tube (Fig. 2(b).

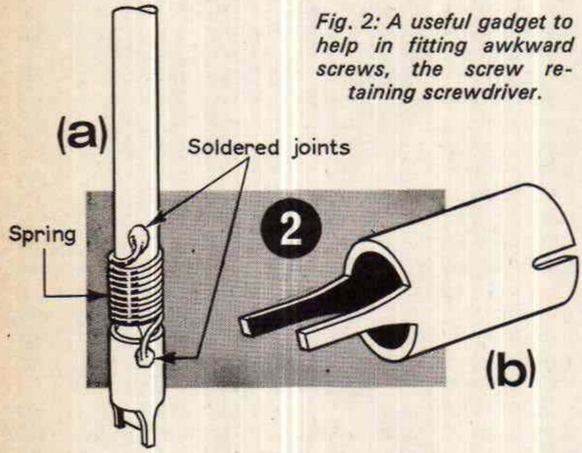


Fig. 2: A useful gadget to help in fitting awkward screws, the screw retaining screwdriver.

Finally a spiral spring which also makes a good fit over the shank of the screwdriver is fitted to it. The tube is positioned so that the prongs protrude slightly beyond the end of the screwdriver blade. One end of the spring is engaged in the slot at the other end of the tube and soldered in position, and the other end of the spring is soldered to the shank of the screwdriver (Fig. 2(a)).

To use, the tube is given a single turn in the direction which compresses the spring. This will shorten the spring and bring the end of the prongs to the same level as the screwdriver blade. Now the screw is fitted to the screwdriver blade and the tube released whereupon the prongs will grip the inside of the screw slot and hold it firmly. When the screw has been fitted the screwdriver can be pulled away and will disengage from the slot.

Although very effective for medium and large screws smaller types especially if of the round head variety may present some diffculty in engaging with the prongs. For these some alternative method must be found. One way is to use a magnetised screwdriver which is made thus by stroking several times along a permanent magnet such as used on a loudspeaker. These are obviously not effective with brass screws, which are in common use, and even on ferrous screws the screwdriver blade will not always stay in the slot and the screw tends to wander on the blade sometimes even ending up upside down. Really magnetic screwdrivers are more of a nuisance than a help.

The best alternative is to have a lump of wax handy (this can be very useful for other purposes as we shall see in future Workshop Hints). The head of the screw to be fixed can be scraped along the wax thereby filling in the slot. The screwdriver is then inserted in the slot and in the case of small screws the screw will be held in place. With larger screws the weight will be too great and the screw will drop off, but for these the special screw-retaining screwdriver can be used.

Tracing Brushing and Corona

Brushing or corona is not an easy thing to trace. The symptom, a jagged vertical white line usually but not always on the left-hand side of the picture, may be very pronounced or it may be merely a background trace. Sometimes it is not visible on a strong signal at all and can only be seen when the tuner is switched to a channel not normally received in the area. The source can be anywhere where there are high pulse voltages at line frequency. This includes the line output transformer, line output valve and e.h.t. rectifier, width and linearity coils, scanning coils and sometimes the high-voltage ceramic capacitors that are associated with the line output transformer. A discharge can sometimes be seen as a faint blue glow at the point of origin but this needs darkness for successful observation. An easier method of detection is aurally rather than visually.

The sound produced by corona discharge is high pitched, as would be expected at line frequency, and quite faint. This means that it is only audible with normal hearing a few inches from the source, an advantage when trying to identify the source. But putting one's ear a few inches away from pulse-voltage sources is not to be recommended! The same results can however be obtained by using a toy stethoscope. These can often be obtained from a local toy shop and the only drawback is that the probe tube is rather short. A new length of tubing can easily be obtained and fitted to make a very useful workshop test instrument.

Of course similar results could be obtained by just using a single length of tubing; but this would have to be held in the ear with one hand while the other ear would need to be blocked from extraneous workshop sounds. Yet another hand would be needed to explore with the other end of the tube, so a single tube is not very convenient to use! The stethoscope by fitting both ears cuts out workshop sounds and leaves one hand free. When using all likely sources should be explored by holding the stethoscope probe an inch or two away. When located the sound will leave no doubt as to the origin of the trouble.

TO BE CONTINUED

TRANSISTORS IN TIMEBASES

PART 5 LINE DRIVER STAGES

H. W. HELLYER

THE LINE driver stage is a phenomenon peculiar to transistorised television receivers. With valved design it is easy enough to generate a pulse and apply to the grid of an output stage quite enough voltage to drive it. Transistorised output stages as we have already discussed need more attention to timing and drive pulse waveform, triggering and isolation from the oscillator. Thus there are some special requirements of the line driver design. Again I am indebted to Mullard for information on the line driver circuits used in their single-standard colour television chassis, which is a good example to study.

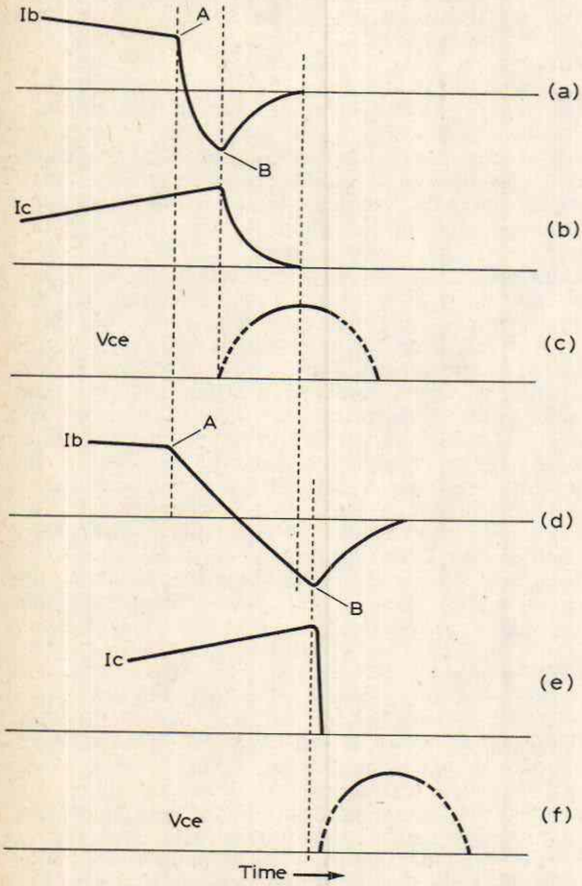


Fig. 1: Incorrect output transistor base drive (a-c) with turn-off (base current) between A and B too fast, producing a tail in the collector current and increased dissipation. Correct turn-off (d-f) with greater delay from A to B and slow turn-off base current.

In the last part (see PRACTICAL TELEVISION, November 1969) we showed the line oscillator and driver circuits used in this design so let's return to the point where we left off and tackle the problem of *why* we need to be so careful with the driver stage.

SWITCHING OFF THE BU105

The reason in a nutshell is that the output transistors have to be kept well and truly bottomed during the line scan and their collector current must fall rapidly during the flyback period in order to keep the collector dissipation down. Not only is the amount of drive current important, the pulse timing is also very important. This is because there is a finite time between the application of the switch-off pulse to the base and the moment when the actual turn-off of the collector current commences. This delay is due to minority carrier storage—electron storage in the case of npn transistors such as the BU105—near the collector junction. With too fast a turn-off pulse the emitter junction will be reverse biased while the collector junction is still storing carriers. In Fig. 1(a) we see the base current with a fast turn-off pulse applied, i.e. the steep slope between points A and B along the time scale. Because of the charge storage in high-voltage transistors a tail is produced in the collector current waveform, see Fig. 1(b), and this will result in high collector dissipation during flyback.

The solution is to make the base A-B slope less steep, i.e. slow down the turn-off pulse. This will then allow the collector current to fall smoothly to zero with good switching speed—the Mullard BU105 line output transistor having this virtue. Fig. 1(d-f) shows the difference.

Fitting an inductor in series with each base of the output pair is the answer to the problem of obtaining the required base waveform on switch-off. The value of the inductor is chosen to give a delay time larger than the storage time of the transistors and is chosen to suit the collector current to be turned off as well as the reverse base-emitter voltage. For the circuit shown in Fig. 2 the reverse base-emitter voltage should be greater than 4V.

TURNING ON THE BU105

With this voltage fixed by the turn-off requirements, the forward voltage available at the secondary winding of the driver transformer to turn on the

BU105 will be fixed by this reverse voltage and the mark-space ratio of the drive waveform. The necessary forward base current is obtained and variations due to transistor tolerances reduced by insertion of a series limiting resistor in each output transistor base circuit. To adjust for differences in storage time between the two series output transistors one of the base inductors is made variable. But the most important thing we need consider here is the determination of that A-B slope, i.e. the timing of the base drive pulse.

The best way to work it out is to consider the maximum and minimum on periods of the driver transistor, which is something over which we have definite control. The minimum on time is the flyback time plus maximum output transistor collector current delay time which, when it is correctly driven, is 8μsec with a ±2μsec tolerance. Thus the worst case is 10μsec and the flyback time, allowing a 5% tolerance for component variations, we can call 11·5μsec. The total minimum on time is thus 21·5μsec. The maximum on time is sum of the minimum flyback time, the minimum output transistor collector current delay time and the minimum "efficiency diode" time (the time before the output transistor collector current waveform swings positively). This works out to 10·5+6+16=32·5μsec. Taking the mean of these two limits we get 27·5±5μsec for the driver stage on time. Actually the on time can be kept to a closer tolerance than this; ±2μsec is more likely in practice. This ensures that the forward bias is not applied to the BU105 before the end of the flyback period but is applied before the BU105 collector current waveform becomes positive.

BASE SWITCH-OFF PATH

There is one more point about the base circuit of the BU105 which though not directly associated with the driver needs explanation. This is the 10Ω resistor and 1,000pF capacitor between the base and emitter. Their purpose is to provide a low-impedance path when the BU105 is switched off. The necessity for this, which is also the reason why the driver is conducting when the output stage is cut-off and vice-versa, i.e. operates in the non-simultaneous mode, is tied up with two more factors, prevention of ringing and protection against transients. Ringing is damped during flyback by the resistor and the base-emitter junction is protected by the capacitor against flashover which could appear at the collector and be transmitted to the base via the reverse-biased base-collector junction self-capacitance.

DRIVER CIRCUIT

So we get a driver circuit which looks simple, as shown in Fig. 2, but is in fact worked out to very careful switching limits, with a transformer that has to be arranged for the non-simultaneous mode and whose turns ratio is chosen to give the right (at least −4V) voltage at the BU105 base when the current is zero. Across the primary winding we find more damping components and the transformer itself, small and "ordinary" though it may look, is closely specified. A Ferroxcube cup-core type with a large cross-sectional area is recommended. The two secondary windings are wound side by side with a space between them to get the required

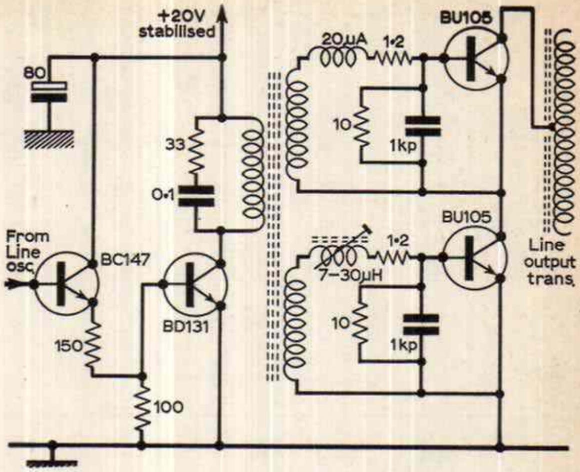


Fig. 2: Mullard low-voltage driver circuit.

1,500V voltage insulation and keep the leakage inductance equal.

Because of the inductive load formed by the leakage inductance of the driver transformer and that of the output transistor base inductors, the driver transistor must withstand a higher voltage than is simply determined by the transformer turns ratio and the load impedance. The values of the *R* and *C* damping components across the primary are chosen for a compromise between optimum reduction of peak voltage without seriously affecting the BU105 current waveform.

One more small point about drivers. We showed both the high- and low-voltage circuits last time (Fig. 1, Part 4). In the high-voltage version the driver was driven directly by the oscillator but in the low-voltage version, see Fig. 2 this month, an emitter-follower is necessary to provide the base current of about 90mA which is needed to bottom the BD131 driver transistor. This is a fast transistor with a low bottoming voltage, hence the collector dissipation is quite small.

PHILIPS AND SONY CIRCUITS

Another low-voltage driver circuit, but with a rather "old-fashioned" look about it, using a transistor that may be more familiar to us as part of a portable radio is the line driver of the Philips T-Vette portable television receiver shown in Fig. 3. The trick is the coupling between the oscillator and driver, so arranged that they conduct together, whereas the driver-to-output section is in the non-simultaneous mode that we have just examined. Again we see a damping network across the output transformer of the driver, limiting the collector current. The three waveforms of Fig. 3, taken with an oscilloscope (using a high-impedance probe and timebase set to line frequency) at points A, B and C of this driver circuit are interesting.

We have discussed the Sony Model TV9-306UB as an example of complete transistorisation that occurred early in the history of the art and include here the driver circuit (Fig. 4) which is not at all conventional. The dual-standard switching is shown in the 625-line mode, with the 0·15μF

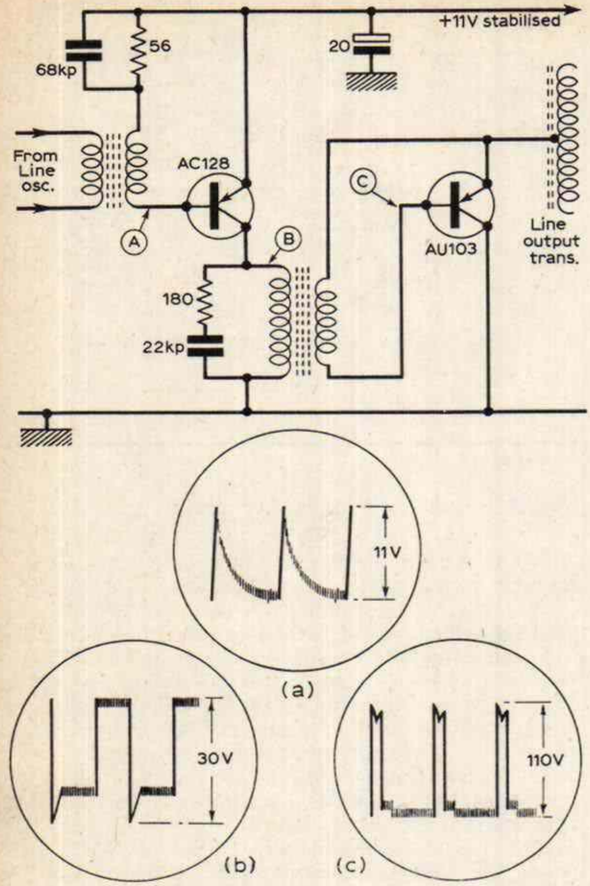


Fig. 3: Circuit of the Philips T-Vette line driver stage and waveforms.

capacitor disconnected from the primary of the driver transformer, increasing its resonant frequency, and the drive limited by the inclusion of a series resistor. This resistor is selected for optimum conditions and can be anything between 1 and 18Ω.

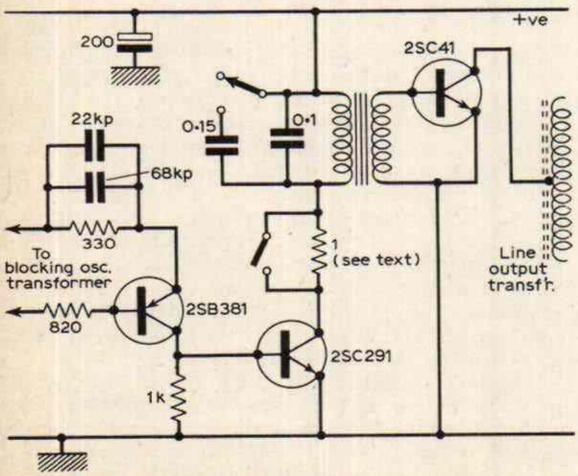


Fig. 4: Driver and line output coupling circuit used in the Sony portable Model TV9–306UB.

Selection is made by checking collector current (in the 625-line mode) with a 100mA meter in the collector lead. The current should be 85mA with a tolerance of only 5mA either way. In practice, however, I have never yet had to alter the value of the resistor as fitted (even though it has been necessary several times to upset line section conditions with the replacement of a damaged line output transistor). More important is the check on pulse width by scoping the output from the line oscillator with its base load coil shorted (L1, Fig. 8, Part 3 in this series) to obtain a pulse width of between 12·5 and 13·5μsec.

In the next part we shall take a look at the use of thyristor stabilised supplies and e.h.t. regulation and the distinctive Mullard way of controlling and stabilising power supplies. Thyristors are still a big mystery to too many engineers whose "acceptance threshold" stopped short when silicon diode rectifiers were introduced. Please don't tell me I am old-fashioned or cynical: I have worked with too many hidebound technicians who will go on the way they always have done and refuse to study the theory of their subject as it progresses. They will continue to exist so long as industry offers better prospects than the retail servicing business.

TO BE CONTINUED

LINEAR TIMEBASES

—continued from page 159

the end of their sweep trigger a Schmitt circuit.

Another use for timebases is the conversion of analogue information into digital—for example in a digital voltmeter. When d.c. voltages are being measured the timebase runs at a slow rate and the start of the timebase sweep also opens a gate which allows clock pulses (narrow pulses at high frequency) to pass to the counter. The voltage being measured is used (by way of isolating or amplifying stages) to bias a diode whose other connection is to the timebase. When the timebase amplitude equals the measured voltage the diode conducts and the conducted voltage is used to shut off the gate. A transistor may be used instead of the diode.

Timebases seem to have settled into a pattern yet the introduction of m.o.s.f.e.t.s has given the bootstrap timebase a new lease of life. This is a field in which the amateur with some time to spare can still invent new and worthwhile circuits and in which there are still some little-known lines of work. For example the circuit of Fig. 21 should in theory give a perfect sawtooth from a squarewave input.

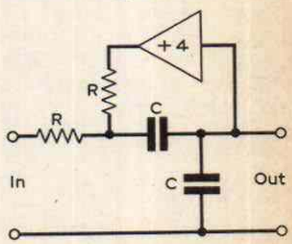
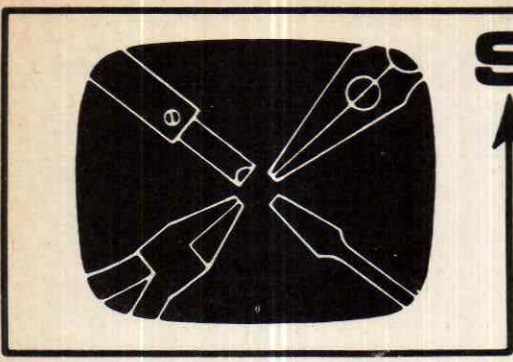


Fig. 21.

The amplifier has a gain of exactly four times, easily ensured by negative feedback, and is non-inverting (for example a long-tailed pair). By the look of it the amplifier should have high input impedance and low output impedance, and the squarewave drive to R should be from a low impedance. As far as I know no one has ever made a timebase on this principle despite its advantage. ■



SERVICING television receivers

L. LAWRY-JOHNS

THORN 1400 CHASSIS—continued

Field Timebase

The PCL85, used as the field oscillator-output valve, can contribute its own quota of troubles with no help from any other source. These include loss of height, bottom compression, bottom fold-up and loss of field hold. The bottom fold-up occurs when the PCL85 develops grid-cathode leakage which cancels the standing grid bias from the heater line. A collapsed field scan (just a white line across the screen) should direct attention to the PCL85 valve and then to the boost line where C104 usually shorts to chassis (see points to note at the beginning of this epic). Lack of voltage at C104 would of course direct attention to the capacitor before the valve if voltage readings are taken as they should be.

There are occasions when the boost voltage is present at the height control (or C104) and the PCL85 is not at fault. It is then that the voltmeter is to be used in a logical manner. First take a reading at pin 7 of the PCL85 valvebase: this should be a little over 200V. If there is no voltage here there will not be any at pin 6 and the fault is in the supply from R135, 1·5kΩ, which is the centre section of the dropper. This section can become open circuit with no other component failure to cause it.

If however there is a voltage of well over 200V at pin 7 but not at pin 6 it is fair to suspect that the field output transformer T3 has an open-circuit primary winding.

If there is voltage at both pins 6 and 7 check the bias voltage at pin 9 and apply a hum test here to see if the scan opens up. If it does the fault is earlier, probably in the triode section. If it doesn't check C99 and the continuity of the deflection coils, X1 etc.

If the fault appears to be in the triode section it is worthwhile to note the effect of shorting the vertical hold control to chassis as this can become open-circuit. Capacitors to check here are C92, C87 and C90. C93 is more likely to become leaky and

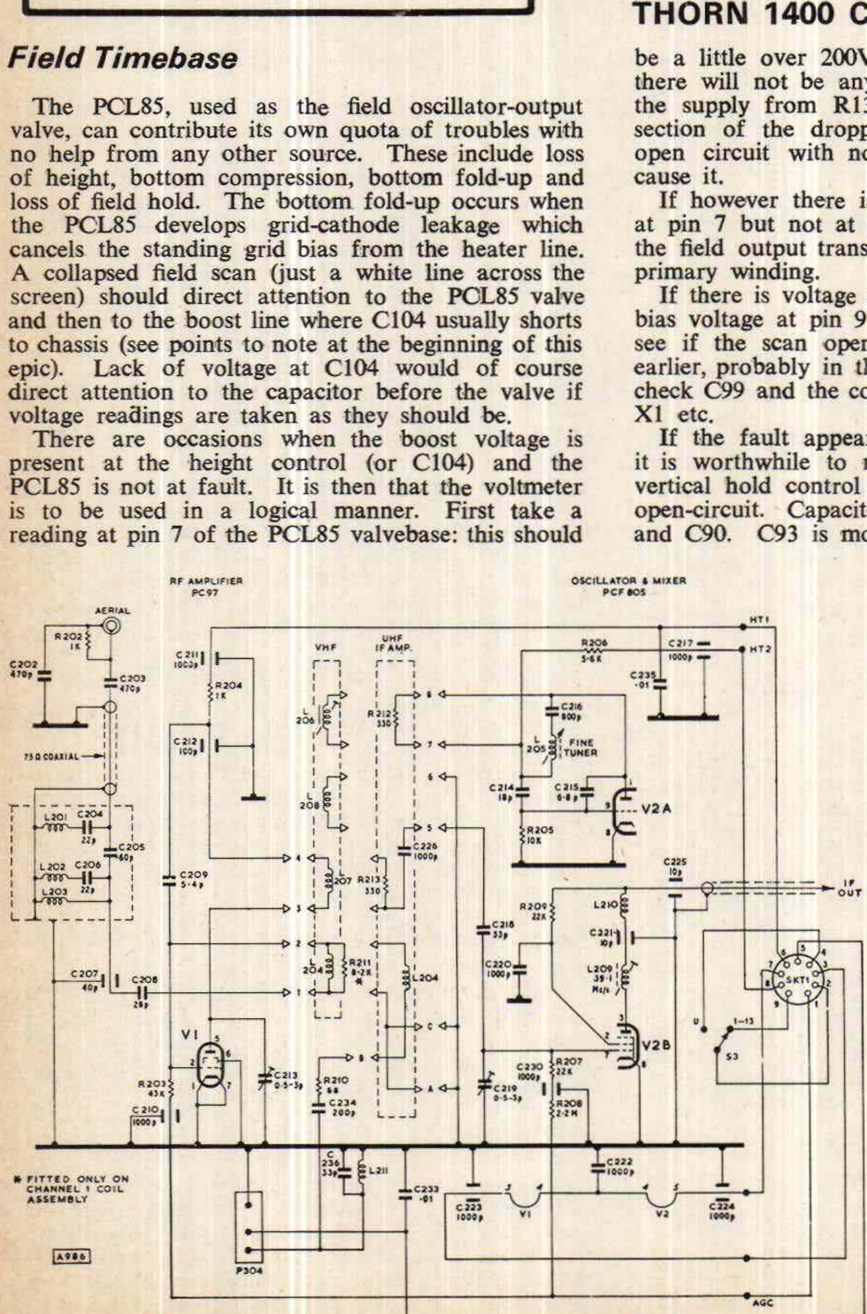


Fig. 3 (left): Circuit of the Type 1516 v.h.f. tuner unit used with the Thorn/BRC 1400 chassis.

MODELS FITTED WITH THE THORN/BRC 1400 CHASSIS

Baird
8691 and 8693

Ferguson
3645, 3646 3647, 3652, 3653, 3654, 3655, 3658, 3659, 3660 and 3661

HMV
2639, 2645, 2646, 2647, 2648, 2649, 2650, 2659, 2660, 2661 and 2662

Marconiphone
4623, 4624, 4626, 4649, 4659 and 4661

Ultra
6648, 6649, 6652, 6654, 6656, 6657, 6658, 6659 and 6661

VOLTAGE DATA

The voltages given in the table below were measured with 240V a.c. mains input, no signal, contrast controls and local/distant control (R11) at maximum, using an Avo Model 8 (20,000 Ω/V). HT1 is 200V, HT2 225V and HT3 215V (both systems). E.H.T. measured with an electrostatic meter approximately 20kV. Voltage at P1 pin 5 12V (u.h.f. tuner line), pin 6 125V (405) and 135V (625), pin 8 130V (405) and 0V (625).

Valve		*Anode volts*		*Screen volts*		*Cathode volts*	
		405	625	405	625	405	625
V3	6F29 (EF183)	185	185	45	45	—	—
V4A	30FL14 (PCF808)	130	130	160	160	2	2
V4B		60	100	—	—	10	8·5
V5	6F28	115	115	170	170	2·5	2·5
V6A	30FL1	80	90	—	—	—	—
V6B		150	140	—	—	—	—
V7	6F30 (EF184)	195	195	60	30	—	—
V8A	30PL1	16	18	—	—	—	—
V8B		175	175	180	180	9	9
V9A	PCL85	150	140	—	—	—	—
V9B		205	205	215	215	—	—
V10	PL500	—	—	200	200	—	—

cause the picture to fold up at the bottom as the bias is cancelled.

No sound, picture in order

Apply hum test to pin 2 of V8, 30PL1. If there is no response—with the volume fully up of course—apply test to pin 9. If no response check the valve and the valvebase voltages. If there is a hum from pin 9 but not pin 2 check R92 and C78.

If the sound is distorted on strong signals check R91 or bridge it with a resistor of near value. Distortion under all conditions can be due to a faulty 30PL1 or a leaky coupling capacitor (C80).

If the no-sound condition is not due to a faulty audio stage check that all channels are affected and check V7 and associated components, particularly C60 and R77.

No vision signal, sound in order

This assumes that a raster of normal size can be resolved when the brilliance is advanced but that no picture can be displayed. The fact that the sound is in order means that the tuner and the V3 stages are functioning and that the fault is therefore almost certainly in the V4 (30FL14-PCF808) or V5 (6F28) stages. A check on the valves, valvebase voltages, continuity of coils etc. should quickly reveal the cause of the trouble.

Poor sync, particularly on 625

Check R38 (39kΩ) also C34 (0·15μF). If these are in order check R45 (47kΩ) and C40 (0·1μF). In most cases the field timebase will be mainly affected making the setting of the vertical hold control very critical.

No signals, raster in order

If there are no sound or vision signals on either standard, 405 or 625, the fault should be looked for in the V3 (EF183-6F29) or the v.h.f. tuner unit stages. We could include in this the symptom of weak signals if both standards are affected. Check the EF183 valve and the voltages to pins 7 and 8. It may well be found that R14 has risen in value: this 39kΩ resistor is liable to do this or it can be damaged if C10 shorts to chassis.

If the V3 stage appears to be functioning properly attention should be directed to the tuner unit. The i.f. output cable of the v.h.f. tuner is inclined to bend at an acute angle at the point of connection to the tuner and can give trouble either by shorting to core, which upsets R8 and R9, or by becoming open-circuit—perhaps intermittently. Check the PCF805 and the resistors and coils associated with this valve. Trouble in the PC97 stage will affect v.h.f. only and trouble in the u.h.f. tuner will affect u.h.f. only. The three-pin plug at its connection to the three-pin socket on the rear of the v.h.f. tuner can give intermittent reception on u.h.f.

Variation of tuning on VHF

This implies that the tuning is continuously varying each time the channel selector is operated, the fine tuner appearing to operate at times and at others to be ineffective. The usual cause of this trouble is either that the fine tuner lever is not operating the wire which goes through to the core or that the metal sleeve on the core is loose and is not following the movement of the core.

Removal of VHF tuner

Whilst the mounting may vary in different models the fixing is the same. The front knobs pull off to expose a single screw. When this screw is removed the tuner can be unlatched from the mounting flange on the opposite side to the screw.

UHF tuner

This may be of the rotary type or push-button. Servicing should be restricted to the bare minimum. Check resistors if necessary but leave the inside alone. The tuner should be returned to the nearest makers servicing depot should any trouble develop inside it.

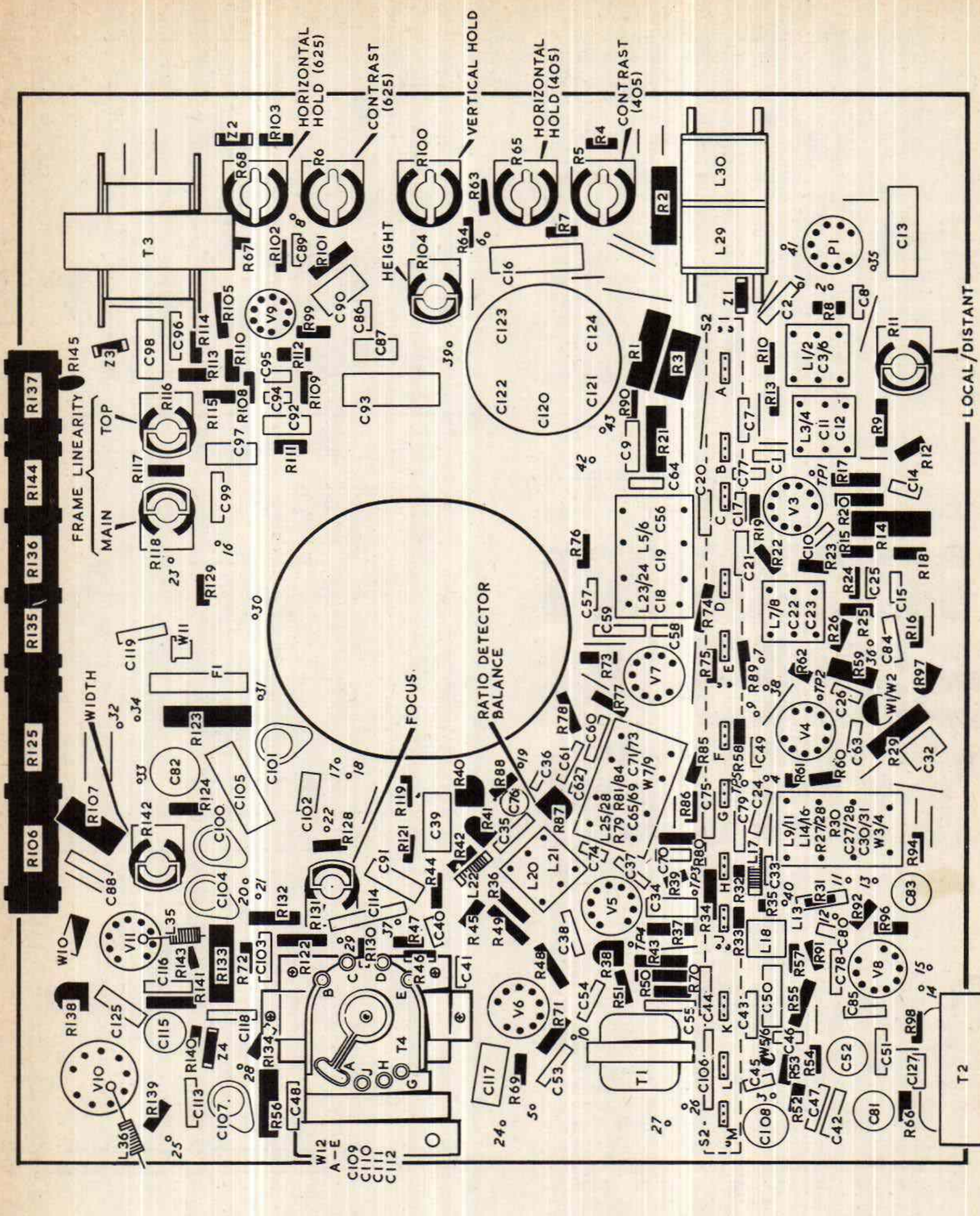


Fig. 4: Layout of the main chassis assembly.

The printed panel

Almost all printed panels can be subject to fractured tracks, which can usually be traced with a meter, and dry-joints, which can sometimes be seen to be dry, both defects being more quickly located by movement of the panel or suspect components. The appearance of these defects does not follow any regular pattern on the 1400 chassis; not so far!

Modifications

The circuit diagram shown last month is for schedule C chassis. In some schedule A chassis a 1,000pF capacitor is fitted across the mains input and also across the brightness control. R90 and tags 43 and 44 were added on schedule B chassis to provide for 625-line v.h.f. working. Fusible resistor

—continued on page 170

A CONSTRUCTOR'S 625-LINE RECEIVER

DAVID ROBINSON

MY interest in 625-line conversion was first sparked off by an article in the September 1966 issue of PRACTICAL TELEVISION which described modifying the original i.f. strip of a 405-line receiver for 625. I decided, however, to take the easy way out and purchased a u.h.f. tuner—actually an integrated u.h.f./v.h.f. type—and commercial i.f. amplifier panel—of the type intended for converting the Thorn/BRC 850 convertible chassis—from Manor Supplies. The total cost of these items at the time was about £4.

I connected these to my Alba T655 receiver and obtained reasonable results, but it was clear that the original timebases were not going to prove satisfactory. Field linearity was poor, as was interlace, and the original direct line sync was far from adequate. I therefore decided to build my own timebases. The result has given me a 17in. 625-line receiver at very modest cost.

Line timebase

In the final circuit there is only one section of the original set left, the line output stage. This is unmodified except for the value of the S-correction capacitor C75. The flywheel sync and line oscillator sections (V8, V9) were adapted from a Decca circuit and have two important features: first a reference pulse from the line output transformer is not required, making it ideal for adding to almost any set using direct sync, and secondly it has a very wide pull-in range so that the line-hold control can be used to "phase" the picture within the raster to remove the slight foldover on the left of the screen which is characteristic of almost all 405-625 conversions. A further advantage of the circuit is that it uses no inductors. The triode section of V8 acts as a pulse amplifier feeding the screen grid of the coincidence detector pentode section to the control grid of which is applied the reference waveform from the multivibrator V9.

Field timebase

The field timebase is of the self-oscillating type and was adapted from the Bush TV135 circuit. Linearity is very satisfactory. A thermistor in series with the scan coils stabilises the height but cannot be used with the original field output transformer without a serious effect on linearity. Selection of another transformer (used on the Ferguson 636T) from the spares box solved this. The self-oscillating type of field timebase has the disadvantage that interlace is affected by feedback of line pulses into the oscillator via the scan coils. This is not too serious on a 17-in. screen on 625 but to obtain really good interlace other readers are recommended to use the type of field timebase in which the multivibrator is separate from the output stage.

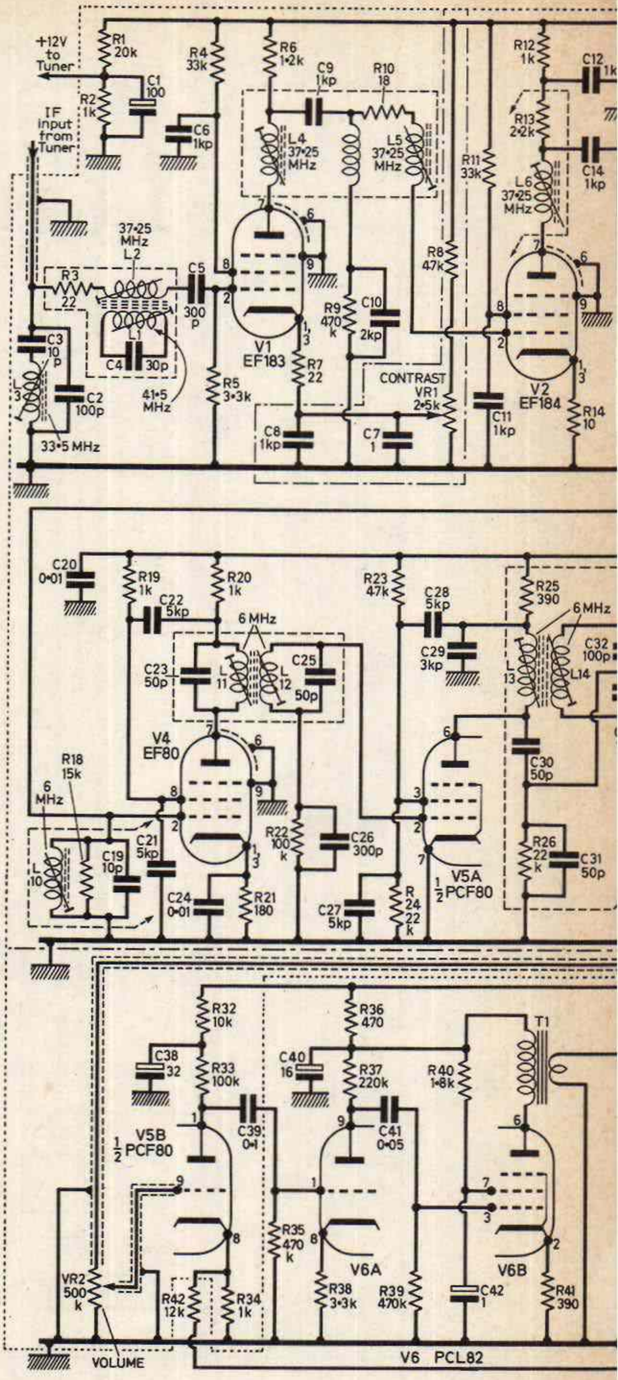
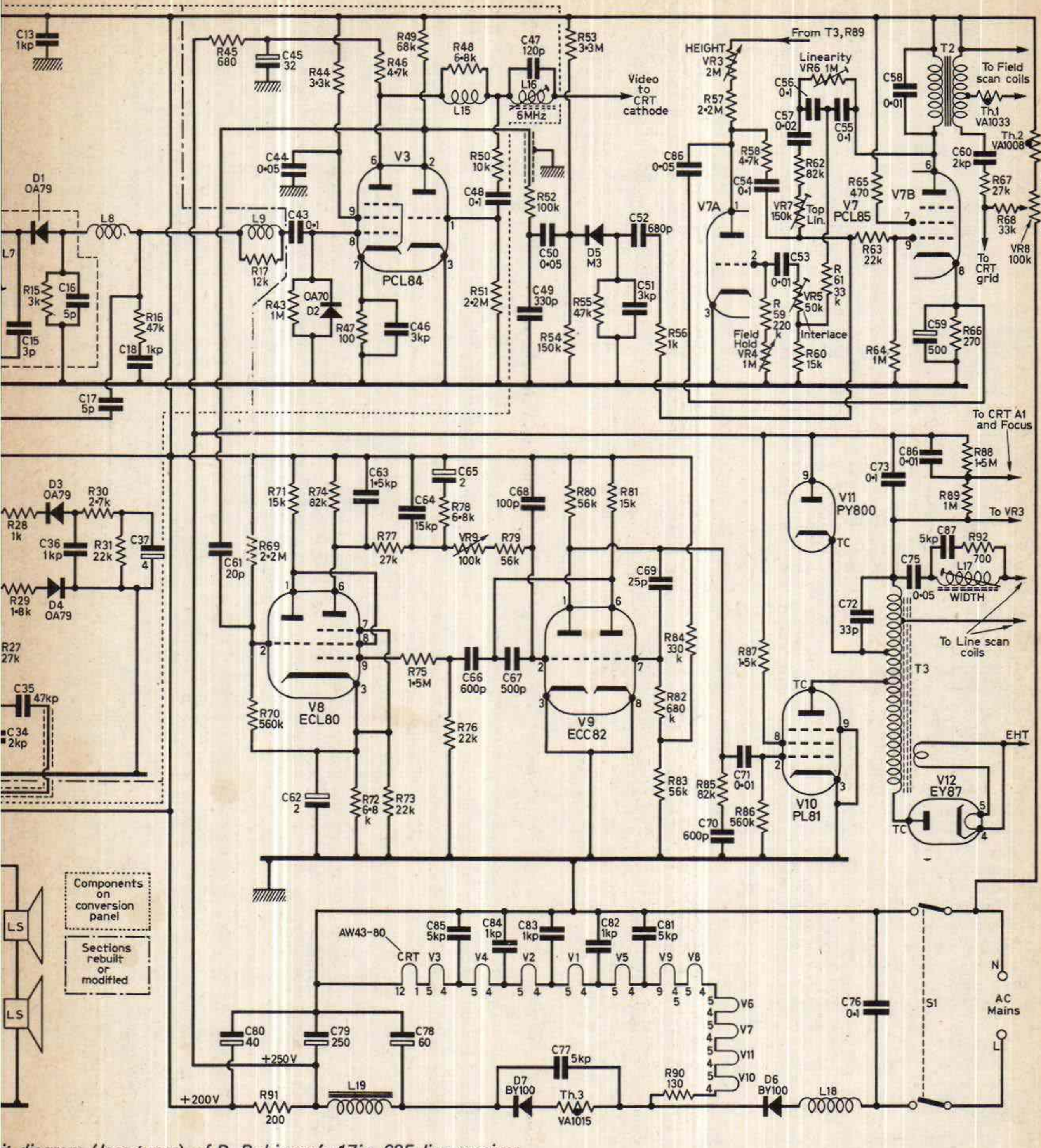


Fig. 1:



it diagram (less tuner) of D. Robinson's 17in. 625-line receiver.

Video and AGC

The original video amplifier on the i.f. chassis used a PCF80. However I found that this was not capable of providing a really adequate output and therefore changed to a PCL84. The most important feature of this particular circuit is that the d.c. level is fully retained.

A.G.C. is not really necessary as the u.h.f. transmissions are immune to aircraft flutter and with all three programmes coming from co-sited transmitters on a fairly closely spaced channel group large deviations in signal strength from station to station on u.h.f. will be unlikely. Control of contrast is therefore obtained manually by means of VR1 and R8 and this is found to be entirely satisfactory in practice. And very handy for setting up aerials!

Direct coupling from the vision detector to the video amplifier is not at all satisfactory however since under no-signal conditions the current in both the PCL84 and the c.r.t. would be very high. Also under these conditions adjustment of the contrast control is tricky, an increase in contrast producing a darker picture. The difficulty is solved by C43 and D2 which acts to clamp the sync pulse tips to chassis potential so that the video amplifier may be biased almost to cut-off as in conventional 405-line practice. Turning up the contrast then brightens the picture, as would be expected, and with no signal the screen is blacked out completely as it should be. Large electrolytics cannot be used on the cathode and screen grid as these would increase the a.c. gain of the stage without increasing the d.c. gain. The small capacitors which are used in these positions merely provide a little h.f. boost.

Even with all these precautions the lack of a regulated e.h.t. supply and other imperfections result in a slight loss of the d.c. component. This is corrected by R45 and C45, which are not a decoupling network but serve to make the anode load of V3 larger by 680Ω for d.c. than for a.c. The value of 680Ω is found to give perfect d.c. restoration and the improvement which results from this cannot be over-emphasised. Even the non-technical members of the family appreciate the improvement on night scenes and captions etc. and I doubt if they would put up with an a.c.-coupled set now that they are used to a " black-level clamp", my 405-line set also having this feature.

Sync Separator

The triode section of V3 acts as a simple but effective sync separator.

Audio Circuits

On the audio side I found that the output from a ratio detector is not all that great and to allow for a reasonable amount of negative feedback I decided to use a three-stage audio amplifier. The circuitry around V5B replaces the flywheel sync circuit of the original Thorn design. Hum and buzz from the field timebase are reduced to negligible levels by plenty of decoupling on the h.t. supplies, and another important point often overlooked is that if the output lead of the sync separator is of any length it should be screened to prevent radiation of field sync pulses which are picked up by the audio amplifier (and often mistaken for intercarrier buzz!). The amount of negative feedback used is such that the audio amplifier gives full output at the maximum setting of the volume control.

Cabinet

An important point on the audio side is the use of twin 7 x 4in. speakers, one on each side of the screen. This reduces distortion and makes the sound appear to come directly from the screen, a useful contribution to realism. To accommodate these speakers and also to improve appearance and make room for the conversion apparatus I had to build my own cabinet for the set. This has a slimline appearance from the normal viewing position, although as the c.r.t. is a 90° type there is a considerable projection at the rear!

Power Supply Circuits

Finally the power supply. The use of a BY100 diode (D6) in the heater line avoids what would otherwise be a very large mains dropper as there are only twelve valves. Connecting the two rectifiers D6 and D7 in series ensures that the transistor tuner does not receive a.c. in the event of a short in one of the diodes. A thermistor in the h.t. line avoids a large surge of current through the electrolytics at switch-on. The 250V output from the choke is used for the line output stage and also, to ensure adequate drive for the c.r.t., for the video amplifier anode. The rest of the set is supplied from a 200V line.

Results

The final results are most satisfactory, bandwidth being about 4·5MHz with little overshoot. D.C. restoration and contrast from the rebuilt video amplifier are perfectly adequate and sensitivity is very high, due mostly to the tuner having an inbuilt transistor i.f. amplifier (actually intended as the v.h.f. mixer). The tuner has since been changed for a two-transistor u.h.f.–only one however as I intend to use the integrated one for a dual-standard set I am constructing. The results are almost the same, using an 18-element loft array at about 15 miles from the Waltham transmitter (channel 64).

Timebase linearity and stability are good and I have not yet had to adjust the line hold control since I made the set. Width is more than adequate due to feeding the line output stage from a 250V line. The total cost of the project was under £6.

Sound quality (something which is usually skimped over in commercial sets, generally with ear-splitting results) from the twin speakers is at least as good as many commercial v.h.f. sets I have heard.

I found this a most interesting and instructive project and one which I would recommend to other readers. ■

SERVICING TV RECEIVERS

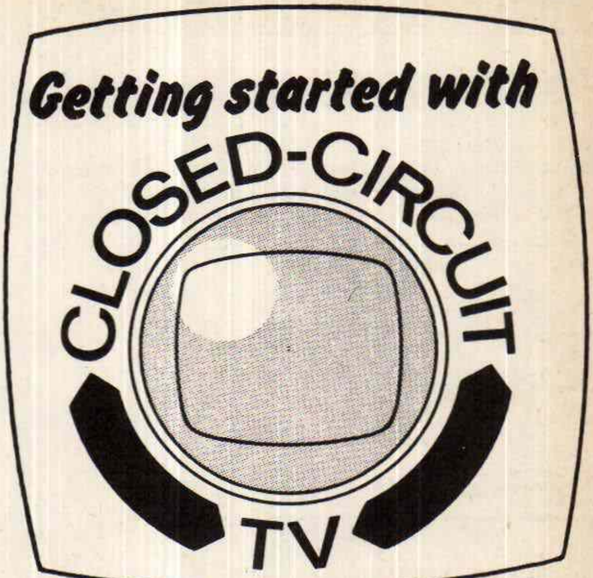
—continued from page 167

R145 was added with the schedule C chassis, R137 at the same time being changed from 226Ω to 126Ω. In later schedule C production R107 and the associated shorting link are not fitted.

The following component differences from Fig. 2 may be found: C48 3pF; C89 0·1μF; R4 3·9MΩ; R69 360kΩ; R71 15kΩ; R102 1kΩ; L36 not fitted; V10 PL504; V11 PY800. Note that Sparkguard tube bases are used and may be of two types, S or R, the tube type numbers bearing these suffixes. A tube with an S Sparkguard may be fitted in an R chassis if the flat side tag is bonded to tag 5 of the base connector. If replacing an S type with an R type connect tag 5 of the c.r.t. base connector direct to printed board tag 29 and disconnect the c.r.t. aquadag earthing lead from the chassis frame and connect direct to tag 5 of the c.r.t. base connector.

Late modifications released to us are: C114 210pF, R141 3·3MΩ and V6 30FL2 on some chassis and in later production the h.t. feed to the line hold controls taken from the junction R66, C51 with C52 raised to 12μF.

NEXT MONTH: PHILIPS 210 CHASSIS



PART 3 I.R.SINCLAIR

In any television system it is essential for the scanning of the receiver to be in step with the scanning of the camera. This is achieved by means of synchronising pulses which serve to mark the points of time at which a scan, line or field, must start. The generation of reliable sync pulses is an essential feature of a TV system and many amateur CCTV systems fail through the use of badly shaped sync pulses.

In professional studio work the sync pulses are generated quite separately from the camera. For broadcast television the sync pulses must constitute part of the transmitted signal and must maintain a constant frequency (the sync signals used are shown in Fig. 4). For CCTV such sync generators are too elaborate and too costly. The greatest amount of complication arises from the use of interlace, so this is usually omitted in CCTV signals, causing the bandwith of the signal to be greater if the same resolution is to be achieved as that of a broadcast transmission.

When a CCTV system consists only of a camera and one monitor it may be easier to carry the video signal on one cable and the sync signals on another, so avoiding the task of adding the sync signals to the video and separating them again in the monitor. There is no saving in camera circuitry however as the video signal has to have a blanking signal added—this is derived from the syncs—so that there is no video during the flyback intervals. The system is more useful when video signals are switched, as it avoids the difficulties of keeping syncs constant during video switching. We will now deal with the methods of generating sync pulses, amplifying them and at the same time preserving their shape, and adding them to the video signal.

Generating Field Sync Pulses

In most applications the field sync pulses are locked to the a.c. mains frequency. Professionally this is done by generating at a frequency equal to twice the line frequency, frequency dividing this down to field frequency and comparing this with the mains frequency. Any difference is used to generate a voltage which is used to correct the "double-line" oscillator. In CCTV circuits it is more usual to generate the field sync from the mains waveform itself, unless the equipment is entirely battery operated. It is worth noting that all 625 line broadcasts in this country are made with the field scan unlocked so that smoothing in 625 receivers must be considerably better than in 405-only sets to avoid the appearance of dark hum bars moving up or down the screen at a speed set by the difference between the field frequency and the a.c. mains frequency. Colour transmissions must use an unlocked field because of the essential requirement of a fixed frequency for the subcarrier, which then sets the line and field frequencies.

If the field sync is to be obtained from the mains frequency the problem then becomes one of obtaining a sharp pulse from the slowly-changing mains waveform in such a way that the pulse always occurs at the same point in the waveform.

One method is to overdrive an amplifier so that only the faster portion of the 50Hz waveform is amplified. The output is then differentiated by *CR* networks and the required polarity of pulse selected by a diode. If the sync pulses are being used apart from the video they can be left as they are, but if they are to be combined with the video and afterwards separated by the sync separator of a monitor a broader pulse will be required and must be obtained by using the 50Hz pulse to trigger a flip-flop (Fig. 1). Another method is to obtain the

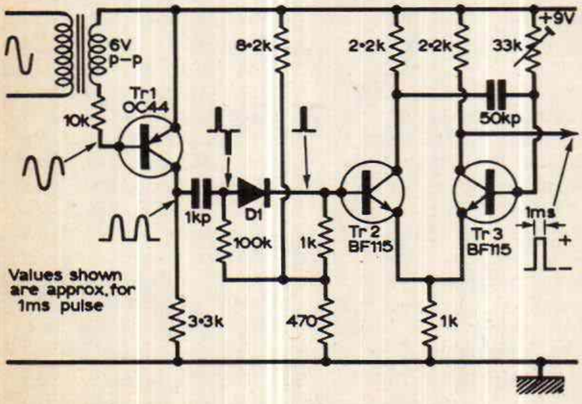
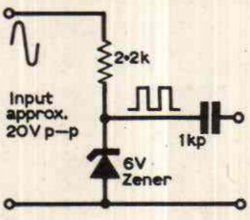


Fig. 1: Obtaining a field sync pulse from a flip-flop circuit (Tr2, Tr3) triggered by a stage (Tr1) providing 50Hz spikes derived from the mains waveform.



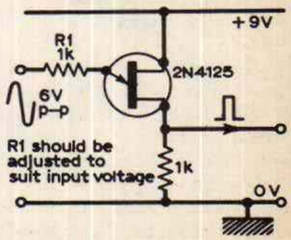


Fig. 2 (left): Obtaining a field sync pulse from a zener diode. Fig. 3 (right): Field sync pulse obtained from a unijunction transistor.

trigger pulse from a zener diode or gas stabiliser as in Fig. 2 or from a unijunction transistor (Fig. 3).

Line Sync Pulses

The line sync pulse should ideally be identical in form to the line pulse of a broadcast signal if a monitor is to be reliably synchronised. The shape of the "standard" line sync pulse is shown in Fig. 4; for CCTV work a much less precise sync can be tolerated since there is no risk of further

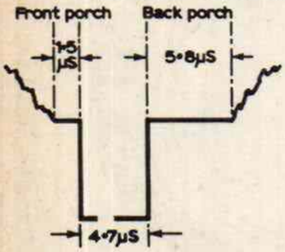


Fig. 4 (left): Standard 625-line sync pulses. For 405 the front porch is 1·7μsec, the pulse width 9·3μsec and the back porch 7·5μ sec.

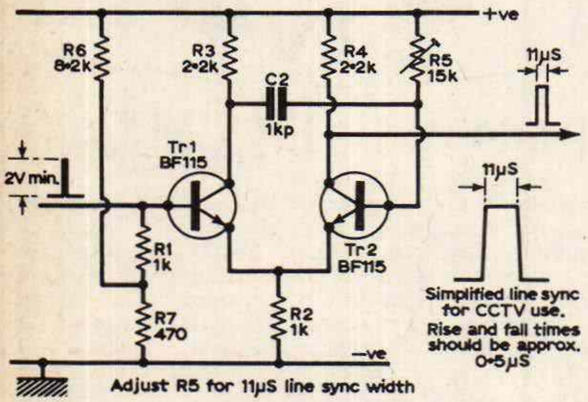


Fig. 5: Flip-flop circuit suitable for providing the line sync pulse. Adjust R5 for 11μsec pulse width (625 lines). Tr1, Tr2, BF115 or similar.

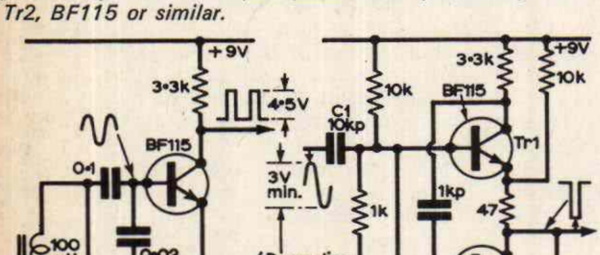


Fig. 6: Methods of obtaining a trigger pulse from a sinewave generator. (a) The Colpitts oscillator produces a sinewave at its base and emitter but the collector waveform is square because of the resistive rather than tuned load. (b) In this circuit both transistors are normally off. A sinewave at the base of Tr1 makes it switch on when its base becomes sufficiently positive, thereby switching on Tr2 which brings down the emitter voltage of Tr1 making the switchover very rapid. When the sinewave goes negative the switchback is equally rapid.

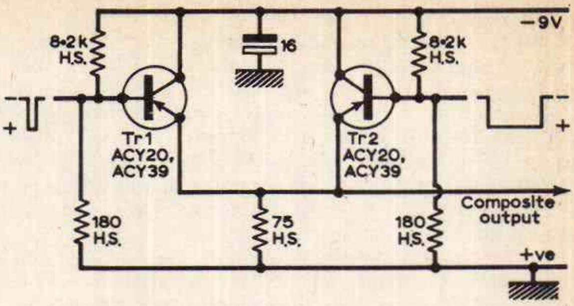


Fig. 7: Line and field sync pulse mixer. The suggested transistors are switching types. The circuit will work using r.f. transistors but if they are obtained from a dubious source the leading edges of the pulses will suffer. The ACY series of transistors is cheap and readily available. Another advantage is that the standing current can be comparatively high (about 8mA per transistor in this circuit) to assist sharpness. The output is a 1·5V pulse which is trimmed to size either when mixed with the video signal or at the cable feeder stage.

mutilation occurring in transmission. In particular the front and back porches can be omitted and the slope of the sides of the pulse can be rather less sharp. A suitable pulse can be obtained from the flip-flop circuit shown in Fig. 5. A trigger pulse at the base of Tr1 turns this transistor on and the drop in voltage at its collector cuts Tr2 off. Tr2 stays cut-off until resistor R5 charges C2 up again to the voltage at the emitter, when Tr2 starts to conduct again and Tr1 is rapidly cut off. The waveform at the collector of Tr2 is a good pulse whose *width* depends on the time constant C2, R5.

This circuit has to be driven by a trigger pulse which occurs at the frequency of the line sync required. This trigger pulse may be obtained from a blocking oscillator or multivibrator, or from a sinewave oscillator (straightforward or crystal controlled) whose output has been "sharpened" into trigger pulses by over-amplification and differentiation. The circuits of Fig. 6 show the methods of obtaining a trigger pulse from a sinewave generator.

Composite Sync

In some CCTV applications a composite sync (a mixture of line and field sync) is not needed, but where there is any appreciable distance between the camera and the monitor it is desirable that the number of cables should be kept down. A suitable mixer is shown in Fig. 7. Each line sync pulse at the base of Tr1 causes a sync pulse to appear at the emitter by emitter-follower action. When a field sync pulse arrives at the base of Tr2 line sync pulses have no affect on Tr1 which is cut off by the field sync voltage at its emitter. In a simple system where there is no fixed ratio between the line frequency and the field frequency the first line or two of any field is usually out of sync, but it can be arranged that these lines are off the screen by manipulating the field amplitude control of the monitor.

Mixing the composite syncs with the video to form a composite video waveform is rather less easy. The video waveform must first be *clamped*, that is the black level must occur at a fixed voltage. In the

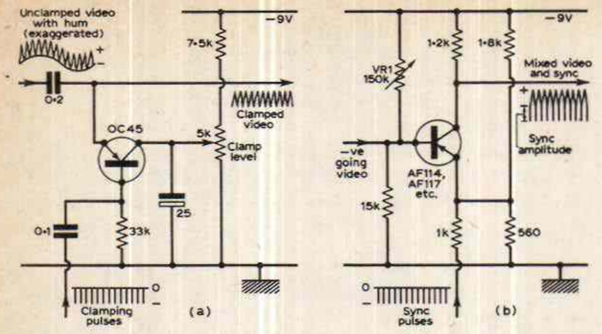


Fig. 8: (a) Transistor video signal clamp. (b) Sync and video mixer stage. VR1 sets the sync pulse amplitude.

standard video waveform it is customary to clamp the video waveform at 0·3V above earth and to add the sync pulses in the remaining 0·3V.

A circuit for clamping a video waveform and adding composite sync is shown in Fig. 8. The clamping stage shorts the video waveform to an 0·3V supply every time the clamping pulse (a line sync pulse) arrives so that the lowest video level is 0·3V. The mixed sync pulses are then fed into another stage which shorts the waveform to earth on each pulse, so adding the required 0·3V of sync pulse.

On the face of it, it might appear simpler to cut out the clamping stage so that the sync pulse is added directly, but this has the effect of leaving both the black level and sync pulse amplitude uncontrolled.

Interlacing

The bandwidth required in a video amplifier depends, as far as vertical resolution is concerned, on the product of the number of lines per frame and the number of frames per second. In closed circuit applications the large bandwidth required may be no handicap. If for example a system is required which can resolve 405 lines horizontally and 625 lines vertically with 50 frames per second then the bandwidth required is 625 × 405 × 50 Hertz, which comes to about 12MHz. This is not an impossible bandwidth though few CCTV video amplifiers have bandwidths of much more than 10MHz and none attempt the 19·5MHz bandwidth which would be needed for equal vertical and horizontal resolutions of 625 lines.

Where bandwidth is restricted, as it may be by the requirements of broadcasting or of cable transmission, either the vertical resolution, the horizontal resolution or the frame rate must be reduced. One way of keeping resolution unchanged and halving bandwidth is to cut the frame scan rate from 50 frames per second to 25, but this has the disadvantage of making the flicker of the received picture very much more noticeable. Interlace is a device for having the resolution cake and still eating the same frame rate!

In an interlaced picture a complete frame of 1/25 second consists of a *field* of half the total number of lines in half the frame time followed by a field consisting of the remaining lines in the next 1/50 second. For example a 625-line frame consists of a field of 312½ lines in 1/50 second followed by the remaining 312½ lines spaced between the first set in the next 1/50 second. In this way the resolution is unchanged and the flicker problem is very much less than it would be if complete frames were scanned every 1/25 second. Also, the bandwidth requirement for the 405 × 625 line picture becomes 6MHz instead of 12MHz, a considerable advantage for broadcasting purposes.

Interlace is however difficult to provide in the camera and difficult to maintain in the receiver. It is achieved in the camera by modifying the sync signal so that the field scan is synchronised at times corresponding to the start of line 1 and the middle of line 313; in the receiver this requires considerable accuracy in the synchronisation of the field scan and, unless the field sync waveform is identical for both line and half-line conditions, lines will tend to pair together. In the 405-line system poor interlace was a feature for many years, but the 625-line system has used the technique of "equalising" pulses which occur before the field sync pulses for the half-line field start and equalise the conditions so that the integrated field pulse reaches synchronising voltage at the same time after the first field pulse.

Amplifying & Shaping Sync Pulses

To synchronise a timebase a sync pulse should ideally have a perfectly regular shape with steep sides to ensure that synchronisation takes place at a precise instant of time. However in the course of being added to a composite video signal, passing through cables and being amplified the shape of the sync pulse suffers and synchronisation becomes erratic.

Several circuits can be used to combat this. First sharpening of the leading edge can be applied to the sync pulse before it is added to a composite waveform. This makes the leading edge (from which the timing of the line starts) sharp enough to be able to stand some integration in subsequent circuits. Sharpening circuits generally operate by adding a differentiated (sharpened) pulse to the leading edge of the sync pulse; such a pulse is obtainable from the trigger pulse which generates the sync pulse. If this trigger pulse is picked off at a earlier stage at a high voltage it can be sharply differentiated to bring its amplitude down to that of the final sync pulse (about 0·3V) and then added to the sync pulse, any final clipping being carried out by the stage which combines the sync pulses with the video. Since the trigger pulse

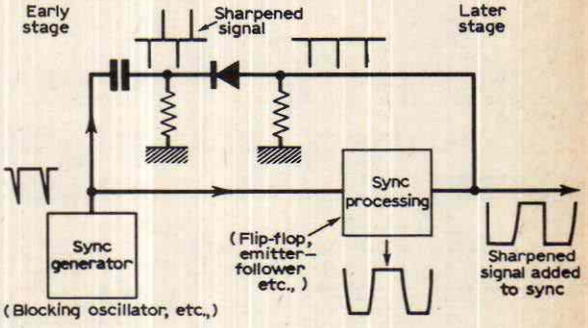


Fig. 9: Principle of pulse sharpening. This can work only when the differentiated sharpening pulse can be taken from a higher voltage signal than the output sync pulses. As the sync output is usually less than 1V this is practically always the case.

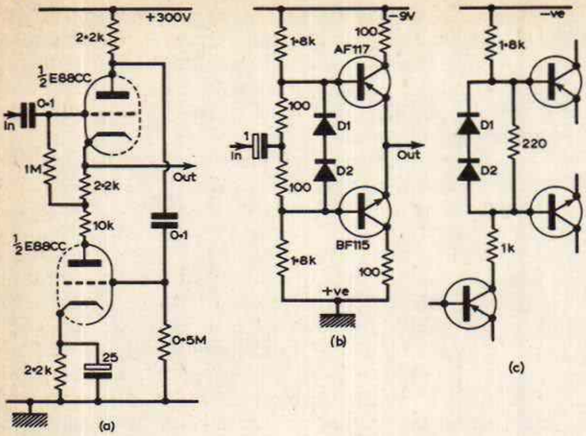


Fig. 10: Compound matching amplifiers. (a) Compound cathode-follower. (b) Compound emitter-follower (complementary symmetry simplifies the circuit). (c) Direct-coupled version of (b).

occurs fractionally (a few nsecs) before the sync pulse there is a definite improvement in the sharpness of the leading edge. Fig. 9 shows an outline of a typical circuit.

Note incidentally that the effect of long lengths of cable is to delay pulses, due to the time taken by a pulse to travel from one end of the cable to the other. For composite video this is usually unimportant but where video and sync pulses are separate a large *difference* in the lengths of the separate cables can make a noticeable difference in synchronisation. For example if the length difference is about 100yds the time difference is about 1μsec (in a 64μsec line time on 625 lines), which amounts to $\frac{1}{3}$in. in a 19in. monitor. When video and sync are composite of course no time difference arises.

The transmission of waveforms through cables causes rounding of the sync pulses due to the shunt capacitance unless the cable is very well matched to the output stage of the sync generator or camera. A simple emitter- or cathode-follower is not sufficient, especially if the video is positive-going making the sync pulses negative-going. Circuits of the type shown in Fig. 10 are better able to cope with composite waveforms as they can deliver current to a capacitive load, such as a cable, in *either* direction.

Finally, at the monitor the sync pulses can be sharpened by amplifying and differentiating. Where composite signals pass through a sync separator the operations of amplification and sync separation ensure sharpening of the pulses since the line syncs are separated by differentiation and the integrated field pulses still contain sufficient line frequency peaks to ensure good sync. Where separate sync and video exist however the sync pulses arriving at the timebase may well be of poor quality and need sharpening. The arrangement shown in Fig. 9 is useful in this respect—a sharp differentiated pulse is generated and added to the sync pulse in the same way as in the sharpener discussed earlier.

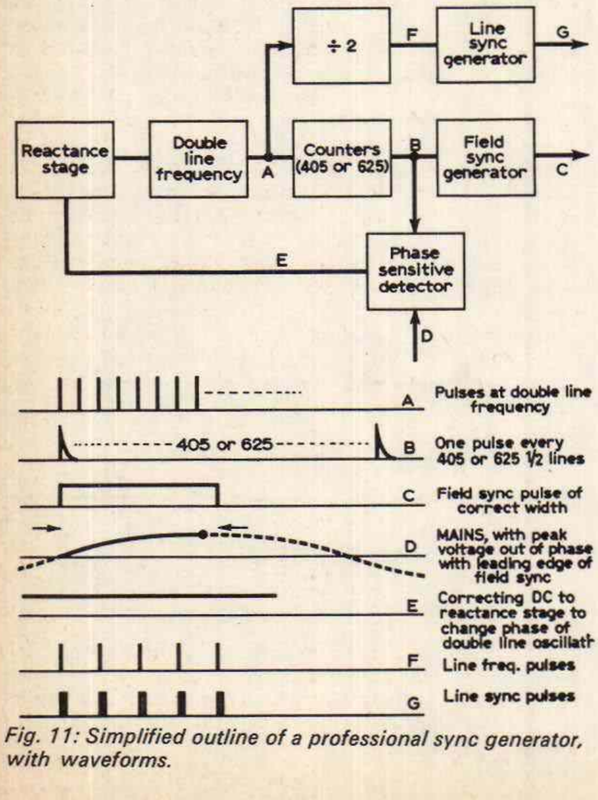


Fig. 11: Simplified outline of a professional sync generator, with waveforms.

Professional Sync Generators

For professional use a sync generator must supply sync pulses suitable for interlaced signals and which comply with internationally recognized standards. Such standards are seldom needed for CCTV work but an outline of the methods used may be of interest.

The heart of a professional sync generator is the "double-line" oscillator. As its name suggests it generates a frequency which is twice line frequency and can be crystal-controlled, free-running or mains-locked at will. Since this frequency is at double line frequency there are 810 pulses for each complete frame in a 405-line system and 1250 pulses for each complete frame in a 625-line system, and in each interlaced field there are 405 and 625 pulses respectively. This gives us the means of interlacing since 405 half-line pulses occur in the time of 202½ lines and a field pulse at the end of 405 half-line pulses automatically ensures that a 2 : 1 interlace is maintained.

The double-line pulses are therefore fed (Fig. 11) to a set of counters which deliver one pulse for each *field*. For 405 lines this means dividing the pulse rate by 405, and this is done in five steps of division (÷5, ÷3, ÷3, ÷3, ÷3); for 625 lines the process can be done in four steps of division by five. The output pulse from the last counter occurs every field and becomes the trigger for the field sync generator which consists of a flip-flop stage.

The line pulse frequency is half the double-line pulse rate and is obtained from a scale-of-two counter whose output triggers a flip-flop set for the standard line pulse width for the system in use. In some systems a few pulses of line width and double-line frequency are used before the field

—*continued on page 183*

DX TV

CHARLES RAFAREL

A MONTHLY FEATURE FOR DX ENTHUSIASTS

OCTOBER has produced the expected decline in SpE, being the end of the season, but fortunately there has still been some SpE DX about. It is however rapidly fading out so we must resign ourselves to a patient wait until April 1970 when the season should open up once again. I think next year will be better SpE-wise for the reasons that I have already given. The SpE results bear comparison with the corresponding period last year and in fact I would say they have even been marginally better. It is perhaps rather too early to say that this is a pointer to better things next year, we shall have to wait and see.

As usual I give the SpE log first, a rather poor one but not for lack of trying!

6/10/69	W. Germany E4.
9/10/69	W. Germany E4 and USSR R1.
12/10/69	Poland R1 and Spain E4.
13–15/10/69	W. Germany E4.
18–19–20/10/69	Sweden E4.
21/10/69	Sweden E4 and W. Germany E4.
22/10/69	Poland R1 and Czechoslovakia R1.
24/10/69	USSR R1 and Norway E4.
27/10/69	Spain E2 and E4.
29/10/69	Czechoslovakia R1 and USSR R1.

On 26/10/69 the 38-41 MHz band produced some weak USA paging stations and on 28/10/69 the same band of frequencies gave some strong USSR forward-scatter network signals. This looks like the predicted late F2 opening but if it seemed a rather insignificant one there is still just time for some F2 DX to come in before we have a ten year wait until the next time.

What has been much more interesting has been the advent of early Tropospheric openings this year. Normally these come later—the 1968 ones began at the start of November—but this time down here the first opening was on the 9th October. The unusually settled weather has of course contributed to this and long may it continue! If we get similar weather in November the cooler evenings will give us the required conditions for even better Tropospheric propagation. Once again we must wait and see and hope.

Just to digress a little before noting the u.h.f. log here I would comment that alas this may well be my "Swan song" for good u.h.f. DX. I am already getting "clobbered" with new locals in the form of BBC-1 London Ch.26, ITV London Ch.23 and BBC-2 Sandy Heath Ch.27, all new stations for me that I could well do without! From my location all these lie in approximately the same direction as Holland and W. Germany, etc., so you can imagine the problem here. But there is still worse to come: any moment now BBC-1 Rowridge 500kW Ch.31 and ITV Rowridge Ch.27 will go on test and subsequently enter service and as they are to the east of me too the u.h.f. channels 22 to 32 will be blotted out, and that is the best end of the band. It looks as if there may be some relief early Sunday mornings if there are Continental openings or maybe early a.m. before 08.00 when the W. Germans open. BBC u.h.f. has however been on test as early as 07.45 recently. It seems one just cannot win!

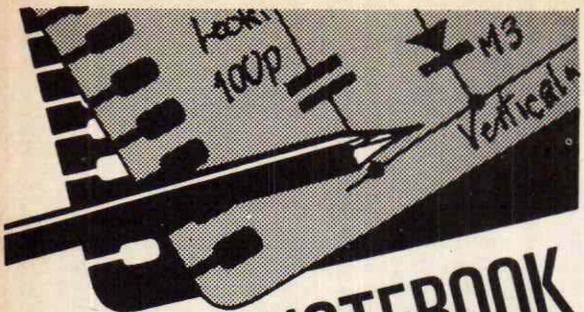
On a more cheerful note one old pal may survive ORTF-2 Ch.25 at Caen. For this one I am on the nul point for the aerial for the new BBC/ITV stations at Rowridge so I may just get away with it! We have French students in the house and they welcome a sight of home from this station. Otherwise "Plan B" will have to go into operation: I shall have to install group E aerials and hope for some success at the h.f. end of the band (difficult, I hear) and I live in an awkward area for u.h.f. from Western Europe other than France. The only other solution would be to emigrate to East Anglia and that is a little impractical!

Now to the current Trops, u.h.f. and v.h.f.

9/10/69	Holland Chs. 27, 29, 32 and 39. W. Germany Chs. 21 and 35.
10/10/69	Holland Chs. 27, 29, 31 and 32. W. Germany Chs. 25, 29, 30 (Hamburg very good), 31, 34, 37, 39 and 41.
17/10/69	Holland Chs. 27, 29, 31, 32 and 45.
28/10/69	Holland Ch. 29. W. Germany Chs. 29, 30 and 27.

East Anglian DXers must have had a ball! Over the same dates all the usual French stations were in plus some "weirdies" as yet unidentified on Chs. 26, 50, 62 and 64. I suspect that the high channels are low-power coastal relays and am investigating further. Another interesting Trop, in Band I this time, has been the frequent reception of Holland Lopik E4 which is normally very rare here.

I have saved the pièce de résistance until last. On 28/10/69 Roger Bunney telephoned me at 08.45 in great excitement and a quick check here on my gear confirmed his startling news, Mont Rigi E6 Switzerland was coming in on test card. I still do not know why, other Band III trops were poor. The "ducting" must have been just right for the characteristic Swiss test card to appear. It was admittedly a weak signal but who could ask for more! I telephoned Ian Beckett at Buckingham but as his phone was giving trouble I could not get him until 09.30 and by that time the signal had dropped down into the mush again. Still we tried and I hope perhaps some other DXer was lucky too. —continued on page 177



SERVICE NOTEBOOK

G. R. WILDING

AF Testing

WE came across a 19 in. Rediffusion model recently with normal picture but no sound. Our first move was naturally to replace the PCL82 a.f. amplifier but this produced no change. We then commenced voltage checking. The pentode anode and screen voltages were normal and on contacting the former point we obtained slight speaker clicks indicating that the output transformer and loudspeaker were in order. The presence and strength of such clicks —caused by the slight voltage changes produced by meter application—are usually as informative as voltage indications when tracing complete sound failure. Then on contacting the pentode control grid we obtained the characteristic a.f. hum, indicating that the entire stage was working satisfactorily.

On next contacting the triode anode we found that voltage was present but no clicks were produced although they should of course have been very much stronger than those produced at the pentode anode due to amplification by this valve. The only possible cause was an open-circuit or dry-jointed grid feed capacitor and as the printed circuit wiring did not seem too healthy we decided to cover both possibilities and fit a replacement.

We then obtained really strong clicks on contacting the triode anode again but there was still no sound. As test prod application to the triode grid produced no a.f. hum we again replaced the PCL82. There were still no results so next we checked for a short from the triode grid to chassis, possibly caused by a solder blob or deteriorating screened lead.

In older receivers care must always be exercised when moving screened leads that have been subject to prolonged warmth from a nearby valve, for the interior and end insulation can easily crack and flake off to result in a complete short-circuit. However there was no short-circuit present so as the triode stage was live from its anode and as the valve itself could be ruled out there remained only one real possibility apart from valveholder disconnection and that was an open-circuit cathode to chassis connection.

In TV triode a.f. stages the cathode is usually returned directly to chassis without bias resistor and shunting capacitor. This was the arrangement used in this model and after connecting a jumper lead from valveholder cathode connection to chassis we obtained normal sound. We subsequently learnt that prior to the sound going off completely it had been intermittent on occasion. This explained why we had to cure two separate faults to restore sound.

No Field Lock

THERE was complete loss of field lock on a 19in. KB model fitted with the STC VC51 chassis although the line lock was perfectly good. Our first response was to change the PCL85 although as field lock was completely absent there seemed small prospect of it effecting a complete cure. There was no improvement. The triode of this valve forms a multivibrator with the triode section of a PCF80—the pentode section being the sync separator—so we next replaced this valve. Again there was no improvement.

The field sync circuit of this and similar STC chassis is unusual in that the triode of the video PCL84 is used as a field sync pulse amplifier to boost pulse levels before their application to the multivibrator pair. Thus we next replaced this, but with no improvement. Clearly we must have a component defect. Inspection revealed no interlace diode which may have gone open-circuit and as there were no discoloured resistors we shunted a replacement across the pulse feed capacitor C6 connected from the pulse amplifier anode to the PCF80 triode grid.

It will be seen in the accompanying diagram that the field pulse amplifier V2 is arranged as a grounded-grid stage with the sync separator anode output applied to its cathode via R6, R7 and C3. These two resistors, in conjunction with R8, also form a d.c. potential divider between V1 anode and V2 cathode.

As the line sync was good we naturally began voltage checking at V2 and immediately found complete loss of h.t. on the anode. It seemed that R4 must be open-circuit since as it was cold the possibility of a short-circuit from anode to chassis via C5 could immediately be ruled out.

However, further tests showed that there was no voltage at the other end of the resistor and therefore no screen grid voltage at the sync separator. We then found that R1 the 330kΩ feed resistor from

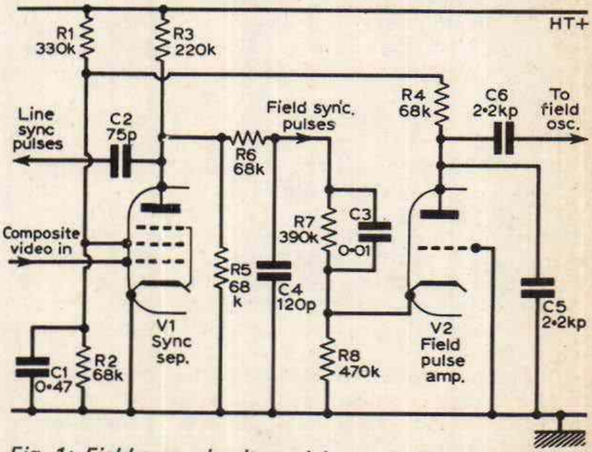


Fig. 1: Field sync circuit used in many STC chassis from the VC2 on. V2 is a grounded-grid stage to maintain correct pulse phase and d.c. level.

the h.t. rail to the sync separator screen was completely open-circuit and when we replaced this we obtained normal field lock.

The interesting and surprising point is that the sync separator gave such good line lock while without screen voltage, although it must be added that once we had replaced the resistor the line lock held if the hold control was rotated from one extreme to the other.

The cause of newish resistors going completely open-circuit is that one of the lead-out wires loses contact with the resistive interior.

Aerial Feeds

NO RASTER but normal sound was the complaint on a Bush 21in. model. We were unable to draw a spark from the PL36 anode but as a faint line whistle was present the most probable cause was that the PL36 itself was defective. On replacing this valve we obtained an excellent raster but the picture on both Bands was grainy.

The set was fed via a long extension lead from an aerial outlet socket and our first move was to make sure that both coaxial plug connections were good. We remade both connections and on replacing the aerial plug in the receiver momentarily obtained a greatly improved picture just as the centre pin contacted the centre socket, but the picture reverted to its original grainy appearance as the plug was pushed fully in.

This naturally aroused suspicion of a short-circuit across the coaxial lead but there was no tape join and a meter test showed the lead to be perfect. On next moving the few feet of loose lead near the receiver the results varied and it became apparent that the lead was functioning as the aerial. Whenever moving an aerial lead varies the signal strength you can be sure that it is not properly terminated to an aerial and that it is providing all or part of the signal input.

We then found that virtually the same results were obtained whether or not the extension lead was plugged into the outlet socket. The set was sited in a new house and many builders now run an aerial lead from a socket in the lounge to a similar socket in the loft, leaving the choice and fitting of the aerial to the occupier. This proved to be the case and the extension lead had been providing a fair signal.

Until such time as an aerial could be fitted in the loft we removed the receiver coaxial plug and inserted the inner conductor only to the receiver's central socket and obtained what were quite satisfactory pictures on both bands. This dodge often gives acceptable results until riggers are able to attend to the fault when there is a short in the lead or an aerial element has broken off.

Loss of Height

THE RASTER on a 17in. GEC receiver suddenly reduced to about 1in. with a pronounced foldover at the base. When height suddenly falls so dramatically you can be almost certain that a component defect is the cause since valve failure in field circuits usually results in gradual reduction in height over a period of time, increased base cramping as temperature rises or complete or intermittent field collapse.

The foldover strongly suggested an output stage fault so we commenced voltage checks on the PL84 output valve. Anode and screen grid voltages were normal but we obtained a reading of about 40V on the cathode pin. This was about treble the expected figure so we then momentarily shorted the cathode pin to chassis. Doing this we obtained a full-sized though grossly distorted raster and on switching off we found that the bias resistor was open-circuit and that cathode continuity to chassis had been maintained via the shunting electrolytic which, not unexpectedly, had developed a considerable leakage.

It was completely impossible to read the value of the bias resistor and the service manual was not to hand. However in a small valve data book we always carry in our tool kit we found that although the value of the cathode resistor wasn't given, with 170V on anode and screen the bias should be −12·5V to give an anode current of 70mA and a screen current of 5mA. This gave a total cathode current of 75mA and Ohm's Law indicated a resistor value of about 160Ω. On fitting both a new resistor and shunting electrolytic we obtained a full-sized raster and then on readjusting the linearity controls we obtained excellent vertical shape.

TO BE CONTINUED

DX-TV

—continued from page 175

More u.h.f. stations in service include the following:

France: Besancon/Montfaucon Ch.23 250kW hor.; Avignon/Mont Ventoux Ch. 45 125kW hor.; Chartres/Montlandon Ch.50 250kW hor.; Bayonne/La Rhune Ch.58 500kW hor.; also Forbach/Kreuzberg Ch.22 is now up to 20kW.

W. Germany: Verden Ch. 25 66kW hor.; Hochsauerland Ch.40 250kW hor.; Schnee Eifel Ch.40 250kW hor.; Bad Marienberg Ch.44 138kW hor.; Kaizerslautern Ch.44 25kW hor.; Eggegebirge Ch.48 110kW hor.; Ebersbach Ch.58 174kW hor.; Pfarrkirchen Ch.57 250kW hor.; also Hamburg Ch.30 is now up to 500kW (perhaps the reason for the good signals on 10/10/69).

Austria: Galgenberg Ch.43 10kW hor.

Switzerland (for Optimists!): Haute Nendaz Ch.43 30kW hor.; Monte Ceneri Ch.46 35kW hor.; Gebidem Ch.52 30kW hor.; Monte San Salvatore Ch.54 30kW hor.

READERS' REPORTS

We have a startling Band III Trop report from D. Waller of Consett, Co. Durham. He had Poland R8 on 19/10/69 from 07.35 GMT to 09.20 GMT, fully identified by test card, TVP clock and "Warszawa" caption, then like so many of us he got swamped by his local ITV station opening. He suggests that the station was probably Koszalin R8 100kW and this is I feel correct. It is on the Baltic near Seczecin (Stettin) at a distance of approximately 750 miles from him. He would have a nice sea path across the North Sea then over Denmark and the Baltic.

He asks whether Poland has ever been received here in Band III and as far as we know the answer is no. However we would be interested to hear from other DXers. Other successful DXs for him are Norway E9, Sweden E9, W. Germany E8 and E9, E. Germany E3 and E4 plus Switzerland E2. He notes the absence of Rumania and Finland like so many of us this year.

UNDERNEATH THE DIPOLE

WITHIN the last thirty years mankind has achieved greater technological progress than in the previous 30 centuries. Enormous momentum has been developed and acceleration is still taking place.

AMERICAN MOTION PICTURE AND TV RESEARCH CENTRE

That, at any rate, was the conclusion reached on 15th January 1968 when the American Motion Picture and Television Research Centre at Los Angeles began operations and its objectives were set down in writing. These comprised a three-year plan with basic goals as follows: First year, document the state of the relevant technologies inside and outside the industry; second year, project planning and definition with set three-year, five-year and ten-year goals; third year, tangible results in cost reductions and in product quality and profitability.

Wilton R. Holm (Executive Director of the American Motion Picture and Television Research Centre) said that when the Centre had been constituted in 1968 American industry had been *without* any unified and co-ordinated research effort for more than seven years though during the same "seven lean years" individual technological progress had been the most prolific in world history.

Mr. Holm concluded the introductory summary of his first report with an eloquent peroration which ought to be studied carefully: "*The motion picture was born of technology; it grew up in technology; and though its image is one of artistry and glamour, it remains a medium in which the tools of the trade are enormously complex. In no other industry is artistry more dependent upon technology. Unquestionably a bright technological future is possible for the motion picture. It is the Motion Picture and Television Research Centre's purpose and challenge to see that this promise is fulfilled.*"

EXCHANGE OF TECHNICAL INFORMATION

Elsewhere in this important report it was stated: "We found that a considerable amount of technical work had been done at some of the Hollywood studios on an individual and, in most instances, confidential basis."

How thankful we must be that the exchange of information in Britain between television and film engineers and technologists has been readily given. BBC and ITV engineers (and their associations) frequently met at Pinewood Studios, for instance, and Pinewood's backroom boys pay return visits to Yorkshire TV, Southern, BBC, Thames and the rest. Pinewood's own new development of pole-operated luminaires on a TV lighting grid attracted much attention when hundreds of engineers from the USA, Europe and elsewhere made a special Studio visit during *Film '69*.

BUSINESS ASPECTS OF TECHNOLOGY

The Council of the American Motion Picture and Television Research Centre point out that while *science* is a knowledge-generating process, *technology* is the application of that knowledge to create material progress. A lot of research work does not necessarily result in material progress and the American Motion Picture and Television Research Centre undertakes no significant project which does not meet the dual criteria of cost-effectiveness and a high-probability of success. This has been precisely the objective of British television and film engineers during the past seven years.

COLOUR SERIALS

A writer of tough American detective novels, Raymond Chandler, once described a radio serial as his idea of *the square root of nothing!* The same can be said about both American and British television serials in black-and-white and I suppose in colour. Somebody said many years ago that there were only five basic plots for plays in the live theatre. Theatre playwrights certainly used to manage to dress up those same plots in a variety of ways: in this year of grace they undress them! In television serials the story-lines seem to move around in circles, finishing up at the starting post (after the inevitable chase), with a weekly change of villains and bad men.

The same could not be said about *The Forsyte Saga,* Donald Wilson's classic BBC television serial which gradually attracted a large audience not only in Britain but in many other countries. The period décor, wardrobe, long hair and beards could have turned the whole story into a Fred Karno pantomime, but Donald Wilson won't accept inexpert make-up, long hair and beards which might have come out of a Christmas cracker. These are the personal furnishings of his cast and the BBC make-up and hairdressing department do their superb best for him.

The old type movie producers used to say to their scenarists when short of ideas: "*Remember, boy, put the flag, mother, child, horses and a cat in your story-line, and you're home and dry!*" Not a bad idea and better than some of the programme material dished out by a few of the BBC producers.

HISTORY REPEATING ITSELF

The earliest technical and artistic developments in radio and television will, like those of the film industry, later reappear in an improved form. Sixty years ago prodigious efforts were made by several kinematograph inventors to astound the world with motion pictures that talked as well as walked. For years they didn't get very much farther than sound recorded on cylinders or discs, synchronised (more or less) with the film and reproduced by the feeble acoustic gramophone sound box. The Gaumont Company ingeniously amplified the sound volume by supercharging with compressed air through the sound box. However it was not until the thermionic valve amplifier and loudspeakers arrived that "talkies" became successful.

CURRENT AFFAIRS

Technological and artistic history reveals that nearly everything seems to have been done before, even if unsuccessfully. Current affairs television programmes are still hailed artistically as a new concept of presentation, but this is not so. Let us go back to 1914. Within two or three days of the start of the Great War in August of that year the film makers at the Samuelson Studios, Warton Hall, Isleworth, were busy reconstructing the world-shattering events of the previous week, presenting reproductions of the Emperor Francis Joseph, the Kaiser, Mr. Asquith, Lloyd George, the figure of Britannia, flags, symbolic torn-up treaties and so on. This was filmed and edited in montage form with superimposed subtitles and superimpositions galore. Bertie Samuelson, the enterprising producer, ordered large quantities of elaborate uniforms, guns, wigs and beards for his filmed representations of current events entitled *The Great European War*. Fortunately the theatrical wardrobe suppliers had plenty of fancy "Ruritanian" uniforms at that time, surplus possibly from the theatrical touring companies performing *The Chocolate Soldier*, *The Lifeguardsman* and other musical comedies. Fifty years or so later current affairs TV programmes and Mossman's art magazine review present the people themselves, whose beards and moustaches often look far more like clip-on or hook-on types than Samuelson's ever did.

In Donald Wilson's *The Young Churchills* for television very great care has been taken for accuracy in uniforms, accoutrements and so on as with make-up, beards, wigs and periwigs (the latter requiring the head to be very closely cropped). These are the details which are essential for achieving the status of a TV classic which, with good scripting, production and acting, will ensure periodic reissues to audiences over the years ahead.

FLICKERS

In the flickering film days of 1914 lack of good photographic resolution, colour and a sophisticated story-line didn't matter. The audiences of those days lapped up the well-edited and quick two-second flashes of Samuelson's royalties, eminent politicians and of course Britannia with the same enthusiasm they gave to the blood-and-thunder melodramas of the period.

The quality of television colour is now so good (in the UK) that the slightest imperfections are revealed on the splendid colour monitors used at all UK studios. There the best four-tube colour TV cameras reveal by comparison the deficiencies of both 35mm. and 16mm. film, even with the finest flying-spot telecine machines. I forecast however that film, especially 16mm. colour film, will catch up in quality, flexibility and editorial advantages—quite apart from lower cost.

Iconos

waveforms in COLOUR receivers PART 7

GORDON J. KING

SO FAR we have traced the receiver signals through the i.f. and intercarrier channels, through the luminance channel and colour-difference stages right up to the grids and cathodes of the picture tube. However, we have purposely refrained from becoming too involved with the signals in the chroma (short for chrominance) channel. It is now time to delve into this department and study the signals from the composite output at the vision (or chroma) detector right up to the output of the synchronous V and U detectors.

We saw last month that the V and U detectors deliver R−Y and B−Y colour-difference signals and that from these two is derived the third G−Y signal by a process of matrixing. The three colour-difference signals proper then activate the picture tube direct in conjunction with the Y signal or they are applied to matrices along with the Y signal to yield primary-colour signals for working the tube.

The V and U signals and hence the R−Y and B−Y signals are derived directly from the chroma signal by quadrature demodulation based on the PAL system. This might sound a bit formidable right now but later we shall see that it is not half as bad as it sounds. The department now under examination is shown in Fig. 1.

As we have seen, some sets have just a single vision detector while others have two at the end of the i.f. channel, one for the luminance or Y signal and the other for chroma. When there are two detectors the intercarrier signal is often taken from the chroma detector as this makes it easier to suppress the 1.57MHz chroma/sound beat by the inclusion of a 33.5MHz sound i.f. rejector in the Y detector circuit. The chroma detector may also deliver signal for the a.g.c. amplifier, but we shall have more to say about this in a later article.

Whether the one detector serves both luminance and chroma or whether a separate chroma detector is fitted, the chroma signal proper has to be separated from the Y signal before being applied to the chroma amplifier. This is done by a chroma bandpass filter located between the detector and the input stage of the chroma amplifier. In its simplest form this might be nothing more than a coupling capacitor whose value is selected to provide a high-pass characteristic—that is, allowing the chroma part of the spectrum easy access while deleting the luminance part down to d.c. The overall spectrum and the chroma part are illustrated in Fig. 1 of Part 4 (October 1969 issue).

Figure 2 shows at (a) the composite colour signal at the detector output and at (b) the chroma signal remaining at the output of the bandpass filter. These waveforms were obtained from colour-bar signals in various proportions (i.e. not necessarily the standard colour-bar signal).

Chroma Controls

In addition to boosting the chroma signals the chroma amplifier must possess a response characteristic to suit the bandpass nature of the signal, remembering that it spreads out 1MHz either side of the subcarrier frequency (see Fig. 1(b) in Part 4) and it must also embody various "controls". An important one of these relates to *burst blanking.* Chroma entering and leaving the bandpass filter carries components corresponding to the colour bursts, and for the V and U synchronous detectors to work correctly these components must be removed or at least attenuated.

Figure 3 shows at (a) a chroma waveform after initial amplification but prior to the burst-blanking stage. The burst components between the three lines of chroma signal are clearly visible in this. At (b) the same signal subsequent to the burst-

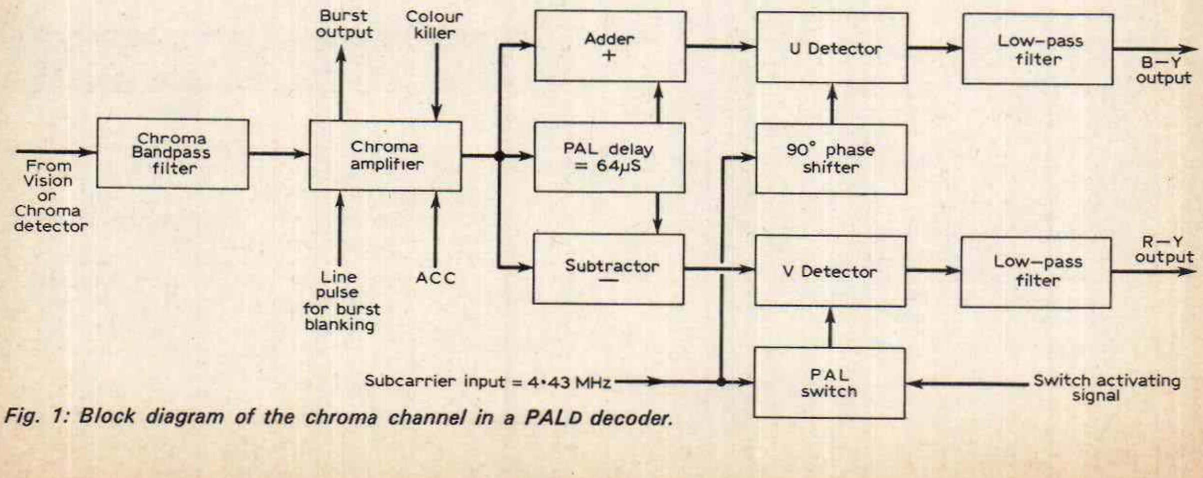
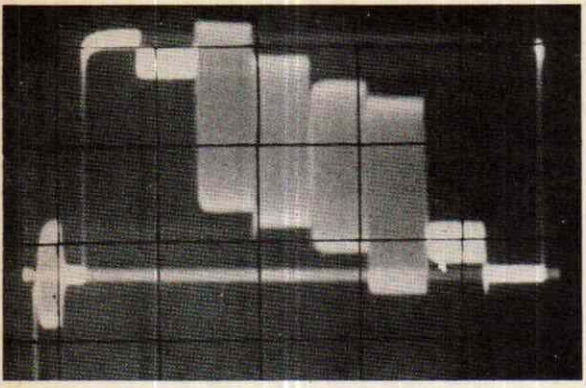
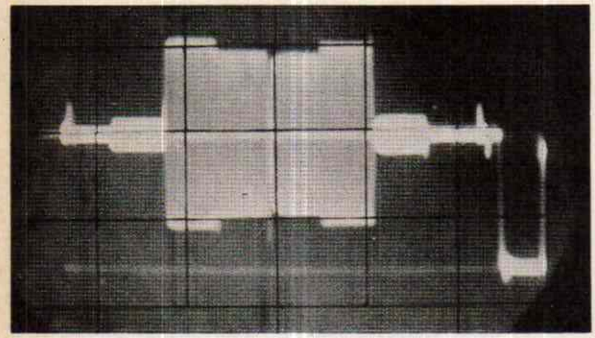


Fig. 1: Block diagram of the chroma channel in a PAL D decoder.

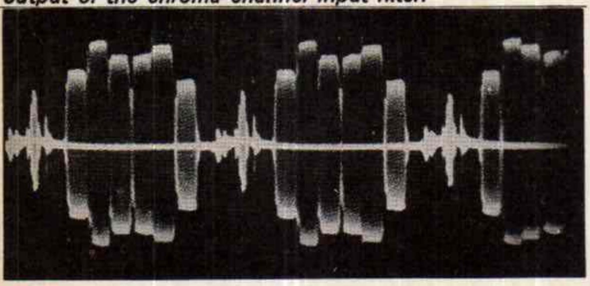


(*a*)

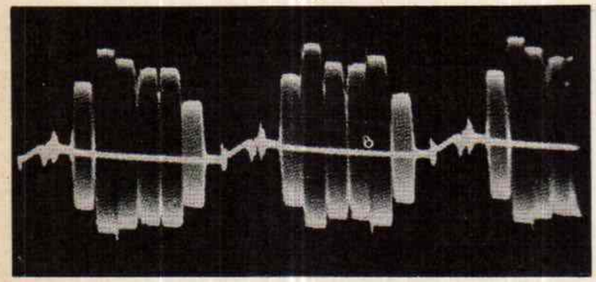


(*b*)

Fig. 2: (a) Composite colour-bar colour signal at the detector output. (b) Colour-bar chroma signal at the output of the chroma channel input filter.



(*a*)



(*b*)

Fig. 3: Chroma signal after initial amplification. (a) Prior to burst blanking, (b) after burst blanking.

blanking is seen to have the unwanted components significantly reduced in amplitude.

There are various circuit artifices for securing this blanking and we shall in a later series highlight these and indeed examine all the circuit techniques used in colour sets; but for the time being we are concerned essentially with the signals in colour sets and not so much with the actual circuits. Nevertheless to give an example one method is to apply a positive-going line flyback pulse of about 28V peak via a diode to the emitter of an npn chroma amplifier transistor. The pulse cuts off the stage during the burst period provided it is accurately timed. Thus when the chroma signal is displayed on a 'scope at—or sometimes after—the point of blanking the trace may also reveal blanking pulses. This is not significant but worth noting.

Although we do not require the bursts at the V and U detectors we certainly need to extract them separately from the chroma channel since they are required for phasing the subcarrier generator. A tuned circuit at the subcarrier frequency (4.43MHz) filters them from the chroma at an early stage in the channel (prior, of course, to burst blanking) They are then passed to a so-called *burst gate* which opens only during the period of each burst, closing during each line period and thus blocking the chroma signal proper. We shall be dealing with this section later.

Another chroma channel control is that for the *colour killer*. The idea is for the chroma channel to shut down completely when the transmission is monochrome and not colour-encoded. This ensures that the black-and-white display is not affected by spurious noise in the chroma channel. It is possible with the chroma channel "open" during a monochrome transmission for transmission and/or amplifier noise to be filtered into the subcarrier spectrum and appear as coloured grain (snow) on the picture.

The colour killer prevents this from happening by biasing the chroma amplifier into cut-off. In fact the colour killer proper is nothing more than a muting bias on one of the chroma stages. When the signal is colour-encoded the bursts which such a signal carries are rectified and applied to the muted stage as a counteracting bias. The chroma channel is thus closed on monochrome and open on colour.

Most sets also have a control which automatically adjusts the chroma amplifier gain. This is called *automatic chroma control* or a.c.c. for short. It is similar to a.g.c. but while a.g.c. controls the gain of the i.f. channel and possibly the tuner's r.f. amplifier in accordance with the overall signal strength, the a.c.c. controls merely the gain of the chroma channel relative to the amplitude of the colour bursts.

To summarise then, the chroma channel commences with a bandpass filter to delete the Y signal, it has a blanking arrangement to get rid of the bursts, a tuned filter to pass the bursts out from the chroma to the burst gate for phasing the subcarrier generator, a colour killer control and generally a.c.c. The signals associated with all these controls will be investigated separately in subsequent instalments but right now we are interested mainly in the amplified chroma signal which is fed to the V and U detectors.

Chroma Passband

To ensure the chroma signal possesses all the required characteristics for good colour it must be

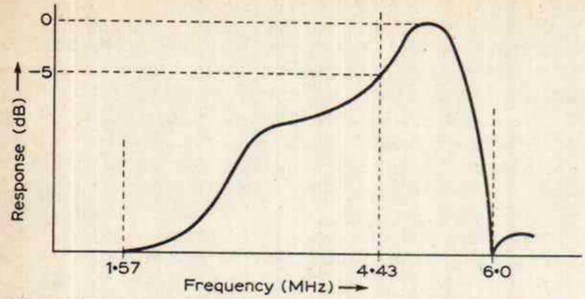


Fig. 4: The response of the chroma channel is sometimes like this.

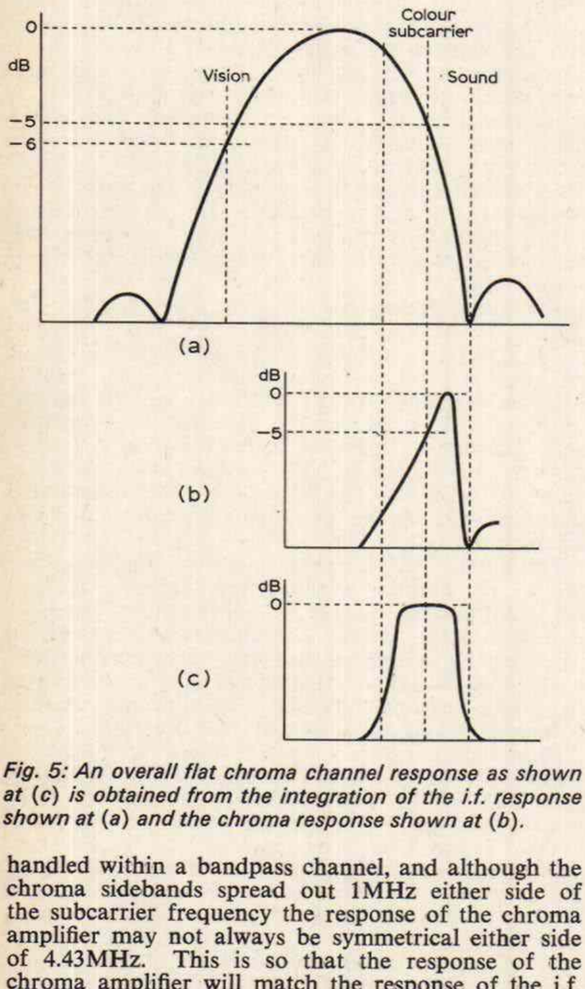


Fig. 5: An overall flat chroma channel response as shown at (c) is obtained from the integration of the i.f. response shown at (a) and the chroma response shown at (b).

handled within a bandpass channel, and although the chroma sidebands spread out 1MHz either side of the subcarrier frequency the response of the chroma amplifier may not always be symmetrical either side of 4.43MHz. This is so that the response of the chroma amplifier will match the response of the i.f. channel in a way that will produce a uniform response over the chroma sidebands. It will be recalled that the i.f. response at the luminance carrier frequency is 6dB below maximum, and in some sets the colour subcarrier is about 5dB below maximum at the other side of the i.f. response. Now when the colour subcarrier is below maximum response the lower sidebands of the colour subchannel receive more amplification than the upper sidebands, and to counteract this the response of the chroma channel is made asymmetrical with the subcarrier frequency falling at about the −5dB point, as shown in Fig. 4. Fig. 5 shows how an integration of the two responses (subcarrier at i.f. and subcarrier at chroma) produces a flat chroma passband.

So far so good; now let us return to Fig. 1. The level of chroma signal fed to the PAL synchronous detectors can be regulated by the colour control on the set. This merely serves as a sort of colour contrast control and on some models when fully retarded all colour disappears from the picure, leaving the display in black-and-white. Conversely therefore as the control is advanced—after first setting the brightness and contrast in the usual way—so colour is gradually added to the picture, the control being set to satisfy the viewer's saturation preference.

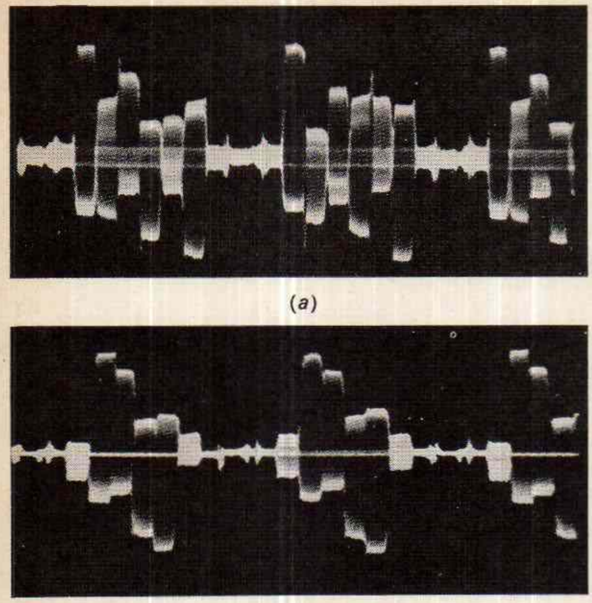
We have seen that the chroma signal consists of the sidebands of the V and U signals, originally derived from the R−Y and B−Y signals at the transmitting end of the chain, that the 4·43MHz subcarrier is automatically suppressed and that the V and U signals are in phase quadrature. Part 2 in the August issue revealed the chroma signal makeup and its various characteristics and it is not intended here to go all through this detail again. However we must keep in mind that the colour saturation as displayed on our screens is a function of the *amplitude* of the chroma signal, while the hue is a function of its *phase*, bearing in mind that the quadrature modulation of the two lots of information—V and U signals—is itself a function of phase. It was shown in Part 3 (September 1969) just how the phase is related to hue over the chromaticity diagram.

Chroma Phase Problems

Now one of the big problems of the original NTSC colour TV system lies in maintaining phase stability all the way from the transmitting camera to the receiving picture tube, taking in not only the circuits between but also the propagation medium (i.e. ether and landline). Variation of phase characteristics anywhere between the camera and picture tube obviously affects the phasing of the V and U sideband components of the chroma signal and thus tends to cause the displayed hue to veer from that being televised. This can happen due to changes in the propagation medium or camera channel and in the USA, where the NTSC system is used, it is not unknown for the hue to change significantly on switching from one camera channel or telecine unit to another. For this reason NTSC sets carry a user's hue control to enable the viewer to compensate for such hue changes during a transmission, the usual technique being to match up on flesh tones. It is also possible on the NTSC system for changes in signal conditions, resulting from tropospheric influences, reflections and so forth, to change the displayed hue; but this again can be corrected by the hue control.

Conditions which tend to alter the chroma signal amplitude are less disconcerting since a change in amplitude merely results in a change in saturation which can be compensated for automatically in the set by the a.c.c. system.

Now one part of the PAL chroma channel neutralises the NTSC phase problem very neatly. This is the part in Fig. 1 between the chroma amplifier output and the V and U detectors; that is, the adder, subtractor and PAL delay line. This department is worked by the alternating phase of the V component of the chroma signal in the PAL system



(*a*)

(*b*)

Fig. 6: U (a) and V (b) signals at the output of the PAL delay line/adder/subtractor circuits. These are the signals applied to the synchronous detectors.

referred to in Part 3 (September 1969). In the NTSC system the chroma detectors operate directly on the chroma signal, but those in the PAL system operate separately on the V and U signals. In other words the PAL department between the chroma amplifier output and the detectors in Fig. 1 separates the V and U components of the composite chroma signal and does this in a way that compensates for spurious phase changes. The action is as follows.

PAL Decoder Action

Figure 1 shows that the chroma signal is fed simultaneously to the PAL delay line and to the adder and subtractor; and that the delay line output also feeds the adder and subtractor. Considering the adder first: this is presented with signals from two sources, direct from the chroma channel and via the delay line, which delays the signal exactly by the time taken by one line (64μsec on 625 lines). The U component of one line is thus added to the U component of the next line, giving a signal equal to 2U. The V component of one line is similarly added to the V component of the next line, but this is where the PAL "trick" comes in, for while the U phase remains fixed the V phase alternates from line to line so that we get the *addition* of +V and −V, resulting in complete cancellation. This means then that the adder feeds only U signal to the U detector.

Now considering the subtractor: this is also presented with signals from two sources, direct from the chroma channel and via the delay line, which means that the U component of one line is subtracted from the U component of the next line, resulting in complete cancellation. The V component of one line is similarly *subtracted* from the V component of the next line, but since on one line we have +V and on the next −V, the subtractor yields a signal equal to 2V, and only this signal feeds the V detector.

To sum up therefore, the adder cancels the V components of the chroma, leaving only the U components for processing by the U detector, while the subtractor cancels the U components of the chroma leaving only the V components for processing by the V detector. In other words, the adding and subtracting actions in conjunction with the alternating V phase neatly separate the V and U signals of the composite chroma signal *and in so doing completely delete spurious phase changes in the transmission.*

Figure 6 shows the U signal at (a) and the V signal at (b) resulting from the chroma signals shown in Fig. 3, as delivered by the PAL decoder for application to the U and V detectors.

Synchronous Detectors

Now for the V and U detectors to produce the R−Y and B−Y colour-difference signals they must also be presented with a signal corresponding to the subcarrier that was purposely suppressed at the transmitter. This usually emanates from a crystal-controlled subcarrier generator in the set, though there are other ways of getting the subcarrier (e.g. direct from the bursts) and these will be considered in the series dealing with colour TV circuits.

To satisfy quadrature demodulation the subcarrier phase at one detector must differ by 90 degrees relative to the subcarrier at the other detector. This is accomplished by the 90deg. phase shifter shown in Fig. 1. Moreover the phase at the V detector must also alternate in synchronism with the PAL V phase alternations. This is where the PAL switch comes in. This is activated by a signal geared to the swinging bursts. (Either the reference subcarrier, as shown here, or the V signal itself, may be switched.) Finally the R−Y and B−Y signals are cleaned of unwanted subcarrier components by passing from the detectors through the low-pass filters shown in Fig. 1.

Next month we shall be looking at the subcarrier, PAL switching and swinging burst signals, seeing how they fill in the gaps of Fig. 1.

TO BE CONTINUED

CLOSED-CIRCUIT TV

—continued from page 174

sync to equalise conditions since one field sync comes halfway between line pulses and the other simultaneously with a line pulse. The use of equalising pulses makes both field pulses equal as far as their effect on a sync generator is concerned, and greatly improves interlace.

Before the generated pulses are fed to the output stage they are sharpened by the addition of a differentiated pulse gated from the master generator.

In addition the field trigger pulse can be fed into a circuit which compares its phase with that of the mains and generates a voltage proportional (positive or negative) to the phase difference. When the generator is being run locked to the mains this voltage is used to correct the generator frequency by means of a voltage variable capacitance so that the generator is completely locked. Alternatively a similar circuit can be used to lock a local sync generator to others in use remotely.

NEXT MONTH: VIDEO CIRCUITS

TRANSISTOR AND DIODE ANALYSER

MARTIN L. MICHAELIS, M.A.

PART 4

CONCLUSION: GENERAL NOTES ON THE USE OF TRANSISTORS

The eight systematic tests previously described will have provided very exhaustive information concerning the type and general applications of a given transistor. The results of Test 8 largely form the working basis for setting up a practical circuit using a transistor in the ways in which it is suitable according to Test 7. Tests 1 to 6 merely establish the type and the connections of a transistor and to determine whether it is intact or faulty.

A few typical examples have been included in Table 3. The readings were obtained with the transistor analyser with a specimen of each named transistor type taken at random from the author's spare-parts box. The following general principles of establishing a practical circuit are illustrated thereby.

TEMPERATURE EFFECTS

(1) The collector leakage current *I*co or *I*coe is always strongly temperature dependent so that only a few degrees change of ambient temperature suffice to double or halve the leakage current. The temperature coefficient is always positive so that leakage current increases with temperature. As a rule of thumb, the minimum value of collector current for a satisfactorily stable operating point is ten times the leakage current for an a.c. amplifier or a hundred times the leakage current for a d.c. amplifier with *I*coe the valid leakage current if the base is being driven from a source with very low d.c. resistance or *I*co if the base drive source possesses a very high d.c. resistance. Since *I*coe is always considerably less than *I*co the thermal stability of an operating point is always improved by reducing the d.c. resistance of the base drive source, i.e. by reducing the d.c. resistance effective between base and emitter.

Temperature compensation measures using n.t.c. resistors, large unbypassed emitter resistors or other forms of d.c. negative feedback are always useful unless the collector current at the operating point is very much greater than the leakage current, and such compensation is quite essential if the operating point to leakage current ratio has to be smaller than the values stated above (e.g. in Class B push-pull stages with very low quiescent current). If it is desired to measure the leakage current for a given base-to-emitter resistance simply plug-in a resistor of this value between the base and emitter in addition to the transistor and read in the μA base mode at zero base drive current.

OPERATING POINT

(2) On the basis of (1) we see for example that the OC303 requires at least 20μA base drive giving at least about 1mA collector current for stable performance in an ordinary a.c. amplifier. β is seen to be much reduced but still very considerable at 2μA base drive giving 100μA controlled collector current. However with some form of efficient temperature compensation, and especially if a low-resistance base circuit is used, the transistor may well be usable in a circuit with this lower operating point. The position is very similar for the OC71 except that this type scores over the OC303 in that its current gain is essentially constant right down to the very low operating points so that it gives superior amplification here. Note that the current gain of the OC71 drops appreciably at currents greater than $Ic = 50$mA. This behaviour means that it is undesirable to operate the transistor at standing collector currents much greater than this roll-off point.

The BC108C is an example of a virtually ideal general purpose transistor with absolutely constant current gain from less than 50μA to more than 50mA collector current corresponding to base drive currents from 50nA to 100μA. Even at the lowest operating point of 50nA base drive current giving 29μA standing collector current little temperature compensation is indicated as being necessary because the leakage current is still much smaller at room temperature.

Now the fact that a particular transistor possesses very low leakage current is not alone sufficient reason for using it in very low current (very high impedance) circuits because the current gain may be uselessly small at low currents. This is exemplified by the BSY51, which only really gets cracking in the range of several milliamps collector current for a considerable fraction of a milliamp base drive. Its current gain has clearly vanished for such low base drive currents with which the BC108C still gives full normal current gain. These distinctions may be important for example in selecting suitable transistors for high-impedance low-current discriminator circuits in television equipment or for designing complex portable equipment where available battery current per stage is at a premium.

POWER TYPES AT LOW CURRENTS

(3) Although it is often assumed that power transistors in groups D and E will operate satisfactorily only at altogether larger currents than suitable for

the groups A to C, this is often a fallacy. Many large power transistors function very well at surprisingly low currents so that they are ideal for circuits subject to enormous ranges of signal current swing (stabilised power supplies, high-level operational amplifiers, servo controls, etc.). Germanium power transistors tend to have rather large leakage currents which restrict the permissible usable reduction of collector current even if current gain remains good at low currents as exemplified by the L004C or 2N257. But the leakage currents of large silicon power transistors are usually as negligibly small as for the small-dimension silicon types. The BD107 shown in the table is a typical example. It will operate very satisfactorily with 50nA base drive current giving 1·5μA collector current representing a very useful beta of 30 for this extremely low operating point. However this current gain is drastically lower than the normal value of over 100 developed at around half an ampere collector current.

PRECAUTIONS WHEN EXAMINING β

(4) Note that only the four lower ranges 0·1, 1, 10 and 100mA of the transistor analyser meter operate via VR1 and may be used in the described manner for investigating the current gains of transistors belonging to any group A to E. The 1A meter range does not operate via VR1, which is here switched out of circuit and internal fixed resistors corresponding to a setting of 120% f.s.d. are switched into circuit. This 1A meter range is intended *only* for power transistors in groups D and E, *with caution* for some transistors in group C, and for metering the current drain when using the 12V supply for powering external circuits.

Some caution is also needed when using the 100mA range for groups A to C, to avoid exceeding the maximum permissible power dissipation, but in the 0·1, 1 and 10mA meter ranges it is hardly possible to damage a transistor by wrong VR1 settings. When testing microminiature pinhead-size transistors or transistors in integrated circuits, extend caution to the 10mA meter range too. Unless otherwise known assume that these devices will not tolerate more than 5mW power dissipation.

CONSTANT & VARIABLE-β TYPES

(5) Note that only constant-β transistors such as the BC108C, L004C and 2N257 in our examples are suitable for handling large-signal swings whose dynamic current amplitude is comparable to the standing current at the operating point, i.e. only these constant-β transistors will operate as low-distortion high-level a.c. amplifiers with good power efficiency.

Variable-β transistors obviously produce heavy distortion on large-signal current swings so that their use in linear signal amplifiers is normally restricted to the low-level early stages of an amplifier chain or to any other application where the signal current swing is only a small fraction of the standing current at the chosen operating point. On the other hand these variable-β transistors respond extremely well to a.g.c. applied simply as base bias to shift the operating point. For example a BSY51 may be expected to work better as an a.g.c.-controlled vision i.f. amplifier than would a BC108C whose current gain is hardly affected by a shift of operating point.

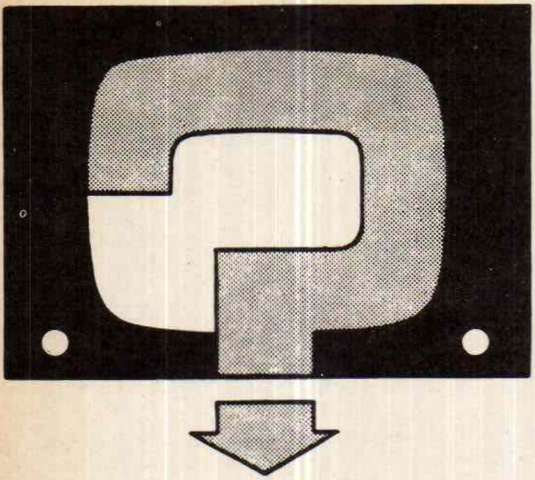
Other factors also play a role in establishing the final optimum choice. Variable-β transistors such as the BSY51 will also perform better as mixers with a local oscillator drive sufficient to swing the instantaneous operating point through a large range of variation of β because the ensuing non-linearity is an essential condition for frequency conversion. In this sense the BC108C would give much poorer conversion conductance unless of course the oscillator drive is so large that the device rectifies by cut-off. On the other hand the BC108C suggests itself as promising for use in fairly high-level amplifiers in which crosstalk between many signals handled simultaneously must be avoided at all costs (e.g. in aerial preamplifiers and distribution amplifiers). With the BC108C there is much less danger of strong local stations cross-modulating weaker stations than when using a BSY51.

If it is necessary to use a transistor with significantly variable β in a high-level amplifier which is supposed to be strictly linear quite heavy a.c. negative feedback is essential to achieve the desired overall linearity. On the other hand an almost ideally constant-β transistor such as the BC108C already amplifies in a very linear manner without negative feedback so that the obtainable stage gain is greater.

For readers familiar with valve techniques, the behaviour and applications of variable-β and constant-β transistors may be taken as roughly analogous to variable-μ and straight pentodes respectively. In quite a lot of instances in modern television and radio equipment the top roll-off of β is used for a.g.c. instead of the bottom roll-off, i.e. gain is reduced by biasing to larger collector currents as illustrated by the OC71. This is permissible only if the resulting long-term operating points never exceed the permissible maximum power dissipation and due attention must be given to the increased danger of thermal runaway.

SILICON THRESHOLD

(6) Silicon transistors have a base-to-emitter threshold voltage below which no controlled collector current appears. This threshold voltage lies between some 100mV and 600mV according to the desired collector current and is *very strongly temperature-dependent*. Thus if the required base drive current is drawn through a low resistance from a low-voltage source temperature drift of the operating point is aggravated through the temperature coefficient of the threshold voltage. Thus the circuit may be less stable than when using an equivalent germanium transistor. It is better to provide the base drive current for a silicon transistor through a large resistor from a source voltage much greater than the silicon threshold. In other words, remember the useful rule of thumb that wherever possible silicon transistor circuits are advantageously voltage-operated in a high-impedance base drive circuit (to offset threshold drift) whilst germanium transistors are advantageously current-operated in a low-impedance base drive circuit (to offset leakage current drift), although this distinction is relative and need not be taken as a rigid rule. ■



YOUR PROBLEMS SOLVED

Whilst we are always pleased to assist readers with their technical difficulties, we regret that we are unable to supply service data or provide instructions for modifying equipment. We cannot supply alternative details for constructional articles which appear in these pages. WE CANNOT UNDERTAKE TO ANSWER QUERIES OVER THE TELEPHONE. The coupon from page 188 must be attached to all Queries, and a stamped and addressed envelope must be enclosed.

KB OV30

This receiver does not receive London transmissions at my address as it was brought here from Scotland. Can you say how I can receive the local stations?—L. Alexis (London, W.2).

There are still quite a large number of KB 'New Queen Special' receivers as we would judge from readers' queries and we would therefore expect that it should be fairly easy to obtain the two coil sets that you require from a surplus receiver. For this we would suggest you try the dealers in your neighbourhood or perhaps one of the advertisers in PRACTICAL TELEVISION. We mention dealers because quite often they take receivers in part exchange and these are of no use to them. We have obtained many gems ourselves in this way.

If all else fails, rather than let the set waste you can always wind your own on any spare coils there are in the receiver. The coils will have to be larger than the ones for the higher channels that you have used before but the old ones can be used as a guide. We can offer very little other advice other than be patient if you do attempt this!

FERGUSON 3638

Could you state the correct procedure for chassis removal of this 16in. screen dual-standard portable receiver?—C. Elgey (East Yorkshire).

The chassis can be removed as follows: Remove rear cover, channel selector knob assembly and u.h.f. tuning control knob assembly. Each knob assembly is secured by a screw accessible from inside the cabinet. Pull off the four front control knobs. Unplug the speaker connections and remove four chassis fixing screws and ease chassis from cabinet to the extent of the interconnecting leads. Access to parts underneath the upper chassis is gained by hinging it upwards after removal of two fixing screws. Complete removal demands unplugging the tube base connector and e.h.t. connector. Then slacken the deflector coil assembly from the tube neck, noting the position of the linearity correcting sleeve. Finally remove the tube earthing lead from the chassis side panel.

FERGUSON 506

When this receiver is first switched on the sound comes through as normal but after a few seconds it suddenly cuts off, then the picture appears. The picture is poor and has a $\frac{1}{2}$in. black border at the bottom. After a few minutes the sound returns with a hum in the background and the picture becomes perfect.—M. Varnals (London, E.11).

Symptoms of this kind are often caused by worn or intermittent sound and vision channel valves. It would be as well therefore to have the valves checked for both emission and intermittency before getting too involved in the sound and vision circuits proper. For the $\frac{1}{2}$in. black border check the h.t., the PCL82 field output valve and its 100μF cathode capacitor.

PHILIPS 19TG170A

The picture oscillates rapidly up and down about $\frac{1}{8}$in. making wording in black on white appear out of focus. The picture is satisfactory in all other respects (Bands I and III). I have checked for interlace faults but all components appear to be in order. —L. Hudson (Derby).

The only way to find an interlace fault like this is to replace components one at a time until it is cured. This kind of fault is usually caused by insufficient amplitude of the field pulses reaching the oscillator to lock it or by the shape of these pulses being inconsistent.

The components to check would be first C432 (82pF), R454 (1·5MΩ), the screen decoupling component on V404 (EF80) and R275 (150kΩ). Then check the anode voltages on the two halves of the field oscillator. And of course replace the sync separator valve.

FERGUSON 3602

A few seconds after switching on this set I get a loud howling through the speaker. The vision remains quite good. I have changed the PCL82 and the EF80 sound i.f. amplifier valve.—D. Latchfield (Essex).

We would advise you to check the 3·9MΩ resistor which is wired from pin 9 to pin 6 of the PCL82 (V12), the resistor being R130 on the panel.

GEC 2018DS-T

BBC-1 and BBC-2 are OK but on both ITV positions the picture is grainy. I have fitted a new PC900 which improved the vision slightly and a new PCF801 was tried but with no effect. I cannot gain access to the switch contacts to clean them. At random intervals a crackle occurs and the vision is good but it only remains so for a short period before reverting to the original symptoms.—E. Smith (Shropshire).

You will have to extract the tuner for detailed examination as it seems that a resistor in the r.f. amplifier circuit is breaking down. Such trouble is often intermittent as you describe and affects the higher frequency ITV channels more than the lower BBC-1 channels. (The u.h.f. channels are derived from a separate tuner.) When you have extracted the tuner the switch contacts can then be cleaned and the resistors associated with the r.f. amplifier replaced if necessary. However, it often demands a special alignment jig and test assembly to evaluate the goodness of the tuner, a job best left to a dealer or the manufacturer.

BUSH TV166U

There is ghosting on BBC-2 which I cannot eliminate by any means.—D. Dawson (Sheffield).

No one can tell you exactly how to get rid of your ghost. It is caused by the aerial picking up indirect, reflected signals a fraction of a second after the direct signals. The only possible solution lies in achieving improved discrimination against the reflected signals at your aerial. This usually calls for an aerial of better directivity (narrower beam width) very carefully orientated until the strength of the reflected signal is 200 times at least below that of the direct signal. When this occurs the ghost will disappear!

PHILIPS 1768U

On switching on I get a normal picture for approximately half a minute. It then breaks into a series of white lines about ¾in. apart. These sometimes roll up or down and sometimes just "shimmer". While the picture is normal the boost h.t. is perhaps a trifle high but when the picture breaks up the boost volts drop to 350V (a loss of 130V). I have changed the PY81 and also checked both field circuit valves.—G. Crossman (Hampshire).

The fault you describe on this set is very suggestive of boost capacitor breakdown. This is C57 (39 kpF). If this fails to cure the fault check the line output valve, the e.h.t. rectifier and the screen voltage on the line output valve. Also check the anode feed resistors to the field oscillator valves and the electrolytic capacitor in the cathode of the field output stage.

QUERIES COUPON

This coupon is available until January 23, 1969, and must accompany all Queries sent in accordance with the notice on page 187.

PRACTICAL TELEVISION, JANUARY 1970

TEST CASE

86

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

? *A PAL-D colour set worked perfectly all right on monochrome transmissions but on colour transmissions intermittently displayed Venetian blind effects, commonly called Hanover bars. These are "shaded" horizontal lines from the top to the bottom of the picture. This symptom is not uncommon in Europe on the PAL-S type of set—i.e. the type of set which relies on the eyes to integrate equal and opposite colour errors on adjacent lines of the picture which can be caused by differential phase errors of the chroma components of the composite signal from the transmitter to the receiver—but should not occur on the PAL-D type of set which includes a PAL delay line and associated circuitry for cancelling such errors electronically.*

Thinking that possibly the aerial was at fault the service technician took special pains to reorientate this for the maximum pickup of signal in the local Band IV channel. The picture was then totally free from the symptom, but a few days later he was called back to the set again for exactly the same complaint.

What part of the colour set was most likely to be at fault? See next month's PRACTICAL TELEVISION *for the solution to this problem and for a further Test Case item.*

SOLUTION TO TEST CASE 85
Page 140 (last month)

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Reclaimed TV Tubes with six months' guarantee 17in. types AW43/80, AW43/88 **40/-.** MW43/69 **30/-.** 14in. types, **17/-.** All tubes **12/-** carriage.

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