TELEVISION

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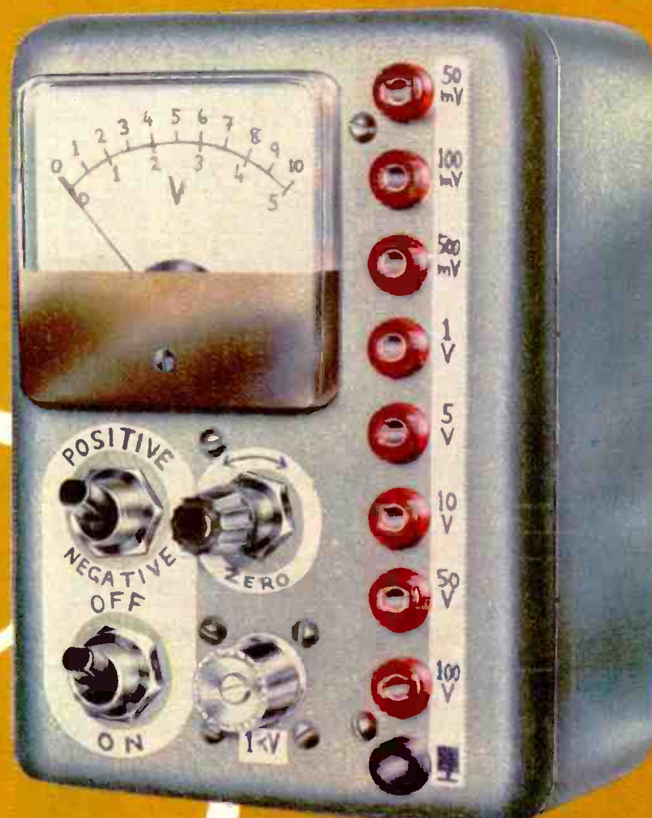
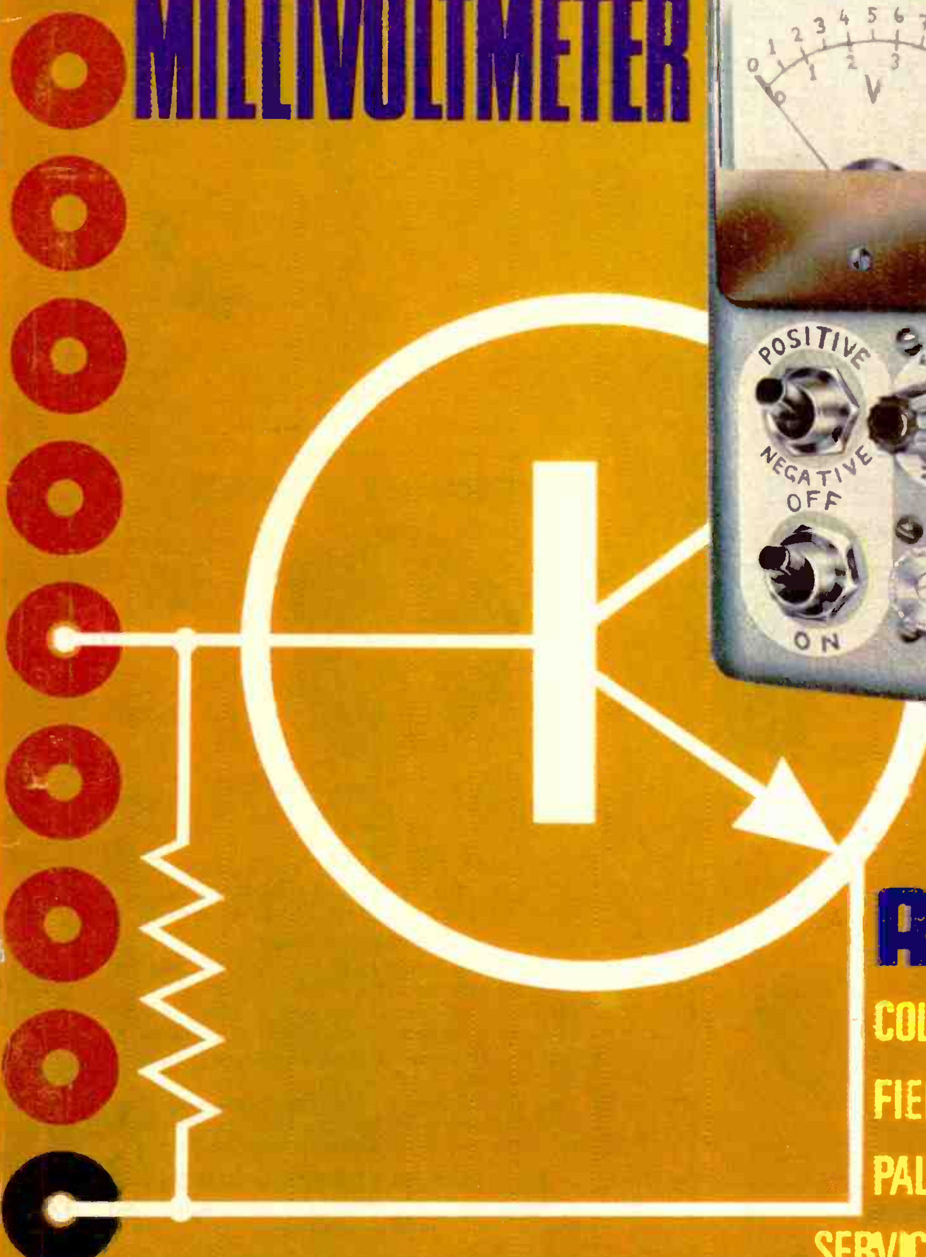
SERVICING · CONSTRUCTION · COLOUR · DEVELOPMENTS

OCTOBER 1970

I.C. MILLIVOLTMETER





ALSO:

COLOUR RECEIVER CIRCUITS

FIELD EFFECT TRANSISTORS

PAL SWITCHING TECHNIQUES

SERVICING PYE HYBRID MODELS

TELEVISION

VOL 21 No 1
ISSUE 241

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RENT OR BUY?

The UK has a much higher proportion of rented to individually owned TV sets than any other country. In fact the TV rental shop is today something of a high-street institution. It's worth however asking from time to time whether this predominant position of renting is justified, and *Which?* in a recent report has done just this.

It's unlikely that the newly-marrieds of today will be aware of the very real worry that the thought of a new TV tube caused a few years ago. Tubes and servicing were expensive and sets none too reliable. Renting, with servicing the responsibility of the rental organisation, was an obvious answer and caught on.

But there have been underlying changes in the situation. Company taxes have changed and overheads increased, and as a result there has recently been a tendency for rentals to edge up. Also, takeovers have reduced the number of rental organisations and hence the competition. On the technical side the situation has a nice touch of irony: the rental organisations, most of whom handle their parent company's sets, demand reliable and easily serviced chassis—but since the same chassis are offered for sale the individual buyer also gets the benefit! The modern chassis is very much more accessible than those of years ago, and with the latest single-standard ones we seem to have reached a state of very welcome set reliability.

These are probably the facts underlying *Which?*'s conclusion that if you want a new black-and-white set today and are not going to want colour for a while "you would do better to buy." *Which?* goes further and concludes that maintenance contracts for monochrome sets, costing up to £10 a year, are not worthwhile since yearly servicing costs for monochrome dual-standard sets average £2-£3.

On colour *Which?* decided that renting a single-standard set was the best course. The reliability of colour sets has greatly increased, but it can be expensive if things go wrong. Will the position change for colour as well in a few years' time we wonder?

W. N. STEVENS, *Editor*

THIS MONTH

THE NEXT ISSUE DATED NOVEMBER WILL BE PUBLISHED OCTOBER 23

TELETOPICS

VIDEOTAPE COLOUR ADAPTOR

Ampex have adapted the FAM (frequency-amplitude modulation) system for a colour adaptor for use with their 1in. helical-scan videotape recorder. The unit costs about £625 and provides an add-on colour facility for systems which are otherwise suitable for only black-and-white due to restricted bandwidth and poor phase characteristics.

The encoder which produces a coded signal for recording accepts an RGB input. After the usual matrixing to obtain luminance and colour-difference signals, low-pass filters are used to limit the U (B−Y) and V (R−Y) colour-difference signals to 0-0.7 MHz while the luminance signal is limited to 0-2 MHz. The V signal then frequency modulates a 2.65MHz carrier which is subsequently amplitude modulated by the U signal. The frequency-amplitude modulated carrier is then added to the luminance signal, giving a coded signal with a bandwidth of 3MHz.

To decode the signal on playback a 2.1-3.9MHz bandpass filter separates the chroma signal while a delay line notch filter with maximum rejection at 2.65MHz removes the chroma signal from the luminance channel. The chroma signal is fed to separate a.m. and f.m. demodulators which recover the original U and V signals. These are matrixed with the sharpened (to improve resolution) luminance signal to provide RGB outputs. No phase-sensitive circuits are required in the decoder.

The frequency of the carrier used for the colour-difference signals is not related to the line frequency and so is independent of the line and field standards used. The FAM encoded signal is not compatible, i.e. it cannot be replayed on a black-and-white only videotape recorder.

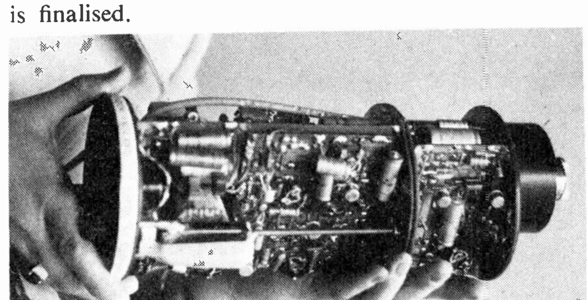
IMPEDANCE-COMPENSATED UHF AERIALS

The Labgear Colourmatch range of u.h.f. aerials now incorporates what Labgear call a "compensated collector assembly". This consists of a specially shaped and positioned first director element in their Yagi array. They point out that the optimum spacing of the first director in a multi-element Yagi array for greatest gain is not necessarily the same as the spacing required to give optimum matching to the feeder (especially necessary for good colour reception). The design of the first director in the "compensated collector" arrangement has been tailored to meet these two requirements—best gain and matching—giving good signal pick-up, a clean polar response and reflection-free matching. There are three models, the CMT11, CM14 and CM18, for the A, B and CD aerial groups respectively. Further details from Labgear, Cromwell Road, Cambridge CB1 3EL.

CCTV SYSTEM FOR £45

The CCTV system being demonstrated.

The latest constructional project to be produced for schools and other teaching establishments by the Mullard Educational Service is a closed-circuit TV camera which can be built for as little as £45. The camera uses a 1in. vidicon tube and employs extremely simple circuitry. Given reasonable lighting conditions, the camera will provide an output signal of 1·0V peak-to-peak into 75Ω. The prototype was housed in a length of 2½in. domestic plastic tubing, and a simple home-made lens system can be used. Although this project is primarily intended for schools, we hope to publish fully comprehensive constructional details in TELEVISION when the design is finalised.



View of the inside of the prototype camera.

MECHANICAL-FILTER IF BANDPASS COUPLING

The US Zenith Corporation has been experimenting with the use of a mechanical filter for bandpass coupling in TV receiver i.f. stages. The device consists of a piezoelectric lead zirconate plate to which "transmit" and "receive" electrodes are attached. The signal is fed to the transmit electrode which stresses the ceramic plate, causing mechanical waves to travel along its surface. These create a varying electric field which is detected by the receiving electrode. The electrodes are comb-shaped, the comb spacing affecting the frequency response of the device. A complete colour receiver i.f. strip has been built using four of these filters (called surface wave integral filters) together with i.c.s. on a 2 × 1in. thick-film circuit with a ceramic substrate.

STATIONS NOW OPERATING

BBC-1 and ITV programmes are now transmitted on u.h.f. from **Pontop Pike.** BBC-1 is on channel 58 and ITV channel 61. A group C aerial installed for horizontal polarisation is required. The BBC-1 u.h.f. service from **Waltham** on channel 58 (horizontal polarisation, group C aerial) and the BBC-2 service from **Rosemarkie** on channel 45 (horizontal polarisation, group B aerial) have also started. The ITA has been authorised to advance the timing of the construction of a new main u.h.f. transmitter at **Stockland Hill** near Honiton Devon. It is hoped to bring this station into operation in the Autumn of 1971, radiating Westward Television on channel 23.

The ITA has also now brought into operation its v.h.f. relay stations at **Ballycastle** Northern Ireland—on channel 13 with horizontal polarisation—and **Newhaven**—on channel 6 with vertical polarisation. The opening of these stations marks the completion of the ITA's network of 405-line v.h.f. transmitters.

COLOUR FROM A MONOCHROME RECORDER!

The German Korting firm has demonstrated how a low-cost monochrome video recorder can be used to reproduce colour on a colour TV set with the aid of a signal generator. The technique used is the FAM system described elsewhere in these notes. Korting have adapted their colour television signal generator for this purpose, and are now offering it as a standard item. The generator will be marketed in the UK by Decca Radio and Television who handle other Korting test equipment in this country. Korting consider the main application of the technique to be in education and advertising in stores, where for example several ordinary colour receivers could be used as monitors in a low-cost set-up.

LATEST SETS & TRADE NEWS

Much news this month from the Philips/Pye group. First a new single-standard colour chassis, the G8, to be used initially in the **Philips** 22in. Models G22K250/02 and G22K250/06. The chassis is the first UK produced one to feature "electronic tuning" by means of varicap diodes (five of them) in the u.h.f. tuner. The channel-selection buttons operate switches which select different preset bias potentials for the varicap diodes, thus altering the tuning. The chassis uses modular construction and is all solid-state except of course for the c.r.t. itself. Four i.c.s., one for stabilising the power supply for the electronic tuning system, one for the intercarrier sound channel, one for the luminance preamplifier and sync stages and one as PAL switch and synchronous demodulator are used. It is understood that later versions will use a further i.c. for colour signal matrixing and preamplification. The chassis uses RGB drive to the c.r.t., and a stabilised thyristor power supply circuit. A.F.C. is applied to the tuner along with the varicap diode biasing. There are five new monochrome **Pye** models. The 93, a 24in. model at £92, and the 94, a 20in. model at £83.10.0d, are dual-standard models fitted with the 368 chassis. Single-standard models fitted with the 169 chassis are the 24in. Model 95 at £82.16.0d, the 20in. Model 96 at £74.10.0d and the Model 92 "Rambler", a 17in. model designed for the second-set market and fitted with a loop aerial—it is expected to sell at around £73. The other news from the group is that there are to be no more **Ferranti** sets, the group now having relinquished the right to use the name. Spares will continue to be available for the same periods as for other brands marketed by the group (7 years for TV sets and 5 years for radio receivers from the date of purchase).

The ITT-STC group have introduced two new **KB** models, the 20in. Model SV043 at £71.15.0d and 24in. Model SV143 at £80. These are de-luxe versions of the other two recently introduced models, and all are fitted with their new VC200 single-standard printed-circuit chassis.

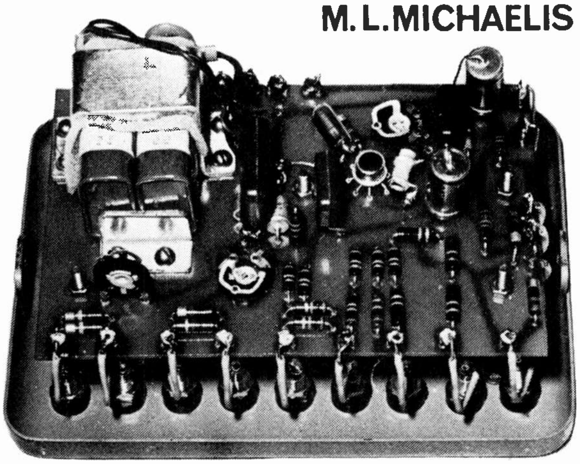
A new model in the **National** range is the TR419 "Pana-Pana", a 9in. portable for battery or a.c. mains operation. It is fitted with a loop aerial and earphones for personal listening and has a recommended price of £69.10.0d. It is of course a single-standard model. National models are handled by Unamec Ltd., United Africa House, **Blackfriars** Road, London, SE1. **Rediffusion** now have a 26in. square-screen colour model for use with their wired TV system.

An interesting new u.h.f. set-top aerial, the MCA11, has been introduced by **Panorama.** This is a wideband seven-element log-periodic aerial, with recommended price of 53/-d. Unusually for log-periodics, all the elements are dipoles. (Panorama Radio Co. Ltd., 73 Wadham Road, London SW15).

The latest BREMA figures, for June, show colour TV set deliveries up once again, at 38,000. This means that UK setmakers have now delivered half a million colour sets to the market since the colour service was started in 1967. Over half of these have been delivered in the last nine months. There has been a further slight slackening in the deliveries of monochrome receivers, with figures of 133,000 and 124,000 for May and June respectively. Deliveries of single-standard monochrome receivers have increased and these are now estimated to account for 40% of the monthly deliveries of monochrome sets. The six-monthly figures show radio deliveries down slightly, radiogram deliveries up slightly, and record player deliveries up by the striking figure of 42%.

I.C. MILLIVOLTMETER

M. L. MICHAELIS



THE complete theoretical circuit of the i.c. millivoltmeter is shown in Fig. 1 and is simple to understand in the light of the detailed discussion of operational amplifiers given in the August issue. A high input impedance is required so the voltage from the input bleeder network is taken to IP. VR3 is R_{FB} and its ratio with respect to R19 determines the operating gain factor which is adjustable with VR3 to set the overall sensitivity of this electronic voltmeter.

Since the input voltage to be measured is tied to chassis and moreover we cannot tolerate back-injection of voltages into the circuits being measured, offset compensation with VR4 is applied to $\overline{IP}$, not to IP. The range of VR4 has been made sufficient to reach full scale deflection of the meter in either polarity with no input voltage, so that half-scale deflection can be set to give centre-zero facilities when aligning f.m. discriminators, or large zero-point suppression can be used to measure small changes of large voltages. The component values around VR4 have also been chosen so that the criterion for exhausted batteries is that full scale deflection can no longer be reached with VR4 in one or both polarities.

MEASURING RANGES

The i.c. operational amplifier permits lowest ranges with much smaller f.s.d. voltage values than were realisable previously with straightforward valve or transistor voltmeters. Stable ranges with acceptable residual zero point drift are possible down to an order of magnitude above the offset voltage, i.e. down to 20mV f.s.d. Transistor and valve voltmeter circuits give trouble below 1V f.s.d. on account of temperature-dependent and sample tolerance variations of threshold voltage or grid current respectively. The i.c. operational amplifier is thus superior by nearly two orders of magnitude in comparable circuits. In fact a further two orders of magnitude could be obtained by slight circuit refinement amounting to stabilisation of the power supply, because the residual zero point drifts of the present circuit are almost entirely due to drifts across VR4 with ageing batteries, not due to imperfections of the i.c. The latter are determined by the temperature coefficient of the offset voltage, which no longer lies in the low millivolt region but down in the microvolt range.

We have however set out to devise the simplest possible circuit with attractive performance. We have made no attempt to stabilise the battery voltage which varies through its own order of magnitude in the course of battery life. Consequently the millivolts sample of the battery voltage stepped down across VR4 for offset compensation also varies but the resulting zero point drift is acceptable if the required input voltage for f.s.d. output voltage is an order of magnitude greater. The zero point of the meter then drifts by only a few percent of f.s.d. through the battery lifetime. The zero point drift over a few hours' continuous operation is quite negligible as long as the batteries are still healthy.

FULL SCALE DEFLECTION

The typical input offset voltage of the MC1709CG is 2mV so the input voltage required at IP for full-scale meter deflection was fixed at 25mV (approximately). R21 and R26 convert the 1mA meter into a 2.5V f.s.d. voltmeter, so VR3 must be set to give an operating gain factor of 100. All component tolerances are taken into account by adjusting with respect to known input voltages as described below. An input voltage of about 25mV is required on all ranges for f.s.d. This means that about 1μA must be injected into the 27kΩ resistor R18, fixing the meter sensitivity at 1MΩ/V for all ranges. The large input impedance at IP ensures that R18 dominates, and the accuracy is not impaired by tolerances or uncertainties of the actual input impedance at IP.

INPUT NETWORK

The purpose of the input network is to make the current into R18 equal to 1μA when the nominal f.s.d. voltage is applied to each respective input terminal.

C6 shorts any a.c. or hum components so that d.c. readings can be taken in circuits in the presence of signals and unscreened test leads may be used. Diodes D1 and D2 protect the i.c. if excessive input voltages are applied. The voltage applied to IP can never exceed the silicon threshold of these diodes, i.e. $\pm$600mV maximum. This cannot damage the i.c. The lowest available range has been made 50mV f.s.d. instead of 25mV f.s.d. because it is necessary to insert series resistance VR2 to limit the current through D1 and D2 in case of excessive applied voltages. VR2 is set to about 25kΩ so that even if the f.s.d. value of the highest range (100V) is applied to the 50mV input, only 4mA will flow through the diodes D1 and D2. This is harmless.

The ranges up to 1V f.s.d. require the trimmers VR1 and VR2 because their total series resistances with respect to R18 are not large enough to make R18 negligible. Such trimmers are not necessary for the higher ranges, but several resistors are used in series to improve insulation on the printed circuit

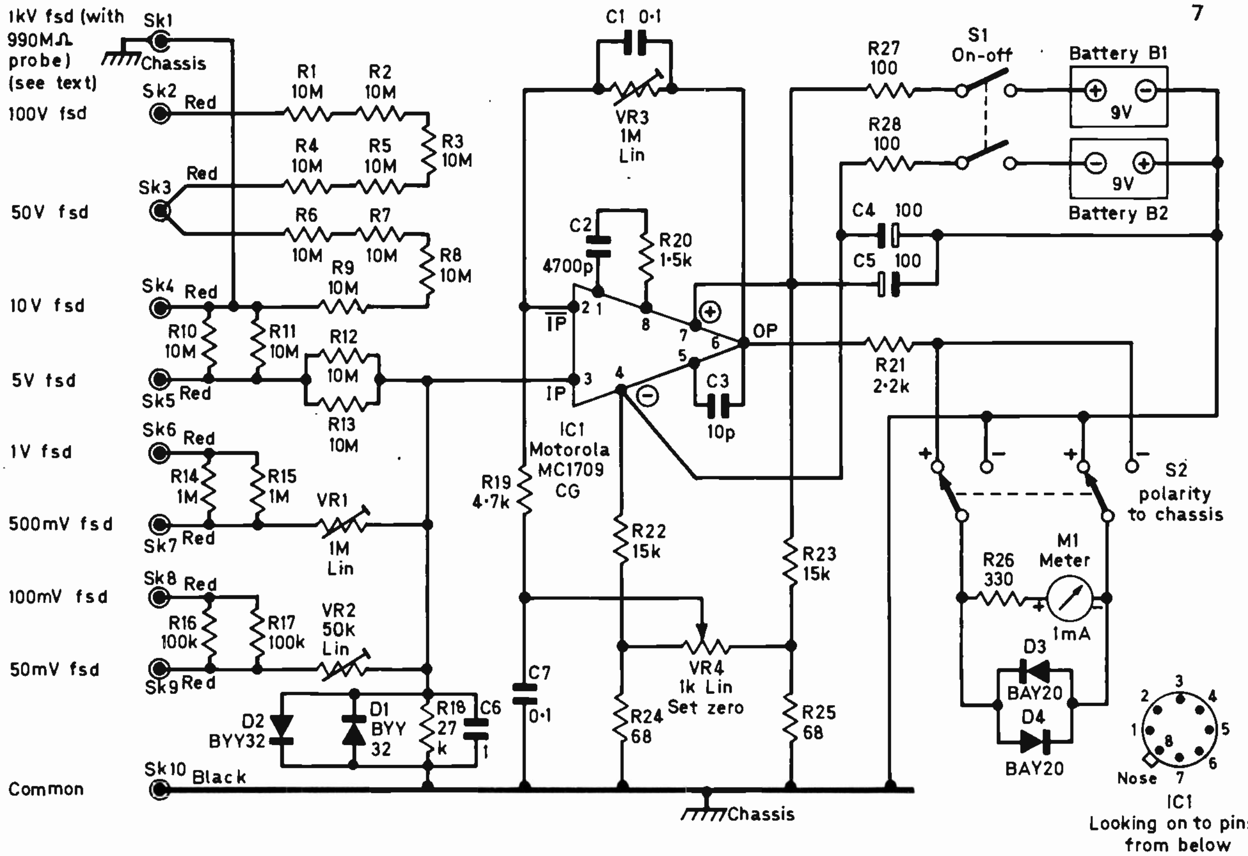


Fig. 1: Circuit diagram of the i.c. millivoltmeter. The basic principles of using operational amplifier i.c.s were explained in the August issue.

Resistors:

R1-R13	10MΩ
R14	1MΩ
R15	1MΩ
R16	100kΩ
R17	100kΩ
R18	27kΩ
R19	4·7kΩ
R20	1·5kΩ
R21	2·2kΩ
R22	15kΩ
R23	15kΩ
R24	68Ω
R25	68Ω
R26	330Ω
R27	100Ω
R28	100Ω

All ½W carbon 10% (R1-R18 preferably 5 or 1%)

Potentiometers:

VR1	1MΩ
VR2	50kΩ
VR3	1MΩ

Lin., miniature skeleton types

VR4	1kΩ lin.

Miscellaneous:

B1, B2	Miniature 9V personal portable batteries
M1	Moving-coil meter, panel mounting, 1mA f.s.d., internal resistance should be much less than 300Ω
S1	D P.S.T. toggle switch
S2	D.P.D.T. toggle switch
Sk1	Transmitter-type coaxial socket
Sk2-9	Red insulated wander plug sockets
Sk10	Black insulated wander plug socket

Capacitors:

C1	0·1μF microfoil 100 or 250V
C2	4700pF microfoil 250V
C3	10pF ceramic, 250 or 500V
C4	100μF 15V electrolytic
C5	100μF 15V electrolytic
C6	1μF microfoil 60 or 100V
C7	0·1μF microfoil 100 or 250V

Semiconductors:

D1, D2	Any small silicon l.t. rectifier, ½A
D3, D4	Any small silicon signal diode
IC1	MC1709CG Motorola

board, or in parallel in other positions to avoid non-preferred values.

The set of ranges up to 100V f.s.d. is adequate for working with all normal transistorised circuits. A 1kV range is required too for valve circuits. This calls for a total series resistance of 1,000MΩ which would involve insulation problems on the printed circuit board. Thus a well-insulated coaxial socket has been strapped to the 10V range socket, behind which 10MΩ are already present. The 1kV probe to extend the range consists of a piece of well-insulated coaxial cable ending at the bottom end of a plastic tube containing a series chain of any combination of resistors totalling 990MΩ, with the prod at the other end. The tube should be filled with good quality insulating wax.

OUTPUT CIRCUIT

D1 and D2 limit the amplifier input voltage to a safe maximum value but this still slams the amplifier output to ± battery potential, a full 9V being applied to the meter circuit. Diodes D3 and D4 in conjunction with R26 limit the meter current to somewhere between f.s.d. and twice f.s.d., safeguarding the meter under all circumstances. S2 permits polarity reversal so that Sk10 may be left clipped to the chassis of equipment being tested and voltages of either polarity observed.

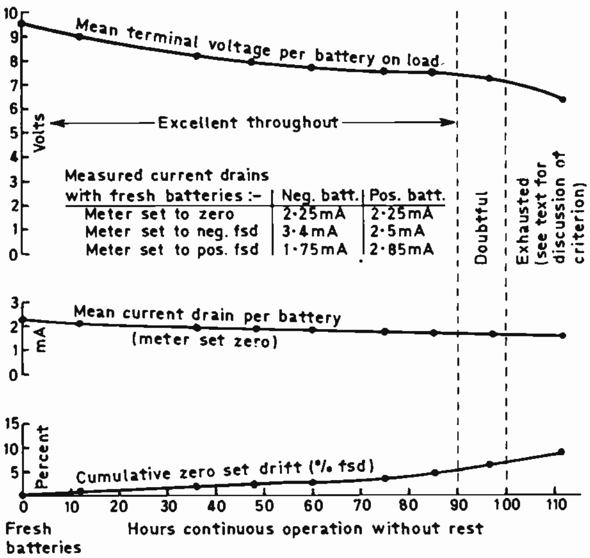


Fig. 2: Battery life, current drain and zero drift of the i.c. millivoltmeter.

This electronic voltmeter is foolproof in that it cannot be damaged by applying any voltage up to f.s.d. of the highest range in either polarity to any lower range including the lowest. The meter will slam hard to full scale or back against the bottom stop, but cannot be damaged.

POWER SUPPLY

Two miniature 9V batteries are used. C4 and C5 preserve stability with batteries approaching exhaustion. R27 and R28 limit surge currents into C4 and C5, protecting the contacts of S1. These resistors also afford a convenient means for measuring load currents for checks and adjustments by using another meter to measure the voltage drop across them.

The nominal current drain is 2.25mA per battery with a fresh battery, so the voltage drops across R27 and R28 should be 225mV each. Note that the current drains imposed on the two batteries are equal only if the meter is set to electrical zero. As shown in Fig. 2 the current drains from both batteries increase for negative-polarity measurements, but the negative battery current drops and the positive battery current rises for positive-polarity measurements. Thus to preserve battery life keep the meter zeroed during idle periods and do not unnecessarily leave inputs connected for long times, or a centre zero setting. And use positive polarity in preference to negative polarity. These considerations are not critical however and merely make the difference whether 70 or 100 total operating hours will be obtained per battery set.

The meter is ready to operate at once upon switching-on, without any zero crawl during warm-up, so that it may be switched on briefly only when taking actual voltage readings. A continuous operation test has been made and the results are also shown in Fig. 2. Even if the meter is switched on by the service engineer each morning at the start of work and off again in the evening it will take at least a fortnight before it is necessary to renew the batteries. The batteries should last almost their shelf life of 1 to 2 years with average intermittent amateur use of the instrument.

The exhaustion test in Fig. 2 was run with the meter zeroed and a full check-through made each time a zero drift was just perceptible through battery ageing (about 12 hour intervals). The drift was corrected with VR4, but noted for plotting. The instrument was never once switched off throughout the soak test of over 100 hours. The performance criterion was taken to be as still correct reading of exactly full scale with an external accurately stabilised 100V source connected to Sk2. The meter was set up as described below with quite fresh batteries so that after correct zero setting with VR4 the 100V reading was exact in both polarities. For each check, the meter was first exactly zeroed again and then the stabilised 100V source applied in both polarities in turn. Finally the battery terminal voltages were measured on load with a separate precision voltmeter. All results are plotted in Fig. 2.

ZERO DRIFT

The 100V readings in both polarities were exact and did not change visibly for 30 seconds, after which time exact zero reading was restored as soon as the voltage was removed, throughout the range of time marked "excellent throughout" up to 90 hours total. For the next 10 hours readings began to creep slightly, i.e. the 100V f.s.d. reading changed by a few per cent over half a minute and exact zero did not return at once when the voltage was removed. The creep was acceptable however. It became quite intolerable in the region beyond 100 hours, marked "exhausted".

The reason for this creep is that the batteries were then so far discharged that the slight differences of current drains with readings changed the e.m.f.s and thus the offset cancellation appreciably. This could be compensated with diodes across R24 and R25, but that would inject the temperature instability of such diodes into the amplifier. The creep effect is negligible before 90 hours.

Note that the cumulative zero drift is also very slight indeed over long periods of time, rising sharply only when the batteries are close to exhaustion. With the given component values the point where VR4 could no longer be set to give full scale meter deflection was reached between 90 and 100 hours, so this is a very good criterion for exhausted batteries. The batteries which were exhausted to the 110 hour point in one stretch without a rest did not recover again to a pre-90-hour performance point even after 10 days idle. Thus batteries exhausted at one stretch are absolutely exhausted. But if rests are interposed earlier than the 90 hour point the total operating lifetime will probably be very much in excess of 100 hours.

SETTING UP

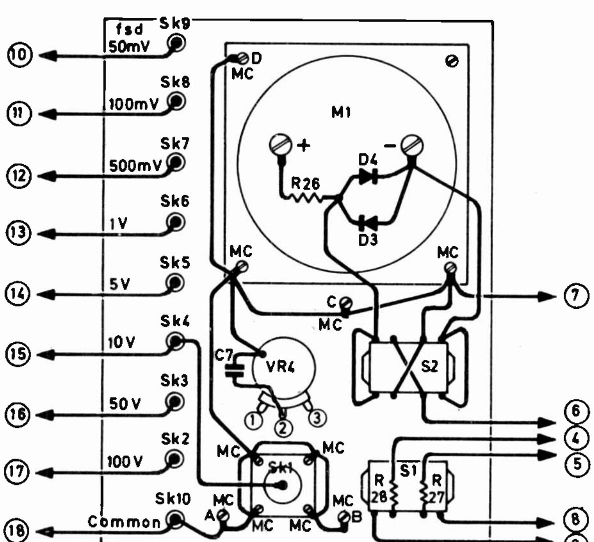
Adjust VR4 for meter zero after checking the mechanical zero setting whilst the instrument is still switched off. Then apply exactly 100V or some other exactly known voltage giving near f.s.d. to the appropriate terminal Sk2 to Sk5 (not the lower ranges). Trim VR3 for correct meter reading. Now apply an exactly known voltage to Sk6 or Sk7 and adjust VR1 for correct meter reading. Finally apply a third exactly known voltage from a very low-resistance source to Sk8 or Sk9 after first shorting this terminal to Sk10 and readjusting zero with VR4. Adjust VR2 for correct meter reading. The setting up adjustments must be made in this order.

OFFSET SHIFT

There is an inevitable offset shift effect on the lowest two ranges, i.e. the electrical zero setting with VR4 is different with the input open-circuit and short-circuited. This is because the offset current condition demanding equal source resistance at IP and $\overline{\text{IP}}$ cannot be satisfied in this simple circuit. It is impossible to make R18 equal to R19 without either sacrificing input sensitivity or running into unacceptably large values for VR3 giving incurable parasitic oscillation.

Now normally the current offset is perfectly stable and compensated with VR4 together with the voltage offset. Whenever the input of the instrument is short-circuited on any range the top end of the corresponding part of the input network is placed in parallel with R18 thus altering the ratio of the two input source resistances and hence the degree of current offset. The resulting change of IP resistance is negligible for all higher ranges because shorting them merely places many megohms across R18 which is only 27kΩ. Thus there is no significant offset shift. The percentage change of IP resistance is larger however if the 50mV or 100mV range is shorted, giving an offset shift of some 5 to 10 per cent f.s.d.

This is nevertheless acceptable on the following considerations. The meter resistance must be at least ten times the resistance of a circuit being measured to avoid false readings due to loading.



MC : Chassis soldering tag under fixing bolt
A,B,C,D : Fixing stand-off bolts for printed circuit board
①–⑱ : Connections to printed circuit board

Fig. 3: Rear view of the front panel assembly. The panel is approximately 4 × 6 in.

Thus the maximum acceptable circuit resistance for the 50mV range is 5kΩ which is virtually a short-circuit for the meter input. Consequently the offset shift error is reduced to negligible proportions if the 50mV or 100mV range *is first shorted and VR4 re-set for electrical zero in the shorted condition* before taking readings in these low ranges. The meter will of course move back below zero in between taking readings but the readings are nevertheless correct. For all the ranges from 500mV upwards a common zero setting holds regardless of the input circuit impedance and the meter reads zero on open-circuit. Bearing these points of operating procedure in mind, the instrument is capable of giving readings with normal accuracy down to a few millivolts d.c.

PARASITIC OSCILLATION

Speaking generally, there is a danger of parasitic oscillation in any amplifier with negative feedback if the gain has not dropped below unity for the frequency at which the inevitable strays produce a 180° phase shift in the negative feedback loop so that it has become positive feedback causing regeneration at this frequency.

FREQUENCY COMPENSATION

The trouble will obviously be more severe the heavier the applied negative feedback, i.e. the larger the open-loop gain is and the greater the factor by which we reduce this gain with negative feedback in the wanted operating frequency range. Thus the problem will be particularly acute with operational amplifiers, calling for so-called *frequency compensation* to ensure overall stability. It is important to bear in mind the paradoxical fact that the tendency towards instability, calling for heavier frequency compensation, is the greater the *smaller* we make the *operating* gain factor — because this calls for heavier negative feedback. There is also a normal tendency towards instability due to excessive gain in the open-loop state, so that optimum stability, requiring the least frequency compensation, is given at medium gain, usually the highest usable operating gain factor for a well-designed device.

The purpose of frequency compensation is to make the loop gain roll off more rapidly than the phase shift increase above the cut-off frequency. In a multistage amplifier such as these i.c. operational amplifiers it will be necessary to compensate more than one stage independently. This is effected with C2, R20, for the input stage and with C3 for the output stage of the i.c. in our circuit.

OUTPUT LAG

The output compensation is usually called *output lagging* and the pin to which a sample of the output voltage is capacitively fed back (pin 5 here) is the *output-lag* pin. The operation is essentially that of a Miller integrator, i.e. capacitive feedback from collector to base of a transistor, as can be seen from Fig. 3, the i.c. internal circuit, shown in the August issue. This causes a delay between the injection of an input signal and the appearance of its effect at the output, so that there is a drastic reduction of gain for all frequencies above a certain threshold determined by the delay (Miller time-constant). The

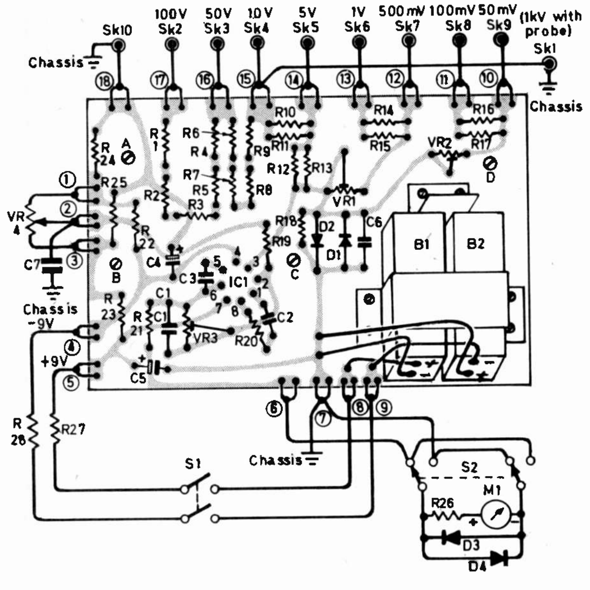


Fig. 4: Printed circuit board viewed from the components side—printed wiring on rear. A-D are the bolts for fixing the board to the front panel.

input compensation between pins 1 and 8, which are provided solely for this purpose, is similar in principle but milder because resistance is included in series with the Miller capacitance.

Some i.c. operational amplifiers are marketed with internal frequency compensation, claimed to be a desirable feature of quality. This is doubtful because it tends to restrict the range of applications. The data sheets for general-purpose i.c. operational amplifiers list values of external frequency-compensation components and output-lag capacitor values for various gains and circuit arrangements, and inspection of the wide range of variation of these component values according to circuit configuration with one and the same i.c. shows the importance of being able to modify these few components externally.

INPUT STAGE COMPENSATION

Output-lag compensation is usually much less critical than input-stage compensation. The exact behaviour differs according to the circuit design of the operational amplifier and this may depart considerably from the MC1709CG. However, the particular circuit used by the MC1709CG usually operates well in most arrangements with a few pF for C3 and a value for C2 ranging from 100pF for large operating gains to some 4700pF for low operating gains approaching unity.

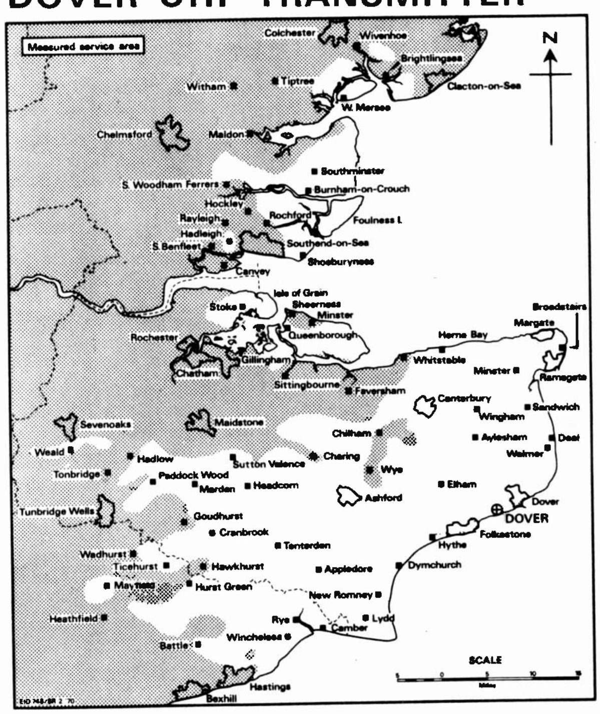
C1 reduces the high-frequency operating gain to unity (to prevent too sudden slamming of the meter on overloads) so that C2 must be chosen for the unity gain condition. If C1 is omitted so that the a.c. gain is also large C3 can usually be reduced to 3pF. The author has found that grossly excessive values for C3, e.g. 4700pF, can reduce the d.c. gain, which is rather a curious result because it is not readily understandable why a purely capacitive coupling should affect the d.c. conditions. This is probably an attribute of the particular circuit used by the MC1709CG, in which excessive output lag may well interfere with proper pull-up of the totem-pole output stage.

CHECKING THE STABILITY

It is not readily possible to check an i.c. operational amplifier for stability with an oscilloscope because the oscillation frequency normally lies in the shortwave band and may thus be well outside the bandwidth of the oscilloscope and, more commonly, the mere act of connecting an oscilloscope may provoke instability which was not present before or silence oscillation otherwise present. I.C.s are extremely small so that a few picofarads change of circuit strays (sometimes even a fraction of a picofarad suffices) may profoundly alter the stability.

The best way to check the stability of this i.c. millivoltmeter is to adjust VR4 very slowly from zero to full-scale deflection in both polarities. If there are no abrupt jumps of the meter needle at any stage and if a given input voltage chosen to produce nearly full-scale deflection leads to precisely the same reading in each polarity setting, the circuit is definitely stable. If any of these conditions are not satisfied increase the value of C2 until complete stability is obtained. Proceed in a similar manner with any other circuit using this device. There is no need to expect difficulties; it is a simple matter to make proper operational amplifier frequency compensation once one has got the feel of it. ■

DOVER UHF TRANSMITTER



The above BBC map shows the approximate service area of the Dover u.h.f. transmitter—the boundary is not however a rigid limit and pockets of poor reception too small to be shown may be experienced. Channels: BBC-1 50; BBC-2 56; ITA 66. Polarisation horizontal, receiving aerial group C, maximum vision e.r.p. 100kW with directional aerial.

LETTERS . . .

As a reader for some 20 years of what I like to call "our" journal, I have read with the greatest interest all your very lucid articles on colour television, and although I have never had the back off a colour set I am confident that I could successfully fault-find given essential data, equipment, time and *solitude.* But . . . After servicing monochrome sets since 1950, on site if a valve change or something simple like a new dropper section etc. is required, or in my workroom if more detailed tracing is necessary, I know full well the tribulations of a service engineer in the field. I refer, amongst other things, to the unrestrained little boy trying to get his head inside the set, delving into my tool box, removing tools, trying my hat on for size and so on, while a teenager's transistor blares out "pop" in another room.

I understand that, due to their weight, manhandling a colour set is a two-man job. Indications are therefore that nearly all servicing should be carried out on site. As a "loner", whipping the set from its stand and making off with it to my private fastness there to pore and probe is clearly out of the question. A horrible vision presents itself to me. This includes the conditions previously mentioned together with trying to guard my crosshatch generator, signal generator, oscilloscope, Avo 8 and Multiminor from the sticky-fingered investigations of, in some cases, more than one little boy: and all this whilst wrestling with colour symptoms and their diagnosis.

I think I will forgo colour television until the sets get a bit lighter!—**G. H. R. Doubtfire** *(Isle of Wight).*

YOUR PROBLEMS SOLVED

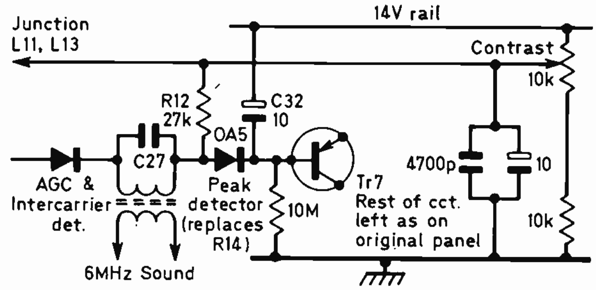
You say in the August *Your Problems Solved* that the 0·01μF S-correction capacitor C98 on the Thorn 950 chassis should be checked for lack of width on 625 lines. The value of this capacitor, however, is 0·1μF, not 0·01μF. This capacitor can short, causing a narrow 625-line picture.—**R. Reid** *(Hull).*

Our apologies for this slip. *Editor.*

In *Your Problems Solved* for August you recommend a reader to check for low h.t. or faulty i.f. alignment as a cure for noises on sound with a Murphy Model V430. I would also suggest replacement of the screen grid decoupling capacitor on the sound i.f. amplifier valve. This is a 1,000pF colour-coded component marked brown-black-red and is frequently responsible for poor sound on this and related models. Paralleling it with a Radiospares polyester capacitor of the same or greater value usually completely clears the trouble—**N. McLeod** *(Strichen, Aberdeenshire).*

AGC MODIFICATION

I have been doing some experiments with the surplus i.f. strip used in Keith Cummins's single-standard receiver and have found that a very simple modification enables the original a.g.c. circuit to be changed to a sync-tip system (for 625-line only operation of course). The circuit is shown in the accompanying diagram. R14 in the original circuit is replaced with an OA5 diode (this happened to be handy: many types will do provided their reverse



resistance and capacitance are such as to prevent a significant amount of video appearing at the output) connected as shown and a 10MΩ resistor is added from the OC45 base to chassis, the a.g.c. amplifier and contrast control circuit being as in the original manufacturer's model. The diode added acts as peak detector.

I subsequently found that removing C32 results in a quicker change of a.g.c. on tuning to a weak signal.—**D. Robinson** *(Nottingham).*

BEFORE BUYING A NEW TUBE

I hope the following tale will help other readers to avoid a pitfall from which I am just emerging. The set is an old Pye Model VT4. The picture was beginning to darken and I was thinking of fitting a new tube. However, there weren't the usual symptoms of failing emission, simply a dark picture with poor contrast but fully filling the screen.

I tested just about everything there was to test and concluded that all was apparently well so that the tube must be on the way out. I keep an emergency tube handy and decided to try this in the set. This tube however is faulty, due to a misaligned gun, but proved the set to be OK so that it seemed a new tube would have to be obtained. I then replaced the old tube and decided to give the works a good blow out and the tube a clean before reassembly.

Imagine my surprise when on switching on the picture came in brilliant and without fault! I sat back to try to work this out. Nothing had been done on the set other than the usual voltage and capacitor/resistor checks. Only one thing was now different—there was no longer a layer of dust stuck to the back of the tube. I hadn't even cleaned the front protective perspex screen this time as I have found a way of removing this from the front and often clean it this way. I had however completely cleaned off with petrol the accumulated dirt stuck to the back of the tube, regreased the areas around the e.h.t. terminal and ensured that the earthing clips were soundly connecting with the graphite tube backing.

It seems clear that although the e.h.t. could provide a good spark, once on the tube it was being lost—or my earthing clips were poor. Either way the lesson was clear: before doing a marathon circuit check make sure that these simple points are in correct working condition. I imagine that many enthusiasts are like me unable to check the e.h.t. accurately and so tend to assume that without a cracking good e.h.t. leak being visible all is well. The moral of this is of course that a new tube might have been unnecessarily bought.—**M. H. O. Hoddinott** *(Chester).*

PAL Switching techniques

S. GEORGE

THE basic technique of R−Y signal phase reversal on alternate lines in the PAL system has been covered not so long since in these pages (see PRACTICAL TELEVISION June 1970). In this article we are concerned primarily with the various different ways in which the R−Y phase reversal line-by-line required in a PAL receiver is carried out. First however a recap for newcomers to the subject.

Principles

The transmitted chroma signal consists of two quadrature-modulated colour-difference signals, B−Y and R−Y. Quadrature modulated simply means that there is a 90° phase difference between the B−Y and R−Y signals, i.e. that one is delayed by 90° of the subcarrier frequency with respect to the other. The effect is similar to stereo recording where two signals, left- and right-channel, are modulated on to a common groove in such a manner that they can be easily separated again.

In addition to this in the PAL system the phase of the R−Y signal is inverted, i.e. shifted by 180°, on alternate lines. This technique enables spurious phase changes, which can occur anywhere in the transmission path and which can lead to the reception of incorrect colours since the exact phase of the signal denotes the colour at a particular point on the picture, to be cancelled at the receiver.

These factors are brought out in Fig. 1 where it will be seen that the R−Y and B−Y axes are 90° apart. Suppose that the chroma signal at any moment is A. This means that it consists of proportions of R−Y and B−Y, both positive. The effect of inverting the phase of the R−Y signal in the PAL system is that on the following line the chroma signal will be at B. The signal shifts to the next quadrant because although the R−Y component has been inverted by 180° the B−Y component is unchanged: hence the composite signal obtained by adding the two together will be in position B.

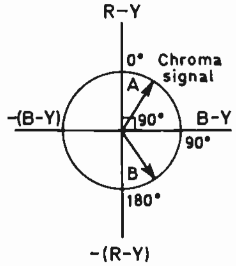


Fig. 1: Basic PAL principle.

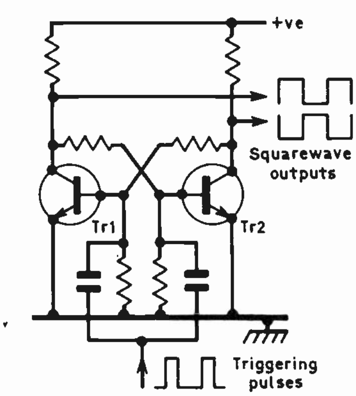


Fig. 2: Basic bistable switching circuit, using transistors.

Need for Receiver PAL Switch

Spurious phase changes are cancelled in this system because they have complementary effects on alternate lines and these cancel out when the lines are added together (as they are in the PAL delay line circuitry). In a PAL decoder the delay line circuitry separates the B−Y and R−Y signals so that they can then be separately detected, but as a result of the phase inversion of the R−Y signal as transmitted the R−Y output from the delay line circuitry is +(R−Y) and −(R−Y) on alternate lines. The phase inversion must therefore be reversed in the receiver or different colours will be displayed on alternate lines.

There are two ways of going about this R−Y phase inversion in the receiver. The synchronous detectors used to demodulate the colour-difference signals are fed with two signals, one of the received colour-difference signals after its separation from the other colour-difference signal in the delay line circuitry, and a signal at the subcarrier frequency from a local reference oscillator in the decoder. To get the right R−Y output from the synchronous detector we can invert either of these inputs on alternate lines—the effect is the same at the synchronous detector output. Both techniques are in use: in one case we are inverting a relatively wideband low-amplitude signal while in the other we are inverting a narrowband large-amplitude signal.

Basic Switching Arrangements

The circuitry used to bring about alternate line R−Y signal inversion is generally and aptly called the PAL switch or 180° switch. As we shall see there are many varied designs, but all use a transformer with a centre-tapped primary or twin primary or secondary windings and a double-diode or diode ring switching arrangement to change the direction of the applied signal. The principle involved is that reversing the transformer primary supply or coil winding direction reverses the core flux and thus the secondary voltage polarity.

The switching diodes control the routing of the signal through the inverting transformer, and have in turn to be alternately switched on and off. This is generally done by means of a triggered bistable circuit using a pair of transistors which produce anti-phase squarewave outputs at their collectors since they are alternately driven fully on and fully off by line-frequency trigger pulses (shaped flyback pulses are used for triggering to synchronise the bistable circuit with the line scanning).

Bistable Circuit

Now a property of a bistable circuit is that the squarewave outputs at each collector are at half the frequency of the trigger input pulses (the circuit divides by two). Thus with line-frequency trigger pulses we get two half-line-frequency output squarewave trains. This will be clear if we look for a minute at the basic bistable circuit shown in Fig. 2. When this circuit is first powered either Tr1 or Tr2 will conduct and its partner will be cut off, due to slight asymmetry in the components used in the circuit. Say Tr2 is on and Tr1 off. A negative-going squarewave appears at Tr2 collector and a positive-going squarewave at Tr1 collector. Suppose next that we are using positive-going line-frequency pulses to trigger the circuit. When the first pulse arrives it will trigger on the non-conducting transistor Tr1 (assuming npn types as shown) and the circuit will then reverse, Tr1 conducting and Tr2 being cut off because of the fall in its base voltage due to the resistive cross-coupling. Nothing more will happen till the next pulse arrives, which will switch Tr2 on again. It will be noted that the pulses do not switch the transistors on *and* off, just on *or* off. One trigger pulse alters the conditions at the two collectors, a second one is required to restore the conditions to the initial state. Thus the squarewave outputs are at half the frequency of the trigger pulses. These can be used to switch on and off alternately the switching diodes used in the inverting transformer circuit.

The bistable circuit must be synchronised to the correct R−Y signal alternation phasing. If it is not, there is an even chance that it will lead to the +(R−Y) instead of the −(R−Y) lines being phase reversed, with the result of incorrect colours on the screen on all the lines. To synchronise the bistable an extra input, the ident signal derived from the burst signal which alternates ±45° as a result of the phase alternation of the R−Y component of the chroma signal, is fed to the bistable circuit. This inhibits the switching action if it is not in the correct R−Y phase.

Representative PAL Switch

A representative circuit for carrying out phase inversion of the reference oscillator feed to the R−Y synchronous demodulator on alternate lines is shown in Fig. 3. This is used in the Decca CTV25 series. The 4.43MHz signal from the reference oscillator is fed via a buffer emitter-follower to the primary of T1. The two secondaries are wound so that equal but opposite phase voltages are induced in them (for the secondary outputs to be in opposite phase it is only necessary to reverse the connections to one of them). Which secondary winding on T1 feeds T2 primary is determined by whether D1 or D2 is conducting. These diodes are switched on and off alternately by the antiphase squarewave outputs from the bistable circuit. When D1 anode is held positive D2 anode is held negative, so that the former diode is conducting while the latter is reverse biased. Therefore the signal fed to T2 primary is via either D1 and consists of the signal induced in T1 secon-

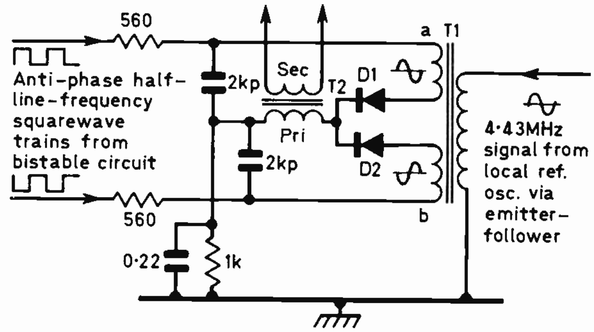


Fig. 3: Representative PAL switch, used to reverse the local oscillator feed to the R−Y synchronous detector.

dary (a) or via D2 consisting of the signal induced in T1 secondary (b). As shown in the small inset instantaneous waveforms, secondary (a) diode feed polarity is opposite in phase to that obtained from secondary (b). The net effect is just as if the reference oscillator signal fed to T2 primary is changed over at line frequency by a mechanically-operated reversing switch.

Ring Modulator Circuit

Most PAL switches are similar to the Decca circuit shown, although in many the primary is centre-tapped and the two secondaries are in phase, phase reversal occurring because of the centre-tapped primary winding. In at least two chassis however a circuit often called a ring modulator is used in place of the pair of switching diodes. We will look first at this type of circuit as used in the Beovision 3000 series.

The circuit is not used for modulation of course in this application. The term ring modulator arises from the fact that this type of circuit is widely used in the modulator circuits of suppressed-sideband transmitters. So far as we are concerned however it is just another PAL switch.

The basic circuit is shown in Fig. 4. It will be seen that the signal from the reference oscillator is applied to the primary of T1. This results in equal but opposite phase voltages appearing across each section of the centre-tapped secondary winding. T1 secondary is connected to the centre-tapped primary of T2 by two pairs of diodes. The pairs D1 and D4, and D2 and D3, are switched on alternately line-by-line by the squarewave outputs applied to the two centre-tapped windings from a bistable circuit. The reference oscillator signal route during any line period is determined by which pair of diodes is conducting. For correct operation of all such circuits incidentally the switching potentials must always be in excess of the maximum reference oscillator signal excursions to ensure that the diode(s) switched off by the reverse switching bias are not accidentally switched on by the peak signal excursions.

Now for a diode to conduct its anode must be positive with respect to its cathode. Thus when, in Fig. 4(a), the left-hand squarewave is negative-going and the right-hand one positive-going, diodes D2

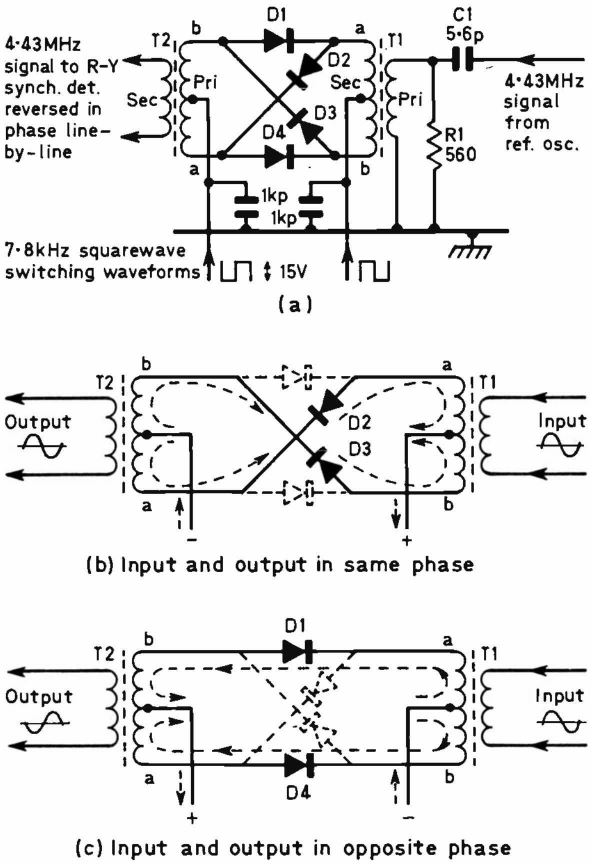


Fig. 4: (a) Ring modulator circuit used as the PAL switch in the Beovision Model 3000. (b) and (c) show how inversion of the signal occurs through reversing the direction of current flow around the circuit.

and D3 will conduct. Fig. 4(b) shows the result: the signal path is such that the secondary terminal (b) of T1 secondary is connected to terminal (b) of T2 primary while terminal (a) of T1 secondary is connected to terminal (a) of T2 primary. As a result the reference oscillator signal is transmitted from T1 primary to T2 secondary in the same phase. When however on the succeeding line the centre tap on T2 primary is positive-going and the centre tap on T1 secondary negative-going, D2 and D3 are reverse biased and D1 and D4 conduct instead. Now terminal (a) of T1 secondary is connected to terminal (b) of T2 primary while terminal (b) of T1 secondary is connected to terminal (a) of T2 primary. As a result of this the phase of the reference oscillator signal is reversed at T2 secondary. The basic arrangement of the two transformers is similar to that of a push-pull amplifier: the input is phase-split at T1 while T2 acts as a push-pull output transformer. The switching diodes alter the direction of the current flowing in the circuit.

ITT-KB Circuit

In the two circuits so far described it is the phase of the reference oscillator signal to the R – Y synchronous detector that is inverted on alternate lines, but as previously mentioned the same result so far as detection is concerned is obtained by inverting

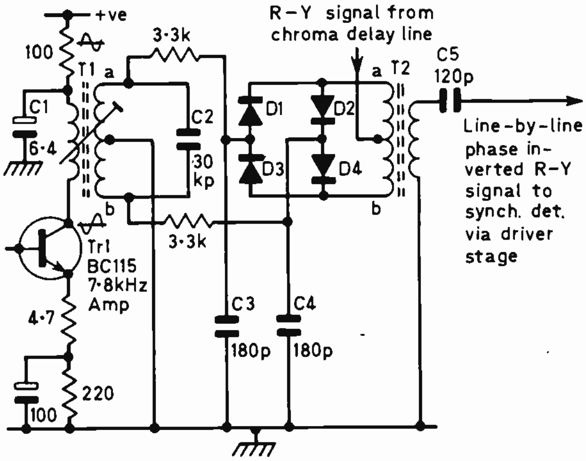


Fig. 5: A diode ring circuit is also used in ITT-KB models This however is switched by the high-amplitude iden signal and is used to invert the R – Y chroma signal.

the R – Y signal itself on alternate lines prior to its application to the R – Y synchronous detector. Amongst the receivers using the latter technique are the KB-ITT colour chassis, both single- and dual-standard. These models also dispense with a bistable circuit, using the half-line frequency ident signal to control the switching diodes directly (as also, in a rather different manner, does the BRC 3000 chassis, see page 76 in the November 1969 issue). The circuit is shown in Fig. 5.

Tr1 is the ident amplifier which produces a high-amplitude 7·8kHz output across the centre-tapped secondary winding of T1—thus in this circuit the switching is controlled by a pair of anti-phase sinewave signals instead of squarewave trains. The R – Y signal is applied to the centre-tapping on T2 primary, the transformer which carries out the R – Y signal phase reversal. Across this winding are two pairs of diodes, each pair series-connected but the two pairs connected in opposite polarity. As in the Beovision circuit the diodes are connected in the ring formation, i.e. anode to cathode, but in this KB circuit different pairs of diodes are conducting each line. If the 7.8kHz sinewave induced in T1 secondary is positive-going at (a) and negative-going at (b) due to the centre-tapping, diodes D1 and D2 will be conducting while D3 and D4 are reverse biased. On the next half-cycle of the sinewave (a) will be negative-going and (b) positive-going so that diodes D3 and D4 will conduct while D1 and D2 are cut off.

The R – Y feed is taken from the chroma PAL delay line and fed to T2 primary winding centre tap. When D1 and D2 are biased off the signal can only pass through the lower section of the primary, through D4, C4 and D3, C3 to chassis. On the succeeding line when the 7·8kHz half-cycle polarity is reversed D1 and D2 are made conductive and D3 and D4 are biased off. The R – Y signal can then only travel through the upper section of T2 primary and via D1, C3 and D2, C4 to chassis. As a result of this the R – Y signal induced in T2 secondary will be reversed in phase line-by-line.

The idea of using sinewaves for switching may seem odd. As however the 7·8kHz signals are of high amplitude the diodes become forward or

—*continued on page 21*

DX-TV

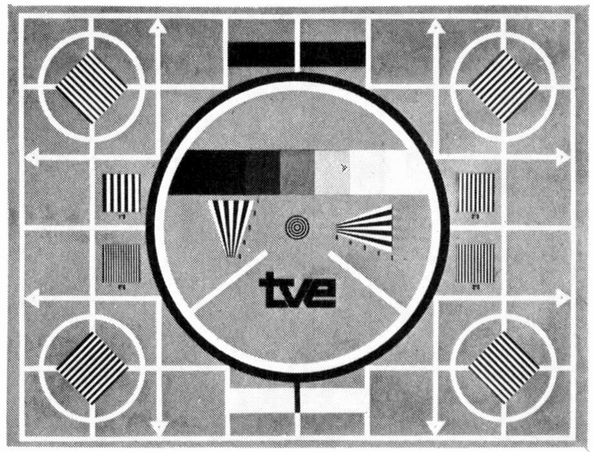
CHARLES RAFAREL

OH dear! What can I say this month about DX conditions except that they were very bad. 1970 must go into my records as the worst July I have known in some 10 years of DX-TV, and I am sure other DXers have had the same lamentable experience. June was a far from ideal DX month but did at least show some promise for better things in July. On the contrary however there was a serious drop in results and I hesitate to make any prediction for August!

All this is of course most depressing and if it is due to the high sun-spot activity, as we suggested last month, then we are in for poor SpE reception for the rest of 1970. The predicted sun-spot numbers for the coming months are as follows: August 94, September 92, October 90, November 88, December 86. These are pretty high numbers so the SpE outlook is not good: on the other hand the figures are not high enough for F2 reception.

This gloom however does not mean to say that there was no SpE DX about during July. There has been something about each day but I have had to work very hard to get it! So here's the log for the period 1-31/7/70:

1/7/70 Poland R1, Sweden E2.
2/7/70 USSR R1, Poland R1, Sweden E2, E3 and E4, Norway E2, E3 and E4, Iceland E2, Spain E2.
3/7/70 USSR R1, Poland R1, Czechoslovakia R1 and R2.
4/7/70 USSR R1, Poland R1.
5/7/70 USSR R1, Poland R1 and R2, Italy IA and IB, Spain E2.
6/7/70 USSR R1, Czechoslovakia R1 and R2, Poland R1, Italy IA and IB, Sweden E2, Iceland E3 and E4.
7/7/70 USSR R1 and R2, Czechoslovakia R1, Poland R1 and R2, Hungary R1, Yugoslavia E4, Spain E2 and E3.
8/7/70 Czechoslovakia R1, Austria E2a, Sweden E2, Portugal E2.
9/7/70 USSR R1.
10/7/70 USSR R1, Hungary R1.
11/7/70 USSR R1, Yugoslavia E3 and E4.
12/7/70 USSR R1.
13/7/70 Poland R1, Sweden E2.
14/7/70 USSR R1, Norway E2 and E3, Spain E2.
15/7/70 USSR R1.
16/7/70 USSR R1.
17/7/70 USSR R1, Spain E2.
18/7/70 Norway E2, Sweden E2.
19/7/70 Poland R1, Sweden E2, Spain E2.
20/7/70 USSR R1, Spain E2 and E3.
21/7/70 USSR R1, Hungary R1, Czechoslovakia R2.



The 1970 TVE Spain test card.

22/7/70 USSR R1, Czechoslovakia R1.
23/7/70 USSR R1, Austria E2a, Spain E2.
24/7/70 USSR R1, Czechoslovakia R1.
25/7/70 USSR R1.
26/7/70 USSR R1 and R2, Czechoslovakia R1, Sweden E2.
27/7/70 Spain E2 and E4.
28/7/70 USSR R1, Czechoslovakia R1, Austria E2a, Sweden E2 and E4, Switzerland E2, Yugoslavia E4, Italy IB, Spain E2 and E4.
29/7/70 Czechoslovakia R1, Austria E2a.
30/7/70 Poland R1, Norway E2.
31/7/70 USSR R1 and R2, Czechoslovakia R1, Poland R1, Sweden E2, E3 and E4, Norway E2, E3 and E4.

The Trops have been far from good, the deterioration in the weather towards the end of the month certainly being the main reason. There were openings to France on the 13th, 17th, 28th and 31st and even to Holland (rare for me) on 28th.

F2 was also still with us, with the USSR Forward Scatter Network (sound only) stations about on many days. At times Russian speech could be heard well above 40MHz. This is unusual and the transmissions appeared to be in connection with the Russian Cosmos series of space shots.

A little more news about the new Austrian electronic test card as printed in our August 1970 issue. This was inadvertently noted as being on channel E2 in the caption. It is of course on E2a. I think the trouble arose because the actual photo was marked as E2 on the back before it was positively identified as Austrian. Incidentally this test card has now also been seen on Ch.E4 from Patscherkofel as well.

At last we have a good printable photo of the new 1970 TVE Spain test card, thanks to Garry Smith of Derby (this is an official photo as issued by TVE) and we have great pleasure in publishing it with our grateful thanks to him. TVE Spain has been one of the best signals received here in past years but has been irregular and only too often weak in the current SpE season.

We have news of Finnish TV via our good friend S. J. Pirhonen of Lahti, but first for any DXer who may wish to contact the Finnish DX Club the address is: Soumen DX, Kuutelatry, Box 10454, Helsinki, Finland. He goes on to give us information we have not previously published. There

continued on page 31

PART 2

IF STRIP for the constructor

KEITH CUMMINS

LAST month we dealt with the technical considerations affecting the design of the i.f. strip. Now we come to the practical part, which involves care and patience since some fine work is required in confined spaces. It is strongly recommended that besides the normal complement of tools, i.e. screwdriver, side-cutters, pliers, etc., the following additional items should be available: surgical tweezers, crocus paper, bench vice, blowlamp and a brick. Two soldering irons, instrument size and large, should also be available.

Fitting Feedthrough Capacitors

The first phase of construction, when the drilled chassis box is to hand, involves fitting the feed-through capacitors which have to be soldered to the metal of the box. It is impossible to fit the capacitors using a soldering iron only, since the cooling effect of the box is too great. The correct procedure is shown in Fig. 4. A small ring of cored solder is slipped around the body of the capacitor, which in turn is fitted through the hole in the i.f. strip chassis. The i.f. strip is stood on the brick with the capacitors along the top edge, and heated with the blowlamp to a temperature a little short of the solder melting point. Application of the soldering iron then produces enough heat to easily melt the solder and an excellent soldered joint results.

The above method may seem rather dramatic, but in fact it is very easy indeed and much less tedious than attempting the soldering using a soldering iron on its own.

When the capacitors have been fitted to one face, the i.f. strip chassis is inverted and the procedure repeated for the other face. Care should be taken not to overheat the chassis so that the capacitors on the bottom face fall out. The blowlamp in any case should not be left heating one part of the chassis, but kept moving to and fro, playing over the chassis until it is hot enough. The blowlamp can then be put to one side while the individual soldering of the capacitors is carried out.

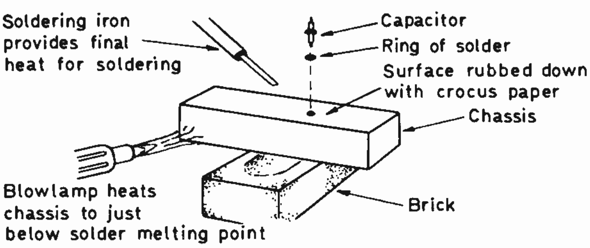


Fig. 4: Method of soldering feedthrough capacitors.

Coil Construction

When the feedthrough capacitors have been fitted construction can commence in earnest. It is best to start at the input end by fitting the input coaxial socket. A logical sequence then follows. The coils can be wound and fitted as each is completed. The method of construction is shown in Fig. 5. The coil is wound on its former, then wrapped with ¼in. p.v.c. tape to hold the turns in position. Special care should be taken with L6, which is a bifilar-wound coil providing tight coupling from Tr4 to the detector diodes, to ensure that the ends of the primary and secondary do not become confused.

The enamel is removed from the leads to each coil by rubbing down with crocus paper. This method is preferable to scraping with a penknife or side-cutters since the risk of breaking off an end is greatly reduced. The ends can next be tinned ready for connection into the circuit. On completion, each coil should have its core fitted. It is much easier to fit the core at this stage than when the coil is fitted into the chassis.

Winding Details

L1 12 turns 28s.w.g. enamelled wire.
L2 7 turns 22s.w.g. tinned copper wire.
L3, L4, L5 10 turns 28s.w.g. enamelled wire.
L6 12 turns 28s.w.g. enamelled wire bifilar wound.
L7 See Fig 5(e) 4 turns.
L8 See Fig. 5(f).
L9 27 turns 28s.w.g. enamelled wire.
L10 15 turns 28s.w.g. enamelled wire.
L11 31 turns 28s.w.g. enamelled wire.
L12 See Fig 7.

General Assembly

Figure 6 shows the physical layout of all the components. It will be seen that the circuit is three-dimensional and some assembly has to take place near the bottom of the compartments of the chassis. It is here that assembly is greatly simplified by the use of surgical tweezers, which reach easily into awkward corners. Certain components (for example transistor biasing resistors) can be assembled together with their associated decoupling capacitors before the whole group is introduced to the chassis. It will be seen that a proportion of the circuit is self-supporting, and tags are not provided for all component junctions. The assembly is nevertheless mechanically stable and should not present difficulty, provided the construction is tackled methodically.

When transistors are being fitted it is useful to bend the ends of other components to which they are connected into eyelets, so that the transistor leads may be pushed through and soldered. The transistor

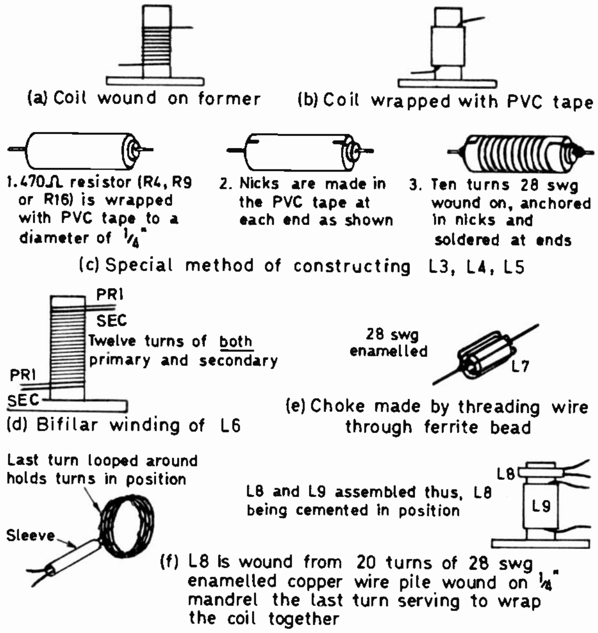


Fig. 5: Methods of constructing the coils.

may then be easily unsoldered for checking if necessary. Note that the BF167 has four connections. Counting clockwise from the tab, these are base, emitter, collector and screen. The transistor connections are shown in Fig. 6. The screen is either connected to emitter or earth.

Video Choke

It has been found advantageous to use a series video choke L12 in the output from the i.f. strip (this was not shown in Fig. 2 last month). This consists of two pile-wound sections of 50 turns each wound on a ¼ in. former as shown in Fig. 7. The coil cannot be fitted in the i.f. strip so it is built on to the plug and socket carrying the video signal out of the strip. The choke should be fitted as near to the i.f. strip as possible and this simple arrangement satisfies this condition. Because of the excellent video response within the i.f. strip and the action of the video choke L12, cathode compensation in the video amplifier valve V1(a) on the main chassis is

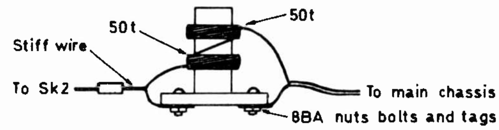


Fig. 7: Video choke: use 28 s.w.g. enamelled wire.

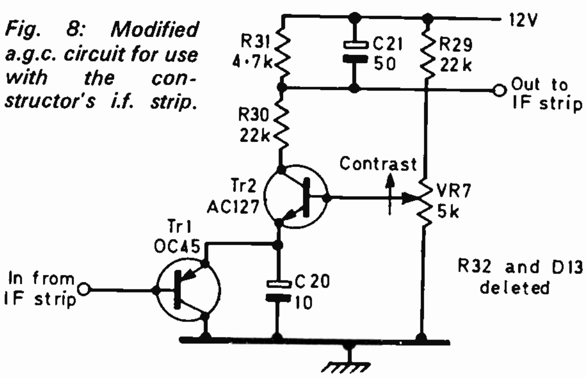
not required and C7 is therefore removed. Retention of C7 produces an undesirable video overshoot.

Revised AGC Circuit

Because a stage of video preamplification is included in the i.f. strip in the form of Tr5, BC107, a smaller a.g.c. signal appears at the output of D1 than occurs at its counterpart in the original i.f. strip used in the 625-line receiver. As a result it has been necessary to modify the a.g.c. circuit to provide more d.c. amplification.

The revised circuit is shown in Fig. 8. Note that D13 and R32 have been deleted and the values of R29, R30, R31, C21 and VR7 changed. The action of the circuit is as follows. D.C. amplifier Tr2 has the buffer transistor Tr1 as its emitter load. Tr2 conducts to an extent determined by the setting of VR7, the contrast control. An increase of signal causes the output from the diode D1 in the i.f. strip to become more positive. This signal is conveyed via Tr1 to the emitter of Tr2 which conducts less, since its apparent base current is reduced. The signal from the collector of Tr2 is conveyed to Tr7 in the

Fig. 8: Modified a.g.c. circuit for use with the constructor's i.f. strip.



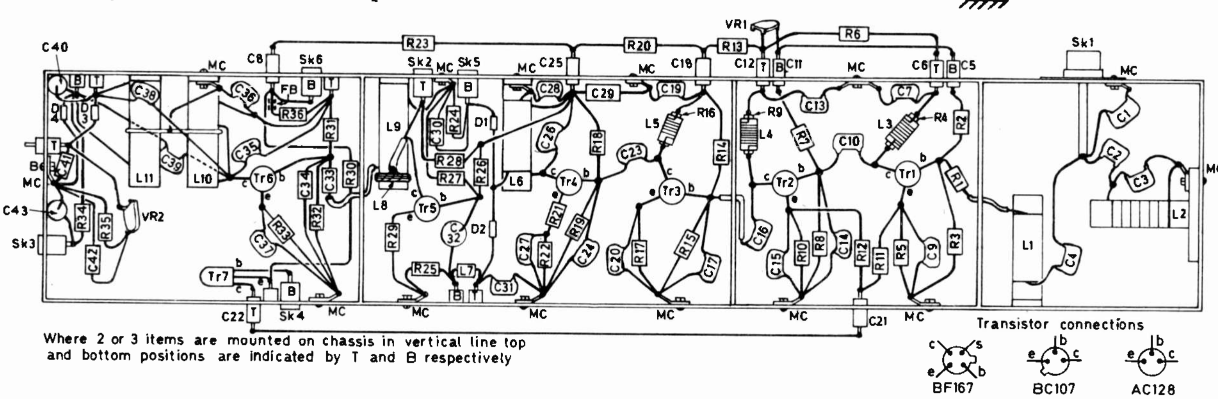


Fig. 6: Component wiring and layout for the constructor's i.f. strip. Note that in order to show the wiring clearly it has been necessary to reduce the size of the components in relation to the box-chassis, i.e. they take up much more space than shown here. The shield connections of the BF167 are as follows: with Tr1, Tr2, Tr3 and Tr6 the shield is connected to the emitter, with Tr4 the shield is taken to an adjacent tag (on L6 upper securing bolt).

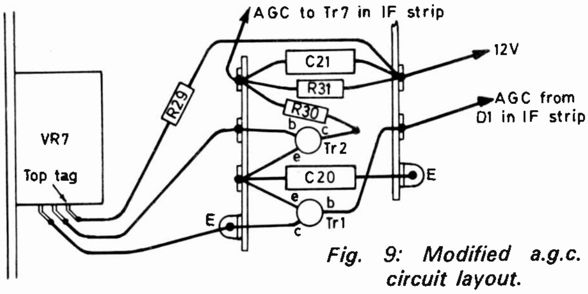


Fig. 9: Modified a.g.c. circuit layout.

i.f. strip which in turn conducts less. Its collector voltage is thus negative-going, increasing the bias applied to and the forward current through the gain-controlled transistors Tr1 and Tr2. C30 in the i.f. strip charges to the sync-tip amplitude. C20 and C21 in the a.g.c. circuit are hum and anti-hunt filter capacitors. Fig. 9 shows the new physical layout of the a.g.c. components.

Tuners and Mounting

Where a two-transistor tuner is employed a.g.c. is not applied to the r.f. stage so components R24, R25, D12 and R27 (see main chassis circuit, page 302, April issue) may be removed. With a two-transistor tuner and the constructor's i.f. strip fitted, there is no requirement for h.t.+ to be conveyed to either the contrast control or R27, so this h.t. lead from the smoothing capacitor may be removed. The tuner only needs a +12V supply from the line feeding the i.f. strip.

Where a tuner of the original type is to be used with this i.f. strip the r.f. gain control arrangements remain unaltered and the a.g.c. lead to the tuner is connected to the collector of Tr7 in the i.f. strip. R24, R25, R27 and D12 are fitted on a tagstrip as originally described, and R26 is increased in value to 100Ω.

For those readers living in proximity to a channel 1 transmitter a 41·5MHz absorption trap is shown in Fig. 10. This can be built into the input selective compartment of the i.f. strip, with L13 mounted mutually at right angles to L1 and L2.

When the i.f. strip has been constructed, it can be bolted on to the side plate of the receiver. The side plate must be drilled to accept the two 6BA fixing bolts of the i.f. strip. It will be found that the i.f. strip fits above the mains transformer. It should be set in ½in. from both the top and rear of the plate, with the input end at the top. The leads from the main chassis should be terminated in plugs to fit the sockets in the i.f. strip, with L12 mounted on the video plug as previously described. As the i.f. strip is bolted to the main receiver this also provides earthing.

Testing and Alignment

Before switching on, the +12V rail in the i.f. strip should be checked with the Avo to ensure that there are no short-circuits. Then VR1 should be set to maximum resistance.

If the remainder of the receiver has not been previously checked the procedure described in the July issue should be followed. For the purposes of alignment—depending upon the type of tuner used—it may be best to leave the tuner unmounted but electrically connected to the receiver so that easy access to the i.f. strip is possible. Various types of tuner are available, both rotary and push-button, and the mounting arrangements are best left to the constructor to resolve as seems most appropriate.

The receiver should first be run up with the +12V supply to the i.f. strip disconnected, taking care that the +12V plug does not accidentally short to chassis. When as previously described a raster has been obtained the +12V supply to the i.f. strip can be connected and the contrast control turned to maximum.

VR1 should next be adjusted for maximum noise, i.e. "black snow", on the raster. L6 is then adjusted in the same way. If a 41·5MHz trap is fitted, its input capacitor should be disconnected. An aerial is then connected to the u.h.f. tuner and the tuner adjusted until a signal is received. At this stage, the line and field hold and contrast controls can be adjusted. The tuner is adjusted to provide as good a picture as possible.

It should be appreciated that adjustment of the tuner effectively moves the received signal spectrum relative to the i.f. response curve. Adjusting for optimum definition involves two basic variables at this stage, the tuner (i.e. local oscillator frequency in effect) and L1. Using one hand to tune the tuner and the other to adjust L1, it is possible to adjust the receiver to provide a well-defined test card which suffers from sound-on-vision effects. L2 can then be adjusted for minimum sound-on-vision and the vision alignment can be considered complete except for the adjustment of the 41·5MHz trap if fitted. If 41·5MHz signals are in evidence the tuner should be disconnected and a piece of wire hung from the i.f. strip input socket. If any 41·5MHz signal is present it will be strongly received and can be tuned out using the trap.

The presence of sound-on-vision at the earlier stage of lining up indicates that a sound signal should be available, and some kind of sound signal may well have been heard during the process of lining up the vision side of the i.f. strip. Leaving the vision side running correctly, alignment of the sound section can be commenced.

First the Avo should be connected to measure the voltage across C42, using the 10V d.c. range. L9, L10 and L11 are next adjusted for maximum voltage, while L2 is finally adjusted for minimum.

It is quite probable that good sound will now be heard, although intercarrier buzz may be in evidence. VR2 is adjusted for minimum buzz. A quite sharp null will be found. Finally, adjustment of L11 is carried out for optimum results. If the sound is still not satisfactory and the buzz cannot be completely cancelled, adjustment of the coupling loop around L10 and L11 will provide the answer. The loop should be moved along the coils slightly and the procedure repeated. Normally, the loop lies over

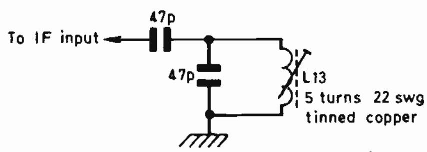


Fig. 10 (left): 41·5MHz trap.

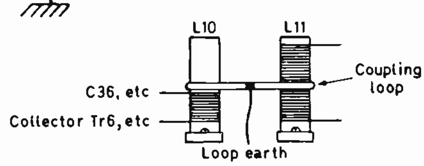


Fig. 11 (right): Ratio detector coil details.

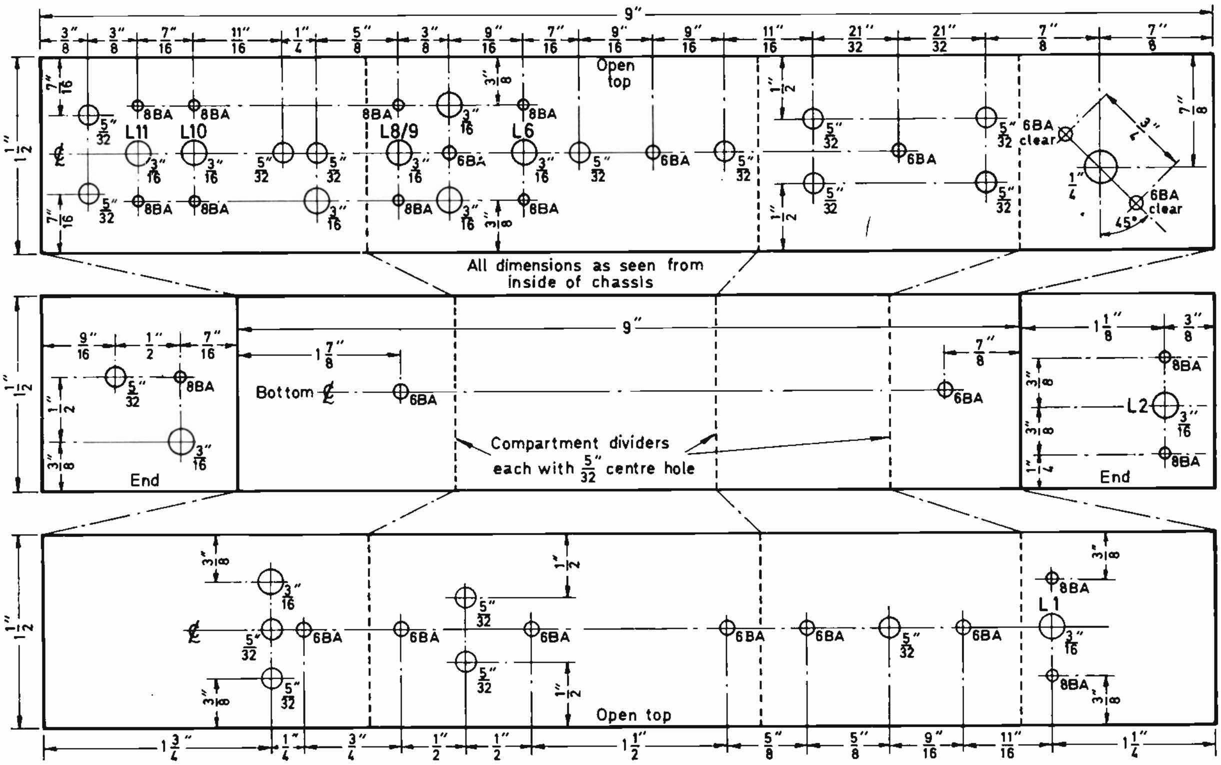


Fig. 12: Drilling details and dimensions of the chassis for the constructor's i.f. strip.

the centre of L11 and in proximity to the earthy end of L10, as shown in Fig. 11.

If the i.f. strip has been correctly constructed the foregoing alignment instructions should enable a first-class picture to be received. If difficulty is experienced it is probable that a fault exists, for the i.f. strip is not really difficult to set up. Note that VR1 can be used as a sensitivity control.

If the i.f. strip seems completely dead check the voltages on the transistors. The collectors should be near the 12V rail potential with an emitter-base voltage of around 0.6V. The emitters of Tr3, Tr4, Tr5 and Tr6 should all lie in the region of 1.5 to 2.0V, while those of Tr1 and Tr2 should vary with the contrast control setting.

Other points to watch out for are open-circuit end connections on L3, L4 and L5 and reversed connections on the bifilar-wound coil L6. Attention should be paid to the security of earthing tags and also the integrity of soldered connections in general, particularly at coil ends and earth tags.

With the screening provided, and the use of fixed tuning coils, the strip cannot fail to operate if it has been correctly constructed and all components are good. So we emphasise again the need for patient, careful construction as the means to a successful conclusion.

The Complete Project

Subjective viewing of the completed receiver, using the constructor's i.f. strip, has shown that consistently excellent results are possible. It has been our intention to provide details of a television receiver which can stand critical appraisal by technical and non-technical viewers alike, is reliable, and represents a realistic project reflecting the current state of the art.

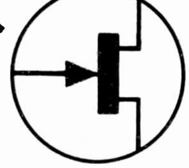
Those readers requiring a two-transistor u.h.f. tuner can obtain both push-button and continuous types from Stephens Electronics, who advertise in this magazine.

Before concluding the current series of articles on the 625-line receiver we would like to mention some problems which have been sent in by readers. One fault condition reported by several readers was briefly mentioned last month. It produces reduced width, striations on the left of the picture with foldover as well as hum ripple and excessive h.t. current consumption. It is caused by the 625- and 405-line output tags on the line transformer having been transposed in manufacture. Transferring the lead from C34 and C35 from tag 3 to the adjacent tag marked "not used" on the line transformer (see page 302, April issue) will clear the problem. Another cause of reduced width with apparent stretching of the raster at the sides (which actually is compression at the middle) is a C34 short-circuit, so this should also be checked.

Some readers have had difficulty obtaining the E298ZZ/06 Varistor. These are stocked by: Gurney's Radio, 91 The Broadway, Southall, Middx.

Another matter which has worried some constructors is the brightness of the valve and tube heaters at the instant of switch on. The tube itself has only 6.3V applied to it, even at switch-on, since a transformer is used, but the manufacturers allow for a 9.5V surge across the heater. It follows that any surge present is well below the manufacturer's limits. Also, no evidence exists to suggest that valve life is shortened by the switch-on surge on this equipment. ■

FIELD EFFECT TRANSISTORS



J. I. SIM

THE field-effect transistor (f.e.t.) combines the advantages of the solid-state device (low power consumption, mechanical ruggedness and small size) with an extremely high input impedance. The well-known *bipolar* transistor depends on the interaction of the two types of charge carriers—holes and electrons—whereas f.e.t.s are *unipolar* devices, their operation depending on only one type of charge carrier—holes in a p-channel f.e.t. and electrons in an n-channel f.e.t.

There are two basic forms of f.e.t. The first type uses a reverse-biased semiconductor junction as the control electrode and is called the junction-gate type of f.e.t. (j.u.g.f.e.t.). This was the first type to become available. In the other type of f.e.t. the control electrode is separated from the semiconductor channel by an insulating oxide layer. This is called the insulated-gate type (i.g.f.e.t.) or metal-oxide-semiconductor transistor (m.o.s.t. or m.o.s.f.e.t.) since the gate is metal and is separated from the semiconductor by the oxide insulating layer. We shall consider the junction-gate f.e.t. first since this is the type more commonly found in television and r.f. applications.

Junction-gate f.e.t.s.

The junction-gate f.e.t. consists basically (in the case of alloy-junction construction) of a bar of doped semiconductor material with an electrical connection at each end (Fig. 1). These connection points are known as the *source* (s) and *drain* (d), and applying a voltage across them causes a current *Id* to flow through the device. The two junctions at each side of the bar are of the opposite polarity to the bar. They are externally connected and termed the *gate* (g). A reverse-bias potential applied between the gate and source will produce a depletion region (region in which there are few charge carriers present to form a flow of current) at each of the pn semiconductor junctions and the extent to which this depletion region extends into the bar depends on the reverse gate-source bias applied. The unsymmetrical shape of the depletion regions is due to the influence of the drain-source bias on them.

The depletion regions are effective insulators so that an increase in their size reduces the cross-section of the bar as far as current flow through the bar is concerned. The larger the gate-source reverse bias, the larger the depletion layer and the smaller is *Id*. An a.c. signal at the gate will therefore vary *Id* in sympathy so that gain is obtained, the variations in gate potential being much smaller than the resultant drain-source voltage variations. Since the gate-source pn junction is reverse biased (unlike the base-emitter junction of a bipolar transistor) the gate input impedance is very high—typically 1-10MΩ, with an input capacitance of 4-10pF. The voltage on the gate at which *Id* cuts off is called the pinch-off voltage *Vp*.

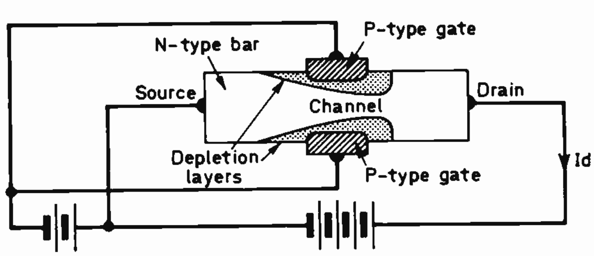


Fig. 1: Alloy n-channel junction-gate f.e.t.

A group of typical characteristics is shown in Fig. 2 and it can be seen that they have a pentode-like shape with a *gm* of between 2 and 6mA/V. Noise in the device is low, noise factors of 2.5 and 3dB being typical.

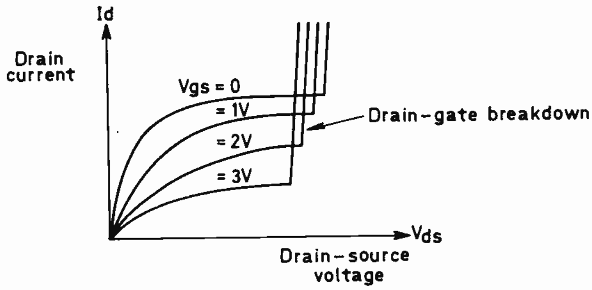


Fig. 2: Typical set of j.u.g.f.e.t. characteristics.

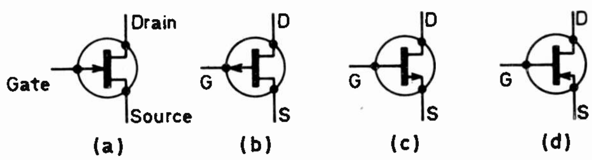


Fig. 3: Junction-gate f.e.t. circuit symbols. (a) and (c) n-channel, (b) and (d) p-channel types.

As with npn and pnp transistors, the bar material in a junction-gate f.e.t. may be of p or n type (with the gate always of the opposite polarity) to suit supply rail polarities. These are distinguished as n-channel and p-channel f.e.t.s. Fig. 3 shows common symbols for the junction-gate f.e.t.

A practical form of diffused n-channel junction-gate f.e.t. is shown in Fig. 4(a). An n-type region is first diffused into the basic opposite-polarity substrate to give the source-channel-drain region, a second diffusion establishing a p-type gate region to provide the gate-source pn junction.

Insulated-gate f.e.t.s.

Figure 4 (b) shows the basic difference with an insulated-gate f.e.t. The source and drain regions

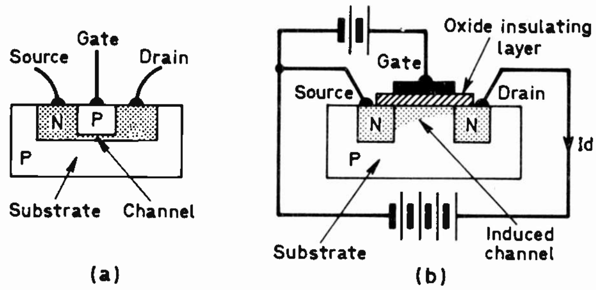


Fig. 4: (a) Diffused n-channel junction-gate f.e.t. (b) N-channel insulated-gate f.e.t., with biasing.

are separate (though a lightly doped channel may exist between them). Suppose now that the gate is made positive with respect to the source. Electrons in the p-type substrate will be attracted towards the gate. The metal gate with its insulating layer in fact operate with the semiconductor substrate as a capacitor. Thus the positive bias at the gate establishes a negatively charged region on the opposite "plate" and this serves as a channel between the source and drain regions.

Enhancement- and Depletion-mode

Clearly increasing the bias on the gate will enable an increased source-drain current to flow (thus giving us amplification). This mode of operation is termed *enhancement-mode operation* since increasing the bias enhances *I*d. The mode of operation described above with the junction-gate f.e.t. is termed *depletion-mode operation* since in this case increasing

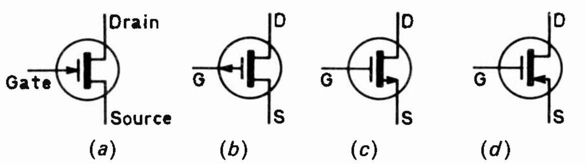


Fig. 5: Insulated-gate f.e.t. symbols. (a) and (c) n-channel, (b) and (d) p-channel types.

the bias decreases *I*d. Some circuit symbols used for i.g.f.e.t.s are shown in Fig. 5.

The Unijunction Transistor

A further related device, the unijunction transistor, appeared in these pages recently (see Time-Delay Techniques, August 1970, Fig. 8). Like the junction-gate f.e.t. this also has a single pn junction—see Fig. 6(a)—but its operation depends on the injection of minority carriers into the bar. Also, it is a switching device, not a linear one. The n-type semiconductor bar has connections—known as the base 1 and base 2 connections, hence its original name the double-base diode—at each end with a p-type emitter region at the side.

Suppose that B1 and B2 are biased as shown in Fig. 6(b)—which also shows the unijunction transistor circuit symbol. Current will flow through the device and a proportion of the voltage developed across it will appear between the emitter and B2 since the device in this respect acts as a simple potential divider. If now a voltage greater than this proportion of the base-to-base voltage *V*bb is applied between the emitter and B2 the pn junction will be forward biased and holes will be injected into the

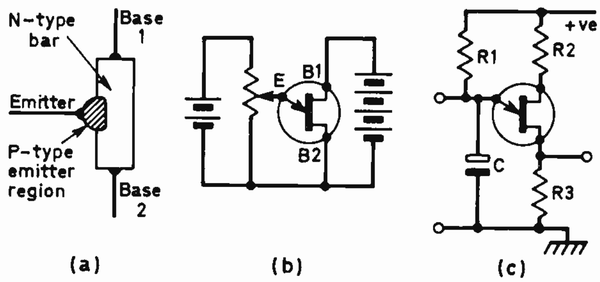


Fig. 6: The unijunction transistor, (a) construction, (b) principle of operation, (c) basic oscillator circuit.

base region. These will flow to the B2 connection and will virtually short the emitter-B2 section of the device. Removal of the emitter-B2 forward bias restores conditions to the original situation.

The practical use of the device—as an oscillator—is shown in Fig. 6 (c). Capacitor C charges via R1 and when its upper plate is sufficiently positive the unijunction transistor will fire, rapidly discharging C via R3. Thus we get a sawtooth waveform across C and a pulse output across R3. R2 limits the current through the device to a safe value. ■

PAL SWITCHING TECHNIQUES

—continued from page 14

reverse biased very shortly after the sinewaves start rising from the zero point and well within the blanking periods at the end of each line.

Decca Single-Standard Circuit

Decca in their latest single-standard colour chassis, the Bradford chassis, is another setmaker dispensing with a bistable circuit and using the ident waveform directly to control the R – Y phase inversion. They also invert the R – Y signal itself rather than the reference oscillator feed to the R – Y synchronous detector, so there seems to be a swing towards this technique. Their very simple PAL switch circuit is shown in Fig. 6. The R – Y signal

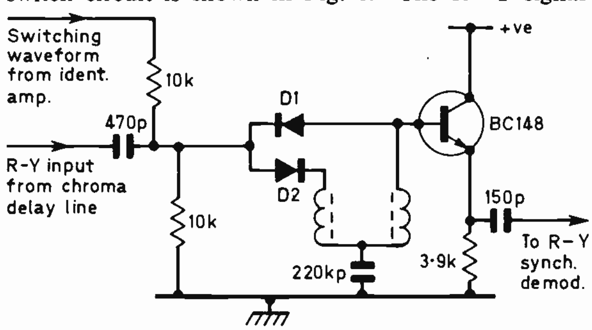


Fig. 6: Simple Decca PAL switch circuit.

from the PAL delay line is applied to the junction of two diodes D1 and D2 which are switched on and off alternately by the ident signal. When D1 is conducting the R – Y signal passes direct to the BC148 emitter-follower. When the other diode D2 is conducting the signal is fed to the BC148 via the 180° inverting transformer.

So with these apparently simple circuits, as in so much colour television receiver circuitry, we find a wide variety of ways of going about things not only possible but in actual use. ■

UNDERNEATH THE DIPOLE

THERE were grim expressions on the faces of some of the backbenchers in the House of Commons that night in August 1954 when legislation was agreed for the constitution of commercial television in the UK. The majority was 27 for television that was intended to be *competitive* as well as being *commercial*. So was born the patchwork quilt of organisations, authorities, consortia, corporations and companies which today make up Independent TV.

ITV'S START—HOUSE OF COMMONS

In the Committee stages of the Television Act, 1954 the constitution of the Independent Television Authority was shaped. It was given technical control of all the transmitters and powers to select the subcontractors who were to produce and supply the television programmes and sell advertising space in approved timed spots slotted into the programmes. The American system of direct sponsoring of television programme material by advertisers was forbidden. Thus was evolved the strange mixture of a national form of communication—*television*—operated by a public corporation and a number of private enterprises. Competition between the fifteen component television companies and the BBC has resulted in the highest standard of artistic and technical qualities in world television. It is interesting to recall how independent television started, from the practical point of view, nineteen years (and a war) after the BBC's television opening at the Alexandra Palace in 1936, with studios and transmitters all together in the same tower of the building.

HOW IT STARTED—IN PRACTICE

In September 1955, only thirteen months after the passing of the Television Act, an efficient (but somewhat temporary) ITA transmitter mast and aerial array were operating on high ground at Croydon, with programmes from Associated Rediffusion (weekdays) and Associated Television (weekends) plus nightly news clips from Independent Television News. It was a race against time. Rediffusion converted the 20th-Fox film studios at Wembley into television studios and also took over the Granville Theatre, Walham Green (formerly a music hall). Associated Television started by converting music halls at Wood Green and Hackney into TV studios, as well as making use of the existing Highbury film studios (see PRACTICAL TELEVISION, December 1969). The Highbury Studios had been occupied by High Definition Films Ltd. who had developed a unique electronic process for making cinema films using Pye Photicon TV cameras to scan the pictures sequentially—instead of with interlace—at 600 to 1,000 lines per frame, 24 frames per second—the present motion-picture standard. The resultant picture was presented on a high-quality TV monitor to the lens of a rather special motion-picture camera. This camera recorded on 35mm. film a good-quality picture recording of a full frame. The flyback on the monitor occurred during the period when the fast film camera pull-down mechanism shifted to the next frame.

TURN OF THE TIDE

The first couple of years of independent television were financially difficult, particularly during the first few months when Associated Rediffusion and ATV had to carry on alone with a limited number of advertisers for advertising slots in the programmes which could be seen by only the limited number of viewers then owning Band I/III sets and aerials. Millions of pounds were lost over the first year or so and it was not easy then for the ITA to find backers to run the provincial areas as programme contractors.

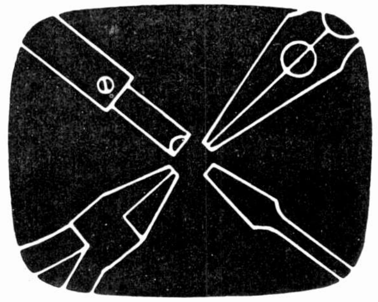
The tide literally turned when the soap and detergent manufacturers decided to take up this form of advertising in a big way, followed by the toothpaste, cosmetic and cigarette makers. It wasn't the advertising however that led to the scramble by viewers for Band I/III receivers or channel converters; it was mainly because of a few compulsive attractions such as *Sunday Night at the London Palladium*, *Coronation Street*, some unusual goon shows, and cliff-hanging detective and hospital series. The competition for TAM-ratings between the ITV companies and the BBC became, and still is, fierce and led to rapid improvements both technically and artistically by both groups

NOW COMMERCIAL RADIO

How will independent radio compare with the progress of independent TV? The Local Radio Association, which has been in existence for six or seven years, hopes to see about 300 radio stations all over the country on medium-wave as well as on v.h.f., the former during the hours of daylight only. The main intention is that communities with populations of between 50,000 and 250,000 should have their own local station—provided the people come within an area that can be served by low-powered transmitters with a range of about ten miles. Like independent television their revenues would come from advertising slots.

There is no doubt that the Government White Paper and lengthy committee debates in the House of Commons when the Television Act of 1954 was being set up will be studied again carefully by politicians of all parties. The Queen's Speech at the opening of Parliament after the General Election indicated that an independent local radio service would be evolved, but just how " local " will be the subject of much political debate.

Iconos



SERVICING television receivers

L. LAWRY-JOHNS

PYE 40F AND RELATED MODELS

WHEN preparing a servicing article for this series it is often difficult to decide which basic model to deal with and which of the near relatives to include: rather like drawing up a list of who should be invited to a wedding. We have selected the 40F as the basic model because it combines many of the features of the 36 series with many of the later 67 and 368 series so that with a little bit of luck we may be able to kill a couple of dozen birds with two or three stones (or something like that)!

This is not to say that the layout of the 40F is the same as that of all the other models—far from it. We shall do our best to include as much information as possible, but can't this time give each and every circuit change in the series and all the minor layout variations. The accompanying notes are intended as a guide in diagnosing the faults which may arise. The layout of the valves and components differ widely between the 40F and the 67 and 368 series but the functions are the same. On the other hand the layout of the 36 series is similar to the 40F but the functions differ. If this seems complicated, add the equivalent Ekco, Ferranti, Invicta Pam, etc. brand names using the same circuits and it is easy to see why it is as well to obtain the correct service sheet for any particular model.

In preparing this article however we are fortunate to have had the tuner unit and i.f. strip adequately described in detail by Keith Cummins in his admirable series of articles upon the construction of a single-standard 625-line receiver. Readers are urged to study the diagrams and text of these articles particularly as far as the tuner unit and i.f. strip are concerned. Thus if the reader feels that this

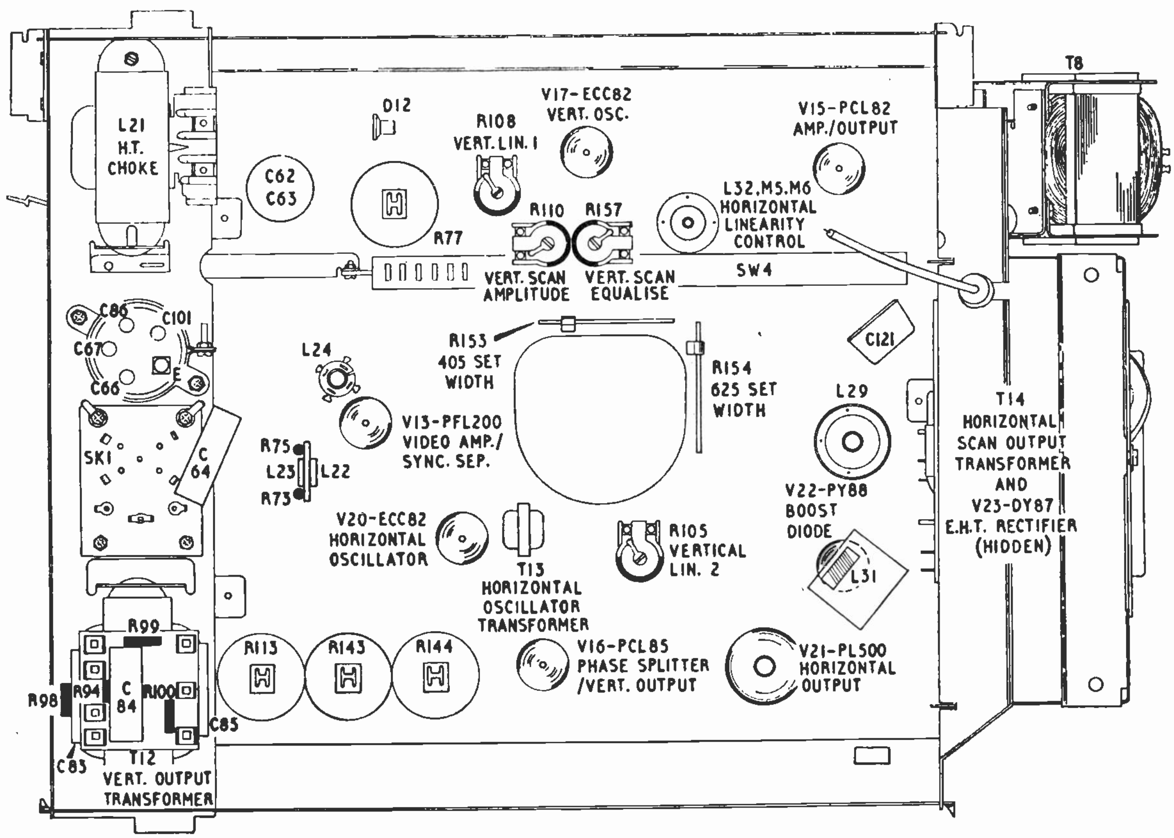


Fig. 1: Pye 40F main chassis layout—shown here in lowered position.

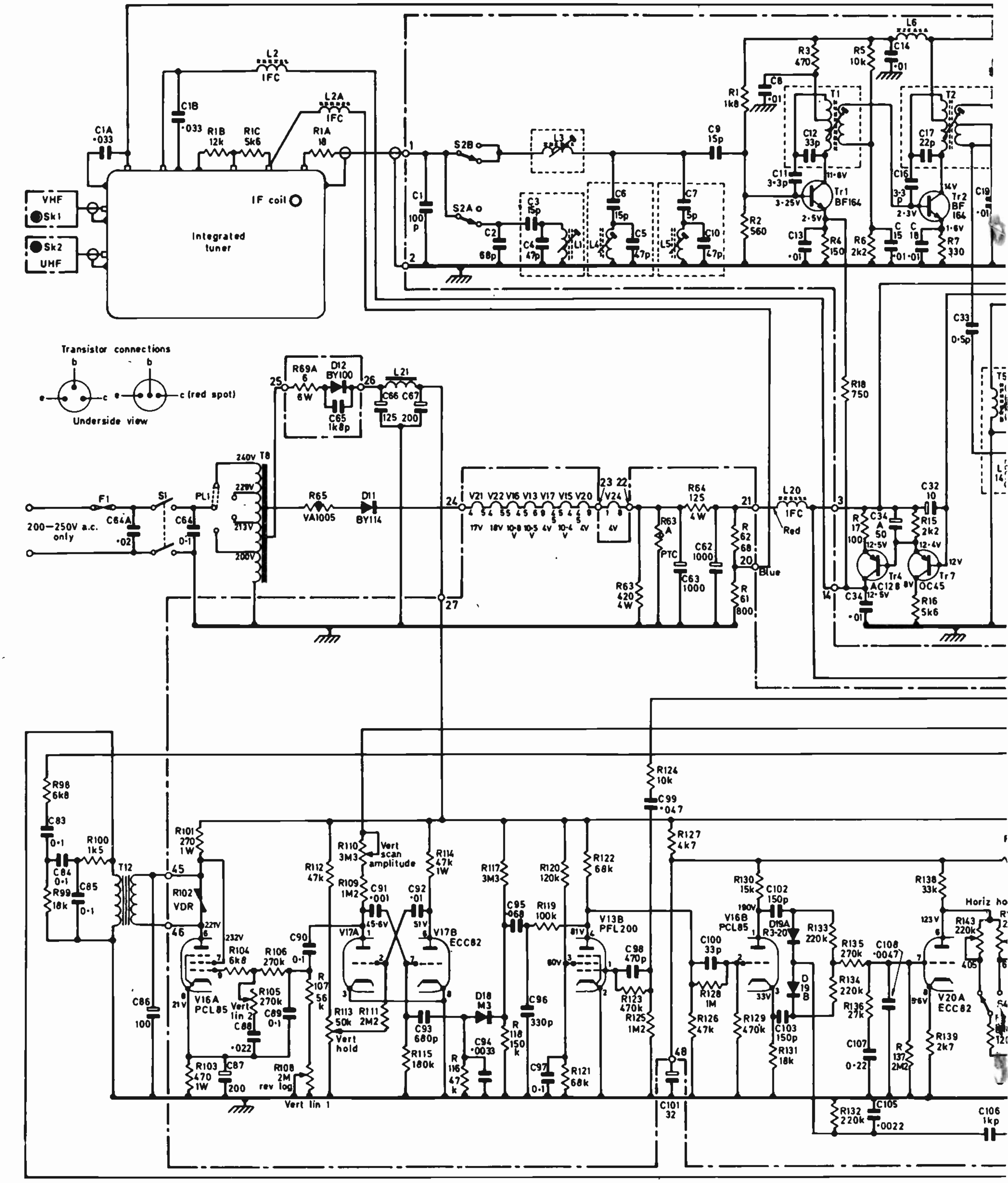
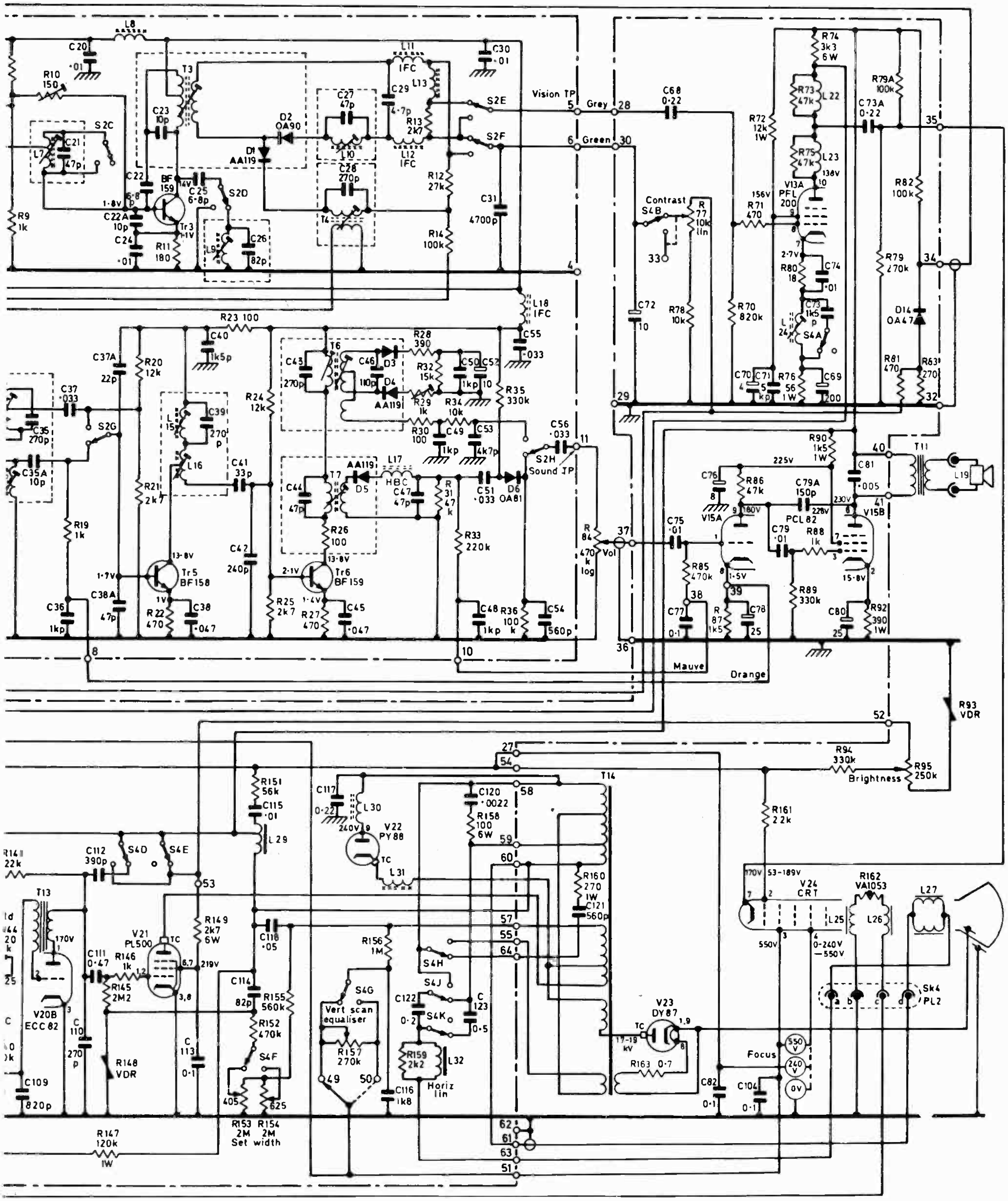


Fig. 2: Circuit diagram of the Pye Model 40F. The system switching is shown in the 405-line position. The mains fuse F at minimum and all other controls set for normal operation and the set switched to 405, using an Avo Model 8 (20,000Ω/V) signal and contrast control at maximum. In early models C1A, C1B, C73A, C34A and R79A were not fitted, L24 wa 25μF, R79 470kΩ, or not fitted, R84 1MΩ, R102 33kΩ and R112 75kΩ. We have in this diagram fol



1 is a 1A anti-surge type. The valve voltage readings were taken with signal input, 240V a.c. mains input, volume control
). E.H.T. is 17-19kV, measured with an electrostatic voltmeter and zero beam current. Transistor voltages taken with no
s centre-tapped, a 47Ω resistor was fitted in Tr3 collector-lead, C12 was 22pF, C25 4·7pF, C32 25µF, C40 1,000pF, C72
lowed the component value convention now used by most setmakers, i.e. 2k7 = 2·7kΩ, 3M3 = 3·3MΩ etc.

article leaves a lot unsaid about these items he should refer back to his earlier issues for more detailed description of the layout and mechanical handling (mainly the June-July issues this year). The writer would like to take this opportunity to raise his hat (or glass) to Mr. Cummins for his very fine and painstaking effort.

Polarity Differences

It is most essential to remember that the 40F and 36 series used a positive supply line to the i.f. strip and tuner unit (derived from the heater circuit) and that in the later 67 and 368 series the heater circuit rectifier was reversed to supply a negative line to the i.f. strip. Thus the voltage readings can be expected to be completely different as will be the type of transistor fitted in any particular stage. For example the AF186 r.f. amplifier fitted in the 40F tuner unit is replaced by a BF180 in the 67 tuner and the feed line is negative.

Beware Storms!

We particularly mention the r.f. amplifier transistor because this is the one most likely to be found faulty. The usual complaint is "It went funny on the night of the storm". The symptoms vary from no signal to a very weak and grainy picture and much reduced sound. An artificial aerial touched to the collector will produce a better signal than the normal aerial input.

There is no particular difficulty in replacing the transistor. Use the right replacement and fit it exactly as the original and no trouble will be experienced. If in doubt don't tackle the job at all but leave it to an experienced person or obtain an exchange tuner. The circuit and layout of the tuner appeared on page 444 of the July issue. This is the 36 and 40F tuner using an AF186 r.f. transistor.

The majority of the other tuner troubles will be found to have a mechanical origin and can usually be traced by closely observing the action of the switch contacts.

Usual Faults

The impression may have been gained from the above comments that it is the tuner which is usually at fault. This is not at all the case. The majority of faults occur on the main panel and are concerned with the valved stages. Before discussing these faults, however, it is essential to understand the valve functions. This is not so obvious as it looks, particularly when one is out on a job without the correct service sheet for the model.

The confusion arises over the function of the PCL85. The pentode section is obviously the field output valve. The triode section is not however the field oscillator. The triode section functions as a phase splitter for the line sync circuit in the 40F, 67 and 368, and as the line oscillator in the 36 series which do not have a flywheel-controlled line timebase. The point about this is that it is surprising how often the triode section of a PCL85 becomes faulty without the pentode section being affected. In the majority of receivers this results in field collapse anyway since the triode is most often used as the oscillator and therefore replacement of the valve restores normal height. In these Pye, etc. models an ECC82 functions as the field oscillator so that this valve as well as the PCL85 is suspect in the event of a narrow white line across the screen to denote total field collapse.

Field Timebase Faults

As the field timebase is practically the same in all models from the 36 to the 368 we will discuss this first. The only practical difference is in the hold control circuit where the 50kΩ resistor R113 is changed to 250kΩ and R112 deleted in later models.

Probably the most frequently encountered fault is insufficient height with an even gap top and bottom. Quite often there is enough adjustment on the vertical scan amplitude control to compensate for this loss but this is not really the answer. The resistor R109, 1.2MΩ, is often at fault. It is placed between the control and the ECC82 pin 1 (anode).

If this is not at fault check the PCL85 and if necessary the ECC82. If the PCL85 is at fault and a replacement restores normal height, don't leave the issue there. The bias resistor may have contributed to the failure of the valve and may impart a similar early fate to the new one. Check R103, 470Ω 1W.

If the trouble is more one of low boost voltage at the vertical amplitude control check R156, 1MΩ. This can rise in value.

Non-linearity

Lack of height should not be confused with bottom compression or other signs of non-linearity of the field scan. The first suspect here is the PCL85, its bias resistor and the electrolytic capacitors C87 and C86 (in that order). Bridging the suspect capacitor with one of similar value and voltage rating will usually prove the point. This however must not be done with the bias resistor. The only effect this will have is to lower the effective value still further and thus worsen the condition. Generally speaking if the bias resistor still retains its original bright colours (yellow-mauve-brown) it is unlikely to have changed value. On the other hand a charred appearance usually denotes a change of value. A little time spent checking these points can save time-wasting repeat calls.

Loss of Field Hold

If the trouble is loss of hold with the control at one end of its travel check the condition of the hold control and its series 47kΩ resistor (75kΩ on early models) R112. If these are damaged change the control to 250kΩ and delete R112 as in later models. If the control is in order check the series 2.2MΩ resistor R111 and the ECC82 valve V17. C92 could be at fault but this is less likely.

Total Field Collapse

The symptom of total field collapse, as evidenced by a single line across the screen, should direct attention not only to the PCL85 and ECC82 valves but also to the boost line supply to the vertical amplitude control R110. The circuit is through R156 to the vertical scan equalise control,

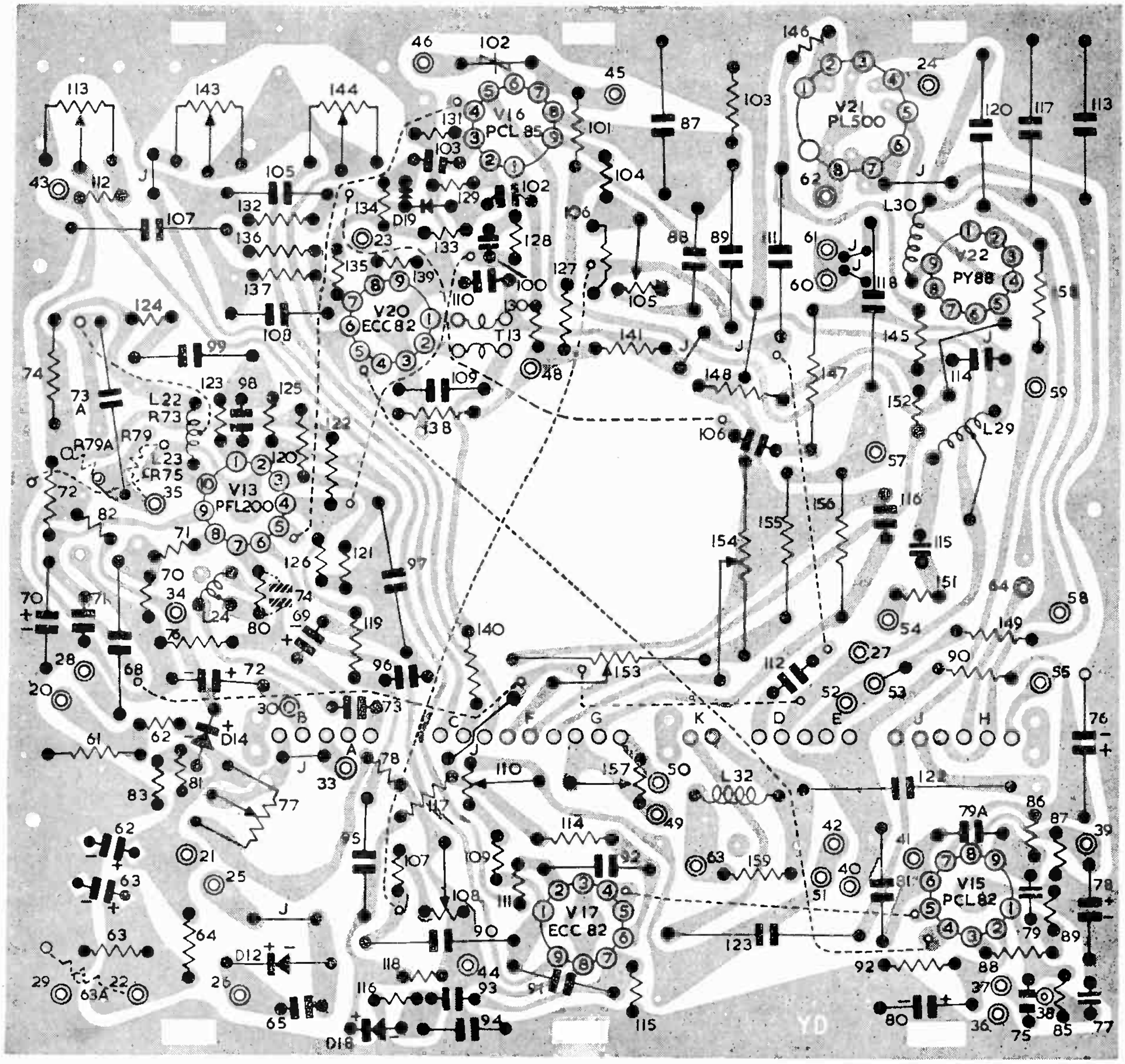


Fig. 3: Layout of the timebase printed panel, viewed from the print side.

decoupled by C116 which can short to chassis thus removing the supply from the controls (the feed arrangements differ on the 368 series).

If it is found that the h.t. supply to pins 6 and 7 of the PCL85 is absent, check the resistor R101 which can be damaged by a faulty PCL85 or a shorted C86 electrolytic (this does not often happen). If however it is found that the voltage on pin 7 is present but pin 6 is very low, check the field output transformer which will probably have an open-circuit primary winding.

A fault which could well occur although the writer has not encountered it in this series so far is a short in C91 ($0.001\mu F$). This would cause the field scan to collapse with very low voltages on pins 1 and 6 of the ECC82.

If the picture cannot be held although the hold control is not at either end of its travel, i.e. loss of sync pulses, check the interlace diode D18. This is an M3. It can often be brought back into service by pinching in the cover with a pair of cutters (to improve the internal contact). This should not be confused with weak sync which only occurs on say 625. Here the trouble should be looked for in the video stage. Check electrolytics C69 and C70 (C69 is not fitted in the 368 series video stage).

Audio Stages

The PCL82 does not give much trouble apart from the odd occasions when it develops grid-cathode leakage causing distortion and overheating of the cathode bias resistor. It is necessary to check the insulation of C79 as this may be the true cause of the trouble.

CONTINUED NEXT MONTH

FIT A BRIGHTNESS-COMPENSATION CIRCUIT TO YOUR RECEIVER

M.A.HARRIS B. Sc.

THE circuit described in this article is used in a number of Rank-Bush-Murphy models and first made its appearance about three years ago in the Bush model TV165, one of which is in the writer's possession. I have yet to see a better picture on a domestic television set than the one this displays. In the Bush models this circuit refinement is called a "black-level clamp" while in the Murphy equivalents it is referred to as a "contrast-compensator circuit". Neither of these terms is strictly accurate: the circuit would perhaps be best described as a brightness or black-level compensation network.

Most dual-standard domestic television receivers employ mean-level a.g.c. This is a simple and effective form of automatic gain control but has the drawback that the control potential is proportional to the picture content rather than, as it ideally should be, the transmitted signal strength. It is however a lot cheaper and more reliable than the more accurate gated a.g.c. circuits that have been used in the past. In combination with a.c. or partial a.c. coupling between the detector and the c.r.t. cathode (common forms of a.c. coupling in video circuits are shown in Fig. 1) it means that the contrast *and* black level will alter in accordance with the picture content. Not surprisingly, mean-level a.g.c. has come to be known as "always grey control"! Various circuits have in the past been devised to overcome this shortcoming, but most require an extra valve at the very least. The Bush-Murphy circuit however requires no valves or transistors, no l.t. or h.t. power supply and is physically small so that it can be squeezed into the most compact television set. The arrangement is shown in block schematic form in Fig. 2.

Theory of Operation

The negative-going output from the detector is a.c. coupled (via a phase-splitter or emitter-follower stage in the actual Bush-Murphy models using the circuit) to the grid of the video amplifier whose anode is d.c. coupled to the c.r.t. cathode. The sync pulses at the c.r.t. cathode are positive-going. The video signal is as usual also applied to the sync separator which provides negative-going sync pulses at its anode. The two waveforms—video with positive-going sync pulses and the negative-going sync pulse train—are fed to a matrix circuit which produces an a.c. voltage proportional to picture content only since the positive- and negative-going sync pulses cancel out (readers familiar with 405-line only models will recall that the same idea was used in the "sync-cancelled a.g.c." system). The important feature of the a.c. voltage at the output of the matrix is that its peak value is the black level of the signal. This is rectified and fed back to the grid of the video amplifier, altering its standing bias to keep the black level substantially constant. Clearly a shift in the black level at the grid, due to the a.c. coupling and a change in the signal strength, will result in an antiphase shift in the black level at the anode, and this is fed back to provide the required black-level correction.

Practical Circuit

The full circuit of the system as used in the Bush-Murphy TV161U/V1910U series of models is shown in Fig. 3. R7, R8, R10, C6 and C7 form the matrix network. If this circuit is used with a valve other than the PFL200 the values of R7 and R10 may have to be altered, but the sum of R7 and R10 should be kept to approximately 270kΩ. If a 'scope is available adjust the values so that at the junction of the resistors the sync pulses just cancel. If a 'scope is not available the results should be good enough using the values given.

In the original Bush-Murphy circuit a BA144 gold-bonded diode is used as the rectifier. Any *good* diode however can be used. The writer has tried OA81s and OA200s, the silicon diodes being better than the germanium devices.

Cathode Circuit

It will be seen that contrary to common practice in dual-standard models the video amplifier cathode bias (Fig. 3) is not switched between standards. If the experimenter's set uses a PFL200 as video amplifier and sync separator the cathode circuit may be rewired as shown in Fig. 3. Otherwise disconnect from the standards switch and leave the cathode

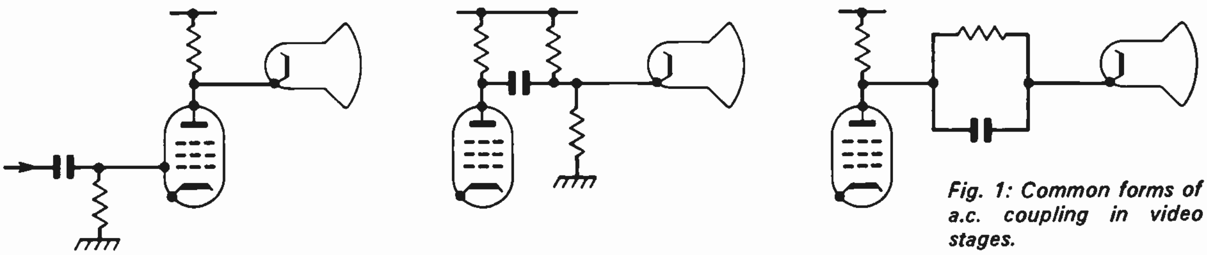


Fig. 1: Common forms of a.c. coupling in video stages.

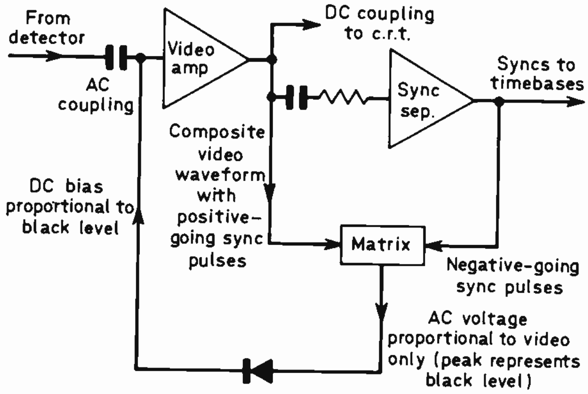


Fig. 2: Block diagram of the brightness-compensation system.

circuit permanently wired in the 405 position.

Some sets have a 3.5MHz trap in the cathode circuit as shown in Fig. 4(a) This would of course detract from the quality of the picture on 625 lines. The trap can be shorted out with a short wire link across the coil. Unless the fine tuning is very accurate however this will result in a mosaic type of patterning on the screen caused by the sound and vision carriers beating together. This occurs on 405 only of course. A better arrangement therefore is to re-arrange the circuitry as shown in Fig. 4(b), leaving the bias the same on both standards and using the switch simply to put the trap into or out of circuit.

Using the Black-level Circuit

The black-level compensation circuit requires only a few components and can thus be mounted on a small piece of Veroboard next to the video amplifier. When adding this circuit the following steps should be taken.

Remove any a.c. coupling or h.t. bleed networks from the c.r.t. cathode and make sure that there is only one wire from there direct to the video amplifier anode (or cathode if a cathode-follower

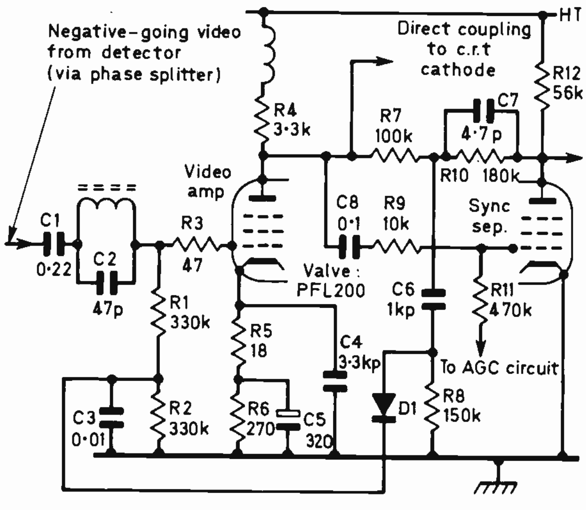


Fig. 3: Video stage (Bush-Murphy) incorporating a brightness-compensation circuit. D1 is type BA144 in the Bush-Murphy chassis.

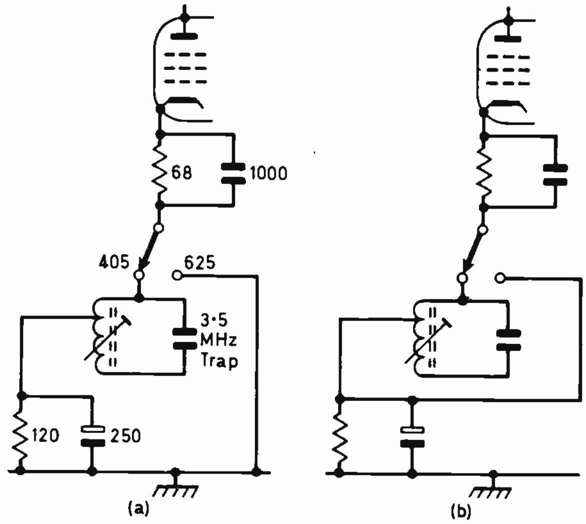


Fig. 4: Video amplifier cathode circuit with 3·5MHz trap. Typical component values shown.

is used in the set).

Ensure that the video amplifier grid is a.c. coupled to the video detector output (if the c.r.t was originally a.c. coupled the coupling capacitor can be used for this purpose). If not, use a capacitor of 0.22μF, 150V working or thereabouts. Also fit a grid stopper (R3) if one is not already fitted. Use a 47Ω resistor and wire it as close to the valve grid pin as possible. This may entail cutting the printed-circuit board.

Ensure that the video amplifier cathode bias is *not* switched when changing line standards. If a PFL200 is used the cathode circuitry may be rewired as in Fig. 3. If another valve type is used, leave the bias set in the 405 position by disconnecting from the standards switch or modifying as previously suggested where a 3.5MHz trap is incorporated.

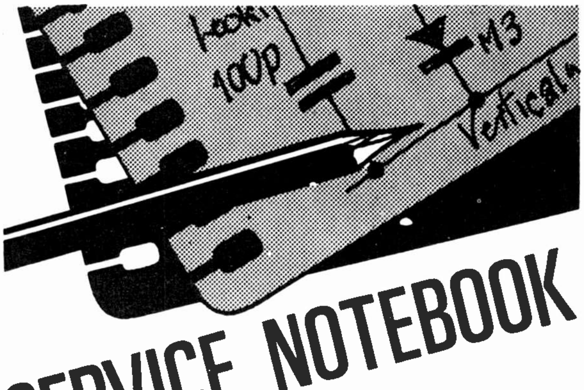
We have mentioned rewiring the cathode circuit where a PFL200 is used in the set: where the stage has extensive frequency response compensating circuitry however it is preferable merely to ensure that the cathode bias is kept at the 405 value on both standards.

If the black-level compensation circuit has been built up on Veroboard or something similar only four more connections are needed, to the video amplifier anode and grid, sync separator anode and chassis.

Brightness Control Range

The range of the brightness control may require altering if the set originally had a.c. coupling to the c.r.t. cathode. If there is insufficient brilliance add an extra resistor across the one between the top end of the control and h.t.—start with something like 100kΩ ½W. Conversely too much brilliance requires the extra resistor across the brightness control itself.

When viewing with a set incorporating this black-level compensating circuit a great deal more enjoyment will be had from the programmes, the black level staying where it should be and there being no tendency for streaking or contrasty captions. ■



SERVICE NOTEBOOK

G. R. WILDING

Insufficient Brilliance

THERE was a dark picture on an 11in. KB portable even with the brilliance control fully advanced. On removing the aerial it was found that the raster only just became visible at maximum setting, but rotating the tuner produced quite bright streaks across the screen so it was obvious that the tube was quite good but excessively biased. We also noticed that there was a distinct lag between turning the brilliance control to maximum and raster appearance.

When a c.r.t. is d.c. coupled from the video pentode there will be insufficient raster brilliance if the valve fails to pass normal current so increasing the c.r.t. cathode voltage above the normal value. However in this model as in other KB-RGD receivers the c.r.t. is a.c. coupled so that a video stage fault could be ruled out, implying that the tube's d.c. biasing circuitry was holding the cathode voltage too high or the grid voltage too low.

On removing the cabinet shell we found the cathode voltage close to normal but the grid voltage very low, producing only a small meter deflection at maximum brilliance setting. Due to the high-value feed resistors employed it is rarely possible to make accurate voltage checks to the tube grid, first anode and focus electrodes. In this model the h.t. feed to the first anode is via a 4·7MΩ resistor from the boost h.t. rail while the grid potential is via two medium-value resistors from the 0·5MΩ brilliance control which is fed from the boost rail via another 4·7MΩ resistor. Even the best moving-coil meters on high-voltage ranges will give readings below the voltage present before test prod application, so considerable voltage reading deviations do not necessarily imply a circuit fault.

In this KB portable the c.r.t. grid voltage should range from 12-130V but the readings we obtained on an Avo Model 8 were so low that it became obvious something was wrong with the feed to this point. The possibilities were (a) that one of the feed resistors had increased in value or (b) that a decoupling capacitor was slightly leaky. The definite time lag however between advancing the brilliance control to maximum and raster appearance suggested that a decoupling capacitor was taking increased time to charge due to increase in the value of a feed resistor.

Studying the circuit indicated that R161 was the most likely culprit and on test we found that although there was normal boost rail voltage at one side there was very little voltage at the other. We then stabbed an equivalent across this resistor and obtained full raster brilliance at a midpoint control setting. This didn't necessarily imply that the original was high-resistance since paralleling another resistor across it would halve its value and reduce the effect of any slight capacitor leak. The only conclusive test was to measure its resistance, but being of such high value it was necessary to unsolder one end otherwise conduction around the circuit would increase the ohmmeter deflection. On test the resistor proved to have a value approaching 7MΩ and on fitting a replacement we obtained normal brilliance.

Unstable Line Hold

THE 'phoned complaint was "lines on BBC" and on arrival we found an unconverted 23in. Philips receiver with a grossly over-contrasted picture and intermittent line tearing on BBC while on ITA the picture was fairly stable although it lacked contrast. On turning back to BBC and reducing the setting of the rear-mounted contrast control the line tearing disappeared but the line hold was distinctly edgy. Clearly the excessive signal strength had contributed to the complaint.

As the field hold was good we first replaced the ECL80 V400. The triode section of this forms half of the line generator with the line output stage

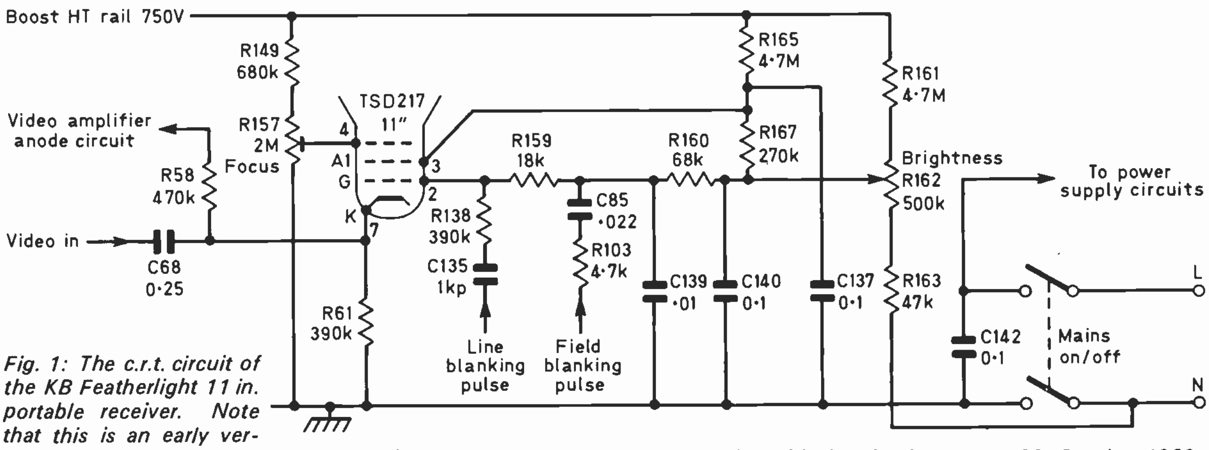


Fig. 1: The c.r.t. circuit of the KB Featherlight 11 in. portable receiver. Note that this is an early version and several modifications were introduced. Compare for example, with the circuit on page 23, October 1969.

while the pentode section is a line sync pulse clipper. There was a marked improvement but the line hold still remained edgy while horizontal bands across the picture tended to shift slightly one way or the other. We therefore replaced the ECL80 sync separator and also the PL83 video output pentode but without any noticeable improvement. It appeared therefore that we had a component failure in the receiver but before getting too involved we decided to replace the PL36 since this acts as line oscillator together with the V400 triode.

As there was no improvement we commenced voltage checking and although the sync separator voltages were almost as specified the anode voltage of the line pulse clipper was 32V instead of 24V. This naturally suggested a reduction in the value of the single 39kΩ anode feed resistor or a decrease in grid bias. As the valve was without cathode resistor, developing autobias on signal application, we first checked the anode resistor and found that it was only about 32kΩ. On replacing this component the anode voltage was closer to the specified figure but we then found that R402 (22kΩ) in the grid circuit had also reduced in value thereby decreasing the self-bias and attenuating the input. After replacing this resistor we obtained perfect line lock with complete freedom from the horizontal picture shifts.

Finally we replaced the PCC89 r.f. amplifier to improve the gain on ITA and were then able to reduce the contrast control from its former maximum setting so that both programmes were received with about equal strength and without the previous over-driving on BBC which had accentuated the weak line lock. The owners said they never adjusted the rear presets and had apparently accepted the over-contrasted BBC picture as good reception compared to the originally weak ITA picture. One more instance of how viewers can get accustomed to the most deplorable TV reception!

Inspect First: Meter Later

Intermittent crackling with coincident screen flashes had culminated in complete loss of sound and picture with a smell of burning on a Thorn 850 convertible chassis. A burning smell is generally caused by an over-run resistor so we first looked for visual signs, especially around the PCL84 video pentode since internal shorts in this type of valve crop up occasionally and usually result in cathode, screen feed and even the detector load resistor becoming burnt up if d.c. coupled. All resistors round this valve were in good condition however but the several years' accumulation of dust and dirt over both chassis panels made complete inspection difficult.

At this point since the short-circuit was not heavy enough to blow the fuse and the over-run resistor would need replacing anyway many service engineers find it quickest to switch the set on, keep a close watch on the chassis and let the overheating resistor identify itself before smartly switching off. Although the overload h.t. current must be comparatively small —otherwise the fuse would blow—the main objection to this practice is that prolonged excessive heat from an over-run resistor can damage and/or loosen printed circuit wiring and make further service work necessary.

As the highest proportion of TV h.t. shorts are valve interelectrode short-circuits—with i.f. pentodes figuring high in the probability list—we next connected an ohmmeter from the h.t. rail to chassis and noted if the reading reduced as we removed each of these valves in turn. As the h.t. rectifier was a low-resistance silicon type we first took the precaution of removing the c.r.t. base connector so that ohmmeter current could not flow through the rectifier and then through the heater chain to chassis to give an erroneous short-circuit reading.

Removing the valves had no effect but on taking out the EF183 common i.f. amplifier we could see that the 33kΩ resistor feeding the screen grid was badly discoloured. Slight pressure from a screwdriver blade completely disintegrated the component and reference to the circuit diagram showed that only the 1,000pF screen decoupler could be at fault. On replacing both these components normal results were restored.

We have since had several other instances of i.f. decouplers going short-circuit so that the associated feed resistor(s) burn up. As with so many faults, looking for visual evidence and applying light pressure to suspects generally proves far quicker than tracing with a meter.

At one time PCL83s and PCF80s had a high incidence of internal shorts, generally from control to screen grid, but such failures now seem to be quite rare.

TO BE CONTINUED

DX-TV

continued from page 15

appear to be delays in the commissioning of the TV2 transmitters at Sippola Ch.49 (600kW) and Jyväsklä Ch.25 (600kW). These will not now be in service until February 1971. Also the TV2 transmitter at Helsinki Ch.24 is at present operating with a power of 10kW only.

At least four DXers—R. Bunney at Romsey, H. G. Adams and A. Thynne at Birmingham and R. Roper at Saltash—have in addition to myself now managed to get Iceland on Ch.E3 from Stykkisholmar in the North-West of the island. It looked for a while as if this was just not on, but it can be done although the signal here was weak. Just for the record E4 Skalafell has been pretty good at times this year, so if you want a new country I recommend you to turn your aerial array to the North-West and watch out for the test card, even after 22.00. Weather maps of the island have also been seen (by R. Roper) and these provide a positive means of identification when all else fails—as alas can so often happen on programmes.

R. Finch of Birmingham has an excellent June-July log with just about all European countries via SpE. He even got Denmark Ch.E3 (this one has eluded me so far this year). He queries the origin of a "cartoon like a cat's face" with the letters DTCA below it on Ch.R1. Has anyone any idea who uses this?

Garry Smith of Derby has reported some very interesting Trops, with WDR Langenberg Ch.E9 and Cologne Ch.E11 from W. Germany, Wavre Ch.E8 and E10 from Belgium and Holland Lopik Ch.E4. Apart from these he too has a very impressive log of SpE reception including most European countries: he too has managed to get Denmark on Ch.E3.

COLOUR RECEIVER CIRCUITS

TUNER UNITS-1

GORDON J. KING

In this new series I propose to explore the circuits which are to be found in contemporary colour receivers. The plan is to look not only at the circuits themselves but also at the basic design problems as a means of highlighting the techniques which are adopted to resolve them. In common with my previous series dealing with waveforms *(Waveforms in Colour Receivers)* I shall start at the aerial side of the set and work through the small-signal circuits to the luminance and colour circuits and conclude with the timebase and power supply circuits. This first article therefore is mostly concerned with the so-called front-end.

Small-signal Stages

The small-signal circuits are designed to have phase-linear bandpass characteristics with filters to provide the required amount of signal rejection at certain frequencies within and outside the pass-band. These things happen essentially in the intermediate-frequency (i.f.) stages. At the front is the tuner or tuners. Some of the first dual-standard models were equipped with two tuners, one for the v.h.f. channels and the other for the u.h.f. channels. Later dual-standard models adopted the "integrated" or "all-band" tuner, a single unit capable of tuning over Bands IV and V as well as Bands I and III. Recent single-standard models of course have just one tuner capable of responding to the u.h.f. signals in Bands IV and V.

Although colour is transmitted only in the u.h.f. channels and on the 625-line standard there will have to be some references to v.h.f. signals and the 405-line standard because dual-standard colour sets contain circuits to process them. However, since it is likely that the majority of readers of these articles will already be fully conversant with v.h.f. and 405-line circuit techniques in monochrome receivers I propose to give them only passing attention, especially when they are not directly concerned with the u.h.f. 625-line aspects of the circuits under discussion. If I was writing this series about five years hence I would probably be able to forget all about v.h.f. and 405 lines as most of the country would by then be covered by three u.h.f. channels on 625 lines. As it is at the moment however quite a number of dual-standard colour receivers are in use and there are still some being produced. Most of the current colour sets being manufactured though are single-standard models, which could almost be termed "second-generation" colour receivers.

Tuner Requirements

Early v.h.f. and u.h.f. tuners used valves as the active devices. The performance of these tuners is significantly below the latest versions in which transistors are used as the active devices. However there are some areas in which valves win even today! The design problems connected with colour receiver tuners are common to those of monochrome receiver tuners. To obtain optimum signal transfer from the aerial downlead to the r.f. stage the tuner input circuit has to receive special attention, with particular reference to its noise figure. The front-end must also have the best possible crossmodulation and intermodulation performance, factors which can conflict with the low-noise requirement. The input impedance must present a good match to the 75-ohm coaxial aerial downlead and conversely the downlead must present a correct load to the tuner over the u.h.f. spectrum. The radiation from the local oscillator section must not exceed a certain specified maximum value and the tuner overall should be capable of operating over a relatively wide dynamic range of input signal levels without calling for external signal attenuation or difficult adjustments.

In some respects the front-end of a colour receiver is more demanding than that of a monochrome receiver. For example on the 625-line standard intercarrier sound is employed. One advantage of this in black-and-white receivers is that slight drifting of the frequency of the local oscillator signal can go unnoticed since the intercarrier frequency is "locked" to the frequency difference (6MHz) between the sound and vision carriers. In colour receivers however such drift can affect the colour display by modifying the relative level of the colour subcarrier on the i.f. characteristic. Thus it is becoming more common for the u.h.f. tuners of colour receivers to incorporate automatic frequency correction (a.f.c.).

Representative U.H.F. Tuner

Let us now have a look at the circuit of a u.h.f. tuner. That shown in Fig. 1 is used in the Rank-Bush-Murphy CTV25 and CV2510 dual-standard models. For the v.h.f. channels there is a separate tuner. The circuit shown in Fig. 1 has much in common with recent monochrome u.h.f. tuners in that it features two transistors and a four-section tuning gang. Each section of the gang has the job of resonating a quarter-wave tuning line, and the circuits are trimmed so that the four tune in step. The main tuning lines are 4X3 aerial, tuned by 4C3A and trimmed by 4C1, 4X4 with 4X5 for the r.f. output and mixer input in a bandpass coupling tuned by 4C3B and 4C3C and trimmed by 4C6 and 4C9, and 4X7, the local oscillator circuit, tuned by 4C3D and trimmed by 4C12.

Tr1 is the r.f. transistor and Tr2 the frequency changer (i.e. self-oscillating mixer) transistor. Both of these are operated in the common-base mode. The input signal from the aerial down-lead is coupled to

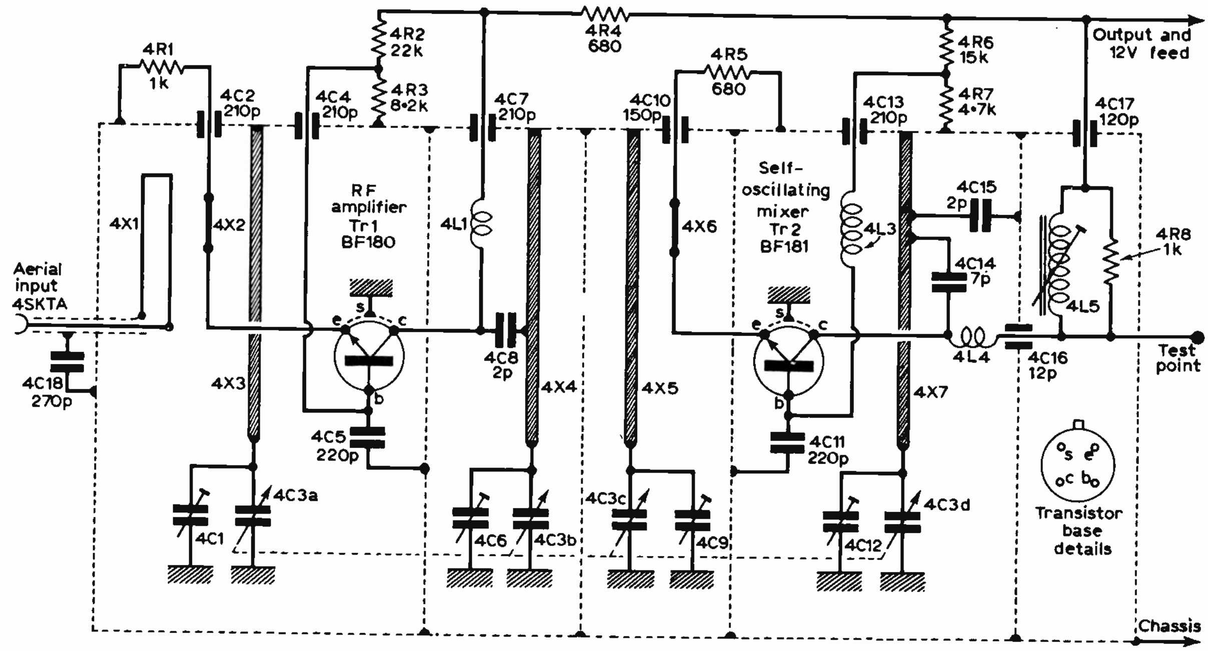


Fig. 1: U.H.F. tuner unit used in the Rank-Bush-Murphy dual-standard colour chassis (a separate tuner is used for v.h.f.). A modified version of this tuner is used in the later single-standard chassis.

Tr1 emitter via the aerial coupling loop 4X1 and the untuned line 4X2. This scheme gives the input a fair degree of selectivity which was at one time considered to be absolutely essential to tame possible crossmodulation problems with the advent of multiple u.h.f. channels. We shall see in a minute however that a tuned selective circuit like this tends to impair the noise performance, and in view of this at least one main manufacturer uses untuned coupling to the emitter of the r.f. transistor and hence only three tuned quarter-wave lines, considering that optimum noise performance is more important than designing for an unnecessarily large crossmodulation margin.

The base of Tr1 is earthed signalwise by 4C4 and 4C5 and the amplified signal is generated at the collector across 4X4. 4L1 is a hold-off choke in the feed to the collector and is decoupled by 4C7. The signal across 4X4 is inductively-coupled to 4X5, the two circuits in unison, being critically coupled, providing the bandpass characteristic mentioned earlier.

Tr2 oscillates at a frequency determined by the tuning of 4X7 and at the same time the amplified and tailored aerial signal is applied to its emitter via the untuned line 4X6 which picks up signal from 4X5. Tr2 base is effectively earthed from the signal point of view by 4C11 while 4L3 is another hold-off choke which blocks signal but passes bias to the base. The operation of a self-oscillating mixer is to produce sum and difference frequencies, the required i.f. signal being taken via the filter 4L4 and 4C16 to the i.f. coil 4L5. The output from 4L5 is fed to the mixer stage in the v.h.f. tuner, which provides additional i.f. amplification on u.h.f., via 4C17, and the 12V supply for the u.h.f. tuner is fed in at this point.

The r.f. amplifier is biased at its base by 4R2 and 4R3, with 4R1 acting as the emitter bias resistor, while the self-oscillating mixer is biased at its base by 4R6 and 4R7, with 4R5 being the emitter bias resistor. Since the two transistors are npn types the supply is positive relative to the emitters. 4R4 is merely a decoupling resistor which works in conjunction with the various feedthrough capacitors.

Although the circuit of a u.h.f. tuner may appear to be fairly simple, the design is far more complex since at u.h.f. even the shortest length of wire has an inductance that can impair the amplification, conversion efficiency and stability unless properly taken into account. Even the positioning of wires is highly critical, so for these reasons any servicing operations must be handled with extreme care. It is generally undesirable to attempt u.h.f. tuner servicing. It is far better to acquire a replacement unit from the manufacturer via a dealer, for very few dealers have proper facilities for realigning a tuner to optimum after a servicing operation.

All-Band Tuner

The circuit of an all-band type of tuner is shown in Fig. 2. This is from the BRC 2000 series colour chassis. The u.h.f. section incorporating transistors Tr1 and Tr2 is similar in general design and operation to the u.h.f.-only tuner just described. However, in the oscillator circuit there is a capacitance-diode (W1) providing a.f.c. which I shall be dealing with when I investigate the tuner of the BRC 3000 series receivers later.

All-band tuners commonly use two more transistors than u.h.f.–only ones, making a total of four as in Fig. 2. Here Tr3 operates solely as the v.h.f. local oscillator while Tr4 operates as the mixer on the v.h.f. channels and as an extra i.f. amplifier on the u.h.f. channels, the latter boosting the tuner gain on the u.h.f. channels to match more closely that on the v.h.f. channels.

Although there is a five-gang tuning capacitor in this tuner only four sections (C10 trimmed by C9, C23 trimmed by C22, C27 trimmed by C26 and C35

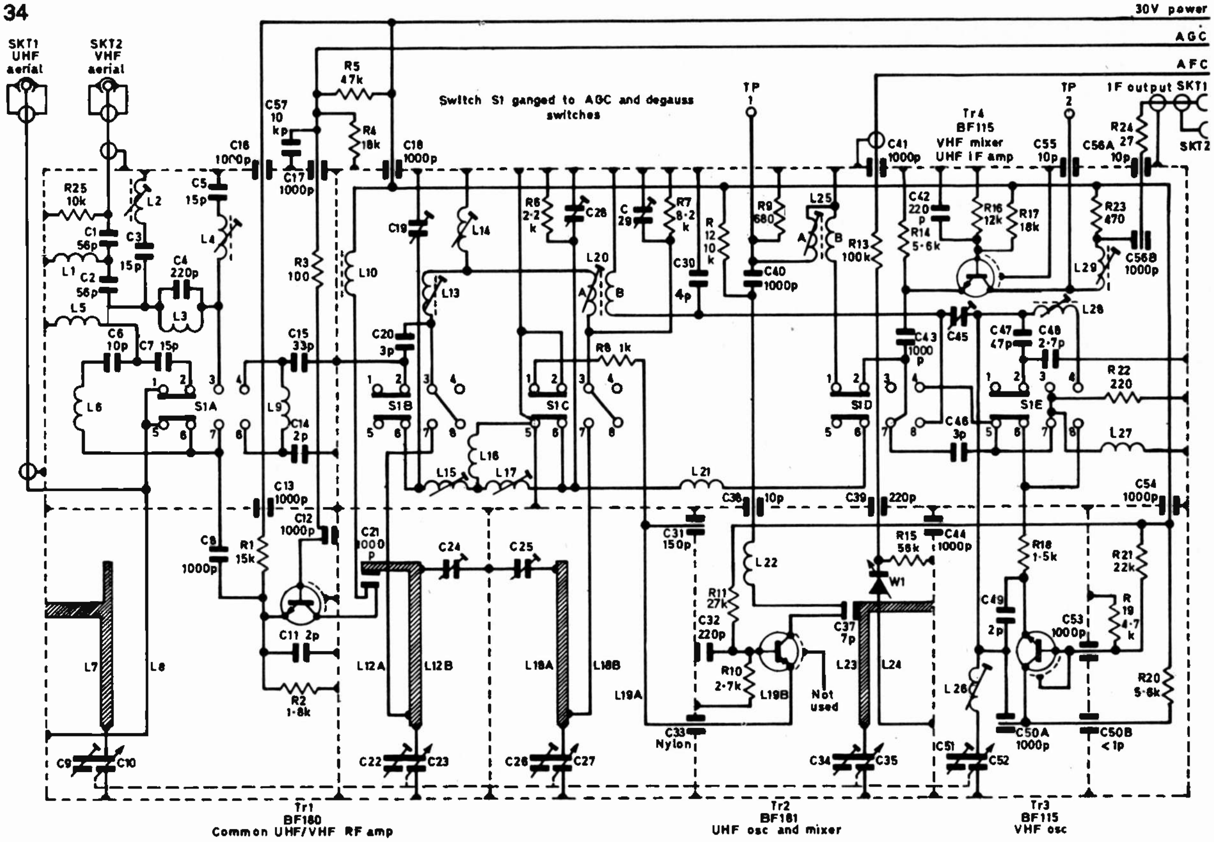


Fig. 2: All-band tuner unit used in the BRC 2000 dual-standard chassis. S1 shown in u.h.f. position. Contacts 2, 3 and 6, 7 closed on Band III, 3, 4 and 7, 8 closed on Band I.

trimmed by C34) operate on the u.h.f. channels, just the same as in the tuner in Fig. 1. The fifth section is C52 trimmed by C51 which tunes only the v.h.f. local oscillator. It is noteworthy that sections C23 and C27 not only tune the quarter-wave lines on 625 lines but also the v.h.f. circuits in the upper part of the diagram on 405 lines. A system of changeover switches is ganged to the set's standard-change switch. In the tuner this changes from one tuning arrangement to the other.

To summarise, therefore, Tr1 is the r.f. amplifier on u.h.f. *and* on v.h.f., Tr2 is the self-oscillating mixer on u.h.f. only, Tr3 is the local oscillator on v.h.f. only and Tr4 is the mixer on v.h.f. *and* an extra i.f. amplifier on u.h.f. The ganged switches also mute the stages that are not required on the standard selected.

Sets fitted with the BRC 2000 series chassis have automatic degaussing which operates not only when the set is first switched on but also when the standard is changed at the tuner. This is worked by a switch ganged to the tuner band changeover switch S1. The a.g.c. applied to the r.f. transistor is also modified by the action of a switch ganged to the main changeover assembly.

The tuner is powered from a 30V stabilised supply and since the transistors are npn types the supply is positive relative to the transistor emitters. Forward a.g.c. is applied to Tr1 base.

The block diagram Fig. 3 brings out the functions of the transistors on the two systems. On u.h.f. the i.f. selected by L25 in Tr2 collector circuit is coupled via the changeover switch to Tr4 emitter, this transistor then working as an i.f. amplifier. The u.h.f. oscillator frequency is controlled by the capacitance-diode W1 which is coupled to the oscillator tuning line via loop L24. The capacitance of the diode is varied by a reverse potential which is derived from the a.f.c. circuit in the i.f. section (the subject of a later article).

On v.h.f. Tr1 is again the r.f. amplifier with a.g.c., but the aerial input circuit this time includes the static discharge resistor R25 and the high-pass filter composed of C1, L1 and C2 which attenuates all frequencies below Band I. An i.f. rejector is formed by C3/L2 and C5/L4, while rejection at Band III frequencies is provided by the switched low-pass filter consisting of C14, C15 and L9. Finally in the aerial circuit is a Band I rejector made up of C6, C7, L5 and L6.

The appropriate bandpass and oscillator coils are selected by the changeover switch sections and as

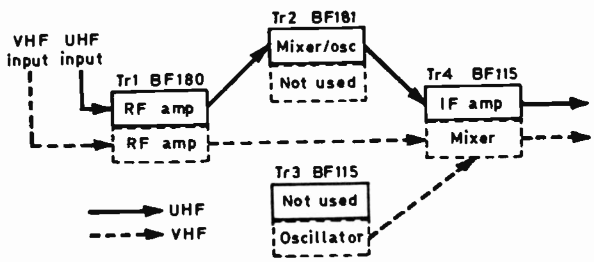


Fig. 3: Block diagram of the all-band tuner used in the BRC 2000 chassis.

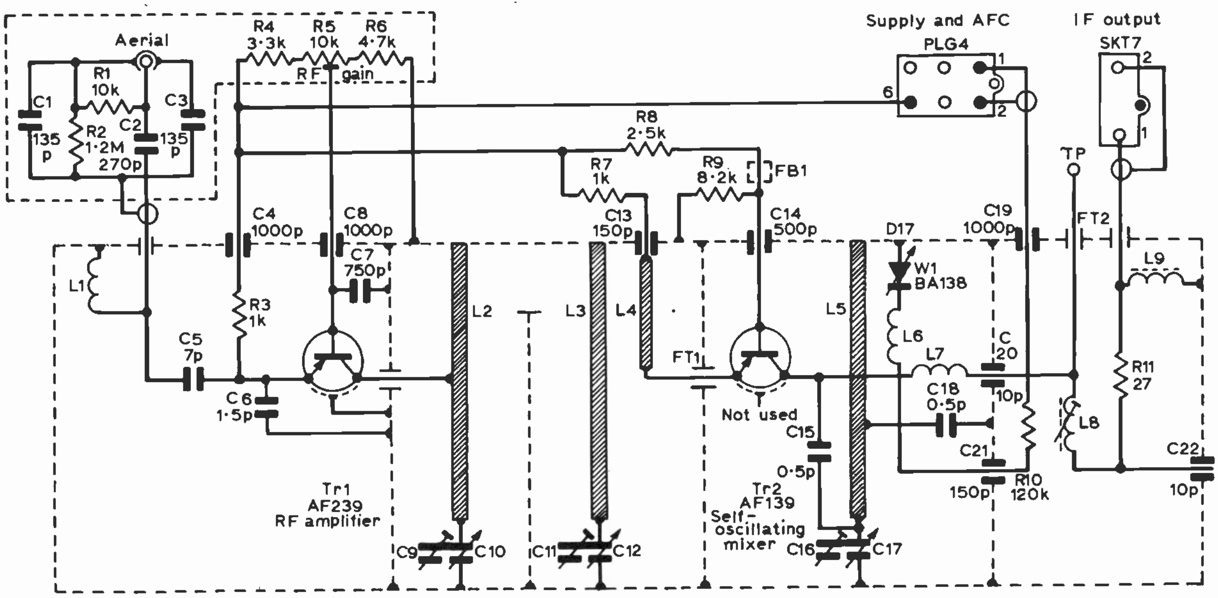


Fig. 4: U.H.F. tuner used in the BRC 3000 single-standard chassis.

already noted during v.h.f. reception the tuning lines do not function as such but merely make the required connections between the tuning coils and the sections of the tuning gang.

BRC 3000 UHF Tuner

Figure 4 shows the complete circuit of the u.h.f. tuner used in the latest BRC 3000 series single-standard chassis. This differs from the other circuits in that only three tuned lines are employed, L2 and L3 in a bandpass coupling and L5 in the local oscillator department. The gang sections are C10 trimmed by C9, C12 trimmed by C11 and C17 trimmed by C16. This tuner is designed for maximum noise performance, for which reason the aerial signal is coupled direct to the emitter of Tr1 via C5. The "pad" at the aerial socket end of the screened (coaxial) cable provides mains isolation and static build-up protection, the capacitors for the former and the resistors for the latter. Choke L1 also helps to prevent transistor damage due to transients on the mains or coming in through the aerial.

The impedance of the emitter circuit is optimised for maximum signal current transfer from the aerial, an action which ensures the best input signal-to-noise ratio. This also makes the input stage virtually wide open to unwanted signals outside the selected channel. About 70 per cent improvement is possible by the use of a tuned selective circuit, but BRC believe that the more important performance feature is noise and not crossmodulation. Hence this particular design.

From tests it has been discovered that the worst possible crossmodulation situation in practice is when the aerial signal due to *one* of the three transmissions of a local group is just at the minimum noise-free level, the other two possibly 10dB adverse. Under these conditions the r.f. gain control would be at maximum which, in the case of the 3000 series tuner, corresponds to the most critical crossmodulation state. Even so, when the tuner is correctly aligned and fault-free it can accept a signal of some 10mV level from the wanted station of the group, with the other two also active, before exhibiting signs of crossmodulation (i.e. patterns on the picture). In fact it has been calculated that with the existing three-channel system a crossmodulation performance of about 3mV is satisfactory. Thus in spite of the 3000 series u.h.f. tuner only having three tuned lines and no pre-r.f. stage tuning it still has a reasonable crossmodulation margin.

It will be seen from Fig. 4 that the gain of the r.f. stage is adjustable by a potentiometer in its base circuit. This adjusts the transistor emitter current and hence its gain. Amplified signal is developed across the first line L2 coupled to Tr1 collector circuit. This line is bandpass-coupled to line L3 from whence signal is coupled to Tr2 emitter via the untuned line L4. Tr2 is the self-oscillating mixer,

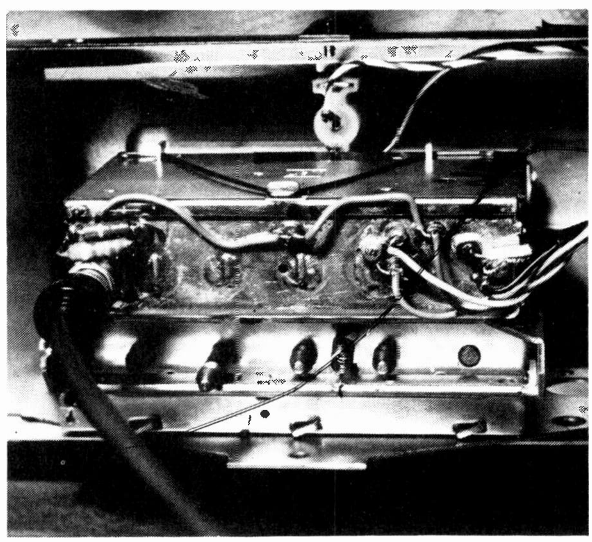


Fig. 5: The u.h.f. tuner wired into a recent Decca single-standard colour receiver.

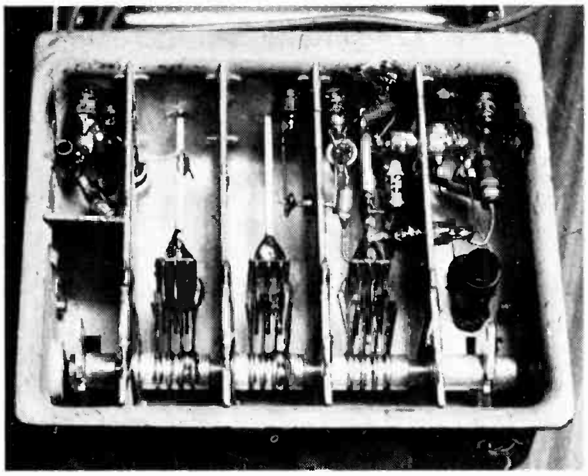


Fig. 6: Inside view of the BRC 3000 series tuner.

tuned by line L5, and inductively-coupled to this is the capacitance-diode W1 which gives the a.f.c. action.

Any junction diode in reverse conduction exhibits capacitance across its two terminals. Capacitance-diodes are designed to exploit this effect with the least losses (i.e. without severe loss of Q). The capacitance decreases as the reverse-bias applied to the diode is increased; that is as the potential barrier at its junction widens. Thus by biasing the diode from a discriminator placed towards the end of the i.f. channel, incorrect tuning is reflected as a plus or minus increase in bias on the diode. As a result there is an increase or decrease in capacitance across the oscillator tuned circuit thereby automatically correcting the tuning provided the vision carrier remains within the discriminator passband. In practice the diode bias is adjusted for correct oscillator tuning when the a.f.c. discriminator output is zero, this condition also corresponding to the correct tuning on the capacitor gang (i.e. C17). Any change in oscillator frequency therefore shifts the carrier within the discriminator response causing a plus or minus output which changes the capacitance of the diode in such a way as to restore the tuning. I shall be having more to say about the a.f.c. discriminator when we look at the i.f. stages.

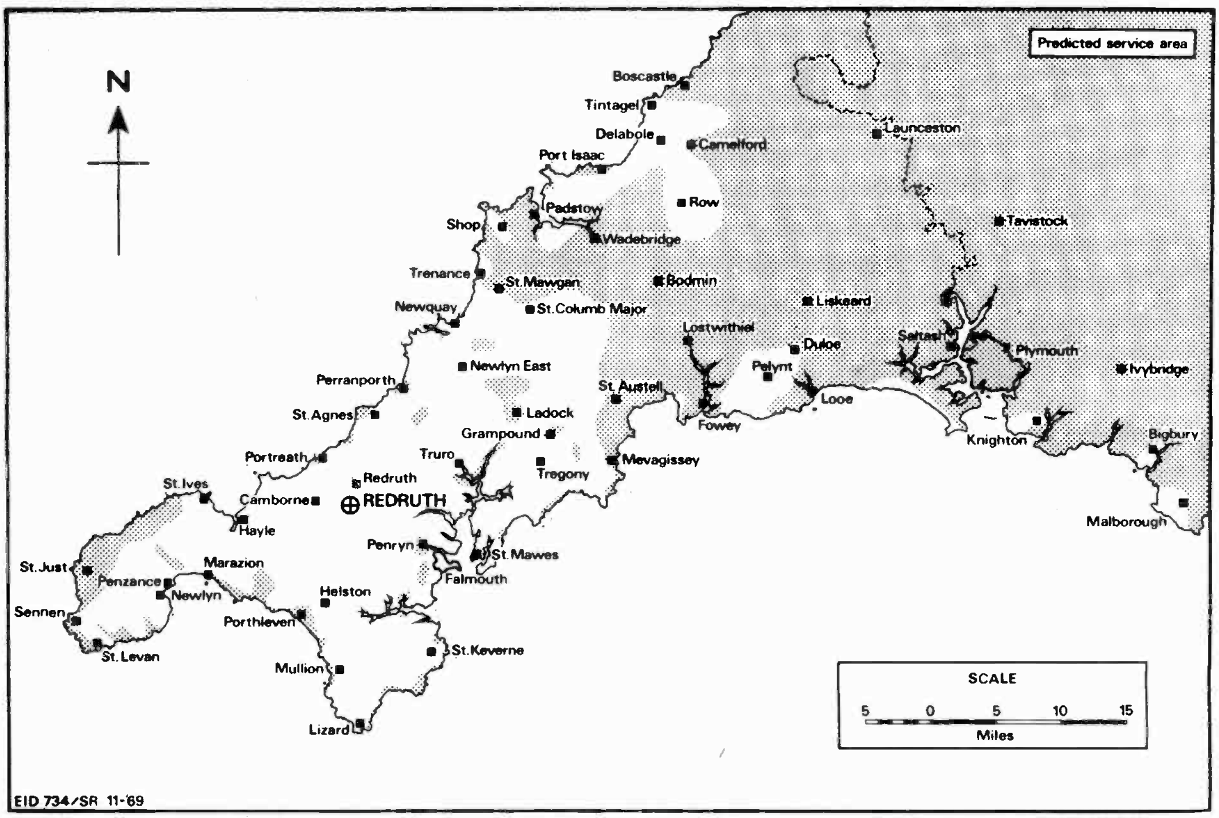
The i.f. output in Fig. 4 is developed across L8 and then conveyed to the i.f. channel.

Fortunately if u.h.f. tuners get into trouble they can be replaced quite easily in the latest sets. Fig. 5 shows the u.h.f. tuner in the latest Decca single-standard set while Fig. 6 shows the inside of the BRC 3000 series tuner. The three main tuning lines can be seen and the gang sections appropriate to them; also the line coupling the capacitance-diode in the local oscillator department, and the i.f. coil.

Next month I shall be continuing with the u.h.f. front end, looking at some more interesting though very important features.

REDRUTH UHF TRANSMITTER

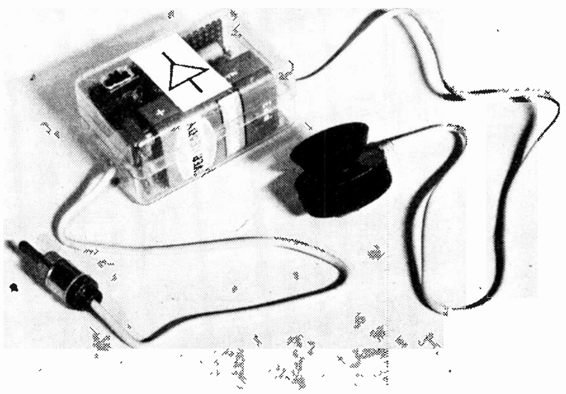
Horizontal polarisation; receiving aerial group B; maximum vision e.r.p. 100kW.



The above BBC map shows the expected service area—the boundary is approximate and there may be pockets of poor reception too small to be shown. Channels: ITA 41; BBC-2 44; BBC-1 51.

Recording from TV

JULIAN ANDERSON



RECORDING the sound from a TV set may at first seem to be pretty easy—until you have actually tried it. The simplest way is of course to hold the microphone near the loudspeaker, but this has the disadvantages of (a) picking up extraneous sounds and (b) poor quality due to reverberation etc.

Tapping off the audio from the secondary of the ouput transformer greatly improves the quality but this is dangerous since one side of the loudspeaker is usually wired to chassis which is live. The output is also very high at very low impedance, causing matching problems. In addition many people rent sets and the rental companies are not too happy about their customers dabbling with the innards however competent they claim to be.

By far the best method is by using the little unit described here. It can be built in a matter of minutes and can be used for recording not only from TV but from *any* loudspeaker.

Magnetic Pick-up

The unit makes use of the magnetic fields produced around the loudspeaker which of course vary at the same rate as the signal. By detecting these the audio signal only is picked up with no extraneous sounds. A telephone recording pickup is used and although the system is very simple the quality achieved is excellent.

Preamplifier

The output from the pickup is rather low for most tape recorders so a simple preamplifier will usually be required. A suitable circuit is shown in Fig. 1. All the components can be mounted on a piece of paxolin and fitted inside a small plastic box which also holds the battery and on/off switch. Construction is simple as the layout is in no way critical. The screened lead from the pickup coil can be wired directly on to the circuit board and the output taken via a second screened lead to the type of plug used on your recorder—DIN, phono, etc.

Some recorders have a very high input sensitivity and it may therefore be worthwhile trying the system first without the preamplifier.

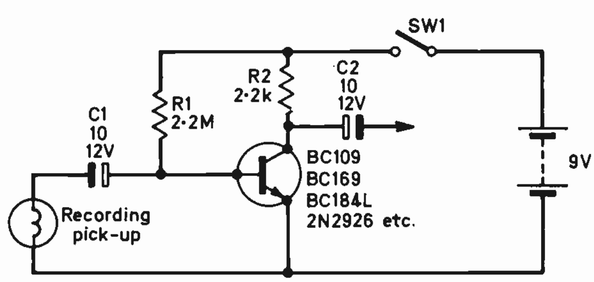


Fig. 1: Suggested preamplifier circuit.

Obtaining Best Results

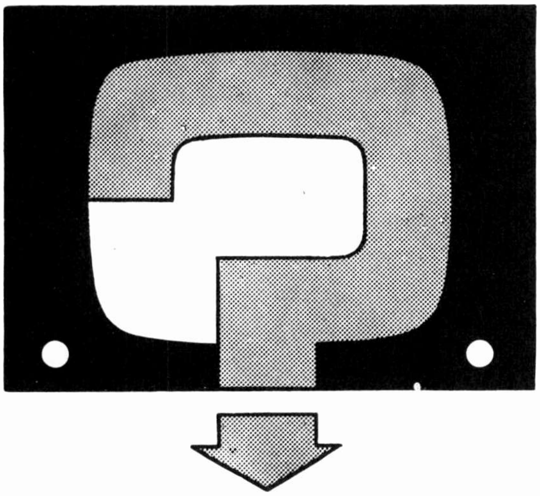
The pickup coil should be held near the centre of the loudspeaker for best results. If this proves difficult a small piece of tape can be used to hold it in position. When recording make certain that the fine tuner on the TV receiver is correctly set—various buzzes that are not objectionable when viewing because you have got used to them will mar any recording.

Suppliers

Suitable telephone pickup coils are available from Henry's Radio and G.W. Smith costing around 10s, while the miniature on/off switch shown in the photograph is available from G. W. Smith at 1s 3d. ■

NEW TV EQUIPMENT

Two new items have been introduced by Aston Micro-Electronics Ltd., Vapery Lane, Pirbright, Woking, Surrey. The first is a vision mixer, type TVM2, intended for educational and semiprofessional use. It is an A/B mixer for cutting, fading and mixing the pictures from five cameras and one videotape recorder. A mixed sync output is also provided to enable other signal sources to be synchronised with the main A/B mixer output. Two rows of preview buttons enable any two vision sources to be viewed before transmission, while automatic interlocks prevent accidental mixing of the videotape recorder output with the camera signals. The mixer is designed for monochrome use but its 8MHz bandwidth is adequate for colour use and PAL encoded signals have been successfully mixed. The second item is a TV waveform generator, type SPG5, for providing fully-interlaced field drive, line drive, mixed blanking and mixed sync pulses to the 525/60 and 625/50 line/field standards.



YOUR PROBLEMS SOLVED

★ **Requests for advice in dealing with servicing problems must be accompanied by a 2s. postal order (made out to IPC Magazines Ltd.) the query coupon from page 40 and a stamped, addressed envelope. We can deal with only one query at a time. We regret that we cannot supply service sheets or answer queries over the telephone.**

BUSH TV128

After switching on the sound and raster appear almost immediately but with a very faint picture. After 10-15 minutes a tap on the top of the set will bring the picture to normal except for a slight pull to the left of the screen.—C. W. Bailey (Chesterfield).

Check the picture tube heater voltage (approximately 6V a.c. across pins 1 and 8). If this is about 3V at first going to 6V when the tube is tapped the tube is at fault. If this is not the case check the upper left video amplifier valve PCF80 and the 10kΩ anode load resistor to pin 6.

EKCO CT102 COLOUR RECEIVER

The a.f.c. was cut out and the set properly tuned for colour, but on releasing the a.f.c. button again the colour tuning was off, i.e. correct tuning with and without a.f.c. ceased to correspond. Some time after when properly tuned for BBC-2 sound and vision the colour suddenly disappeared and did not return. The manual colour control makes no difference but when the set is tuned away from breakup (i.e. away from the sound side) a weak colour picture with noisy colour, poor field hold and noise but no signal on sound is obtained. The colour control is then operative. The set is normal on both 405 and 625 in all other respects.—T. J. Hall (Aberdeen).

Make sure that the system switch is making fully on all contacts as your trouble suggests narrow bandwidth on 625 lines. Failing this your i.f. strip must have its alignment carefully checked.

GEC BT302

The sound is perfect but there is no vision and the U25 e.h.t. rectifier does not light up. As soon as I pull the top cap off the U339 boost diode the picture appears but only on the left-hand side of the screen. The picture on the left-hand side is good.—R. Brown (Colne).

The boost reservoir capacitor is shorted. This is the 0·1μF capacitor on the left side above the screened section. Use a capacitor rated at over 600V for the replacement.

PYE V210

There is cramping at the bottom and the top is stretched. The capacitors between the oscillator and output stage (C47 and C48) have been replaced, and the PCL82 and PL81 changed, but with no improvement.—A. Pateman (Leicester).

Double-check C47 and C48, which must have no leakage. If these are OK check the field output transformer.

PETO-SCOTT TV960

The set worked well on BBC-2 for several years, in fact an aerial attenuator was necessary to enable the preset contrast balance control to be set correctly. The BBC-2 picture however went very "thin" with marginal field hold—the single field hold control now needs a different setting on each system. With the u.h.f. aerial attenuator removed and the contrast set at maximum the BBC-2 picture is only just stable but is free from noise. The BBC-2 sound appears to be unaffected by the reduced picture strength. All the valves have been tested and are OK and the u.h.f. tuner shows no sign of damage.—R. G. Privett (Croydon).

The trouble is in the PCL84 video output stage where the value of some of the resistors is suspect—they tend to change value in this Plessey chassis. Check the 2·2kΩ screen feed resistor R123, and the 10kΩ and 8·2kΩ stabilising resistors R124 connected between the screen (pin 9) and the cathode circuit. Note the effect of connecting a 100kΩ resistor from pin 1 of the PCL84 (grid of the triode a.g.c. amplifier) to chassis, i.e. check R127.

EKCO T402

There is a strong signal from Mendip but I cannot get sound or vision on u.h.f. The raster is quite clear when the coaxial lead which connects the u.h.f. to the v.h.f. tuner is removed, but when I replace it the raster goes black with a lot of white spots but no sound or picture.—B. A. Yule (Devizes).

The u.h.f. tuner appears to be inoperative. Check the supplies to it, then suspect a faulty PC86 mixer valve.

DECCA DR2

There is a full but poor picture on 405 and a vertically folded picture on 625. Also the line output transformer is getting hot. Another, but used, transformer was tried with the same results. It occurs to me that the scan coils are at fault. Do you agree?—A. J. Price (Stoke).

The best way to check whether the coils are the cause of the trouble is to disconnect one connection to them and allow the receiver to run like this for a time with the brightness reduced to prevent screen burn. If the line output transformer does not get hot then the coils are at fault. If it does then the coils are cleared. If the coils are OK check the boost reservoir capacitor (C134, 0·1μF), the PY800 boost diode and that the boost volts at the junction of C137 and R165 are 800V.

BAIRD M683

The sound on the u.h.f. channels fades to a whisper within a few moments of switching on from cold. The sound is clear and undistorted but very low even with the volume control fully up and the set tuned for best sound. The picture quality is good and on v.h.f. both sound and vision are good with ample sound volume.—W. Redrup (Borehamwood).

We have found that the fault you describe is usually due to an alteration in the value of the resistors in the screen (pin 8) supply to the second sound i.f. stage.

BUSH TV125

The PL36 line output valve glows like a lamp. The sound is OK but there is no raster.—J. Allen (Oldham).

Check the PCF80 line oscillator and note the effect of unscrewing the preset trimmer (preset line hold control). It is common for this control to develop a short between its plates. Also check the PL36 itself.

SOBELL ST288DS

I have fitted a u.h.f. tuner and although I get a fair picture and good sound the width is short by about an inch each side on u.h.f.—everything is normal on v.h.f. The valves in the line output stage have been replaced. On checking the voltages I find that the h.t. drops by about 20V on switching to 625 while the boost voltage falls by about 200V.—J. Hegarty (Bristol).

There is a correction coil on the line output transformer which is in circuit on 625 lines only. It appears that this winding has shorted turns.

EKCO T326

On switching on, the sound and vision are OK but after a few minutes the picture fades almost completely and breaks up. This is accompanied by a blue glow in the e.h.t. rectifier. This valve has been changed but the results are still the same.—P. H. Parsons (Launceston).

Your trouble could be a faulty line output transformer, especially if its case is buckled. However, check that the linearity choke is not shorting to chassis.

GEC BT302

I have two of these sets and both have the same fault—there appear at intervals two black lines at the top of the picture and two at the bottom. The PL84 and N308 valves have been replaced without improvement. Sometimes the lines do not appear for hours, whilst at others they are on for hours.—J. Hamnett (Wolverhampton).

The type of lines you describe are usually due to an improper contact in the height control. Check this and all other points of poor contact in the field output stage.

PHILIPS 19TG170A

The picture has a great deal of intermittent distortion and very black bands stretch across the screen from any white object. All valves have been tested and a dud PFL200 replaced. After making this replacement the picture completely disappeared giving a bright screen with a 3in. black band at the top. A further PFL200 was tried with the same results.—C. Warnett (Burton).

It seems to us that coil L232 is open-circuit. This is the 405 3·5MHz trap coil in the grid circuit of the PFL200, in series with R262.

BUSH TV135U

A replacement e.h.t. winding has been fitted to the line output transformer. The picture is perfectly good on 405 but on 625 a series of broad vertical bands, about seven in all, straddle the screen, and linearity is affected. This effect, which I assume to be due to ringing after flyback, cannot be cured by adjusting the line linearity control.—G. A. Sergeant (Walton-on-Thames).

Check the 4·7kΩ resistor 3R49 connected across the linearity coil to provide damping, and the 100pF capacitor 3C34 connected across tags 7 and 8 of the line output transformer to provide tuning of the primary.

TEST CASE

95

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 Bush Model TV125 had a vision fault whereby the picture brightness gradually deteriorated during a period of several hours running, giving the impression of a picture-tube fault. It was noticed that the contrast also fell in sympathy with the brightness, so that the contrast ratio remained fairly consistent in spite of the brightness diminishing.*

As this kind of fault has been encountered on previous occasions as the result of a short in the heater of the picture tube, an a.c. voltmeter was connected across the tube heater and the voltage was monitored during the period that the fault occurred. The reading remained substantially constant however. It was thus concluded that the tube was not responsible.

The next possibility with a fault like this lies in the video amplifier, so the PCF80 was replaced and the set run again. This time there was far less deterioration in brightness but it was noticed that with time the contrast ratio tended to increase accompanied by reducing bandwidth (picture definition) as shown by the test card.

What critical component has been overlooked and why should a fault in this increase the contrast and reduce the bandwidth? See next month's PRACTICAL TELEVISION *for the solution to this problem and for a further item in the Test Case series.*

SOLUTION TO TEST CASE 94

Page 571 (last month)

The adjustment made was to the preset control which sets the colour-killer threshold. The colour killer is in effect a biased-off stage in the chroma channel, and is biased-on by rectifying the ident signal which is of course present only when a colour transmission is being received. The rectified ident signal is the turn-on bias, and in this way the chroma channel becomes operative only on colour and is open-circuit signalwise on black-and-white. The threshold preset sets the level at which the chroma channel is biased-on. If the control is adjusted on a chroma signal so that the chroma channel only *just* switches on, it is possible that it will fail to switch on during some transmissions. This is because the $\pm 10\%$ tolerance in the burst signal amplitude (allowed by the BBC and ITV) might have been on the *plus* tolerance during the adjustment and at the *minus* tolerance on a different transmission or even camera change.

The plan is, therefore, to adjust the threshold control on a transmission (Test Card F is best) just to the "chroma-on" point and then to turn it slightly beyond this to satisfy the tolerance. It should not be turned too far beyond the threshold point otherwise the chroma channel will be triggered on by noise signals and the screen will then possibly show coloured snow on a monochrome picture.

Published approximately on the 22nd of each month by IPC Magazines Limited, Fleetway House, Farringdon Street, London, E.C.4. Printed in England by Fleetway Printers, 17 Sumner Street, London, S.E.1. Sole Agents for Australia and New Zealand—Gordon and Gotch (A/sia) Ltd.; South Africa—Central News Agency Ltd.; Rhodesia and Zambia—Kingstons Ltd.; East Africa—Stationery and Office Supplies Ltd. Subscription Rate (including postage): for one year to any part of the world, £2 5s. 0d. "Television" is sold subject to the following conditions, namely that it shall not, without the written consent of the Publishers first having been given, be lent, resold, hired out or otherwise disposed of by way of Trade at more than the recommended selling price shown on the cover, and that it shall not be lent, resold, hired out or otherwise disposed of in a mutilated condition or in any unauthorised cover by way of Trade, or affixed to or as part of any publication or advertising literary or pictorial matter whatsoever.

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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
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2N1304 4/6	2N2713 5/6	2N3572 17/6	2N4061 4/6	2S102 6/6	AC127 5/-	ASY29 5/6	BC175 5/6	BDY62 27/6	BFY26 4/-	BSY51 6/6
2N1305 4/6	2N2714 6/-	2N3605 5/6	2N4062 4/6	2S103 6/6	AC128 4/-	ASY36 5/-	BC182 4/6	BF115 5/-	BFY29 10/-	BSY52 6/6
2N1306 5/-	2N2865 12/6	2N3606 5/6	2N4244 9/6	2S104 6/6	AC154 4/6	ASY50 5/-	BC183 4/6	BF117 9/6	BFY30 10/-	BSY53 7/6
2N1307 5/-	2N2904 7/-	2N3607 4/6	2N4245 8/6	2S501 5/6	AC176 5/-	ASY51 6/6	BC184 4/6	BF163 7/-	BFY41 10/-	BSY54 8/-
2N1308 6/-	2N2904A 8/-	2N3662 7/6	2N4254 8/6	2S502 5/6	AC187 12/6	ASY53 5/-	BC182L 4/-	BF167 5/-	BFY43 12/6	BSY56 18/-
2N1309 6/-	2N2905 8/-	2N3663 7/6	2N4255 8/6	2S503 5/6	AC188 7/6	ASY54 5/-	BC183L 3/6	BF173 6/6	BFY50 4/6	BSY78 9/6
2N1507 5/6	2N2905A 9/-	2N3702 3/6	2N4284 3/6	3N83 37/6	ACY17 5/6	ASY62 5/-	BC184L 4/-	BF177 6/6	BFY51 4/6	BSY79 9/-
2N1613 5/-	2N2906 6/-	2N3703 4/6	2N4285 3/6	3N128 18/6	ACY18 5/-	ASY63 3/6	BC187 5/8	BF178 7/-	BFY52 4/6	BSY82 10/6
2N1631 8/6	2N2906A 6/6	2N3704 4/6	2N4286 3/6	3N140 19/6	ACY19 5/-	ASY72 5/-	BC212L 4/6	BF179 14/6	BFY53 4/6	BSY90 11/6
2N1632 8/6	2N2907 8/-	2N3705 4/-	2N4287 3/6	3N141 19/6	ACY20 5/-	ASY83 5/-	BC213L 5/4	BF180 7/-	BFY56A 11/6	BSY95A 2/6
2N1637 8/6	2N29023 3/6	2N3706 4/6	2N4288 3/6	3N142 19/6	ACT21 5/-	ASY86 6/6	BCY10 5/6	BF181 6/6	BFY75 6/-	BSW41 8/6
2N1638 7/6	2N2924 3/6	2N3707 4/-	2N4289 3/6	3N143 17/6	ACY22 4/-	ASZ20 7/6	BCY12 5/6	BF184 5/-	BFY76 8/6	BSW70 5/6
2N1639 7/6	2N2925 3/6	2N3708 3/6	2N4290 3/6	3N152 22/6	ACY28 4/-	ASZ21 8/6	BCY30 5/6	BF185 8/6	BFY77 11/6	D16P1 7/6
2N1701 32/6	2N2926	2N3709 3/6	2N4291 3/6	R.C.A.:	ACY40 4/-	AUY10 30/-	BCY31 5/6	BF194 4/6	BFY90 13/6	D16P2 8/-
2N1711 5/-	Green 2/9	2N3710 4/-	2N4292 2/6	40050 13/6	ACY41 5/-	BC107 3/-	BCY32 7/6	BF195 5/6	BFW58 5/6	D16P3 7/6
2N1889 6/6	Yellow 2/6	2N3711 4/-	2N5027 10/6	40250 10/-	ACY44 8/-	BC108 3/-	BCY33 4/-	BF196 8/6	BFW59 5/-	D16P4 8/-
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2N2148 12/6	2N3014 6/6	2N3819 7/-	2N5030 8/6	40310 11/6	AD150 12/6	BC114 7/6	BCY39 8/6	BF200 7/4	BPX29 36/-	GET114 4/-
2N2160 11/6	2N3053 5/6	2N3823 22/6	2N5172 3/-	40311 9/6	AD161 7/6	BC115 6/6	BCY40 7/6	BF224 6/-	BPY10 29/-	GET118 4/-
2N2193 9/6	2N3054 11/-	2N3826 6/-	2N5174 10/6	40312 12/6	AD162 7/6	BC116 12/6	BCY42 3/-	BF225 6/-	BSX19 3/6	GET119 4/-
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SEMICONDUCTORS
continued

GET873	2/6
GET880	6/-
GET887	4/-
GET889	4/6
GET890	4/6
GET896	4/6
GET897	4/6
GET898	4/6
MAT100	6/-
MAT101	6/-
MAT120	6/-
MAT121	6/-
MJ400	21/6
MJ420	22/6
MJ421	22/6
MJ430	20/6
MJ440	19/-
MJ480	19/6
MJ481	25/-
MJ490	20/-
MJ491	27/6
MJ1800	43/6
MJE340	12/6
MJE520	17/6
MJE521	17/6
MPF102	8/6
MPF103	7/6
MPF104	7/6
MPF105	7/6
MP83638	6/6
NKT0013	9/6
NKT124	8/6
NKT125	5/6
NKT126	5/6
NKT128	5/6
NKT135	5/6
NKT137	6/6
NKT210	6/-
NKT211	6/-
NKT212	6/-
NKT213	6/-
NKT214	4/6
NKT215	4/6
NKT216	7/6
NKT217	8/6
NKT219	6/-
NKT223	5/6
NKT224	5/-
NKT225	4/6
NKT229	6/-
NKT237	7/-
NKT238	5/-
NKT240	5/6
NKT241	5/6
NKT242	4/-
NKT243	12/6
NKT244	3/6
NKT245	4/-
NKT261	4/-
NKT264	6/-
NKT271	4/-
NKT272	4/-
NKT274	4/-
NKT275	4/-
NKT281	4/-
NKT401	17/6
NKT402	18/-
NKT403	15/-
NKT404	12/6
NKT405	15/-
NKT406	12/6
NKT451	12/6
NKT452	12/6
NKT453	9/6
NKT603F	6/6
NKT613F	6/6
NKT674F	6/-
NKT677F	6/-
NKT713	5/-
NKT717	8/6
NKT734	5/6
NKT736	7/-

NKT773	5/-
NKT781	6/-
NKT10339	6/6
NKT10419	6/-
NKT10439	7/6
NKT10519	6/6
NKT20329	9/6
NKT80111	15/6
NKT80112	19/6
NKT80113	22/6
NKT80211	18/6
NKT80212	18/6
NKT80213	18/6
NKT80214	18/6
NKT80215	18/6
NKT80216	18/6
OC20	15/-
OC22	10/-
OC23	10/-
OC24	11/6
OC25	10/-
OC26	6/6
OC28	12/6
OC29	15/-
OC35	8/-
OC36	12/6
O341	4/6
OC42	5/-
OC44	4/-
OC45	2/6
OC46	3/-
OC70	3/-
OC71	2/6
OC72	2/6
OC74	6/6
OC75	4/6
OC76	4/6
OC77	5/6
OC78	5/-
OC81	4/-
OC81D	4/-
OC83	5/-
OC84	5/-
OC139	6/6
OC140	6/6
OC169	4/8
OC170	6/-
OC171	6/-
OC200	6/6
OC201	9/6
OC202	9/6
OC203	6/6
OC204	8/6
OC205	8/6
OC207	12/6
OCP71	8/6
P346A	4/6
T1834	12/6
T1843	8/-
T1844	2/6
T1845	3/6
T1846	3/6
T1847	3/6
T1848	3/6
T1849	3/6
T1850	4/6
T1851	3/6
T1852	3/6
T1853	6/-
T1860	6/-
T1861	6/-
T1P29A	13/6
T1P30A	15/-
T1P31A	16/6

STYLII

ACOS	Sapphire	Diamond
GP59	2/6	7/6
GP65	2/6	7/6
GP67	2/6	7/6
GP73-1	6/6	9/6
GP73-2	6/6	9/6
GP79	2/6	7/6
GP81-1	2/6	7/6
GP91-1	6/6	9/6
GP91-2	6/6	9/6
GP91-3	6/6	9/6
GP91-1Sc	6/6	9/6
GP91-3Sc	6/6	9/6
HGP37	2/6	7/6
B.S.R.		
BSR C1 (ST3)	6/6	9/6
BSR TC8H	2/6	7/6
BSR TC8M	2/6	7/6
BSR ST8	6/6	9/6
BSR ST9	6/6	9/6
BSR ST10	—	9/-
BSR X1M	6/6	9/6
BSR X1H	6/6	9/6
BSR X3M	6/6	9/6
BSR X3H	6/6	9/6
BSR X5H	6/6	9/6
BSR X4H	6/6	9/6
COLLARO		
Collaro Studio 'O'	2/6	7/6
Collaro-Ronett TX88	2/6	7/6
Collel SK1	2/6	7/6
Dual CDS2/CDS3 (DN2)	6/6	9/6
Dual CDS/320 (DN3)	6/6	9/6
ELAC KST9 (PE10)	6/6	9/6
ELAC KST9 (PE1B)	6/6	9/6
ER5MB	6/6	9/6
ER5MX	2/6	7/6
ER5 SB	6/6	9/6
ER60 Stereo	6/6	9/6

GARRARD	Sapphire	Diamond
EV26 Stereo	2/6	7/6
GC2	2/6	7/6
GC8	2/6	7/6
GCE12	2/6	7/6
GCS10/1	2/6	7/6
GCS10/2	2/6	7/6
S 1—2—3	6/6	9/6
TS1	6/6	9/6
TS2	6/6	9/6
TS3	6/6	9/6
GOLDRING		
CM50	2/6	7/6
CM60	2/6	7/6
MX1	2/6	7/6
MX2	2/6	7/6
Stereo CS80	2/6	7/6
PERPETUUM EBNER		
PE188	6/6	9/6
PHILIPS		
AG3016	2/6	7/6
AG3063	2/6	7/6
AG3306	6/6	9/6
AG3310/3306	6/6	9/6
AG3400	2/6	7/6
RONETTE BINOFLUID		
BF40	2/6	7/6
DC284	2/6	7/6
SONOTONE		
2T	6/6	9/6
3T	6/6	9/6
8T4A	6/6	9/6
9TA	6/6	9/6
9TA/HC	6/6	9/6
19T	2/6	7/6
20T	2/6	7/6

The Diamond Tip is ·007 in. radius, thus making it compatible to play stereo records on mono equipment without damage to the record; and of course full stereo.
BRITISH MADE
EXPORT ENQUIRIES WELCOMED

CARTRIDGES

ACOS		Inc. P.T. each
GP79		12/6
GP91-1SC	- 1	21/-
	2- 11	17/9
	12- 49	15/6
	50-500	13/6
GP91-2SC		As above
GP91-3SC		As above
Suitable to replace TC8, etc.		
GP92		26/5
GP93-1		24/9
GP94-1		31/-
GP94-5		36/-
GP95		24/9
GP96		31/6
Acos 104	1- 10	41/10
	11- 25	39/9
	25- 50	38/3
	51-499	35/5

B.S.R.		Inc. P.T each
X3M	S/S	27/9
X3H	S/S	27/9
X5M	S/S	27/9
X5H	S/S	27/9
SX5M	S/S	36/3
SX5H	S/S	36/3
SX5M	D/S	39/11
SX5H	D/S	39/11
X4N	D/S	27/3
RONETTE		
105	S/S	19/10
106	S/S	19/10
DC400	S/S	14/-
DC400SC	S/S	14/-
105	D/S	22/4
106	D/S	22/4
DC400	D/S	16/9
DC400SC	D/S	16/9
SONOTONE		
8TA	D/S	25/-
9TA	D/S	35/10
9TAHC	D/S	35/10

TRANSISTORISED UHF TUNER UNITS
NEW AND GUARANTEED FOR 3 MONTHS

Complete with Aerial Socket and wires for Radio and Allied TV sets but can be used for most makes.
Continuous Tuning, 90/-; Push Button, 100/-.

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Jack Plugs and Sockets		Co·Axial Plugs	
Standard Plugs	3/10	Belling Lee (or similar type)	1/3
Standard Sockets	2/6	Add 5d. per doz. p. & p.	

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New and Budget tubes made by the leading British manufacturers. Guaranteed for 2 years. In the event of failure under guarantee, replacement is made without the usual time wasting forms and postage expense.

Type		New	Budget	Type		New	Budget
		£	£			£	£
MW36-20			4/10/-	A50-120W/R	CME2013	10/17/-	
MW36-21			4/10/-	AW53-80		8/18/8	6/5/-
MW43-69Z	CRM171			AW53-88	CME2101	8/18/8	6/5/-
	CRM172	6/12/-	4/12/6	AW59-90			
MW43-80Z	CRM173	6/12/-	4/12/6	AW59-91	CME2303	9/11/8	7/4/-
AW43-80Z	CME1702	6/12/-	4/12/6	A59-15W	CME2301		
	CME1703	6/12/-	4/12/6		CME2302		
	CME1706	6/12/-	4/12/6		CME2303	9/11/8	7/4/-
	C17AA	6/12/-	4/12/6	A59-11W	CME2305		
	C17AF	6/12/-	4/12/6	A59-13W	CME2306	13/13/-	10/19/6
AW43-88	CME1705	6/12/-	4/12/6	A59-16W	CME2306	13/13/-	10/19/6
AW47-90				A59-23W	CME2305	12/12/-	10/10/-
AW47-91	A47 14W	7/13/4	5/7/6	A59-23W/R		12/12/-	10/10/-
A47 14W	CME1901	7/13/4	5/7/6	PORTABLE SET TUBES			
	CME1902	7/13/4	5/7/6	TSD217			6/15/-
	CME1903	7/13/4	5/7/6	TSD282			6/15/-
	C19AH	7/13/4	5/7/6	A28-14W		9/3/4	Not supplied
A47 13W	CME1906	10/5/6	8/10/-				
A47-11W	CME1905	8/17/3	7/-/-				
A47-26W	CME1905	8/17/3	7/15/-	CME1601			7/15/-
A47-26W/R	CME1913R	9/6/8		CME1602			8/-/-

A discount of 10% is also given for the purchase of 3 or more *New* tubes at any one time.
All types of tubes in stock. Carriage and insurance 15/-.

DE BANKS MAGNETIC RECORDING TAPES

POLYESTER Length	Spool Size in.	Price
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600 ft.	5	10/-
850 ft.	5¾	12/6
1200 ft.	7	14/-
Long Play		
210 ft.	3	5/6
450 ft.	4	8/6
900 ft.	5	14/-
1200 ft.	5¾	17/-
1800 ft.	77	20/-
Double Play		
1200 ft.	5	17/6
1800 ft.	5¾	22/-
2400 ft.	7	26/-

EMPTY TAPE REELS

3 in.	1/6
4 in.	1/10
5 in.	2/3
5¾ in.	2/6
7 in.	2/7

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C90	12/6
C120	17/6

P. & P. 1/6 on all orders.

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RADIO & TV SERVICE SHEETS 4/- s.a.e., Service manuals 12/6 each. P.P. 1/6. State make and model no. to: Bell's Television Service, Albert Place, Starbeck, Harrogate, Yorks.

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BAKER AND BAINES
UHF Aerials BBC and ITV 625
10 ele 42/-, 14 ele 47/-, 18 ele 65/-, 22 ele 75/-, Double 22 ele 160/-. All aerials have composite reflector and tilt clamps which take up to a 2 inch mast.

BBC Aerials
Dipole 35/-, X 43/., H 48/-.

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Dipole plus 5 54/-, H plus 5 82/-, X plus 5 90/-. Supplied with 1" or 2" clamps. Loft Dipole plus 5 42/-. This aerial is supplied with loft pole, joist bracket and universal joint.
Diplexers—Triplexers—Matched UHF/VHF Diplexers.
VHF and UHF Pre Amps from 75/-, postage 3/-.
Poles, Lashings, Clamps, Couplers, etc.
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Postage paid on all aerials inland. Accessories postage extra.
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A59-13W	£15.10.0
A59-15W	£9.19.6
A59-16W	£14.15.0
A59-23W	£14.15.0
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AW43-80	£6.17.6
AW43-88, 43-89	£6.12.6
AW47-90, 91	£7.10.0
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AW53-88, 53-89	£8. 5.0
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