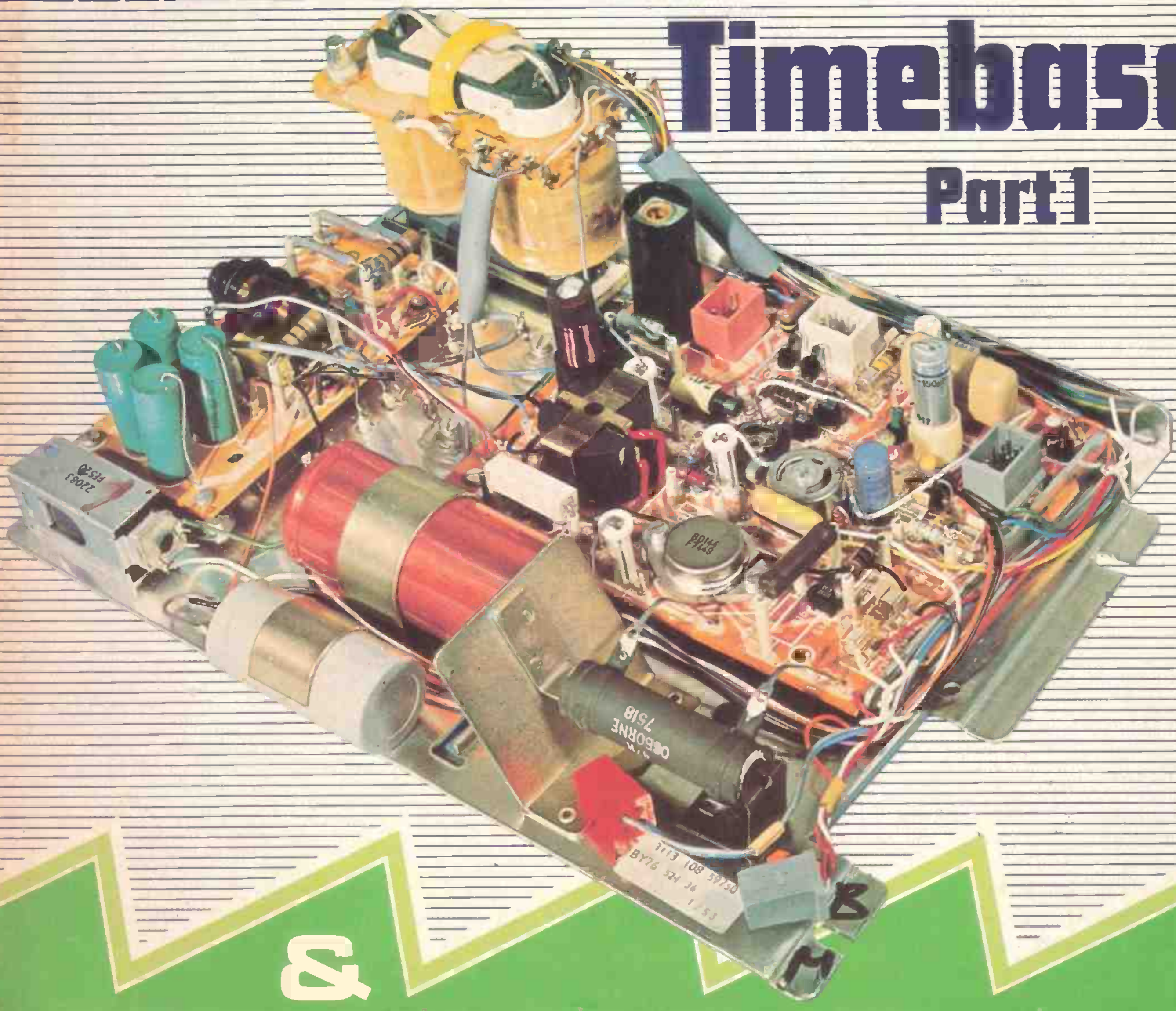
SERVICING·VIDEO·CONSTRUCTION·COLOUR·DEVELOPMENTS

Television

DECEMBER 1975 40p

The Transistor Line Timebase

Part 1



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Television

SERVICING
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CORRESPONDENCE
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We regret that we cannot answer technical queries over the telephone nor supply service sheets. We will endeavour to assist readers who have queries relating to articles published in *Television*, but we cannot offer advice on modifications to our published designs nor comment on alternative ways of using them. All correspondents expecting a reply should enclose a stamped addressed envelope.
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this month

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ECL82	51p	PCC88	69p	PL500	88p	6BW7	75p		
ECL83	75p	PCC89	55p	PL504	88p	6F23	80p		
ECL86	46p	PCC189	58p	PL508	92p	6F28	75p		
EF80	33p	PCF80	44p	PL509	£1.80	6V6	52p		
EF85	41p	PCF82	55p	PL519	£3.10	10F1	75p		
EF86	57p	PCF86	64p	PL802	£2.00	20L1	92p		
EF89	35p	PCF200	98p	PY33	57p	20P4	98p		
EF183	41p	PCF801	55p	PY81/3	41p	30C1	44p		
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Television

THE TIME FACTOR

One hallmark of a free society is the freedom to criticise publicly what one pleases – within the limits of defamation of course. It is a valuable right, and for some it can be a heady mixture. The latter since it is all too easy to flay about one at all and sundry. In particular, this can be a great temptation for the writer of leading articles. It is a simple matter to lay into one thing after another month by month. The role of the critic is vital, but it is wise to be able to appreciate the other side of the picture as well, to understand why we don't live in a perfect world.

It is easy for example to criticise setmakers for lack of innovation. Why, the arm-chair critic settles back and starts, is it that the Germans or Japanese are always first to do this or that? Why doesn't everyone immediately adopt this nice new i.c. with its much improved performance, that nice new tuner unit with its novel control system, or some natty little digital do-da to give you the time on the screen if you've lost your watch and the clock on the mantlepiece has given up, or tell you the programme you've just selected in case you can't remember which button you pushed? In view of the rate at which technical developments have appeared on the scene over the last two decades however, no one would ever have been able to introduce a new chassis if they'd had to try out and adopt each new device or technique as it came along. At some point in the development of a new product someone has to call a halt, to say that the prototype as it is at that instant is what is going to be put into production – maybe for a period of several years, since tooling up for a new product is an expensive business.

What this implies is the necessity of making a compromise decision, which is dictated fundamentally by the time factor involved rather than the niceties of technical innovation. But deciding on the basic technical specification to adopt is only one aspect of the matter. The way in which the industry is organised, with setmakers buying most of the components for their sets from a variety of different sources, means that a considerable amount of time-consuming commercial negotiation is required to ensure that supplies of whatever it is decided to use will be available at the right time and in the right quantity, and will continue in production.

In addition to the obvious economic compromise that has to be adopted – any fool could specify the perfect set, but it would be far too expensive to place on the highly competitive, cost-conscious domestic market – there is, then, a technical compromise, and probably a supply compromise as well. Someone has to decide that a promising new technique will have to wait until the next generation of sets; someone else has to decide say that if a nifty new connector isn't going to be available in the quantity envisaged as necessary then you're stuck with the same old plugs and sockets as before.

The time factor is ultimately set by marketing considerations. Once you decide that a nice new model will make its maximum impact if introduced next spring you are committed to planning your advertising, producing your sales literature and arranging your sales promotion campaign to suit. Your nice new product has to be available on the day, preferably in adequate quantity so that when the orders start to come in they don't go straight into the pending file.

What dominates everything therefore is the time factor, and this is the very thing of which your arm-chair critic is so often entirely unconscious. We get similar problems in producing a magazine. A project can't be redesigned at the last moment just because some new device has become available, even if it would significantly reduce the cost. Then before you've even published a project some firm can decide to unload its stocks of a similar item at prices far below the project's component costs alone. Publication deadlines keep looming up – once a month! – and once a month you have to say that's it for now.

Inevitably then the real world is one of compromises all round. Even so criticism is necessary: avoidable mistakes are all too often made, or an obviously wrong compromise is adopted. But it's difficult being the man in the hot seat. He deserves some understanding and sympathy from his critics.

COVER PHOTO

Our cover photograph this month shows the line scan module used in the Philips G8 colour chassis. Our thanks are due to Philips for the loan of this unit.

teletopics

PO's VIEWDATA SYSTEM

The Post Office has now given the first public demonstration of its Viewdata system – at the recent international computer conference. The proposed service would supply over the conventional telephone network data which could, as with the Ceefax/Oracle off-air data transmissions, be displayed on the screen of a conventional monochrome or colour receiver once a decoder has been added. Since the aim is for the system to be compatible with the Ceefax/Oracle system the same decoder could be used for both services. In use, a subscriber to Viewdata would interconnect his set with the telephone and by means of a simple hand-held control unit select the information he wanted to receive.

Since each subscriber would have his own access to the system's central computer-controlled information centre, the amount of information that could be made available is almost limitless – determined only by the computer capacity installed. The PO emphasises the two-way nature of the service: in addition to individual access to the general information service a subscriber could also send messages to other subscribers.

Tests of the system in conjunction with possible Viewdata equipment manufacturers are due to start next year. The PO claims that if these are successful the service could be offered within three-four years. Talks are also being held with TV setmakers, the BBC and the IBA.

NO DUMPING

Following a six month investigation, the Department of Trade has concluded that insufficient evidence can be produced to show that Japanese colour c.r.t.s – or TV sets for that matter – are being dumped in the UK. To prove dumping, it is necessary to be able to show that goods are being sold in the UK at prices below those current on the home market of the exporting country. Trade reaction has been quick. Jack Akerman, Mullard's managing director, commented that as most Japanese setmakers produce their own c.r.t.s, there is no local free market for them in Japan. Consequently dumping is impossible to prove.

Although the Department has rejected for the present the imposition of anti-dumping duties, it has nevertheless expressed unease over the situation and is to introduce a system of close monitoring by means of "surveillance licensing". This means that in future a licence will have to be obtained prior to the import of colour c.r.t.s from non-EEC sources. Licences will be issued unconditionally on request but will enable the Department to keep a closer watch on imports – until now the situation could be assessed only by the analysis of past trade figures.

The problems of the UK colour tube industry go back to the Autumn of 1972. Following budget action earlier that year the colour set market expanded rapidly and continued to do so through the boom year of 1973. Since colour tube production calls for substantial investment in highly complex equipment, production could not be increased to match. The result was a rapid build up of imports. The subsequent market decline, with the imposition of 25% VAT earlier this year the final blow, has left UK colour c.r.t. manufacturers with excess capacity while the importers show no sign of being willing to give up the share of the market they have obtained.

Between them, Mullard and Thorn now have the capacity to produce about 2·5 million colour tubes a year. But the considerably reduced home market for colour sets is expected to be only about 1·75 million this year. The net result for the tube makers is that on an aggregate investment of some £70 million in highly automated plant a loss of around £9·5 million a year is being made. Thorn are said to be making a loss of around £9 a tube. Their total losses are running at £4·5 million a year. Pilkington, who make glassware for Thorn tubes, have been making losses of £3·5 million a year, while Mullard's loss – less because of their continental link up through Philips – is around £1·5 million a year.

Successive UK governments have advocated increased industrial investment. So have economists, businessmen and trades union leaders. It clearly doesn't always work. UK colour tube manufacturers cannot make up for lack of home demand by exporting because there is world wide excess tube capacity while UK production costs are comparatively high since plant is being operated at an uneconomic level. The situation may well resolve itself in time, with an upturn in the home market, but for the present is clearly a disaster. The only way of safeguarding that £70 million investment is by means of import controls.

FIRE HAZARD

Nothing to do with TV this, but nevertheless worth a careful note. The Electricity Council Research Establishment has discovered that the polystyrene granules commonly used to provide loft insulation react with pvc-sheathed electric cables. The result can be a fire hazard since the life of the cable is reduced while the mixture produced by the chemical reaction burns fiercely when ignited. The two should be kept separate therefore, by a groove or by capping. One shudders to think how many homes are at risk.

110° COLOUR TIP

W.S.J. Brice has passed on an interesting service tip. Many continental 110° sets with transistor line output stages, for example those fitted with the ITT FT110 chassis, the Telefunken 711 chassis and Tandberg CTV2-2 chassis, employ BYX55-350 diodes in the EW modulator circuit. These apparently give a lot of trouble, failing repeatedly. The use of BYX71-350 diodes, which are similar but have higher current and dissipation ratings, as replacements overcomes the trouble. These higher rated diodes are used in most current UK chassis of this type (Pye 731 and Rank Z719).

ANOTHER SWITCH-MODE CIRCUIT

We've had a fair amount to say recently about new and unusual regulated power supply circuits for TV receivers, what with the Thorn Syclops circuit described in our August issue and the feature on switch-mode power supplies in October. But the ingenuity of designers continues unabated. For instance Fig. 1 shows the switch-mode power supply used in several current mains-battery monochrome portables. This is another combined power supply/line output stage arrangement, but unlike Syclops where there are two transformers and one transistor, this time there are two transistors and one transformer. Battery operation is conventional, the 12V supply powering most of the low-voltage stages whilst boost diode D906 and capacitor C906 provide a 17V boost rail for the line output stage from which the high-voltage stages are powered. The interesting thing however is what happens when the set is operated from the mains.

The mains input is rectified and smoothed and the resultant 220V supply fed to the collector of transistor TR902. You can consider this as a chopper transistor or, if you wish, call it a transistor pump as GEC do. Whatever you prefer to do by way of naming it, what happens is that the transistor switches on to feed power into the stage only when a

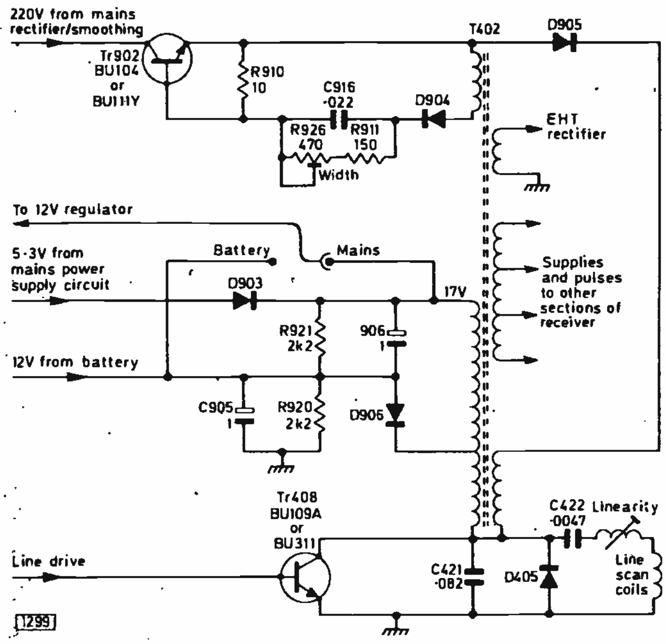


Fig. 1: Switch-mode power supply/line output circuit used in several mains-battery portable models.

positive flyback pulse is fed from its base-emitter circuit winding on the line output transformer T402 via D904 and C916 to its base. Thus the circuit tops up the power during the line flyback period. The on/off time of the transistor depends on the charge on C916, and this is proportional to the set's power requirement. The width control R926 forms part of an *RC* time-constant network with C916. Since on mains operation all the supplies for the set are obtained from the line output stage the whole set is in this way stabilised. At switch on there won't be any flyback pulses of course, so a start up circuit is required. As soon as the mains electrolytics have charged, D903 supplies a voltage to start the line oscillator: once the boost circuit develops the normal 17V, D903 is reverse biased and cuts off. So there we are, something else to worry about.

The circuit reference numbers we have used apply to the Indesit Model T12L, which has been available in the UK for about three years now. An almost identical circuit is used in the GEC Models 3133 and 3135.

TRANSMITTER NEWS

Arfon (Gwynedd, north west Wales): BBC Wales and BBC-2 transmissions are to start this winter. They will be on lower power than the IBA's transmissions, but it is expected that the difference will be noticed only by those living near the limit of the transmitters' service area. The BBC will be using temporary alternative equipment since the equipment for the full-power service will not be available for a further year.

The IBA's Arfon transmitter is now in service on channel 41, carrying HTV-Wales programmes. A vertically polarised group B receiving aerial should be used.

Oldham North: BBC-1 (north west) and BBC-2 transmissions from this relay station have started, on channels 21 and 27 respectively. Vertically polarised group A receiving aerials should be used.

Troon (Strathclyde): The BBC comments that although most people in the Troon area are able to obtain good reception from the Darvel transmitter reception in some areas is spoilt by reflected signals. As a result some viewers have been receiving signals from the Lethanhill relay station. A new relay station at South Knapdale is to open shortly to serve the area around Loch Fyne and will use the same frequencies as Lethanhill. It is likely to cause severe interference to reception of Lethanhill in the Troon area. A relay station for Troon is planned but will not be in operation for some two years. Meanwhile viewers in the Troon area are advised against reception from Lethanhill.

Outer Hebrides: The IBA is to open a high-power u.h.f. station at Eitshal on the Isle of Lewis early next year, bringing a choice of programmes to the area for the first time. Scottish network planning has presented many technical problems due to the mountainous terrain. The Eitshal transmitter will take its programmes via a s.h.f. link over a hundred miles in length – from Rosemarkie (Moray Firth) on the east coast of Scotland via repeater stations at Glen Marskie, the Falls of Conon, Sgurr Marcasaith, Glen Docherty and Melvaig across to the Isles of Lewis.

SATELLITE EXTENDS PAY-TV SCOPE

For the first time, Pay TV cable operators in the US are being served via satellite transmissions. The first receiving terminal has been brought into operation at Fort Pierce, Florida. This has increased the scope of Pay TV operations by enabling live transmissions from distant sources to be fed into a cable system.

TACKLING FAULTS ON PRINTED BOARDS

Vivian Capel

PRINTED circuits have been with us for a long time, though it doesn't seem nearly a quarter of a century since the first p.c. boards met our wondering gaze as we removed the backs of the then latest television receivers to delve into the innards. We have no excuse therefore for not being used to printed boards by now, yet not infrequently faults that tax our powers of deduction crop up and after some time spent unsuccessfully changing likely components the trouble is eventually found to be a print fault.

The snag is that the symptoms can be so misleading, and not capable of analysis from study of a circuit diagram. When considering the circuit, one usually assesses the likely effect of particular component breakdowns on the fault, i.e. which components could be responsible for the symptoms. The possibility of a straightforward open-circuit connection, whether in a printed track or in a wired section, has always to be taken into consideration of course. With printed circuits however there can be subtle, unforseeable complications. For instance, the effect of leakage or a solder bridge to an adjacent print section cannot be predicted without knowing just what is running alongside a particular portion of the print, and this will not be revealed by the circuit diagram. Then there is the break in a section of the print common to a number of circuits, such as part of an earth return. Here the open-circuit may not show up as such, because of various parallel paths. This sort of trouble is especially likely in transistor circuits. There can be common-impedance couplings between some most unlikely parts of the circuit, leading to weird and wonderful symptoms that defy all theoretical analysis.

Such problems are tricky enough as they are, but when they are intermittent we're really in trouble. Replacing possible components "on spec" will obviously not produce a cure, and one can only hope that when the fault does occur it remains long enough for the source of the trouble to be diagnosed.

So let's run through some of the common print faults and see what can be done to trace and repair them.

One factor common to most of them is that they are sensitive to mechanical disturbance. A crack, short, or dry-joint to a wire-ended component will often clear when the board is flexed. This is a useful though apparently crude method of diagnosis. Pressure can be applied to various parts of the printed board by means of an insulated instrument, causing it to flex. This should be done on both sides, since pressure on the component side only for example may simply cause a crack to open farther, whereas pressure on the print side would cause it to close (see Fig. 1). A short on the other hand may be opened by pressure on the component side and be unaffected by a force on the print side.

If the fault symptom can be brought on and off by this means it is reasonably safe to assume that there is a print fault, since components are less likely to be provoked into a fault condition by physical movement. With valve receivers, dirty valve pins will of course be the first possibility to be explored given such conditions. With some components the lead-out wires may make contact only intermittently.

The area in which the fault lies can then be narrowed down by more gentle prodding at specific sections of the board. A warning is necessary here though: one can be misled since prodding at one part of the print can cause movement at another part. For example, if a chassis member, system switch or other solid object is fixed at one point of the board it can act as a fulcrum over which the board can perform a rocking motion (see Fig. 2). If this is suspected, the affected portion can be held steady by firm pressure from another insulated tool while the first part is flexed.

Not all print faults can be brought to light by this means of course, but it's always worth a try. In fact many engineers start their investigation of a faulty set by having a quick prod around the part of the panel bearing the affected circuit. A few minutes spent in this way are often rewarded by a positive result.

Having established the nature of the fault, the next step is to locate the actual trouble. This can often be done by visual examination. Solder bridges or over-long, bent over wires can be seen without any difficulty once the area has been localised. Dry-joints are not always so obvious however, though they can often be spotted when the field of search has been reduced. A surplus of resin flux around the area is often a tell-tale sign. If the wire end was dirty when the joint was made, the molten resin from the solder core will have surrounded the wire but the solder will not have taken so the resin remains.

Dry-Joints

The shape of a joint is often a good indication of its soundness. If the solder doesn't take, the surface tension of the molten solder gives the joint a curved contour which remains when the solder solidifies (see Fig. 3). A good joint tapers away from the soldered surface.

Not all joints having a tapered appearance are sound however. The solder may have taken only at the extreme end, the inside portion being "dry". Contact is maintained

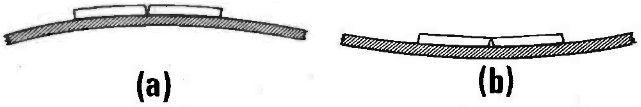


Fig. 1: (a) Pressure on the component side of the board tends to open a print crack farther. (b) Pressure on the print side tends to close a crack.

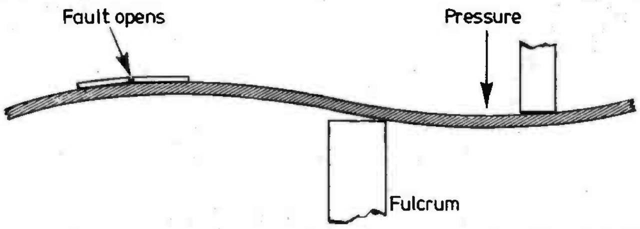


Fig. 2: Pressure on one part of a board may affect a fault in another part due to rocking action over a support which acts as a fulcrum.

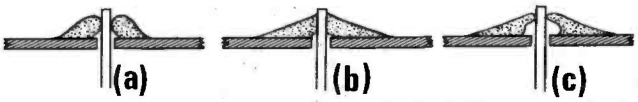


Fig. 3: (a) A dry-joint often has a rounded shape due to the surface tension of molten solder. (b) A good joint slopes gradually from the wire and print. (c) A joint may appear good but, having taken at only the end of the wire, is dry inside and may later break to give intermittent contact.

for a while by the good part of the joint, but stresses due to expansion or other movement cause the solder to fracture. The result is usually an intermittent fault.

Further complications arise with boards that have print on both sides, such as those used by the GEC/Sobell group. It is not only more difficult to trace circuit connections on these – since it entails trying to look at both sides of the board at the same time – but soldered joints on both sides also have to be checked. This is not always easy on the component side, as the joints are often obscured by the components. In fact in many cases it's just not possible to gain access to a joint at all, either to solder or to inspect it. The only course is to solder the underside and hope that the solder runs through the hole and makes a good bond on the other side as well. Needless to say the solder doesn't always do so, and many faults can be traced to this cause on this type of board. Fortunately no other major UK manufacturer uses this method of assembly!

Print Cracks and Breaks

One of the most common print faults is a crack or break in the print itself. Like the dry-joint, this may be affected by physical movement of the board. It's less easy to spot this defect by visual examination however. Very often the fault is caused by mechanical stresses and strains: bearing this in mind can sometimes help direct attention to the most likely area to be affected.

Print runs adjacent to board fixing positions are particularly vulnerable, and cracks in the actual board as well as the print can often be seen radiating out from a screw fixing hole (see Fig. 4). Such cracks can spread across several print runs, so when one is discovered a close examination of all adjacent runs should be made.

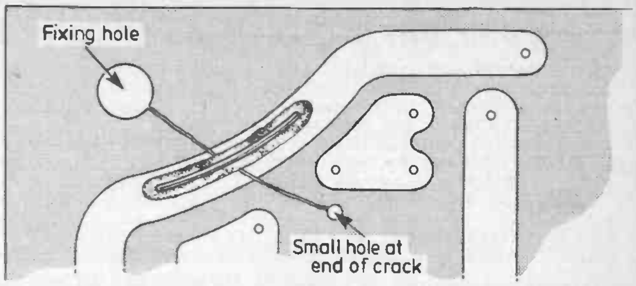


Fig. 4: Board cracks often radiate from a fixing hole and break nearby tracks. Repair with a wire bridge and drill a small hole at the end of the crack to prevent it spreading.

Where a board is fractured, the cracked print should always be repaired by soldering on a wire which bridges the crack, not just by melting solder over the track. The wire helps to restore mechanical strength to the broken part, whereas a solder bridge would be very likely to fracture again. The board crack can be prevented from spreading farther by drilling a small hole at its end. A small model maker's drill is the most convenient and best tool for doing this.

Other possible causes of cracks are heavy components. Thus the print surrounding transformers and large can electrolytics is susceptible and should be checked. This is especially so where the components are secured to the board only by their connections to the print, and also where the board is mounted vertically so that the weight of the part imposes a continuous strain on the print connection. Valveholders can also be a source of print fractures, since removal of a valve for test purposes imposes considerable stress on the securing print. A few such removals are often enough to break the print.

Print will also sometimes crack part-way along a run where there seems to be no direct cause for it to do so. There may well have been a weak point from the time of manufacture. Such cracks are difficult to locate because they are usually very fine and thus almost invisible. Where flexing the board brings the fault on and off yet no visible cracks, breaks or dry-joints are apparent, a fine print crack is a distinct possibility.

One means of tackling this problem is to measure the voltage at one end of a print run in the suspected area, then flex the board to see if the reading alters. This should be repeated at the other end of the same run. The fault condition very often alters the d.c. potentials in the circuit, so applying this test to several print runs will frequently show the source of the trouble. The fault may not be due to the print where the varying reading is obtained, but at least the cause will be traceable to a closely associated part of the circuit.

In the case of a hair-line crack in a nonstressed part of the print, it is sufficient to run molten solder over the track, i.e. it is not usually necessary to make a wire bridge – make sure that the solder coating is thick over the crack area however. This being so it is not essential to discover the precise location of the crack. In difficult cases where the fault does not give a reading variation or any other useful clue, the quickest way of dealing with it is to run the iron over all the print sections in the suspected area of the board, adding a little solder where there is little or none on the print. In many cases it will be found that the fault has been cleared even though the precise position of the break was not identified. This can take a lot less time than pin-pointing the crack and repairing it.

Print Lifting

Another problem that occasionally arises is when the print lifts away from the board. This usually occurs when a component is being replaced. More often than not a section of the print breaks off. There is little to be gained by trying to refit it. The best course is to replace the missing section with tinned copper wire. When doing this, solder the wire to the component lead first, making a loop to fit over the lead to give a firm hold. Then run the wire along the same path as the original print, bending it as required until it reaches the break point. Overlap the print by a generous amount, then solder. While soldering, it will usually be found advantageous to hold the wire down on to the print at the required position using a small screwdriver blade. Otherwise the wire may rise above the print or lay too close to an adjacent run.

It sometimes helps to flatten the wire slightly before fitting it in place. Tap along the length with a small hammer or other suitable blunt instrument.

If the wire is soldered at the print end first instead of at the component lead end it may well pull off more print which will break away when the wire is being bent into shape. Hence the need for fitting in the order described. Short lengths of wire will stay in place quite safely, but longer lengths may bend out part of the way along and short against an adjacent track. This can be prevented by a blob or two of quick-drying cement applied at suitable spots.

Tracking and Leakage

Another fault that can pose problems is tracking. This occurs when a conductive path is set up through or across the board from one section of print to another. The usual cause is local heating of the panel by arcing or as a result of a closely mounted hot resistor. The board chars, producing carbon. No form of treatment by applying silicone grease or any other non-conductive preparation does any good because the conductive path remains. The only remedy is to remove the burnt area.

In mild cases this may involve scraping away just the charred surface of the board. When doing this take care that every burnt fragment is removed, otherwise the conductive path will remain.

If the tracking has continued for a time or the burn up is a bad one, the whole thickness of the board may be affected and the burnt area will have to be cut away completely. This must be done quite ruthlessly, going right back to unaffected material. If not dealt with in this way the tracking can become self-perpetuating: the leakage current heats the material, causing further burning.

The result of removing the charred area will of course be a hole. In the case of a small hole between two adjacent print runs there is little to worry about. Larger holes spanning several print runs may be more of a problem. The print will have to be removed as well, and the sections bridged across with wire. An even greater problem is presented when the affected area supports components. Here some method of mounting will have to be devised. This depends on the component and the extent of the damage.

In the cases quoted so far, the trouble can be quickly located by visual inspection. There are other cases however where the fault is more in the nature of a high-resistance leakage path than a burnt track. These can be very troublesome to locate. The symptom is often that of noise – a tearing sound if the fault is in the sound or common circuits, streaks and flashes on vision where it is in the vision only circuitry. In other forms, leakage can give rise to instability. The snag is that the symptoms could also be caused by component breakdown. Pinning down the actual cause can involve a long search therefore.

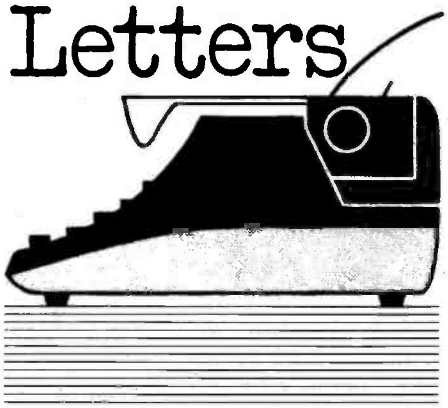
As with most faults the first step is to try to isolate the stage in which the trouble lies. Shunting a capacitor from anode or collector to chassis in successive stages, working backwards along the signal path, will often provide a clue by removing the symptom until the defective stage has been passed. This is not always conclusive however since the noise may be modulated on to the i.f., and removing the signal by shunting the oscillator or an early i.f. stage may also cause the symptom to disappear.

The most likely site of such leakage is around a valve base or plug holder. Here the spacing is restricted, and there are often high and low potentials on adjacent pins. It might be added that because of the higher voltages involved, tracking and leaking are more prevalent in valve circuits than in transistor ones.

The grid pin is usually the vulnerable one as any leakage here will produce noise that will be amplified. If there should be an adjacent pin at high potential an incision can be made in the board between the pins. This will effectively isolate them. Not an easy task, this. The best method is first to drill a small hole and then to extend the hole into a slot by means of a very small mouse-tail file.

In the case of a plug and socket there are often unused pins. Thus the simplest course is to transfer the high-potential connection to one of the others. A small section of the print leading to the former pin can be cut away to isolate it, then a wire jumper soldered from the supply side of the print to the new socket. A corresponding change in the wiring of the plug will have to be made of course. ■

Letters



POOR ENGINEERING STANDARDS

As a professional engineer and a reader of your magazine for many years I have long felt that while you champion the case of service engineers in your editorials you do not do sufficient to bring to the notice of designers and manufacturers the appalling defects in their products from a service viewpoint. I would like to see new sets critically appraised from the servicing aspect, with the hope that manufacturers' production teams might be persuaded to avoid repeating the same old mistakes and irritations in set after set, while at the same time producing more general awareness of the importance of design for ease of servicing. It would be helpful if other readers wrote in about their servicing gripes, and perhaps if some firms could be persuaded to reply. We might find that in some cases we are maligning them, but it would be a help all round.

It seems to be a waste of time for individuals to write to setmakers expressing their views. For example, a certain UK firm brought out a touch tuner panel into which were plugged two identical unidentified six-way plugs. I wrote to the service department and suggested that they look up Murphy's Law. In the event the touch tuner panel was a failure because it did not work reliably if the operator was earthed, so a new one has now been produced. This has three four-way plugs and two six-way plugs, all unidentified and all capable of being inserted in the wrong sockets with, as a bonus, the possibility of burning up four expensive i.c.s if such a mistake is made! I feel that this sort of disastrous design could be prevented if a campaign was started. – **L. P. Watkinson** *(Holsworthy, Devon).*

Editorial comment: We agree wholeheartedly. The fact that we vividly recall how very much worse things were a few years ago is the reason we've not complained on this score in recent times. Readers' views on the subject would be welcome.

GEC HYBRID COLOUR RECEIVERS

I read with interest your article on faults in GEC hybrid colour receivers, having had experience of these sets. There was a slip in the article, in so far as presence of the colour-killer bias at the base of the second chrominance amplifier transistor implies that the first chrominance amplifier stage must be working correctly – otherwise there would be no signal to the burst channel, and no ident signal to rectify to produce the turn-on bias. Thus no colour with the colour-killer turn-on bias present means that the fault must lie in the burst blanking or colour control circuits between the first and second chrominance amplifiers, the delay line driver stage, lack of l.t. to the colour-difference preamplifiers or no h.t. at the screen grids of the colour-difference output pentodes – there is a common feed, the decoupling electrolytic C423 (4μF) usually going short-circuit with the result that the feed resistor R416 (18kΩ) burns out.

Common faults we have had on the decoder include: the reference signal emitter-follower transistor TR329 shorting between base and emitter, giving intermittent colour and bad decoder alignment; the Sufflex capacitors C322/3/4/5/6 in the reference oscillator circuit becoming intermittent – preferably replace with 1% silver mica types; and watch out for C344 (another Sufflex) which is connected across the delay line circuit phase coil, giving intermittent colour pairing when defective.

Headscratchers we have had in the decoder include the coupling capacitor (C302) to the first chrominance amplifier, giving critical colour tuning, and the collector load tuned circuit assembly L301/2 in the second chrominance amplifier circuit giving low colour – probably due to the Sufflex tuning capacitor C336 in this can. The most common dry-joint giving intermittent colour is by the phase comparator transformer T307 at the point where the output from the reference signal emitter-follower TR329 passes through the board to the upper print, to T307. A piece of wire soldered through is the best cure.

When the cut-out in the line output stage is not earthed or is open-circuit one often finds the PL509 line output valve's cathode decoupler C529, which is mounted on the timebase panel, blown to pieces. This is because the PL509 cathode then rises to h.t. – **T. Sucksmith** *(London W13).*

Editorial comment: Our apologies to readers and to John Coombes whose comments we misinterpreted. John Coombes originally gave details of the colour-killer test – check for 3-6V positive at TR319 base – and commented that generally he'd found no colour to be due to the first chrominance amplifier TR318 having an open-circuit base-emitter junction.

SMEARING ACROSS SCREEN

I read with interest the problem – smearing across the screen – experienced by one of your readers with a Pye Model CT201 colour receiver (*Your Problems Solved,* page 545 September) having had exactly the same trouble after undertaking some servicing in the line output stage of one of these sets. The fault turned out to be due to the c.r.t. Aquadag earthing arrangements being ineffectual owing to the lead from the degaussing shield not being connected to the line output transformer screening can. This results in the c.r.t. capacitive loading "seen" by the luminance output pentode being reduced, causing excessive h.f. response and overshoot.

As your reader's problem occurred only after line output transformer replacement it seems quite possible that the earthing lead was left off – it's easily done. – **M. Thomas** *(Brixham, Devon).*

WHITE LINES ON SCREEN

I have just read the letter from C. Avis (September issue) on the problem of two white lines, experienced on sets fitted with the Pye 368 chassis. We too have had this fault to deal with. There are two lines only, which seem as if they have had bright-up applied to them though they are not always visible. Our customer was one of those you could classify as the "what did we do to deserve her" type and a frantic call was made to CES. The voice at the other end said "Oh yes, there's a modification for that" – and he was right. Just two disc ceramic capacitors are needed: add a 3,000pF one across the field linearity-2 control R105 and a 1,000pF one across the 270kΩ fixed resistor R106 in the coupling network between the field oscillator and the field output pentode. – **Alan M. Levett** *(Portslade, Sussex).*

TV COLOUR RECEIVER

While setting up the *Television* colour receiver I encountered an unusual decoder fault. The reference oscillator locked solidly, with good hold-in range and with the trimmer C14 at about mid-position, to give a stable colour picture but with marked hue and saturation changes from the left to the right of the screen. Typically, green objects would appear blue in the centre and tinted towards green and magenta at the sides of the picture. Correct decoder alignment was impossible, but flesh tones could be resolved better when the PAL bistable was stuck in one state.

After first suspecting purity or timebase earthing trouble, I eventually found that the reference oscillator was happily running at 7·8kHz below its correct frequency. It then became apparent that this condition can easily arise since the phase relationship between the reference signal and the incoming bursts is sampled for only a short period each line. If the two signals differ in frequency by a multiple of the line frequency (15·625kHz) they will still be in phase once per line, so the discriminator will give zero output and produce a false lock. Similarly if, as in my case, the error is an odd multiple of half line frequency, alternate line phase reversals will be detected during the burst periods and the discriminator will again give zero output – rendering the PAL switch redundant! Sure enough, on screwing C14 farther in another, albeit shaky, lock was reached, producing literally every possible hue on each line.

To cure the trouble I removed C13, C14 and L2 and then placed C14 in series with the crystal in order to raise its frequency. – **J. Robinson, G4AZX** *(Upminster, Essex).*

Editorial comment: Reports of trouble with the network L2/C13 came from a number of readers, and we assume that the problem is generally due to coil tolerances. Anyone experiencing the symptoms described by Mr. Robinson may care to try the cure suggested above.

Another fault that has been reported by several readers is incorrect switching of the bistable circuit in the decoder, resulting in a strip of incorrect colour down the left-hand side of the screen. If this is experienced, we suggest trying the following component value changes in the bistable circuit: reduce R41 and R42 from 22kΩ to 12kΩ and increase the value of C29 and C30 from 1,000pF to 1,500pF. Also, see correction on page 97.

AUSTRALIAN COLOUR SETS

In a recent *Miscellany* (May) Chas. E. Miller raised the question of what EMI colour sets would have been like had they continued to produce sets for the domestic TV market. Well, EMI (Australia), a subsidiary of the UK company, has designed and developed a colour chassis (C211) over here. Like the locally designed and produced monochrome receivers, it is distributed under the HMV brand name, carrying the famous Nipper motif. It is a thoroughly up to the minute 110° design, featuring i.c.s in the i.f. strip, synchronous vision demodulation, a thyristor line output stage and blocking oscillator switched-mode power supply (of the same type as that used in the Tandberg 110° chassis, see October issue).

Early production sets were slightly unreliable, mainly due to power supply faults, dry-joints and failure of the line output stage thyristors – caused by dry joints on the line timebase panel, mainly associated with the commutating coil. Following initial production these defects have been rectified and the receiver has received a local design award for its service accessibility. The set is of modular design, consisting of a vertical chassis with seven plugable modules: when the chassis is in the service position there is access to both the component and the print side of the modules. The decoder is excellent, and the reliability and indeed picture quality are good though the 26in versions do not focus particularly well. There are still two main problems: convergence variation with temperature and failure to converge particularly well despite the use of fairly elaborate convergence circuitry, and some EW pincushion distortion – it is virtually impossible to straighten the extreme left-hand verticals.

It may also interest you to know that in addition to their locally produced chassis EMI (Australia) import and distribute the hybrid Decca Bradford chassis – under the HMV brand name. – **P. Dancey** *(Surrey Downs, South Australia).*

JUGFETs

Your article on JUGFETs (September) was slightly innaccurate in dealing with their basic operation. In practice the gate and substrate are interconnected: thus depletion regions extend into the channel from both sides. – **G. J. Hollingshead** *(Bristol).*

SERVICE ENGINEERS' PROBLEMS

I have no doubt that the estimate of the number of service engineers given by S. Gaunt of Wigfalls *(Teletopics,* August) is very near the mark. Isn't it a fact however that the quality of service is high only in isolated pockets, and that most service departments depend on the technical ability of an ever-diminishing nucleus? The reward for a highly skilled technician is minimal, and he has none of the perks (i.e. estate cars) enjoyed by the panel and valve jockeys. The basic knowledge and its applications (they have an exponential growth these days) require the dedicated type of individual who will come forward only when the structure of remuneration and promotion is adjusted to match the effort fairly.

Far too often promotion consists of taking a wonderfully skilled person into some management job which requires no skill whatsoever. Valve and panel jockeys should aspire to higher technical levels, and incentive given as a result of radically improved thinking and better organisation throughout the trade. When would be keen trainees see the situation as it is at present it's obvious that what should be a marvellous attraction vocationally becomes instead a disastrous disillusion. – **B.R.H.** *(Nottingham).*

With reference to your comments "How Many Service Engineers?" I write as a qualified service engineer with over thirty years' experience in the trade, including twenty years as a free lance with my own business then later as a service manager and as a field engineer. My view is that most companies do not want genuinely qualified engineers, only ones with bits of paper from Skill Centres who they can

– continued on page 73

LONG-DISTANCE TELEVISION

ROGER BUNNEY

SEPTEMBER and October are traditionally good months for Tropospheric reception. As I write this towards the end of September however there has been no evidence here of the hoped for signals. Hugh Cocks has had better luck at Honiton (Devon) though. He received RTVE (Spain) on September 19, 22 and 23 via the Trops, mainly the v.h.f. channels E3, E4 and E11. The Bilbao ch. E4 signal was particularly strong. TDF (France) signals were also received, at u.h.f., with Cleremont Ferrand chs. E21/24.

The MS (meteor shower) scene has had its moments and reports of reception at the lower end of Band III are coming in. It does seem that provided one can be sure of exact channel selection and that one has a reasonable aerial and amplifier such reception is possible anywhere with the aerial no higher than fifteen feet. Ch. E5/R6 is one of the best, due to the lower frequency and the fact that the two channels occupy the same frequency.

Visits to DXers

I was on holiday for the first part of the month and the log during this time was kept by Keith Hamer (Derby). Whilst away I visited Ian Beckett at Buckingham and James Burton-Stewart at Great Horwood. Ian has been experimenting with a new wideband Band I array which is working well. We hope to give details of this later. Basically the dipole assembly consists one active and two passive resonators, the array being completed by a straight reflector. James Burton-Stewart is using a Fuba XC391D u.h.f. array, Jaybeam Band III array and for Band I reception a three-element wideband array plus an omnidirectional X aerial. For receivers, James has a modified Sony single-standard set and a multi-standard set which operates on 625 lines with negative- or positive-going video and on 819 lines. A Stolle rotor is used for aerial rotation, the control unit being indoors.

Month's Log

The log for the month is as follows, the period September 1-9 being covered by Keith Hamer.

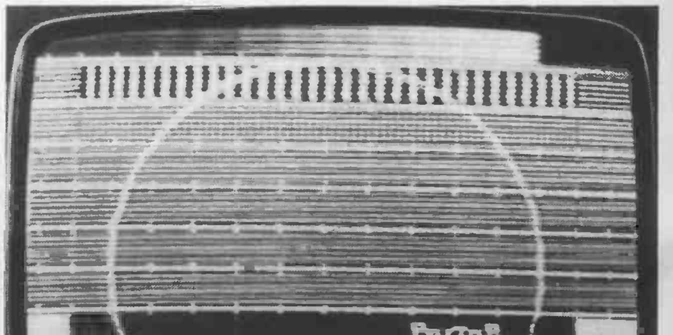
1/9/75	RAI (Italy) ch. IA and TVP (Poland) ch. R1 via MS. WG (West German) and NOS (Dutch) u.h.f. signals via Trops.
2/9/75	DR (Denmark) E3 via SpE. WG u.h.f. Trops.
3/9/75	Unidentified Band I programmes via MS.
4/9/75	YLE (Finland) E3, DR E3. Both MS.
5/9/75	SpE programmes.
6/9/75	TVP R1 via MS.
7-8/9/75	Unidentified programmes.
10/9/75	DFF (East Germany) E4, DR E3, CST (Czechoslovakia) R1, SR (Sweden) E4, RAI IB. All MS.
11/9/75	DFF E4, DR E3. Both MS.
16/9/75	DFF E4 via MS.
17/9/75	RAI IB, RTVE E4. Both MS.
18/9/75	DFF E4, RAI IB. Both MS.
19/9/75	TVP R1, RAI IB, RUV (Iceland) or SWF (WG) on electronic test card on ch. E4. All MS.
21/9/75	SR E3. MS.
22/9/75	DR E4, JRT (Yugoslavia) E3. Both MS.
23/9/75	DFF E4. MS.
24/9/75	DR E4, DFF E3, E4, DR E3, TVP R1. All MS.
26/9/75	DFF E4. MS.
27/9/75	DFF E3, E4, DR E4. All MS.

News from Benelux

We have received a number of items of information from Peter Vaarkamp and the Benelux DX Club. First, ORF (Austria) has at times been using the Marconi No. 1 test card. It's apparently transmitted when requested by service technicians for the purposes of video checks and aerial setting. The usual duration is fifteen minutes.

The CS U 01 electronic test pattern with identification "02 KR" – the R being backwards – originates from the Karelian region of Petrozavodsk (east of Finland). YLE (Finland) now transmits the Fubk test card, with the identification "CNCT YLE", from the second network transmitter at Tampere (ch. E2). Finnish TV is to provide regional programming for Aaland Island which is midway between Finland and Sweden in the Baltic. Many programmes will be in Swedish or with Swedish subtitles. The ch. E5 10kW e.r.p. transmitter is at Ahvenanmaa.

NDR (West Germany) is featuring group identifications for its first chain transmitters. Group 1, East Niedersachsen, includes the transmitters at Dannenberg, Hannover, Harz-West, Stadthagen and Visselhovede plus associated relays; group 2, West Niedersachsen, comprises the transmitters at Aurich, Lingen, Osnabruck, Steinkimmen and Wilhelmshaven; group 3, Schleswig-Holstein, comprises Bungsberg, Cuxhaven, Flensburg, Heide, Kiel and Lubeck; group 4, Hamburg. The test card identification will be "NDR 1" followed by either "ON", "WN", "SH" or "HH" for groups 1-4 respectively.



The CSU test pattern received in Finland on ch. R1 from Rostov-Don USSR (north of the Black Sea) by Seppo Pirhonen.

Finally a correction: the arabic script at the bottom of the Jordanian test card received in Holland reads "Television Jordan", not what we reported last month.

News Items

Poland: A new transmitting station is being constructed at Snezne Kolly in the Karkonosze Mountains, the highest point in Poland. It is expected to open early next year.
Sweden: Swedish Radio and Philips are to co-operate in experimental TV transmissions from an orbiting satellite. This will involve the direct transmission of programme material and will be the first time that such transmissions have taken place in Europe. We hope to obtain further information from the two organisations.
Uganda: Expansion of the TV service and transmission network with a view to colour programming continues. New stations are in operation at Kabala, Masaka, Soroti, Lira and Mbala, and ten more relays are either planned or under construction.
USSR: A new transmitter is being constructed at Riga. The second TV service of the Central TV Service is now being transmitted in this region. Further relays are being constructed to increase the coverage in Uzbekistan. A new TV centre is being built at Tashkent: it will have five colour channel capability.

OM185 Wideband Aerial Amplifier

Ian Beckett has been in touch with us recently regarding the wideband aerial amplifier, featuring the Mullard OM185 hybrid i.c., published in the June issue. The OM185 has now been superseded by the OM335, which has the same pin connections and electrical performance but a somewhat smaller encapsulation. Ian is unable to accept further orders unfortunately due to the extremely long deliveries being quoted at present. Outstanding orders will be completed on receipt of the remaining consignment from Mullard. Two readers have commented that they achieved only mediocre gain. Ian suggests experimenting with input and output coupling capacitors – the input one should be no greater than 20pF in value and the output one no more than 100pF.

Latest EBU Listings

Egypt: The ch. E10 5kW transmitter at Port Said has now been taken out of service. This could indicate that the ch. E3 outlet there is in operation. If so, it's a possible for UK reception via SpE!
Spain: The RTVE-2 ch. E40 transmitter at Murcia has had its e.r.p. reduced from 46kW to 800W.
Switzerland: Monte San Salvatore ch. E57, 100kW horizontal, French service.
Poland: Lublin ch. R2 400W vertical; Glubczyce ch. R2 25/10/5W vertical; Olsztyn ch. R3 1·25kW vertical; Raciborz ch. R3 40W horizontal; Polanica-Zdroj ch. R3 20W horizontal; Tarnow ch. R22 1,000/500kW horizontal (SE Poland, towards the USSR border).

From our Correspondents . . .

Andrew Papaeftychiou writes from Cyprus to tell us that he has on test a Grundig colour set equipped with PAL and SECAM decoders. The set has enabled him to view the CLT (Lebanon) and Amman (Jordan) services. Jordanian colour is at present restricted to foreign films and videotapes, with local news in colour just before closedown at 1900 GMT. All other local programmes

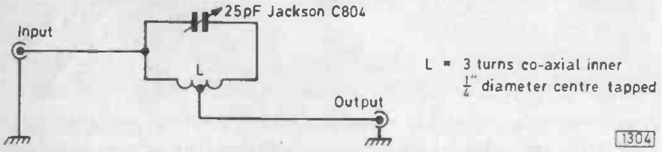
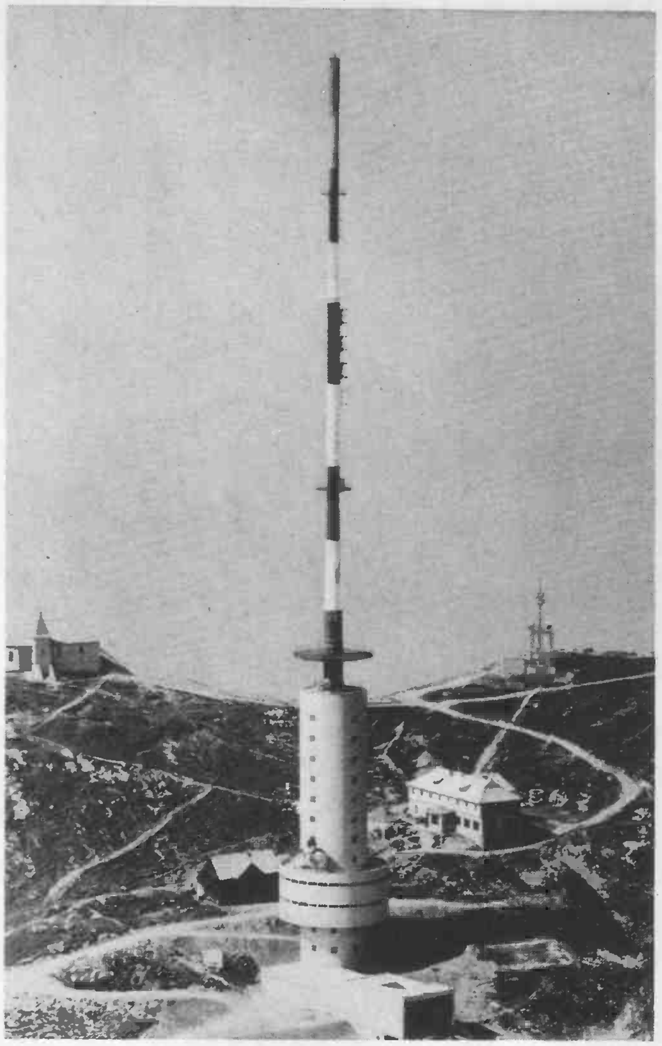


Fig. 1: Band III notch filter being used by Hugh Cocks.



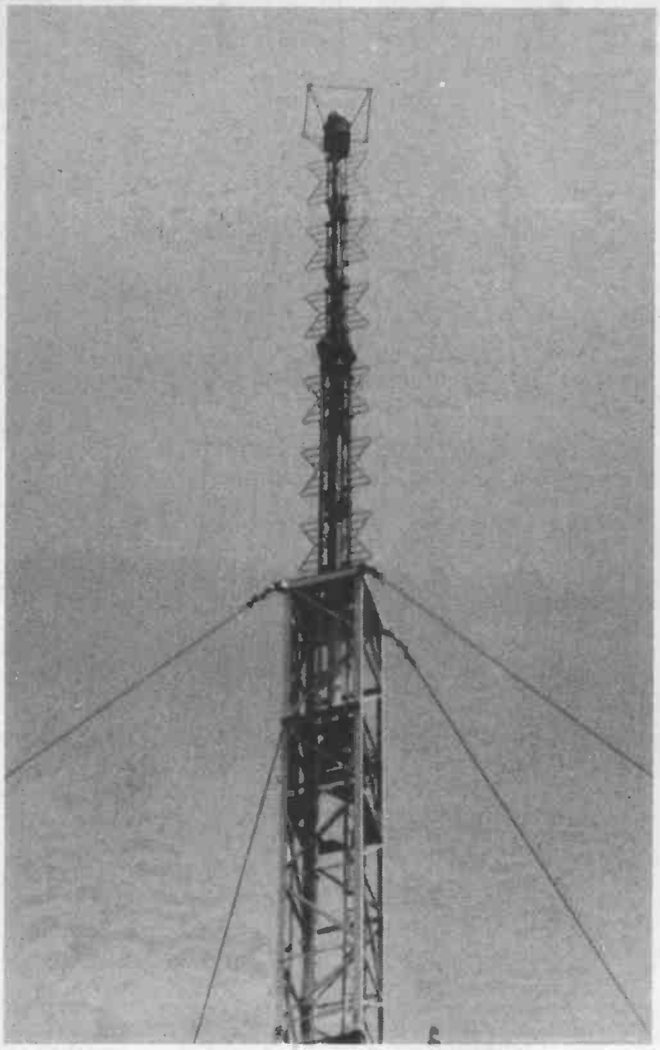
The Klagenfurt/Dobratsch (Austria) transmitting mast. ORF-1 is transmitted on ch. E10 at 160kW, ORF-2 on ch. E24 at 1,250kW. The site is at 2,115 metres while the mast is 155 metres high. Photograph courtesy ORF, Vienna.

and links from adjacent countries are in monochrome. The output from CLT is very similar, but viewers are advised whether programmes are in colour or monochrome.

Mr. Moosai-Maharaj has written to us from Trinidad where he is active with a 63-element combined Band I/III array. He has received signals from Brazil, French Guiana, Venezuela, Colombia, Santo Domingo, Cuba, Barbados, Puerto Rico and, incredibly, Las Palmas (Canary Islands). This transatlantic reception is over a distance of some 3,200 miles. It is probably the first definite case of such reception since the last sunspot maximum was reached in 1957/58. The signal was on channel E3.

Hussam Ali Mohamed (Basrah, Iraq) tells us that in addition to his local service on channel E9 he can receive clearly Kuwait ch. E6, Iran chs. E5 and E8 and Amarah ch. E11. When the humidity rises to over 80%, Qatar ch. E9 (at 700km) and Saudi Arabia ch. E6 can be received well – with the local transmissions off air of course.

Hugh Cocks has been experimenting with a notch filter to remove his local transmitter (Stockland Hill, ch. B9) which is only four miles away. He has had some success with this and the circuit is shown in Fig. 1. Hugh has also experienced some lightning flash reception. This was on August 14th, on ch. E29, coinciding with crackles on a.m. radio. The French u.h.f. transmitters at Nantes, Bourges and Chartres "came in bang-bang, just like MS reception". At the time the signal from Nantes had been just above the noise: strong signal flashes then arrived, confirming the mode of reception. It is interesting that at the same time Garry Smith (Derby) logged signal flashes from RTVE (Spain) on channel E5. At the time Garry thought this was MS



XEWT-TV's ch. 12 transmitting mast.

reception, but it would seem that this too was a case of lightning flash reception.

Finally, Ryn Muntjewerff (Holland) thinks he may have received Vladivostok on ch. R1. Further information is awaited.

South African TV

A recent letter from our contact in South Africa describes the latest position there. The test card (PM5544!) is being transmitted, along with an increasing number of test programmes, for 24 hours a day. There are generally two hours of programmes, from 1100-1200 and 1700-1800, alternating day by day between Afrikaans and English. The picture quality is excellent, and since the satellite link station has been completed it was possible to transmit the recent Apollo/Soyuz space mission. The start of regular broadcasting is still expected to be January 1976: all the transmitters shown in our map in the September 1973 issue have been installed, along with eight 8kW vertically polarised u.h.f. gap fillers.

Initially the single programme will be in English/Afrikaans, and non-commercial. By 1978 an African language service is expected to be in operation – including Zulu, Xhosa, Basotho, Venda and Sotho. This service will be relayed to the various regions from Johannesberg and the cost is expected to be about £100M. Once the African service has been established a separate Afrikaans/English service with commercials is expected to be started.

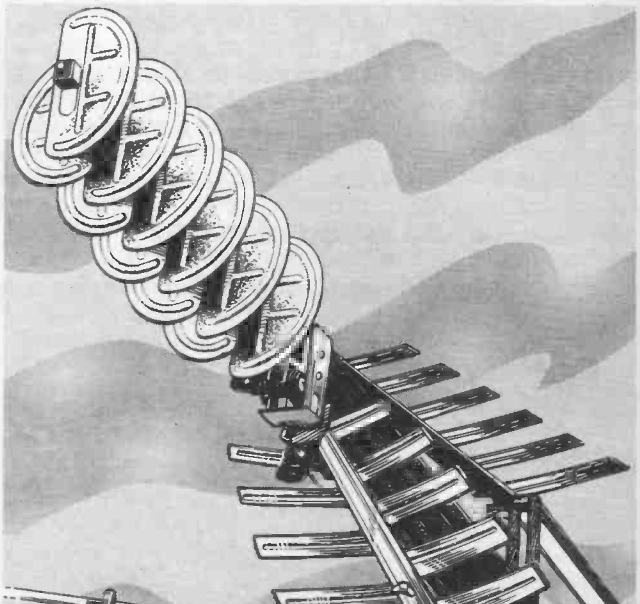
The television/radio licence is to be approximately £40. The receivers must by law be made locally, in one of three sizes – 61cm monochrome, 48cm or 66cm colour. Sales so far have been slow – about 30,000, some eighty-five per cent being colour sets. This is no doubt due to the comparatively high prices – £500 for a colour set and £200 for a monochrome one. The rental firms – Visionhire and Rentacolour – have not done well to date but anticipate increased business once programme transmissions start. Another problem is the shortage of technical staff.

French Transmissions

Peter Vaarkamp has sent us information on the latest situation in France. Since September 1st the first service (TF1) has been transmitted in colour during the afternoons from the FR3 network transmitters. In the Paris region a new TF1 transmitter operating on channel E25 is to come into operation at the beginning of December: the existing channel F8 transmitter will continue in service. There seems to be little difference between the prices of single (625) and dual-standard (625 plus 819) receivers – indeed the price of colour receivers has remained unaltered since the start of colour transmissions in 1967!

Report from Western USA

One of our regular readers, Mark Lewis, recently visited San Diego, California for a few weeks and has sent us the following report. There are numerous local transmitters, including the 100kW e.r.p. XETV one (ch. 6) which is just across the border but transmits programmes mainly intended for US viewers. The CBS affiliate KFMB-TV receives its programme feed from Los Angeles some 135 miles away via a microwave link: it transmits on ch. 8 at 316kW e.r.p. The microwave link from Los Angeles is subject to fading unfortunately. The KGTV 316kW e.r.p. ch. 10 transmitter also suffers from this same microwave link problem. KPBS-TV operates on ch. 15 and is run by a local university: it's educational and non-commercial. The ABC affiliate KCST-TV



Front end of a JFD (US) combined u.h.f./v.h.f. receiving aerial. The u.h.f. section shown above consists of a log-periodic array with a semicircular director chain in front.

LONDON VIDEODISC CONFERENCE

The world's first videodisc conference is to be held at the Royal Lancaster Hotel, London, from April 13-15, 1976. It is hoped that all the various systems that have been announced will be demonstrated.

operates on ch. 39 at 5,000kW e.r.p. (!): it uses two 55kW units which are directly coupled to the aerial system, avoiding the usual combining unit and thus saving power. There are separate exciters for each transmitter unit. A relay at La Jolla operates on ch. 62 with 100W output. XEWT-TV on ch. 12 provides Mexican language programmes and is located across the border at Tijuana, along with XETV. In addition to these off-air transmissions, San Diego has a cable system with a present capacity of twelve channels. The "A" system comprises the six local outlets detailed above while the six "B" channels are taken from the Los Angeles area. The latter are received at a special station to the North of San Diego and microwave linked back to the city. A further channel (51) is expected to be active in the area shortly.

Mark comments that NTSC colour quality is definitely inferior to PAL, while reception generally suffers from cross-modulation plus co-channel and adjacent channel interference on the v.h.f. channels. The US viewer seems to tolerate this annoying interference however. There also seems to be a lack of operating expertise: Mark noticed that the San Diego channels 8 and 10 when taking network programmes from Los Angeles would often inadvertently take the first 3-10 seconds of L.A. commercials before cutting to local advertising material. Mexican TV seems to suffer even more from technical problems, with colour banding, inferior colour mixes and elementary caption decor.

There is a high degree of transmitter saturation in California. Apart from the San Diego transmitters, there are 11 around San Francisco, 15 in Los Angeles and another one at Santa Barbara. The KTLA ch. 5 transmitter at Los Angeles was the first on the West Coast, starting operations in January 1947. In 1951 the transmitter was moved to Mount Wilson – all the Los Angeles transmitters are now atop this 6,000ft mountain.

All shows transmitted at San Diego are prerecorded: the programme linking is also prerecorded the day before. The tapes are then taken to the transmitters which are located atop a 1,000ft mountain.

The microwave link from Los Angeles is direct to Mount Soledad, a distance of some 120 miles. The mountainous nature of the path is the cause of the fading. If this is too bad local engineers switch to off-air pick-up of the Los Angeles ch. 2 and 4 transmissions. The microwave link operates at 2GHz, via a 10W transmitter and large dish aerial.

XETV ch. 6 identification slide.

Typical domestic aerial arrays consist of a high-gain v.h.f. or v.h.f./u.h.f. array on a 30-50ft rotatable mast. The masts themselves are normally telescopic, made of aluminium, and with upwards of 10 guys. A combined v.h.f./u.h.f. array plus rotor and mast costs approximately £75 when professionally installed. Some viewers use their v.h.f. only aerials for u.h.f. reception as well. This naturally results in very inferior u.h.f. reception, especially as most US u.h.f. tuners do not have an r.f. amplifier stage.

Mark has brought back photographs and aerial literature, some of which we will be showing. An interesting point is the common use of a log-periodic u.h.f. aerial array with a director chain in front. This system is used in a number of Philips arrays on the continent.

Our thanks are due to Mark for his efforts in compiling information and taking a large number of photographs of which we shall unfortunately be able to show only a few.

LETTERS

– continued from page 69

employ cheaply with the added carrot of an estate car. My last experience was of calls from 7 a.m. to 6 p.m., all in flats in the N1 district of London: this situation became quite impossible as I ran out of lies. I am now fully employed as a hearse driver at £2,500 a year and with no agro. But what a waste. – **J. A. Bates** *(Tottenham).*

TRAINING TV ENGINEERS

You ask (*Teletopics,* August) for comments on educational standards for TV engineers. Let's first summarise past experiences. City and Guilds together with the RTEB embarked on various patterns of examination levels in radio, TV and electronics. The most popular for the TV engineer were Radio and TV Servicing and for a higher grading of technicians course a colour supplement! This involved a total of six years, three evenings a week. There were also the government training centres, with excellent courses but behind the times when it came to practical matters. Apart from those who fell by the wayside in the first and second years, a reasonable number reached the intermediate or Part II stage: they were quite good engineers, particularly in the field, certainly much better than the bottle changers or untrained. A smaller number reached the final, or Part III, certificate; a further smaller number went on to pass the colour supplement examination.

General experience however did not prove that the fully trained necessarily became the most efficient TV engineers. In fact many self-taught enthusiasts became far more advanced in ability and adaptability to TV servicing than those who attained the highest standards theoretically! Many engineers felt that all those years of travelling to and fro in hail, storm and tempest to attend the classes were almost a waste of time since technology was, and still is, advancing at such a rapid rate that no matter how enthusiastic one may be one just cannot keep pace with it – and work at the same time. The work too is becoming much more demanding.

What then of the future? Apart from basic radio and TV there will be the need to know about various colour systems, the whole complex audio field, video disc and tape systems, CCTV, Teletext and more. It would seem that future engineers will need to be trained using a completely new approach, with a more interesting insight into practical design features so that servicing can be carried out more efficiently, and also a basic knowledge of a much wider field – even say to programme production.

Television magazine is the most up-to-date medium giving the ordinary TV engineer enlightenment on developments and their practical applications, and I would suggest that educational authorities and examiners take example from it. – **R. V. Mead, Tech. (CEI), AMSERT, MRTS** *(London E13).*

Servicing the ITT CVC5 CVC5/8 CVC7 CVC8 CVC9 Chassis

PART 2

E. TRUNDLE

RGB Stages

Up to this point the main chassis of the CVC5, CVC7, CVC8 and CVC9 have differed little from each other, but whereas the CVC8 and CVC9 use a pluggable i.c. (type MC1327P) for colour demodulation and matrixing – this is fairly reliable and easily checked by substitution – the CVC5 and CVC7 use discrete component circuitry in this area. The large 2·2μF couplers C82, C142 and C187 which dominate the decoder board are very prone to dry-joints. The solder-blobs often look innocent, but the capacitor lead-out wire may be found oxydised and not making contact. The result is intermittent tinting and loss of a colour-difference component at erratic intervals.

Other problems in the RGB drive stages are usually confined to the demise of the output transistors T12, T26 and T33. Several types have been used in the past in this position – BD115, BD150, E1617 and BF337. We always use BF337s for replacement purposes. On rare occasions one of the driver transistors T11, T25 or T32 may be found faulty.

The BA145 (BY206) clamp diodes D16, D22 and D31 occasionally become leaky, the degree of tinting of the picture depending on the severity of the leak. A surfeit of one primary colour is occasionally due to one of the 100kΩ stabilizing resistors R92, R175 and R244 going high-resistance.

The RGB drive potentiometers R97, R180 and R249 have been known to go open-circuit (cracked track or slider not making contact). After a bout of this trouble some three years ago however we have had very few cases.

Later Models

The RGB drive arrangements in the CVC8 and CVC9 are quite different. We have found that the 560pF mica capacitors C84, C145 and C188 are physically rather fragile. If a lead-out wire breaks away from the body, or the capacitor splits in half (it happens!), the result is impaired bandwidth of the channel concerned, leading to a slight "smearing" effect of that colour. The result resembles a convergence fault at first sight.

Excessive Brightness

Excessive brightness problems on the CVC5 and CVC7 can often be resolved by replacing of R183 (30kΩ). The same symptom accompanied by an increase in height is usually due to D57 (OA91) being open-circuit. This applies to all chassis.

Beam Limiter Faults

Most beam limiter troubles stem from defective soldering of R423, mentioned earlier in connection with varying contrast/brightness level. A mysterious no colour symptom with the decoder functioning normally can be caused by a fault in the beam limiter circuit, the lack of contrast being less obvious than the almost complete lack of colour. The fault can be due to one of several components in the T18 area but is easily traced using a multimeter.

The beam limiter preset control is R144 in the CVC5 and CVC7 chassis, R169 in the CVC8 and CVC9 chassis. The adjustment procedure is as follows. Turn the brightness and contrast controls to minimum and measure the voltage at the cathode (pin 9) of the PL509. In the case of the CVC8/9 it may not be possible to turn off the picture if the mains supply is low: in this case remove the RGB drive connections to the c.r.t. before measuring this voltage, but reconnect them before making the next voltage measurement. With the CVC5/7 turn the contrast control to maximum and the brightness control to mid-travel; with the CVC8/9 chassis turn both controls to maximum. Then adjust the preset until the voltage at PL509 cathode is 0·95V higher than the reading initially obtained.

Power Supplies

The mains filter capacitors commonly go short-circuit, resulting in a shattered 4A fuse. These 600V capacitors (C257 and C258) are best replaced using 1,000V types which are more reliable. Sometimes the leak is not apparent on an ohmmeter test. The other fuse-detonator, a short-circuit h.t. rectifier (D53 or D54), will be obvious on a continuity check. A BY127 is a satisfactory replacement.

In a few early models the multisection electrolytic C271/3/5/6 had the reprehensible habit of developing a hole in its seal. The resulting highly corrosive tears wrought havoc on their long and sorry route to the bottom of the chassis. If you have the misfortune to encounter this state of affairs, the drill is to wash the printed panel thoroughly with methylated spirits, replacing plugs C and D if necessary together with the offending smoothing block.

The l.t. rectifier D52 may be an encapsulated block (type B30C400-1) or a metal device (type CSD11-8XLZ). Neither of these is particularly reliable and if replacement is required the adoption of four separate silicon diodes (type 1N4001) as fitted in production on the CVC8 and CVC9 is recommended. If D52 goes short-circuit F4 blows of course. If D52 is leaky the resulting ripple at 50Hz

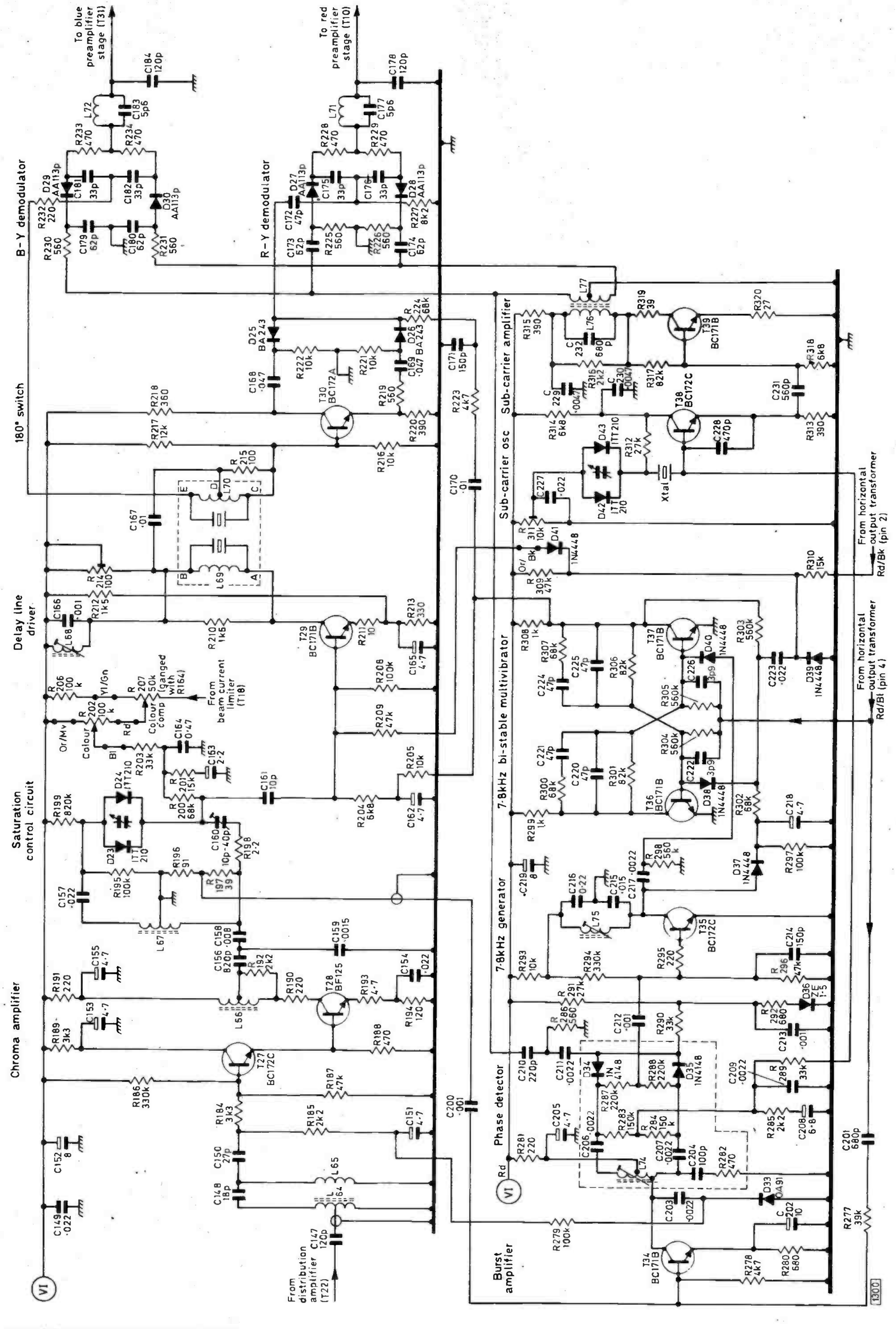


Fig. 3: Circuit diagram of the decoder. An MC1327P i.c. is used for colour demodulation and matrixing in the CVC8 and CVC9 chassis. The circuit changes involved will be shown next month.

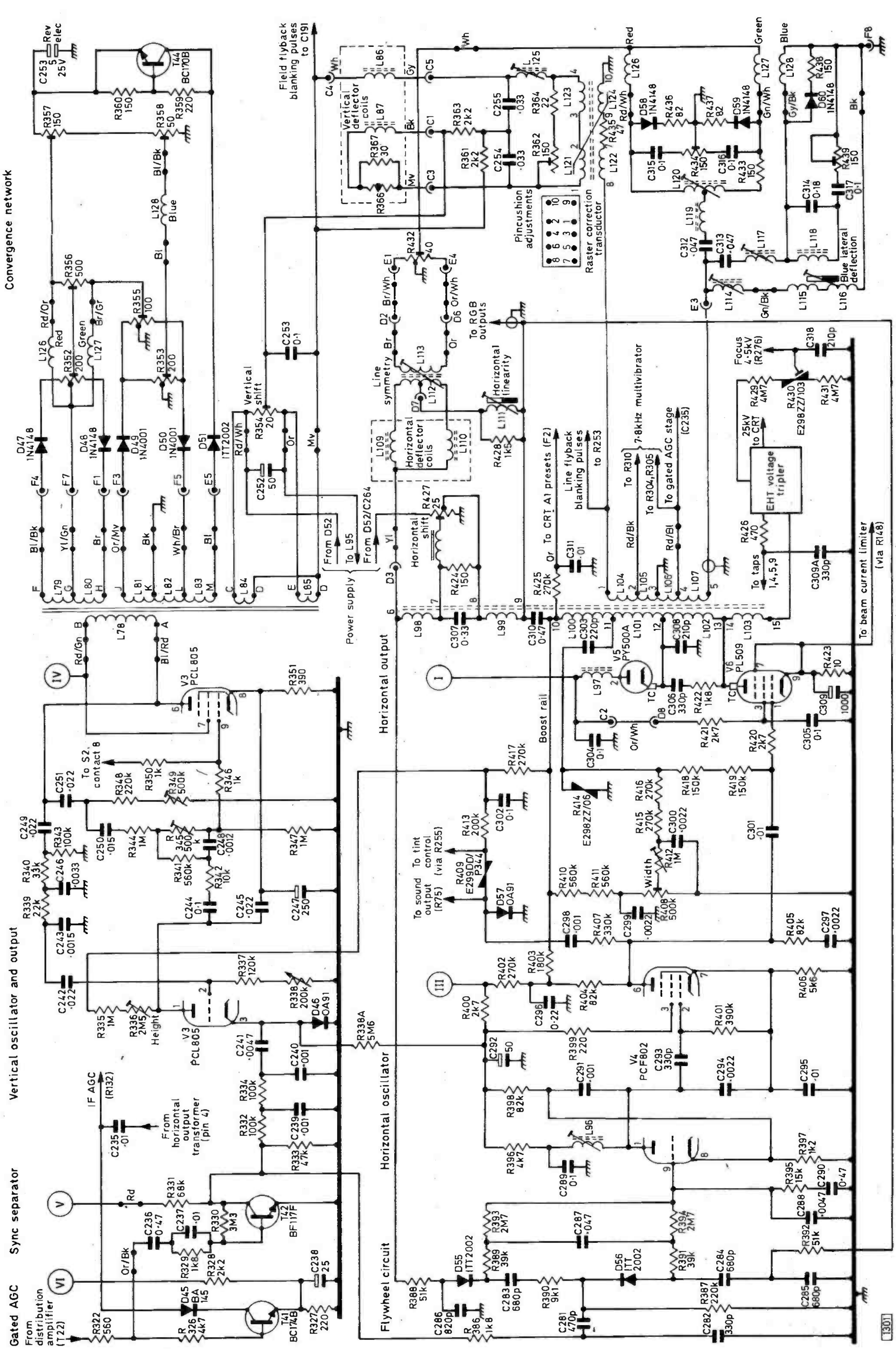


Fig. 4: The timebase and convergence circuits.

produces a single hum-bar on the screen. 100Hz ripple – a double hum-bar – is often caused by a leaky l.t. regulator transistor T46 (AD161). The same effect is sometimes due to a fault in the 10μF tantalum capacitor C263. Again, the symptom can be caused by a leak or low capacitance in the 500μF reservoir capacitor C262, but this is comparatively rare.

The reference for the 20V regulator circuit is derived from the varicap supply stabiliser D11. If this diode develops a fault, hum and voltage variations on the 20V line can result. Long before this stage is reached however the intolerable tuning drift usually calls attention to the diode (or i.c.) D11 anyway.

Lack of saturation can be caused by C265 being leaky since the 18·8V line falls reducing the supply to the colour-difference amplifier stages (this fault applies to the CVC5 and CVC7 only since as previously mentioned the demodulator and following RGB circuitry used in the later chassis differs). If either C262 or C263 is sufficiently leaky the 20V line will fall possibly leading to no sound or vision.

No Sound or Raster

A point that could mislead those who are not used to the type of RGB circuitry used in these chassis is that when the 20V supply is absent – due mainly to D52 going short-circuit and blowing F4, or occasionally to T46 going open-circuit – the symptom will be no sound and no *raster*. This is because the RGB output transistors are left without any base bias, their high collector voltages, d.c. coupled to the c.r.t. cathodes, back-biasing the tube.

The Field Timebase

It is a source of wonder to us that the necessary deflection power for a 90° thick-neck colour tube can be squeezed out of a PCL805. In spite of this, the mortality rate of the device is no greater than in monochrome receivers. A short-circuit in D46 (OA91) will lead to loss of field sync: if the diode goes open-circuit, the field scan collapses: if it is leaky, there will be poor interlace and a tendency to rolling. If the field frequency takes some time to settle down from cold, the valve should be replaced. A faulty cathode decoupler (C247) can cause the usual effects of bottom cramping etc. but has also been known to cause weak field sync without substantially affecting the linearity. This is one to be on guard against.

Field jitter with varying linearity can usually be traced to R344 (1MΩ) in the feedback loop. Less often the same symptom can be caused by leakage in C248 (0·0012μF) or C250 (0·015μF). A dud spot on the height control can cause spasmodic height variation. Intermittent field collapse has been traced to a dry-jointed or open-circuit R340 (33kΩ). C242 occasionally goes open-circuit with the same result.

Insufficient height is usually due to R417 (270kΩ, 2W) going high-resistance; in severe cases the sound is affected via the "silent warm-up" circuit. This component is buried at the bottom of the line timebase board, inside the line output compartment cage. Long pointed pliers and considerable patience are essential when replacement is attempted. Field bounce has also been traced to R417.

An eerie mechanical buzz at field rate sometimes emanates from C253. We replace this with a 400V polyester capacitor from the RS components range.

CONTINUED NEXT MONTH

next month in

Television

● SERVICING THE THORN 8000/8500 COLOUR CHASSIS

The Thorn 8000 and 8500 chassis have been produced in very large quantities and are thus amongst the most commonly encountered colour chassis. They are all solid-state sets with some interesting features that could confuse those not familiar with the basic design. Next month we start a series which will provide a detailed circuit description and deal with faults experienced.

● UHF PREAMPLIFIER

The addition of a preamplifier can significantly improve the noise performance in low-signal areas or enable extra distant ITV transmissions to be received. The design to be presented next month is simple and very stable. It is based on the BF272 transistor.

● SOLID-STATE MONO CHASSIS FAULTS

There have been only two large-screen UK produced solid-state monochrome TV chassis, the Philips 320 and RBM A816. John Coombe describes faults experienced with these.

● TRANSISTOR LINE TIMEBASES

In Part 2 of his series E. J. Hoare describes the exacting requirements for correct line output transistor operation and how these are met in practical designs, and provides a clear account of the complexities of line output transformer tuning.

● N1500 VCR SERVICING GUIDE

Regular maintenance is essential if the performance of a videocassette recorder is to be kept up to scratch. What this involves is mainly careful lubrication and cleaning. Michael Gladwell sets out what is required with the Philips Model N1500.

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CEEFAX/ORACLE

reception techniques

Steve A. MONEY T. Eng. (CEI)

PART 6

ULTIMATELY the objective of any teletext decoder unit is to produce the received page of information in the form of written words which can be read by the viewer. This could be carried out by simply using the decoder system to drive some form of electric typewriter which would produce the text on a sheet of paper. Most decoders will be designed to present the page of text as a picture on a television screen.

Normally the picture produced will consist of white or coloured letters and symbols on a black background but it is also possible to superimpose the text on the normal television picture. Sometimes the text may be displayed like subtitles superimposed over blanked-out areas of the programme picture.

Let us now examine the techniques involved in making the conversion from the received data into a display of letters and symbols on the screen.

Character codes

Up to now the data has been treated simply as a series of 7-bit groups, known as words, each of which represents one of the characters to be displayed on the screen.

For the Ceefax/Oracle system the characters are coded according to the International Standards Organisation seven-bit code which is generally referred to as the ISO7 code. Computer and data processing systems frequently use this ISO7 code to control the operation of typewriters and line printers. The seven bits of the code allow 128 possible combinations and these are allocated to the letters, numbers and symbols as shown in Fig. 32.

In practice only 96 of the available codes are used to define the characters and signs. The 32 combinations which occupy the first two columns of Fig. 32 are normally used for control function codes. These control functions may be varied according to the specific application of the code, and are sometimes used to provide additional characters such as Greek letters or mathematical symbols.

Another code which is commonly met with in computer or data processing systems is the American Standard Code for Information Interchange (ASCII). This code may frequently be referred to in the data specifications for integrated circuit character generation devices. In fact the ASCII code is almost identical to the ISO7 code as far as the letters, numbers and symbols are concerned. In the ASCII code the £ sign is replaced by the crosshatch (#) which the Americans use in much the same way as we would use the No. abbreviation. As a result any character generator unit using either the ASCII or the ISO7 code can be used to give the display signals for a teletext decoder.

Character matrix

Having decided which character is to be displayed for each of the received code words, we now have the problem of actually producing a visible symbol on the TV screen.

				BIT 7	0	0	0	0	1	1	1	1
				BIT 6	0	0	1	1	0	0	1	1
				BIT 5	0	1	0	1	0	1	0	1
BIT 4	BIT 3	BIT 2	BIT 1	COL / ROW	0	1	2	3	4	5	6	7
0	0	0	0	0			space	0	@	P	`	p
0	0	0	1	1			!	1	A	Q	a	q
0	0	1	0	2			"	2	B	R	b	r
0	0	1	1	3			£	3	C	S	c	s
0	1	0	0	4			$	4	D	T	d	t
0	1	0	1	5			%	5	E	U	e	u
0	1	1	0	6			&	6	F	V	f	v
0	1	1	1	7			'	7	G	W	g	w
1	0	0	0	8			(	8	H	X	h	x
1	0	0	1	9			)	9	I	Y	i	y
1	0	1	0	10			*	:	J	Z	j	z
1	0	1	1	11			+	;	K	[	k	{
1	1	0	0	12			,	<	L	\	l	|
1	1	0	1	13			–	=	M	]	m	}
1	1	1	0	14			.	>	N	↑	n	—
1	1	1	1	15			/	?	O	_	o	□

N168

Fig. 32: The ISO7 character code.

The usual method employed is to build up the character required from a series of lighted dots.

Large public displays such as scoreboards at major sports events or news and advertising signs frequently use this dot matrix technique for producing illuminated letters and numbers. For these signs each of the dots in the array consists of an electric lamp and these are arranged to form a large regular matrix. Symbols can be produced by selectively lighting up some of the lamps in the array so that they form the shape of the desired symbol. Some readers may remember the moving news and advertising display that used to operate above the cartoon cinema on Waterloo railway station and which was typical of this kind of display system.

In the earlier displays of this type each of the lamps was fed by its own separate switch. These control switches were arranged in an array in the same way as the lamps that they controlled and the switches were operated by means of a perforated tape or card. The positions of the holes in the control tape determined which of the switches were made and by arranging the pattern of holes to form the shape of the desired symbol the appropriate lamps in the display would light up to show the appropriate symbol.

In a large display there might be a hundred or more lamps in the area occupied by one character but for a TV display a much smaller array can be used. Normally there will be a matrix of seven rows of dots with five dots in each row. This arrangement is known as a 5 × 7 character matrix and can give perfectly legible symbols.

If both capital and lower-case letters are presented some of the lower case letters, g, j, p, q and y (known as descenders) will have tails which fall below the main line of characters. Usually these tailed letters are generated on a 5 × 7 matrix in the same way as the other letters but when they are displayed they are shifted downwards by two or three rows to place them in their correct position relative to the other letters. To accommodate these shifted letters the display matrix is usually extended by two or three lines to give a 5 × 10 or perhaps 5 × 11 matrix. One row of the display matrix is usually left blank to provide a space between rows of letters and make the text easier to read.

In a large display the lamps in a symbol are all lit at the same time but in a television display the character matrix is scanned with only one dot illuminated at a time. Scanning is left to right across rows and top to bottom in the same way as the picture itself is scanned.

Read Only Memory

For a character display on television an electronic switching system is used to control whether the dots in the character matrix are to be illuminated or not. The dot patterns representing the characters to be displayed are held in an electronic memory device which is known as a Read Only Memory or ROM.

To examine the principles of operation of a character-generating ROM let us consider the case of displaying one letter and for simplicity we shall use a 5 × 5 matrix as shown in Fig. 33. For the moment we shall assume that the circuit is driving a set of lamps as shown.

A memory matrix consisting of 25 cells is used to hold the pattern for the character to be displayed, which in this case is a capital Y. In this memory matrix a diode is wired into each cell where the corresponding dot is to be lit up, while those cells representing black dots are simply left as open circuits. Switches S1 and S2 are used to scan the cell matrix by selecting rows and columns to pick out one cell and lamp at a time.

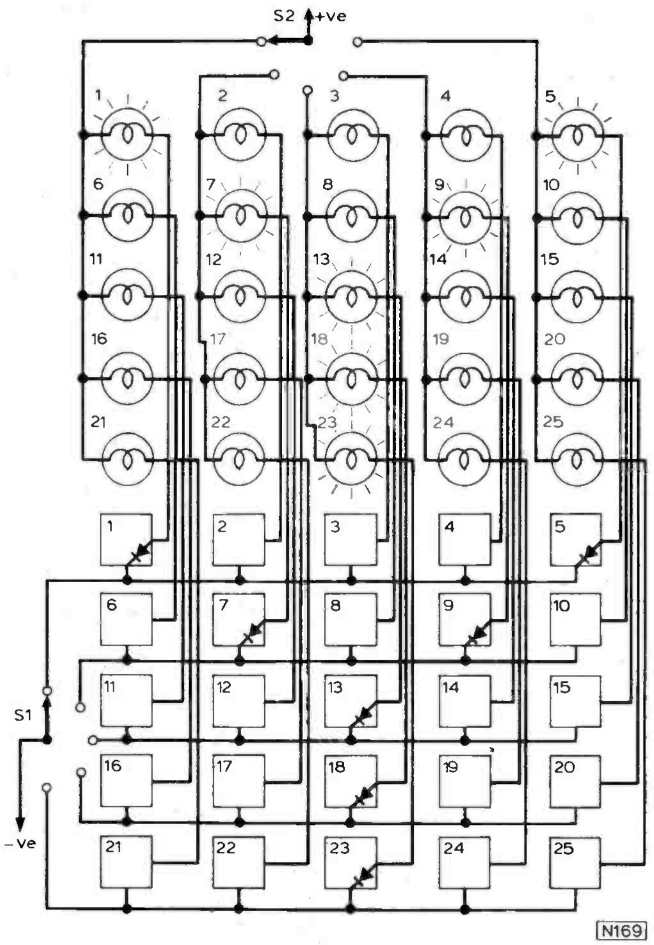

Fig. 33: Principle of operation of the character ROM. The letter Y is being generated on a 5 x 5 matrix.

Let us see what happens as the top row of lamps is scanned. Switch S1 connects the top row of cells to the negative side of the supply whilst switch S2 applies the positive side of the supply to each column of lamps in turn. Only lamps in the top row can light because the other rows have no return path to the negative side of the supply. When column 1 is selected the diode in cell 1 allows current to flow and lamp 1 lights. When columns 2, 3 and 4 are selected no return path exists because there is no diode in these cells so the lamps remain unlit. Lamp 5, however, will light since it has a path through cell 5 in the matrix. For the other rows a similar action takes place and only those lamps with a diode in their circuit will light. Thus by arranging the pattern of diodes in the matrix to make up the shape of a character the lamps will light to display that character. In the example shown a capital Y is displayed.

To provide the 96 different characters required for a teletext display we shall heed 96 separate diode matrices each of which is programmed with the pattern for one of the desired letters, numbers or signs. We could build up such an array by using discrete diodes but for a 5 × 7 character matrix this would involve about 2000 diodes and would be both bulky and expensive.

Fortunately it is relatively easy to fabricate a vast array of diode or transistor cells on to an integrated circuit chip. In this case all 35 diodes of each character array would be fabricated on the chip but only those diodes needed for the dots that are to be lit would be connected. Interconnections on the chip are produced by an etching process in which a photographically produced mask is used. When the layout for the mask is made the patterns for the whole set of characters are designed into it so that every chip will be programmed with the same character set as it is manufactured. This type of ROM is referred to as a mask programmed ROM.

Programmable Read Only Memory

An alternative method of getting the patterns into the ROM is to make the device with every cell connected and to electrically programme the memory after the device has been manufactured. To programme the memory each of the cells is selected in turn. Where the cell selected represents one of the black dots in a character matrix a pulse of electric current is passed through it and this causes either the diode or a connecting link to be fused thus leaving the cell open circuited. No action is taken when cells representing white dots are selected. After this programming process the ROM will behave in the same way as a mask programmed type.

This type of device is known as a Programmable Read Only Memory (PROM) and is generally used in cases where a special character set is required but the number of ROMs to be made does not justify the expense of producing a special photographic mask.

Although the ROM has all the cell patterns for a set of characters programmed into it there is also a need for an addressing system to enable one particular character matrix to be selected and scanned.

The addressing system of a ROM is similar to that in a Random Access Memory device and the address circuits are built into the chip together with the character patterns. A 6-bit or 7-bit binary code is used for the address input, the number of bits being determined by the number of characters programmed into the memory. The address code for each of the characters can be arranged to be the same as the ISO7 or ASCII code for that character so that the character data words can be used directly to address the memory.

In addition to the character selection address the ROM will need a row address to select one of the rows of dots in the character matrix. Usually the ROM is arranged so that all five dot signals for the selected row are brought out simultaneously to five separate output pins. Scanning of the dots in the selected row is then carried out by external circuits in the display control system. To produce a video signal the dot outputs are taken in sequence and used to make up a serial train of pulses which can then be applied to the video amplifier circuits of the TV receiver.

We shall now take a look at some typical character ROM devices and see how they are applied to produce a teletext display.

Signetics 2513

First let us consider the Signetics type 2513 which is one of the simpler character generator ROMs. The 2513 uses a 5 × 7 character matrix and provides a set of 64 characters comprising capital letters, numbers and signs. These symbols are coded using a 6-bit version of the ASCII code. In this case bit 6 of the 7-bit received data is not used and the 2513 then outputs capital letters in place of the corresponding lower-case ones. Fig. 34 shows a typical circuit arrangement for a character generating system using the 2513.

A 3-bit address is used to select which row of dots in the character matrix is to be read out. This address is generated by a divide-by-eight counter operating from the line scan so that the address is effectively a line count which repeats every eight scan lines. The character occupies seven lines

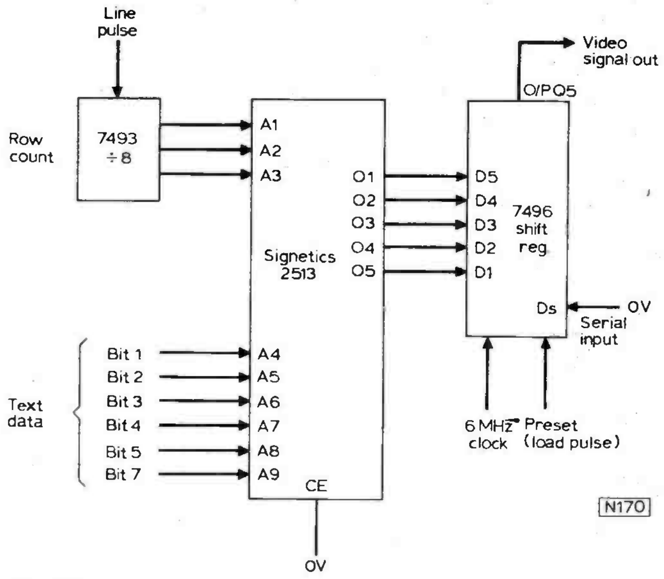

Fig. 34: System diagram of a character generator using the Signetics 2513 ROM.

and the eighth is left blank to give a space between rows of text.

The five dot outputs from the 2513 are passed to the data inputs of a 7496 five-stage shift register. When a preset pulse is applied the dot pattern is transferred to the five register stages. Next the pattern is shifted out of the register as a serial dot pattern which provides the video signal for the display. The shift clock usually runs at 6MHz. If we allow for a sixth blank dot to act as a space between characters in a line, the set of dots for one character will be scanned in 1μs. As the pattern moves out of the register it fills with 0s or blanks.

There are forty characters in one line of text on the screen and the data for the selected row of each character in turn must be fed to the 7496 as the line scan proceeds. This is done by presenting the code for each character in turn to the 2513 as the previous one is being shifted out of the 7496. For a 6MHz clock rate therefore the code to the 2513 changes at intervals of 1μs.

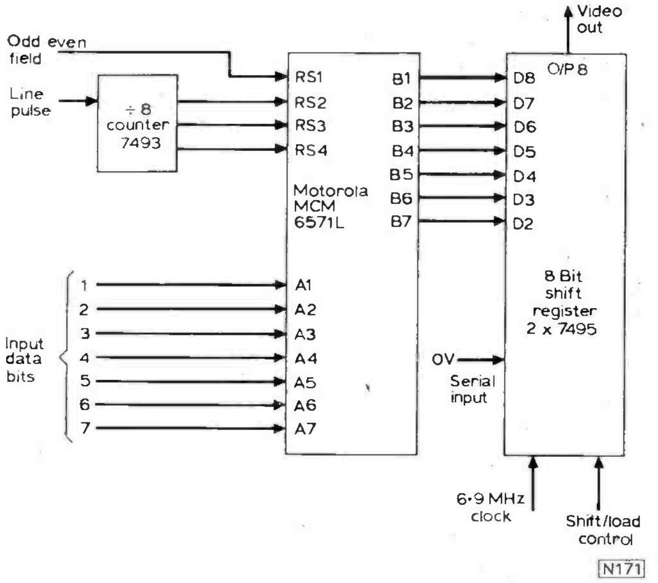

Fig. 35: A character generator using the Motorola MCM6571L.

For the next line scan the sequence of characters is repeated but this time the next row of the character dot matrix is selected. This continues until the eight rows of the character matrix have been scanned. After this the code sequence is changed to present the characters for the next line of text and then the scanning process is continued for the new line of characters.

Because the 2513 is an MOS device it is slower in its operation than the TTL logic used for the display. To allow for the delay between the application of the character code and output of the dot pattern it is usual to change the input character code as soon as the last dot pattern has been put into the 7496. By the time the next dot pattern is required the 2513 will have changed its output to the new pattern.

The 2513 comes in a 24-lead DIL package and requires supplies of +5V and −12V. At the time of writing the price is about £9 each. MOS devices like the 2513 can be damaged by static electricity and although the 2513 has built-in protection diodes on its inputs it is still advisable to mount it in a socket to avoid any unnecessary risks.

Motorola MCM6571

A much more comprehensive character generator device is the Motorola MCM6571L. This unit caters for a set of 128 characters and will produce both capitals and lower-case letters. Like the 2513 the Motorola device is coded according to the ASCII code but in this case all 7 of the code bits are used. Apart from the normal character set the 6571 uses the first 32 code combinations to present a selection of Greek letters and mathematical symbols.

The 6571 uses a 7 × 9 character matrix instead of the more usual 5 × 7 arrangement. To allow for the descending tails of some of the lower-case letters the row address is arranged for 16 rows. The tailed characters are shifted down by three rows when they are read out. For the display the dot matrix can be made eight wide and either 12, 16 or 20 rows deep as convenient.

A typical circuit arrangement for the MCM6571 is given in Fig. 35. As will be seen it is similar to that used for the Signetics 2513.

Unlike the 2513 the Motorola device has a row address which counts down from 15 to 0 as the character is scanned. A simple way of achieving this is to use a normal line counter and to invert its outputs.

In a teletext display with 24 rows of text it is only possible to have eleven lines for each row of characters on each field scan. With the finer dot structure of the characters from a MCM6571 it is necessary to use the interlace lines on alternate field scans for the adjacent rows in the character matrix. This is done by detecting the odd and even field scans and using this information to control the first bit of the row address. The other three bits of the row address now become the line count.

Power supplies

Like the Signetics 2513 the MCM6571L also comes in a 24-lead DIL package but it needs three power supplies, +5V, +12V and −3V. Fortunately the 3V and 12V supplies can be derived easily from the main 5V supply. Typical circuits for this are shown in Fig. 36.

For the 3V bias line a simple oscillator generates a high frequency squarewave which is then a.c. coupled and rectified to produce −3V. For the 12V line a switched choke supply is used. Here the squarewave is applied to an inductor. When the current switches off a large back e.m.f. is produced and this is rectified to give the +12V supply.

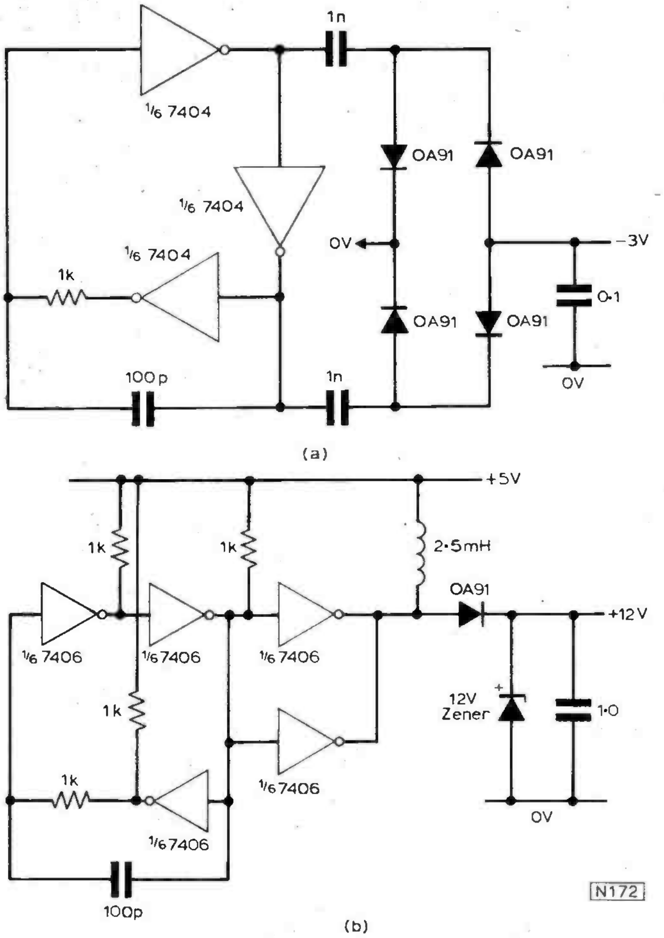

Fig. 36: Generating supplies for the MCM6571L.
(a) The −3V supply uses a simple square wave oscillator.
(b) The 12V supply uses a switched choke circuit to generate the required voltage step-up.

There are a number of alternative types in the Motorola MCM6570 series of ROM devices. The MCM6572L is similar to the 6571 but does not have shifted lower-case letters and uses a simple 7 × 9 matrix. The MCM6576 is coded for ISO7. All of these types sell for about £12 each at the present time.

Character rounding

One problem with the simple 5 × 7 character matrix is that the displayed characters tend to have a rather ragged appearance, especially when they incorporate diagonal lines. In an effort to overcome this difficulty and produce characters with an improved appearance, the engineers of Mullard research laboratories developed a technique known as character rounding.

Basically the idea behind the scheme is that the dot pattern of the character is examined for diagonal lines and then by adding in extra half-length dots the steps in the diagonals are partially filled in to give a smoother line. The general idea is shown in Fig. 37.

Normally the dot in a character matrix will actually consist of two dots, one on one field scan and the other on the interlacing field.

On odd field scans the dot being displayed is compared with the previous row of dots in the character matrix and if two dots are diagonal to one another in this test then a half dot is added to the displayed dot. On the even field scans the displayed dot is compared with dots in the next row of the character matrix.

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SPECIAL PRODUCT REPORT

CHINAGLIA 'DOLOMITI' MULTIMETER

Alan C. AINSLIE

THE Dolomiti multimeter is the latest addition to the range of high quality test instruments manufactured by Chinaglia Dino in Italy. This 32 range instrument offers a large meter scale, a.c. current ranges and high sensitivity a.c. voltage ranges (20kΩ/V), together with extended ohms ranges and two ranges of capacitance measurement.

The meter is quite compact, measuring 125mm x 130mm x 40mm (4·9 x 5·1 x 1·6 in). The case is moulded from tough ABS plastics material which is both functional and attractive. A rigid hinged protective case is supplied with the meter to accommodate the instrument and test leads, making a rugged, easily transportable package for the field service engineer.

Meter movement

Almost 50% of the front panel is occupied by the large 110° meter scale which has an effective length of 92mm (3·6 in). An anti-parallax mirror is provided behind the scale so that the inherent accuracy of the instrument can be fully utilised. A two colour scale is employed with the a.c. ranges clearly marked in red.

The magnet assembly is of the centre pole type which renders the instrument virtually unaffected by external fields, also ensuring that the radiated field is negligible – an important consideration if the meter is to be stood on top of a shadowmask colour TV receiver. Resiliently mounted jewelled bearings are used rather than the irrepairable 'taut band' assembly.

Ranges

D.C. voltage ranges from 0·5V (for sensitive bias measurements) to 1·5kV are provided with a sensitivity of 20kΩ/V. This seems to be the 'standard' sensitivity and most service sheets are prepared with this figure in mind. An optional e.h.t. probe extends the ranges to 30kV f.s.d.

A.C. voltage ranges are incorporated from 5V to 1·5kV at the very high sensitivity of 20kΩ/V which minimises circuit loading and allows the Dolomiti to be used where previously an electronic voltmeter would have been necessary. Few meters outside the Chinaglia range are able to approach this a.c. sensitivity figure.

The voltage ranges follow a 5, 15, 50 sequence which is very close to the ideal 1, $\sqrt{10}$, 10 required for optimum reading accuracy (no indication need then be less than 32% f.s.d.). Two colours are used to distinguish the d.c. scales from those used for a.c. which have been corrected to allow for the effect of the rectifiers.

D.C. current is measured from 50μA to 5A in decade ranges while the a.c. ranges are from 5mA to 5A. Both sensitive leakage current as well as power supply and high current tests are included in this range.

Six decade resistance ranges are provided with mid scale readings of 5Ω to 500kΩ. The range of measurements is from 0·05Ω to 50MΩ. It is unusual to find the two low resistance ranges on an instrument of this type but they are very useful when making up low value resistors from resistance wire (e.g. Power amplifier emitter resistors), or for measuring the resistance of connecting leads.

The resistance ranges are powered from a $22\frac{1}{2}$V photoflash battery and a couple of penlight cells (the low ohms range takes a considerable current so alkaline batteries, MN1500, are recommended).

Capacitance from 100pF to 500nF can be measured on two ranges with mid scale indication at 4000pF and 0·04μF. For these measurements the instrument is connected to the 50Hz mains by a short plug-in lead, supplied as standard. The resistance between the test probes and one side of the mains is only a few tens of ohms so care must be exercised when using the capacitance ranges to avoid an electric shock. The mains lead must be unplugged before using the meter for any other tests.

Operation

The Dolomiti is very simple to use. A 24-position rotary switch selects the appropriate range while a 3-position slide switch is used to select 'DC' 'AC' or 'Ohms'. An 'Ohms' control knob is used to zero the ohms ranges and also to set the infinity end of the capacitance scale with the test probes connected together.

Three sockets marked '–', '+' and '1500V' are used for the test leads. The '–' and '+' sockets are used for all ranges except the 1·5kV range where the '–' and '1500V' sockets are used.

Cut-out

The most carefully used test meter at some time in its life has to withstand gross overloads such as occur when one attempts to measure a power supply output with the meter set to '5mA', or when a resistance measurement is made in equipment before the capacitors have discharged. Such accidental abuse, apart from overloading the shunt and multiplier resistors, is bound to damage the sensitive meter movement unless some form of protection is employed. This usually amounts to diodes connected across the movement, limiting the voltage across the coil to a few hundred millivolts. Such protection is reasonably affective in saving the meter movement (although the pointer may bend as it hits the end stop) but does nothing for the precision resistors in the circuit which may remain under overload conditions.

The Dolomiti is fitted with a novel electronic circuit that monitors the voltage across the movement. When this exceeds the equivalent of eight times f.s.d. a relay energises releasing the cut-out button and isolating one of the test probes. The response time is only a few milliseconds and the isolation is complete before the needle has had chance to reach the end stop. The protection is also effective with negative overloads.

As additional protection a 5A quick blow fuse is contained within the red test probe.

Appraisal

During evaluation the Dolomiti behaved reliably and consistently. In normal use its most obvious attribute is the large clear scale, despite the instrument's compact overall dimensions.

Internal construction is elegantly simple, the whole instrument being built on a single printed board which carries all the controls and the battery mounting clips. All components are of the highest quality. An interesting point is the use of 'thin film' resistor packages which offer a potentially long life and high stability. The Dolomiti is the first meter to come to the author's notice using such up-to-date technology.

The meter movement is fairly heavily damped with a response similar to that of the AVO 8. The smooth deflection immediately conveys an impression of quality about the movement. Repeatability of readings could not be faulted.

The quoted accuracy of 2% d.c. and 2·5% a.c. was surpassed in all cases, most of the d.c. ranges being virtually 'spot on'. The worst d.c. error was only just over 1% at f.s.d. – a truly commendable performance no doubt aided by the 'thin-film' packs.

The frequency response of the a.c. current, 5V, and 15V ranges extends to 20kHz with a drop of less than 1dB. The remaining a.c. ranges are usable to 7kHz.

The a.c. ranges are supplemented with a decibel (dB) scale with 0dB as 1mW into 600Ω, corresponding to 0·775V. The scale is computed for the 5V range with 20dB to be added on the 50V range and 40dB to be added on the 500V range. A nominal factor of 10dB is to be added on the 15V range, 30dB on the 150V range etc. (In point of fact the actual correction is +9·54dB, +29·54dB etc.) A table of the dB factors is engraved on the meter scale. The overall decibel range is from –10dB to +65dB.

The cut-out proved to be very effective preventing the pointer from moving more than 25% of f.s.d. under overload conditions. A definite 'click' is heard on overload as the cut-out trips and the red button lifts by about 6mm (0·25in). When the overload is removed the button is simply pressed for reset.

Power to drive the cut-out is derived from the 22½V battery which should be checked periodically as when exhausted the cut-out would fail to operate. On the sample meter a battery too flat to allow the ohms zero to be set would still operate the cut-out.

The fuse in the red test probe is a very neat idea as it is easily replaced should it be blown by an overload.

Quite obviously such a complex instrument cannot escape without a few criticisms, no matter how trivial. On a test bench it often happens that a single-handed range change is needed. Unfortunately the Dolomiti resists this by sliding about the bench unless 'draught excluder' is stuck to the bottom. The fitting of small rubber feet into the screw holes on the underside would overcome this problem.

The only other criticism concerns the way in which the a.c. mains is used on the capacitance ranges, presenting a slight hazard. Quite obviously once warned the intelligent user will be cautious when using the instrument for capacitance measurements, and in all fairness the instruction book does make clear the possibility of shocks. There is no simple alternative to the circuitry involved – so **BE CAREFUL.** It is, as stated before, important to remove the mains lead before making any other measurements.

Ballistic capacitance ranges

The Dolomiti can be used to gauge the approximate value of large capacitors by noting the needle 'kick' when the meter is applied to the initially discharged component while switched to an ohms range. The kick is a result of the initial charging current and the amount of swing is indicative of the value of the component.

A chart is given in the instruction book which in conjunction with the d.c. volts scale allows capacitors of 0·1μF to 1F (1 000 000μF) to be measured by this ballistic technique.

U.S.I.

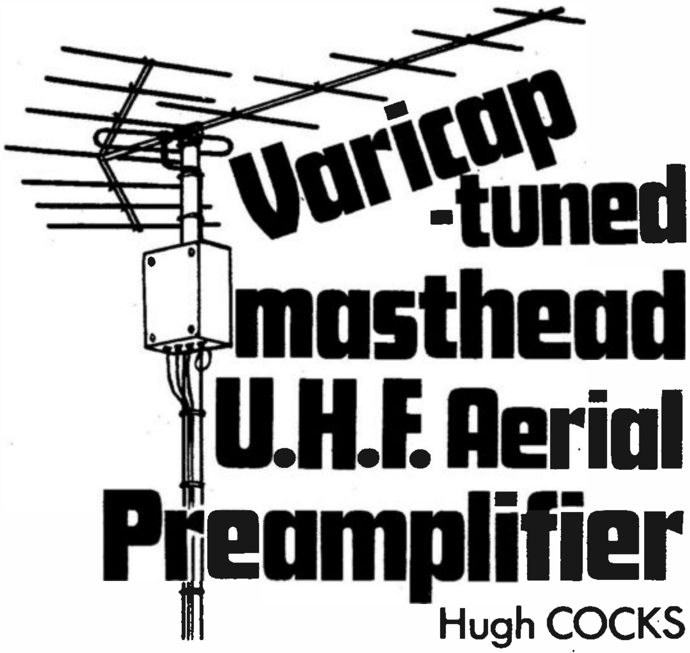
A very useful option on the basic Dolomiti is the provision of a built-in 'Universal Signal Injector'. This is a transistorised blocking oscillator which gives an audio modulated r.f. output rich in harmonics to 500MHz which may be used for many audio, video and r.f. tests.

The U.S.I. function is simply selected on one position of the range switch and is powered from one of the internal pen cells. The U.S.I. output is available from an additional front panel socket and is about 20V pk-pk. The output is d.c. isolated to 500V.

Conclusion

The Dolomiti performed admirably on test and has proved an invaluable companion on the test bench. The large clear scale makes for accurate readings and the instrument is very easy to use. Its high accuracy, bonus features and robust construction make the meter equally suitable for use in the laboratory, workshop or in the field.

The recommended retail price of the Dolomiti, including leads and carrying case, is £27·50 for the basic multimeter, or £31·90 with the U.S.I. option, while the 30kV probe costs £8·80. All prices include VAT at 8%. Further details are available from Chinaglia (U.K.) Ltd., 19 Mulberry Walk, London SW3 6DZ, telephone 01-352 1897.



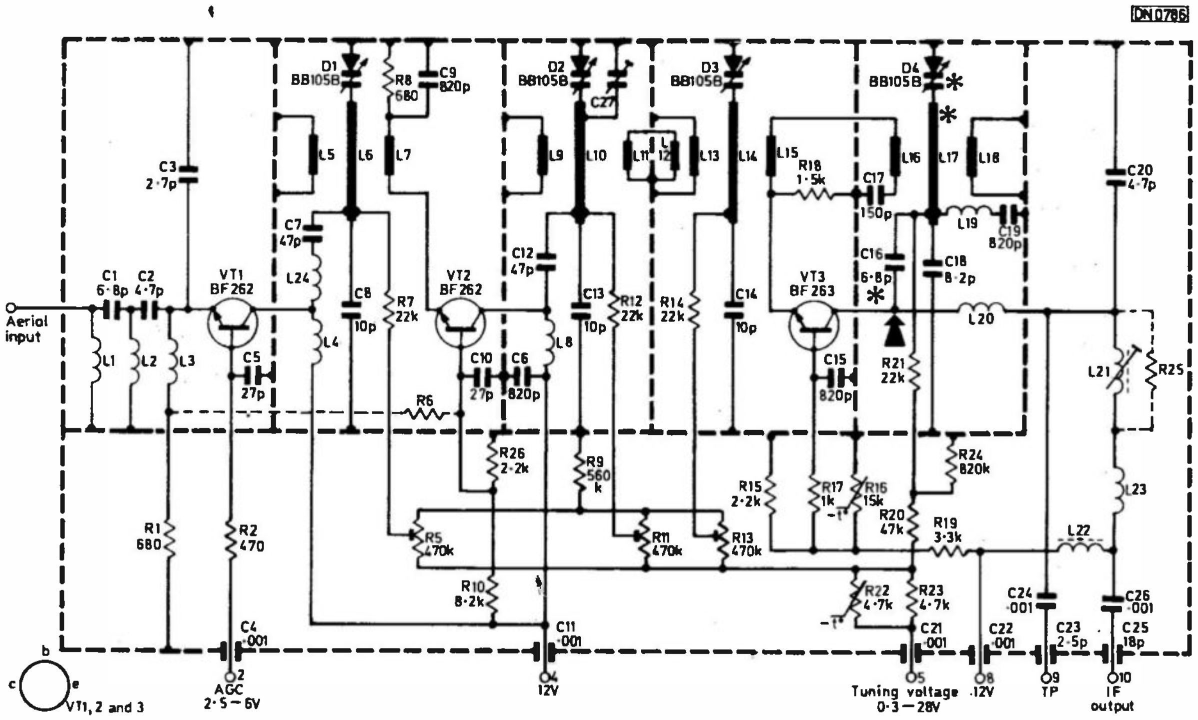
Varicap-tuned masthead U.H.F. Aerial Preamplifier

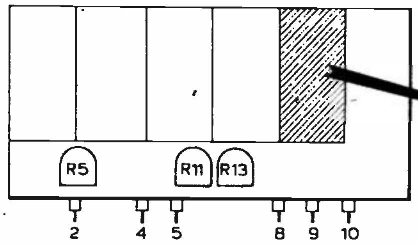
Hugh COCKS

FOLLOWING the author's article on low cross-modulation aerial amplifiers in the March, 1975 edition of *Television*, some thought was given to a masthead version.

The Mullard ELC1043 Tuner gives good gain when modified but the cross-modulation performance is inferior to the mechanically tuned u.h.f. preamplifier. However, as a rotary masthead preamplifier is a little impractical to say the least, it was decided to install an aerial changeover relay up the mast with the modified ELC1043 tuner. The relay switches the aerial feed between the varicap preamplifier and a direct coaxial lead to the rotary preamplifier at the set end. Thus on the "cross-modulated" channels the u.h.f. masthead preamplifier can be switched out in favour of the better cross-modulation performance of the set-side rotary preamplifier.

The most irritating cross-modulation characteristic of the varicap preamplifier is the mixing of shortwave signals up to 10MHz away from the local channels. Ch. E22 reception is good during daylight hours but when dusk arrives pandemonium breaks loose due to mixing with Ch. E23 (the local) acting as the local oscillator (no pun intended!). The varicap preamplifier has a clear advantage on the higher channels where very weak Ch. E59 signals have been just visible using the masthead preamplifier but have been virtually lost in noise with the set-side preamplifier. The coaxial relay causes virtually no loss.





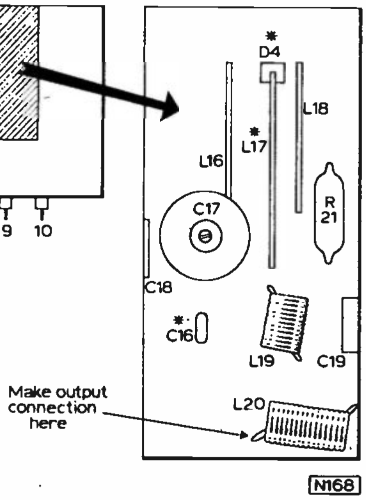


Fig. 1 (top) and Fig. 2 show the circuit and layout of the ELC1043. Components to be removed are marked with an asterisk.

Tuner modifications

Modifications to the ELC1043 are very simple, see Figs. 1 and 2. Remove the screening cover from the local oscillator section and remove C16, D4 and L17. The amplified output feed is taken direct from the junction of VT3 collector and L20 via a 1000pF isolating capacitor. The connection can conveniently be made on the print side of the tuner.

Some thought must be given to the easy connection of the coaxial feeder up the mast. If the reader has an old

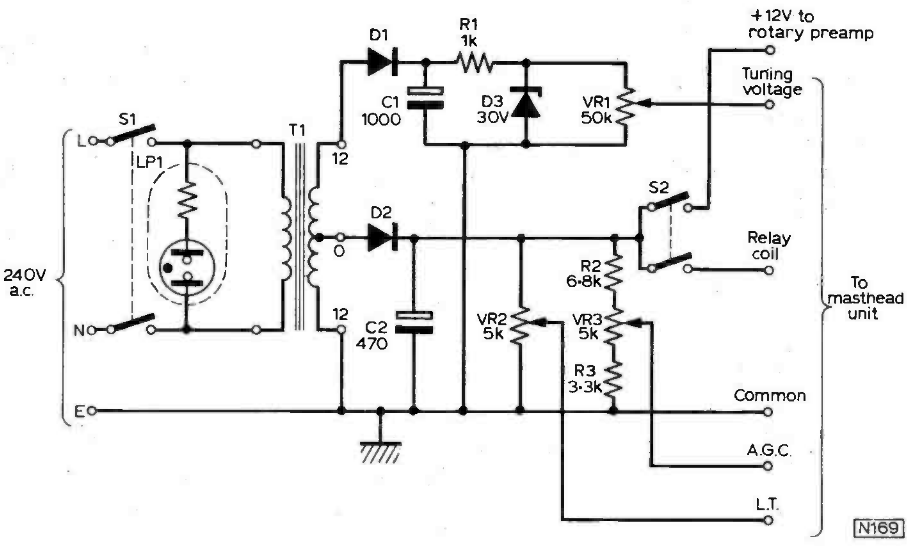


Fig. 3: Circuit diagram of the Power and Control Unit.

"normal" masthead preamplifier with a copper laminate strip on one side, the board can be cut in half and the components removed except for the cable connector. The copper laminate side can then be soldered to the body of the tuner and the isolating capacitor soldered to the base of the connector. In the absence of an old preamplifier suitable for cannibalisation, the reader must devise some other means of making the output connection to the coaxial feeder. The most important thing is to avoid having to take a soldering iron up the mast – not an exercise to be recommended! Whatever method is adopted, the tin lid has to be left off the print side of the ELC1043, but this does not matter. We shall deal with the aerial input connection later.

Power and Control Unit

The box housing the mains power supplies for the masthead preamplifier and relay is also used to mount the varicap tuning potentiometer and the relay control switch, plus two further potentiometers controlling the levels of a.g.c. and l.t. for the preamplifier. A worthwhile reduction in cross modulation can be achieved by judicious adjustment of the latter controls. Fig. 3 gives the circuit of this unit.

A miniature 12-0-12V transformer provides all the necessary power supplies. The tuning supply is obtained by half-wave rectification of the 24V output across the complete secondary. Because of the small current demand, C1 charges almost to the peak value, and R1 and D3 provide a stabilised 30V output to the tuning control VR1.

Half of the secondary winding is half-wave rectified to provide the 12V line which powers the masthead preamplifier and the changeover relay. The author also drove the set-side rotary preamplifier from this source. The 12V line is fairly heavily loaded and no stabilisation is required.

Control wiring

Connections between the control unit and the varicap preamplifier require five conductors, see Fig. 4, which can conveniently be provided by one twin and one three-core cable. Alternatively, two twin cables can be used with the mast as the common conductor.

Relay

The relay used by the author has a 12V 50mA coil and is intended for amateur transmitting use up to 250MHz with powers of 50W. However, when the aluminium screening cover is removed to reduce stray capacitance the relay causes virtually no loss over the whole of the u.h.f. band. The relay is about the size of an i.f. transformer, all the connections being made via pins at the base. The large pin goes to the common contact. The small pin from the

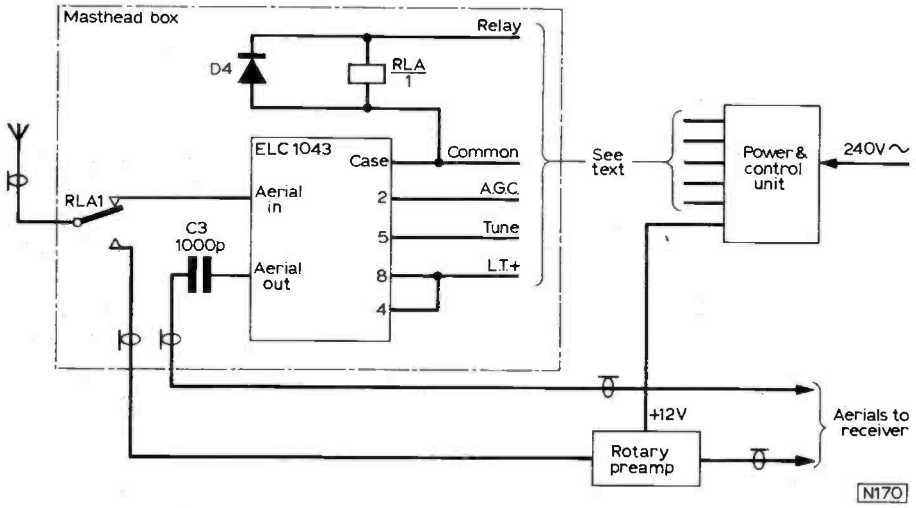


Fig. 4: Internal wiring of the masthead unit and general system connections.

★ Components list

Resistors: (all ±5%, $\frac{1}{4}$W)
R1 1kΩ R2 6·8kΩ R3 3·3kΩ

Potentiometers:
VR1 50kΩ VR2, VR3 5kΩ

Capacitors:
C1 1000μF 63V C2 470μF 40V
C3 1000pF

Semiconductors:
D1 1N 4002 D3 BZY88C 30V 400mW zener
D2 1N 4001 D4 1N 4002

Miscellaneous:
T1 12V-0-12V 6VA; S1, S2 d.p.s.t.; LP1 Neon indicator 240V; RLA Aerial changeover relay, 12V coil, obtainable from P. F. Ralfe, 10 Chapel Street, London N.W.1, price £1.50 + 8% VAT; ELC 1043 u.h.f. tuner; Boxes for masthead unit and power/control unit, plus waterproofing materials.

normally closed contact should be soldered to the aerial input pin of the varicap preamplifier. Assuming a new coaxial cable is to be used for the direct feed, this can be soldered to the other relay pin on the ground and a short length of cable connected to the large pin for the aerial input.

Testing and installation

Connect up the preamplifier temporarily at ground level and ensure that the tracking of the three varicap diodes left in circuit is still good. To do this, set R13 midway (see Fig. 2) and adjust R11 and R5 to give a sharp noise peak on Ch. 21. Tune the preamplifier to the top of the band and check that the tracking is still good: normally no adjustment should be needed. The oscillator compartment screening cover and the tin lid on the component side of the tuner can now be replaced.

If you are lucky enough to have available a suitable watertight box with cable entry glands, housing the masthead circuitry is simple. If not, a suitably sized aluminium box can be used providing steps are taken to prevent the ingress of moisture.

Apply a liberal coating of petroleum jelly to all the cable connections, then spray the inside of the box freely with Damp Start or a similar aerosol plastic spray. Place a dry rag over the tuner unit, screw the lid on and tape carefully over all the joints outside the box. In this way damp should have little chance of entering the unit.

Results

Operational results have been excellent. In practice the varicap preamplifier is used more often but the rotary preamplifier is invaluable for working "close in" to the local channels, and on the mixing channels. These are easy to calculate knowing the channels of the local transmitter. In the author's case these are Ch. 23, 26, 33 and Ch. 9. Ch. 23 and 26 will appear on Ch. 29; Ch. 26 and 33 on Ch. 40; Ch. 23 and 33 on Ch. 43. Ch. 9 will be at approximately 194MHz on the h.f. side of Ch. 23, 26 and 33 on Ch. 47, 50 and 57. A u.h.f. aerial with a very sharp forward lobe will help to reject the local signals arriving off beam. ■

CEEFAX/ORACLE

continued from page 81

When a diagonal runs down from left to right the half dot occurs before the displayed dot on odd fields and after it on even fields. For a diagonal running from right to left the positions of the half dots are reversed.

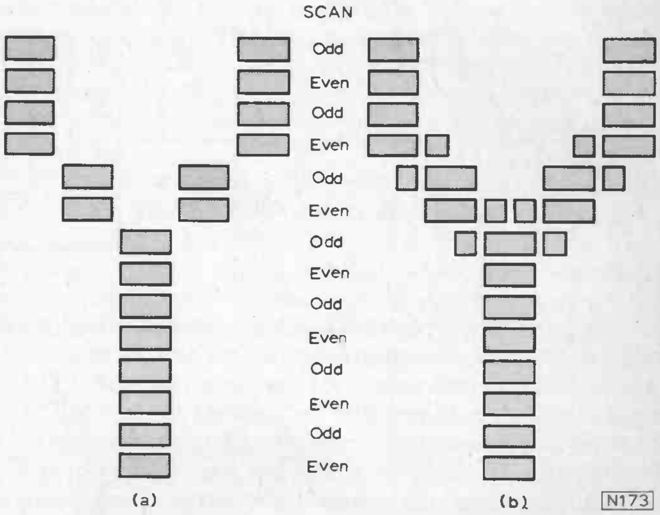


Fig. 37: Principle of the character rounding process.

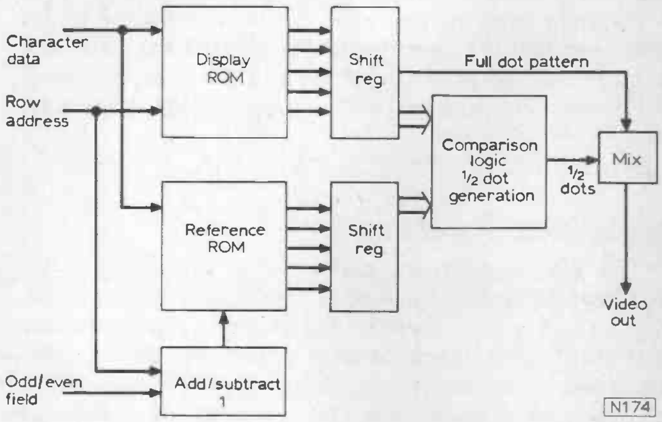


Fig. 38: A basic circuit for character rounding.

To generate the half-length rounding dots an extra character ROM is needed, see Fig. 38. This ROM selects the same symbol as the main display ROM but will produce either the row before or after the one being scanned by the main ROM. Since this depends upon whether the field scan is odd or even an odd/even detector is used to control the row address of the reference ROM. On even scans 1 is added to the address whilst on odd scans 1 is subtracted from the row address.

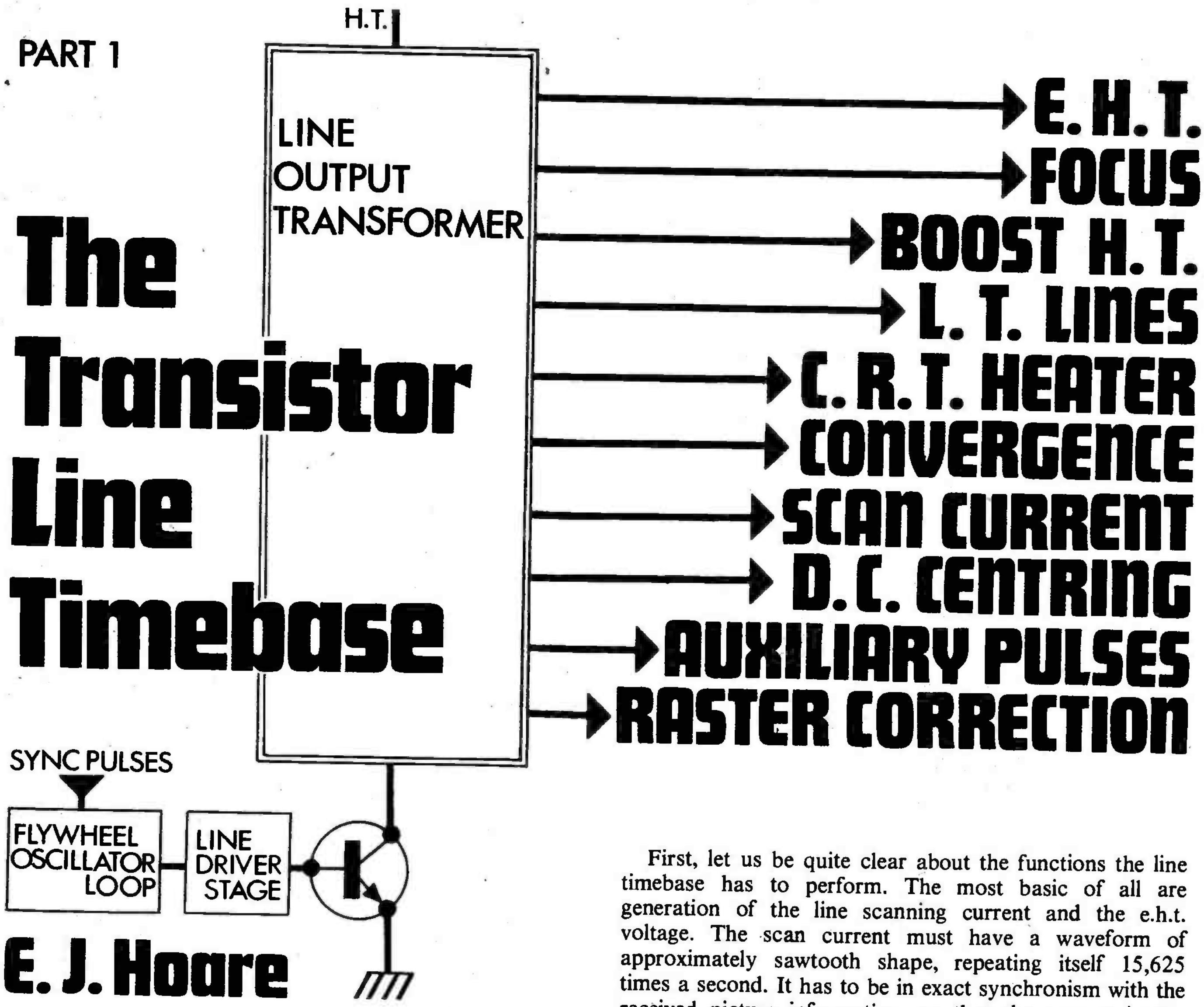
In the rounding logic the dots before and after the one being displayed are compared in the two ROMs and used to detect the presence of diagonally positioned dots. From this logic the half-length rounding dots are produced which are then added to the main serial video signal to produce the required rounding effect on the displayed character.

Next month

Next month we shall take a look at the way in which a graphics type display is built up to produce simple pictures such as weather maps or graphs.

PART 1

The Transistor Line Timebase



E. J. Hoare

A complete line timebase is the most complex and important section of a modern TV receiver, whether monochrome or colour. A number of factors justify this apparently rather sweeping statement. First the line timebase consists of a large group of circuits that occupy a lot of space in a TV set. Then, the timebase has many functions to perform and, since it handles most of the power dissipated by the complete receiver, it dictates the power supply circuit specification. It has to compress into a few inches the sort of high voltages that power engineers isolate with many feet of air and large porcelain insulators. There are further problems to do with protection against c.r.t. flashovers, circuit protection to comply with the safety requirements of BS415, and the radiation of interference. To cap it all, the operating conditions of the line output stage have to be designed to very tight tolerances.

In these articles we are going to take a fairly close look at nearly all aspects of transistor line timebase performance. This will enable us to establish not only how the circuits operate, but also to consider the design aspects and the sort of practical difficulties that have to be overcome. In the course of this investigation we shall see just how closely the line timebase is linked to the whole of the rest of the TV receiver.

First, let us be quite clear about the functions the line timebase has to perform. The most basic of all are generation of the line scanning current and the e.h.t. voltage. The scan current must have a waveform of approximately sawtooth shape, repeating itself 15,625 times a second. It has to be in exact synchronism with the received picture information, so that the current in the deflection coils results in the c.r.t. electron beam starting to move across the screen at the same instant as the picture information for that particular line begins to arrive. This involves using the received line sync pulses to control the line scan current. The e.h.t. is a d.c. voltage of 20-25kV, obtained by some sort of diode rectification of the voltage pulses which are an unavoidable by-product of the scanning process. In some chassis the e.h.t. is generated separately, but this is usually unnecessary and hard to justify in view of the extra cost.

Auxiliary functions

The other functions of the line timebase can to some extent be regarded as auxiliary – they could if necessary be performed by separate circuits elsewhere in the receiver, though this would be much more complex and expensive. Here is a list based on a colour chassis: source of c.r.t. heater voltage; generation of one or more l.t. lines, usually in the range 12-40V but occasionally higher; drive voltage or current for the line convergence circuits; raster shape correction; d.c. centring current; a boosted h.t. voltage of around 700-1000V; and several positive and negative line flyback pulses to trigger or gate various other circuits in the receiver.

In a normal set all the functions just listed are carried out by the line output transformer. The line output stage circuit is usually very badly drawn in manufacturers' service data, with the result that there is very little indication as to how the circuit works. It tends to be regarded by many people as an electronic black box, which is rather a pity. Although it is often difficult to design the circuit to the high standards necessary, and certain aspects of it are rather complex, nevertheless the basic mode of operation is really very simple and is well within the scope of anyone interested in TV techniques.

Our starting point is that we need to generate a sawtooth-shaped current in the line coils of the deflection yoke. A typical colour receiver yoke might have line coils with an inductance (L) of 2·8mH and a resistance of 3Ω. At a scanning frequency of 15,625Hz the reactance of the coils is $j\omega L = 2\pi \times 15{,}625 \times 2{\cdot}8/1{,}000\Omega = 276\Omega$.

This shows that to a good approximation the line scan coils are almost entirely inductive and that the resistance they have can be ignored. As a result, advantage can be taken of a very useful property exhibited by any pure inductance: if a constant d.c. voltage is applied across it, the result will be a linearly increasing current, i.e. the first part of a sawtooth. This is shown in Fig. 1(a). From the instant $t1$, when the switch is closed, a current will start to flow through the inductance and will increase linearly with time as shown. This is of course what we want for scanning purposes. Whilst the current is building up, the magnetic field associated with the inductance is also increasing. In other words, the energy being supplied to the circuit is being stored up in the form of a magnetic field.

Before we go further it is necessary to point out that what we have said so far is an idealised state of affairs. In practice the constant voltage source has some series resistance; the inductance has some series resistance as

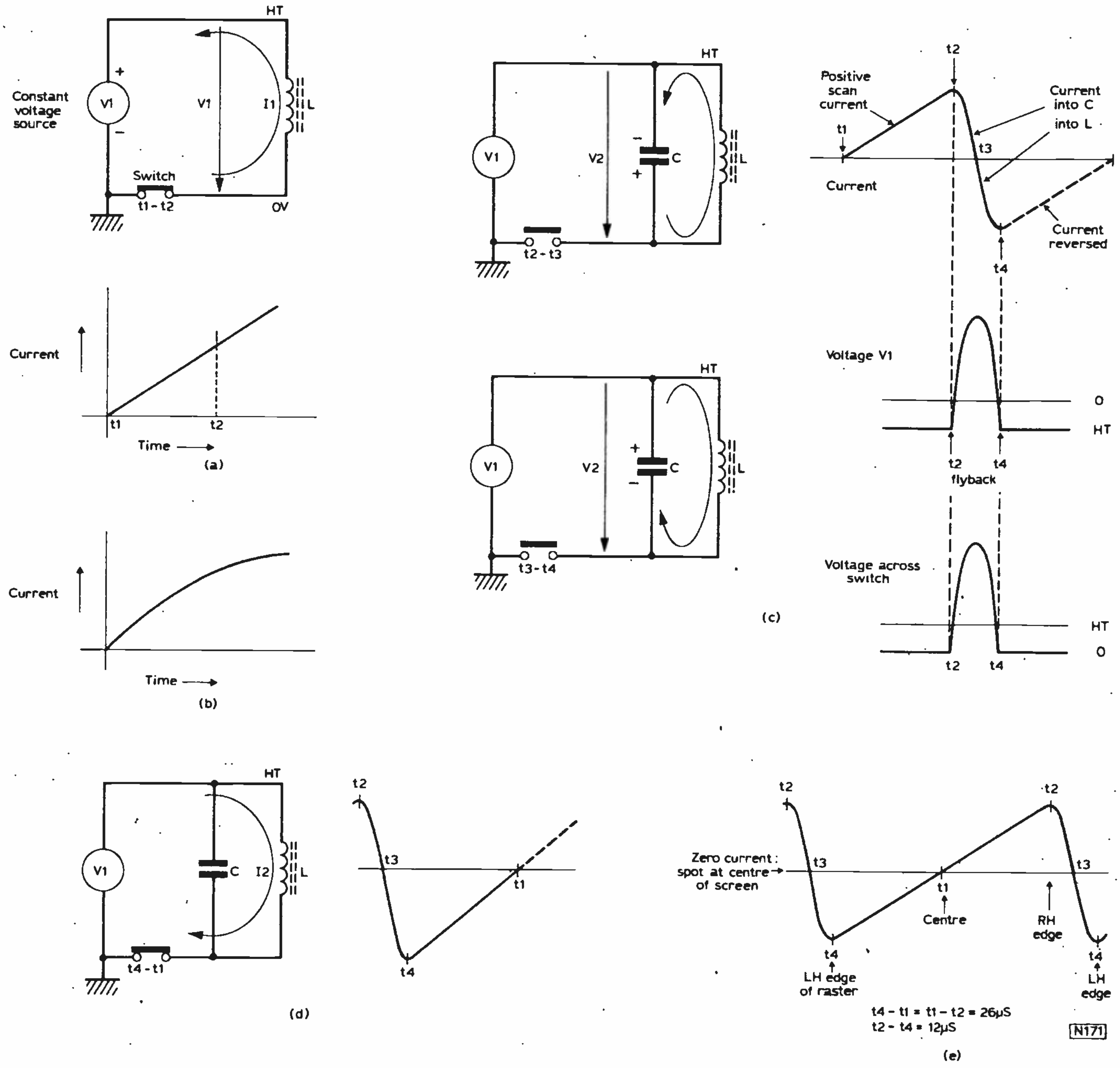


Fig. 1: A Switchable constant voltage applied across the inductance of the line scanning yoke produces a sawtooth scan current and a high voltage pulse. (a) The switch closes at instant t1 to produce the rising current sawtooth. (b) Losses cause the sawtooth to become nonlinear. (c) The flyback cycle is in two parts. (d) The first part of the scan is a decreasing current sawtooth. (e) The complete scan cycle.

well. Furthermore the losses in the magnetic circuit, or core, of the inductance can also be represented as series resistance. Thus if the switch was kept closed indefinitely, the sawtooth shaped current would begin to develop a curve – as shown in Fig. 1(b). It would eventually, as the current became limited by this series resistance, flatten out. This is in accordance with Ohm's Law ($I=V/R$). Finally, as the core material of the inductance became hot, the losses would increase still more: the effective series resistance would increase, and the current would begin to fall. At this point the magnetic circuit of the inductance is saturated: all the extra incoming energy is being dissipated as heat in the resistances.

Timing

In a typical line scanning circuit we want the sawtooth shaped current to last for about 26μs while the c.r.t. beam is travelling from the centre of the screen to the right-hand side. This time is set by the rate at which the incoming picture information is arriving. When the beam reaches the right-hand side of the screen the forward scan must be terminated. Thus 26μs after time $t1$ when the switch shown in Fig. 1(a) was closed it must be opened. This is time $t2$. The sequence of events so far has given us a linearly rising, i.e. sawtooth shaped, current, the time interval being short enough to avoid running into the curved part of the waveform shown in Fig. 1(b). So far so good, but what happens next?

At the instant $t2$ current is flowing in the inductance and the switch is suddenly opened. The current cannot stop instantaneously, because the stored energy in the magnetic field tries to maintain it. As the magnetic field dies away, so does the current. But where does it flow to during this period?

The answer lies in the fact that any inductance has some associated stray capacitance, and in a line timebase this is augmented by an external capacitor. When the switch is opened at time $t2$ the current flows into this capacitance instead of back to the d.c. supply. We thus have current flowing in a circuit (Fig. 1(c)) consisting of inductance (L) and capacitance (C), and the circuit will have a resonant frequency ($f=1/2\pi\sqrt{LC}$).

When the current in L has fallen to zero, the inductive energy, equal to $\frac{1}{2}LI1^2$, has been transferred to C – which has stored energy equal to $\frac{1}{2}CV2^2$. Thus $\frac{1}{2}LI1^2=\frac{1}{2}CV2^2$. If C is small, and in practical circumstances it is, $V2$ is very much larger than $V1$ – typically about eight times larger, i.e. $V2=8\times V1$ at the instant $t3$.

Oscillatory current

We now have the state of affairs where C is fully charged and the magnetic field of L is completely discharged. C therefore discharges through L until C is completely discharged and, at time $t4$, the magnetic field has again been built up in L.

Now note three things. First, the current has been oscillating between L and C at a frequency of $f=\frac{1}{2}\pi\sqrt{LC}$ since L and C form a resonant circuit. The shape of the current waveform produced is therefore a sinewave, not a sawtooth. Secondly the voltage waveform is also a sinewave, and forms a large pulse as shown in Fig. 1(c). Thirdly and most importantly the direction of current flow reverses during the period $t3$ to $t4$. Thus the current is flowing in the opposite direction to that during the previous cycle of events, i.e. the sawtooth from $t1$ to $t2$ and the following period $t2$ to $t3$. During time $t2$ to $t3$ the beam is rapidly deflected from the right-hand side of the screen to the centre; from $t3$ to $t4$ it travels from the centre to the left-hand side of the screen.

To complete the cycle of events, at instant $t4$ the switch is closed. The constant d.c. h.t. voltage now opposes the inductive flow of current in L. As at the end of the sawtooth (time $t2$) the current cannot stop instantaneously. The current dies away linearly to zero as the magnetic field collapses, in doing so giving us the first half of the sawtooth scanning cycle – the beam travelling from the left-hand side of the screen to the centre. The conditions during the first half of the forward scan are shown in Fig. 1(d). L and C do not form a resonant circuit during the forward scan because of the low-impedance source of the constant voltage applied in parallel. This damps the circuit completely, clamping the top end of L to chassis. The complete scan cycle is shown in Fig. 1(e).

At first sight this process may seem rather complex. In essence it is simply a negative current falling linearly to zero and then building up into a linear positive one, deflecting the spot from the left-hand side of the screen to the right-hand side in so doing. The positive current then changes quickly to a negative one to provide the flyback that takes the spot back to the centre of the screen and then to the left-hand side. Any losses in the circuit are made good from the h.t. source: this ensures that the two halves of the current waveform, and hence the scan size, are approximately equal.

Having sorted out the basic processes involved we must now see how they operate in a practical circuit and why this differs from the simple arrangement shown in Fig. 1.

Transformers

If the only requirement was to produce the line scan current for the deflection yoke we could, in principle, adopt the arrangement just described, using a high-voltage transistor as the switch. But we need to generate the e.h.t. and l.t. voltages and to provide the various other features listed earlier. The only satisfactory way of doing this is to use a transformer – some circuits go so far as to use two separate ones.

The use of a transformer to feed the deflection yoke introduces a welcome degree of design flexibility without altering the basic mode of operation of the circuit. The simplest possible arrangement is shown in Fig. 2. In a practical design this would be elaborated in all sorts of ways: most commercial receiver circuits can be analysed in terms of this basic arrangement however.

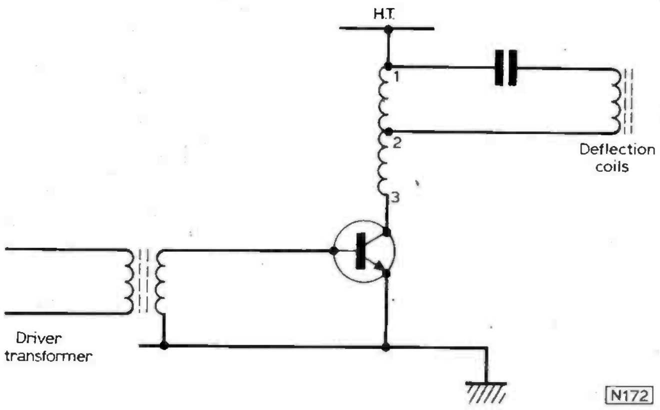


Fig. 2: The basic line output transformer circuit.

Though the circuit looks different from that shown in Fig. 1, they are in fact directly equivalent. The transistor's collector circuit is still almost entirely inductive, and all the transformer does in this case is to provide a convenient means of applying the correct constant voltage across the line coils from whatever h.t. source is being used. The transformer steps the h.t. voltage down in the turns ratio 1-2/1-3 to suit the requirements of the deflection yoke.

The switch shown in Fig. 1 is replaced by a transistor. This has to be a high-voltage type capable of withstanding the high pulse voltage generated during the flyback – commonly about 1·2kV. It also has to be able to handle the large peak scanning current transformed down in the ratio 1-2/1-3. This will usually be in excess of 1·2A. Clearly a very special kind of device must be used.

Reverse conduction

The transistor's specification is further complicated by an important factor that the sharp-eyed reader will have spotted already: it has to conduct in both directions. During the second half of the forward scan the transistor conducts normally, i.e. current flows from the emitter to the collector. The transistor is turned on hard, and the collector voltage is then close to chassis potential. Immediately after the flyback however the direction of current flow must reverse in order to create the conditions for the first half of the forward scan. The current then flows from the collector to the emitter – this is termed the reverse conduction mode, the emitter and collector having effectively interchanged. Base current still flows – from the base of the transistor, see Fig. 3.

At the end of the flyback, part of this base current flows via R1 to chassis. The secondary winding of the driver transformer is applying a negative voltage to the base. Sufficient current flows through R1 however to enable the transistor to conduct in its reverse mode. The base is at about –4V, the collector at about –5V, so the collector-base junction is forward biased. A few microseconds after the end of the flyback the driver stage comes into operation, the base voltage becoming something less than a volt positive. This sudden change of voltage across the transformer causes a discontinuity at the beginning of the scanning stroke. When the reverse conduction current has fallen to zero – from its previously negative value – the

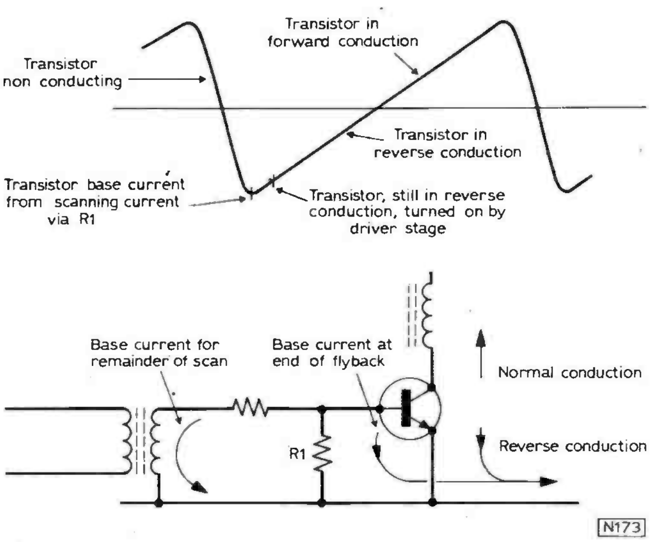


Fig. 3: Current flow in a line output transistor.

transistor conducts in its normal mode and a positive sawtooth current builds up.

The capacitor in series with the deflection coils is necessary to prevent d.c. from the h.t. line flowing through the coils. It also provides linearity correction, a point we shall be returning to. Any flow of d.c. in the coils would result in the picture being displaced in the horizontal direction. This is clearly undesirable, and would upset the operation of the circuit.

We thus have a line output transformer arrangement that makes it possible to match any particular deflection yoke to the characteristics of the line output transistor and to a convenient value of h.t. voltage. In practice the transistor is chosen first and its limiting voltage characteristics determine the h.t. line voltage.

Generating other supplies

During the flyback period there is a large voltage pulse across the transformer. If an extra step-up winding is added – usually called the overwinding – it is a straightforward matter in principle to obtain a 20kV pulse for simple diode rectification in a monochrome receiver or an 8kV pulse for feeding an e.h.t. tripler in a colour receiver.

Taps can be made on the primary winding, or secondary windings can be added, to provide pulse sources for the l.t. and boost h.t. supplies and for auxiliary services in other parts of the receiver.

This then is the basic line output transformer circuit arrangement and the way in which it works. Before considering its various functions in greater detail, let us go back a stage and discuss how the transistor switch is controlled.

Line oscillator

The real starting point in a line timebase is the line oscillator and the way in which it is synchronised by the line sync pulses obtained from the incoming composite video signal. If synchronism is not maintained on every line there will be picture displacement and/or distortion or tearing of the display on verticals.

The enemies of good synchronisation are random noise pulses present under fringe area reception conditions and impulse interference spikes generated by car ignition systems and all kinds of rotating electrical machinery – such as hair-driers and electric drills.

The sync pulses which control the field oscillator are of relatively long duration. They can be passed through an *RC* integrating network having quite a long time-constant therefore. This has the effect of greatly reducing the amplitude of noise or interference pulses. As a result the field oscillator can be directly controlled by the field sync pulses. If a field sync pulse is missing or distorted the synchronisation is upset and a vertical picture movement occurs. In practice however direct field oscillator synchronisation is quite adequate in all except extreme fringe area conditions.

In the line timebase the conditions are different. The sync pulses have a duration of only 4·7μs and so are far more easily distorted by noise or the presence of interference. Furthermore it is not practical to integrate the sync pulses to any significant extent because a time-constant long enough to suppress interference would distort the pulses unacceptably. Another point that has to be borne in mind is that in colour receivers the line flyback pulse is used for certain critical gating functions in the colour decoder. It is thus even more important that the line timebase synchronisation should be carried out accurately, even under adverse reception or interference conditions.

All modern receivers, particularly colour ones, use a line oscillator controlled by a flywheel sync circuit: the whole system may be in either discrete component or integrated circuit form. Flywheel sync differs from direct sync in that the individual sync pulses are not used to control the oscillator: instead, the series of sync pulses provides control averaged over a period of time. In consequence the absence or distortion of a single pulse has very little effect on the oscillator's frequency.

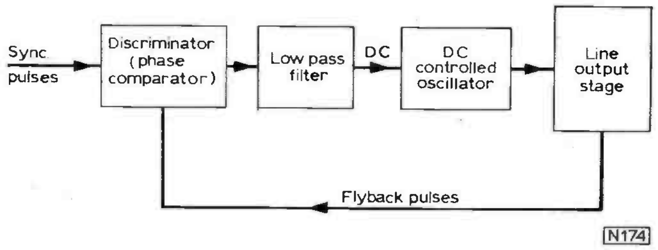


Fig. 4: A flywheel phase-locked loop.

Flywheel sync

A flywheel sync controlled oscillator consists of a high-gain feedback loop – see Fig. 4 – and operates in the same way as the a.p.c. loop used to control the reference oscillator in a colour decoder. A phase comparator circuit is used to compare the timing of the line flyback pulses from the line output stage with that of the sync pulses obtained from the sync separator. If the sync pulses and the flyback pulses arrive at exactly the same instant the comparator circuit gives zero output and the oscillator is thus allowed to continue unaffected. If the two sets of pulses arrive slightly out of phase however a positive or negative error voltage is produced by the comparator. This voltage will vary in sympathy with phase variations between the two sets of pulses and is fed to a low-pass filter which smooths out fast changes. The almost pure d.c. output obtained from the filter is used to control the oscillator frequency in such a way that negative feedback control action is obtained. Thus any drift of the oscillator frequency, shown by the flyback pulses occurring at slightly the wrong instant relative to the sync pulses, is corrected by the feedback loop.

It is the low-pass filter that provides the flywheel effect. If the filter has a long time-constant the effect is the equivalent of a heavy flywheel: a short filter time-constant gives the opposite effect. In general, a long time-constant is preferable, but though this results in good synchronisation and immunity to noise and interference the oscillator may take a long time to pull into lock once it has been disturbed. In experimental circuits the pull-in time can exceed a minute which is clearly not permissible, particularly if synchronism is lost when changing channels.

In the circuit shown in Fig. 5, C1 provides the main low-pass filter action. C2 and R2 form an anti-hunt circuit to prevent the oscillator frequency swinging about above and below the correct frequency before settling down again after a sudden disturbance.

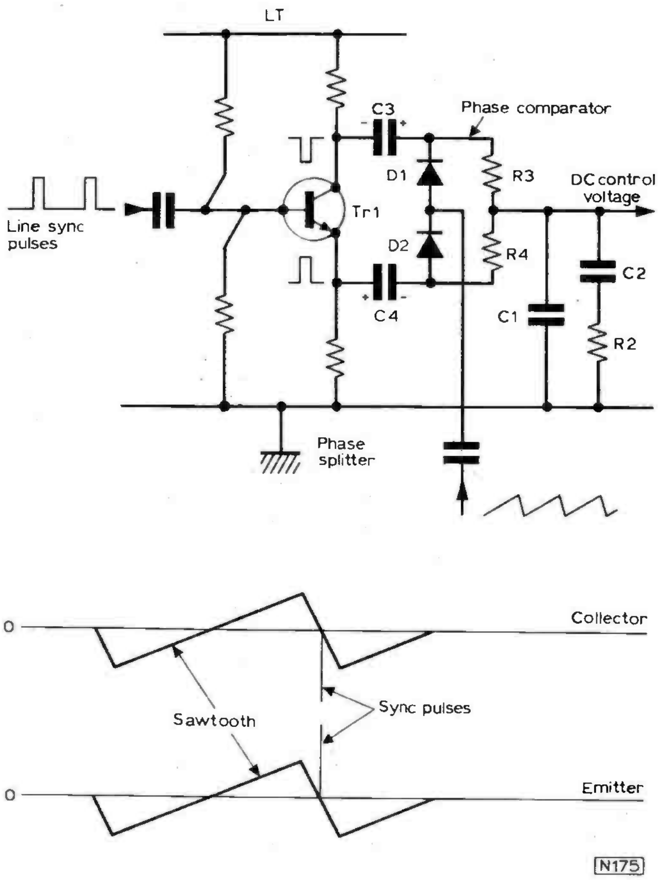


Fig. 5: A simple flywheel phase comparator circuit with pulse timings at the transistor collector and emitter.

Filter action

The flywheel filter action is often glossed over in textbooks, so a few more words on the subject may help. The complete feedback loop of a typical receiver is shown in Fig. 6. It is a large loop with high gain. This high gain helps to reduce picture phase shift (sideways displacement) and increases the pull-in range: it also tends to cause instability however. This will show up as a horizontal wobbling of the picture whenever there is a sudden jump in the time of arrival of the sync pulse – as during a channel change. If the value of C1 is small the wobble will be quite quick. If we want a long time-constant however, to give good noise immunity, the value of C1 must be large. The wobble will then be a slow horizontal waviness or ripple. The anti-hunt network (C2, R2) is connected across C1 to reduce this effect. It forms an *RC* damping network which absorbs some of the energy in the damped ringing action. The action is illustrated in Fig. 7.

Instability

Note that when we talk about the instability of a feedback loop what we mean is that in any such loop the feedback at certain frequencies becomes positive, producing damped ringing or even continuous oscillation. The more complex the loop, the more difficult it is to prevent this happening. Changing the value of C1, and to a lesser extent C2, changes the frequency at which the instability occurs. The addition of the anti-hunt network cures the ringing at the expense of slowing down the response of the circuit for a given degree of noise immunity. The apparently so simple filter circuit – C1, R1, C2, R2 in Fig. 6 – is in fact exceedingly complex to analyse in terms of transient response.

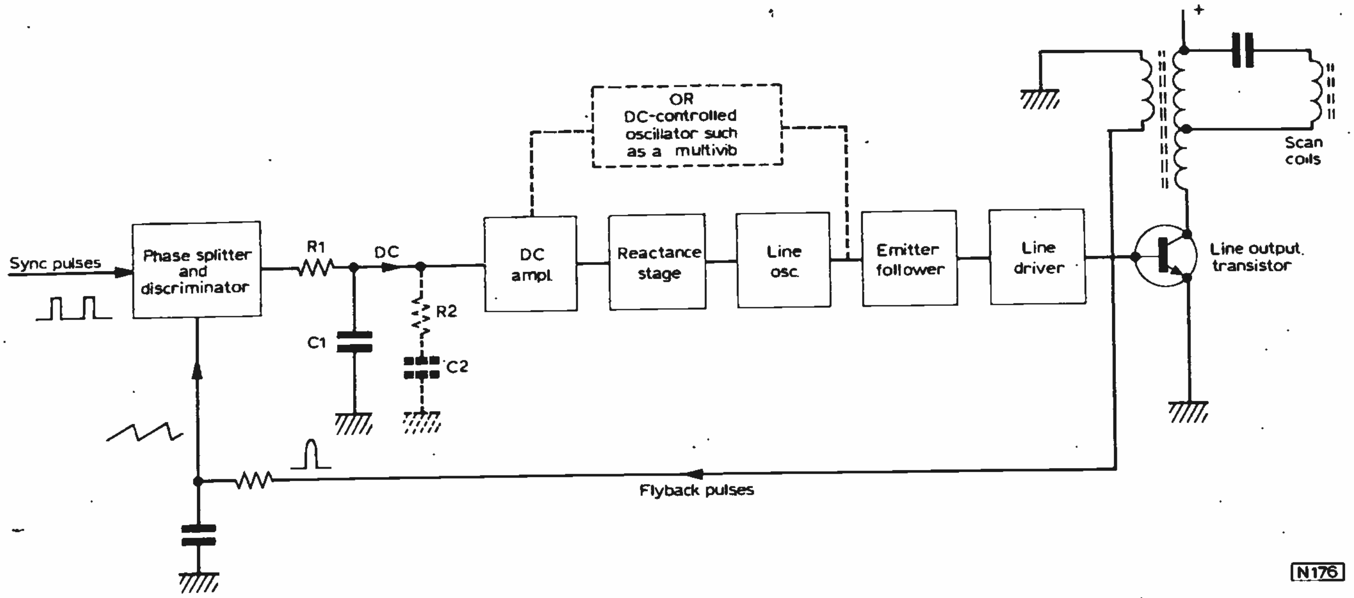


Fig. 6: Complete flywheel line timebase feedback loop of a typical TV receiver.

The filter components usually need to be changed in value when a set is used in conjunction with a videotape recorder. Any mechanical system such as a VTR is prone to changes of speed. As a result the sync pulses are liable to turn up too soon or too late, in sudden jumps caused by the mechanics. Clearly the response time of the flywheel sync filter must be made fast enough to follow these discontinuities, otherwise the picture will be displaced sideways long enough for this to be visible. Accordingly the response of the filter network must be speeded up in order to cater for this state of affairs. In doing so, the noise performance is degraded, but this is no problem since there are no noise or impulse interference troubles with a VTR. Fig. 8 shows the circuit response for VTR operation.

All sorts of different types of flywheel circuits have been used in the past: highly sophisticated ones are found in modern integrated circuits. The circuit shown in Fig. 5 consists of a simple comparator and low-pass filter and will serve to illustrate how such circuits operate.

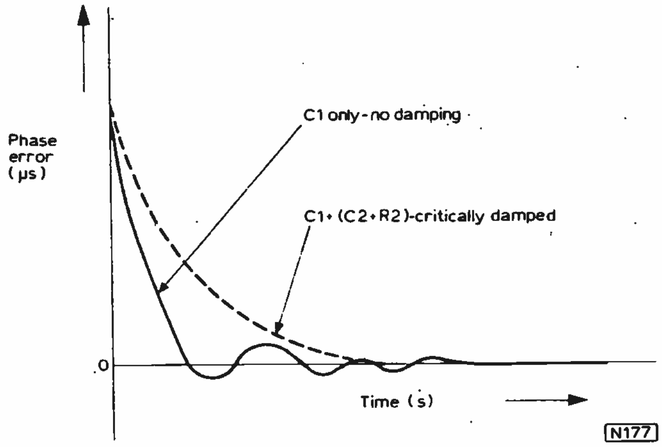


Fig. 7: Effect of the anti-hunt network. The settling time can vary from 20 lines to 20 seconds according to circuit design, and shows up when changing channels.

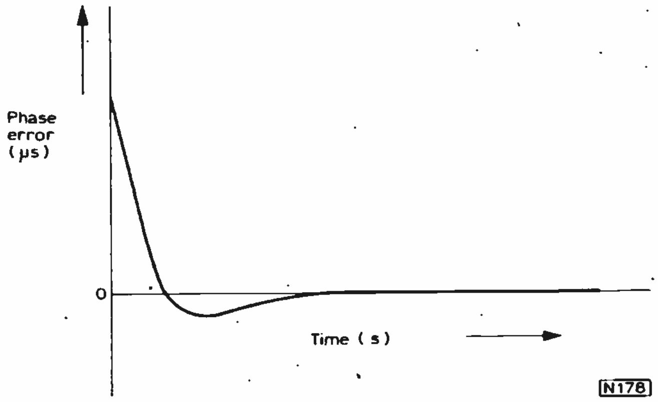


Fig. 8: For VTR operation, the shorter filter time-constant reduces settling time to about 5 lines in a well-designed circuit.

Circuit operation

Transistor Tr1 is a simple phase splitter. The input at its base consists of positive-going line sync pulses from the sync separator. Tr1 thus gives at its collector and emitter outputs consisting of equal amplitude but opposite polarity pulses. C3 and C4 couple these pulses to the phase comparator circuit. This circuit on its own, i.e. without any other input, will settle down into a state of equilibrium in which pulse current flows through C3, D1 and C4, D2, setting up equal and opposite charges on C3 and C4 of the polarity shown. This is a steady state condition and a d.c. voltage could be tapped off from either capacitor. If R3 and R4 are made equal however the positive charge from C3 is cancelled by the negative charge from C4 and the output at the junction of R3 and R4 is equal to zero. The circuit gives no output therefore.

Note that after the sync pulse has passed, the diodes cease to conduct and capacitors C3 and C4 can discharge only very slowly through R3, R4, the collector and emitter load resistors of the transistor and the low source impedance of the l.t. supply. This explains the presence of the near d.c. potentials on C3 and C4.

Now consider the case when a sawtooth voltage is capacitively coupled to the junction of the two diodes. This sawtooth voltage is obtained by heavily integrating a large amplitude flyback pulse obtained from the line output transformer. When the two diodes conduct due to the sync pulse, the *instantaneous* sawtooth voltage is applied to the two capacitors and is added to the voltage produced by the sync pulse. The d.c. balance of the circuit may in consequence be changed.

Let us assume that the phase of the sawtooth is such that the sync pulse arrives at the exact centre of the steep edge of the sawtooth, i.e. at the instant corresponding to the centre of the scanning cycle flyback stroke. Fig. 9(a) shows that the charge on both C3 and C4 remains unchanged – the capacitively coupled sawtooth is passing through zero at the point where the sync pulse switches the diodes on. In consequence there is no d.c. output to the filter network and no control voltage is applied to the oscillator which continues to run at the same frequency.

Now suppose that the oscillator tries to slow down. The sync pulses appear to arrive earlier – or rather the sawtooth arrives later with respect to the sync pulses. The new state of affairs is shown in Fig. 9(b). The result is that capacitor C3 develops a more positive charge while C4 develops a less negative charge. Thus instead of being zero the output at the junction of R3, R4 becomes slightly positive.

This near d.c. voltage is further smoothed by charging the filter components C1, C2, R2 and is then applied to the oscillator which must of course be of a type whose frequency can be controlled by means of a d.c. voltage input. Matters are so arranged that the positive voltage from the discriminator (comparator) circuit results in the oscillator speeding up.

The opposite case is where the oscillator is trying to run fast. As Fig. 9(c) shows, the capacitors develop a more negative charge: hence this time a negative voltage is applied via the filter to the oscillator which in consequence slows down.

What all this means is that we have a *phase* controlled oscillator which tries to run in such a manner that the sync pulse always coincides with the centre of the line scanning system's flyback stroke. The scanning is thus synchronised with the incoming video signal.

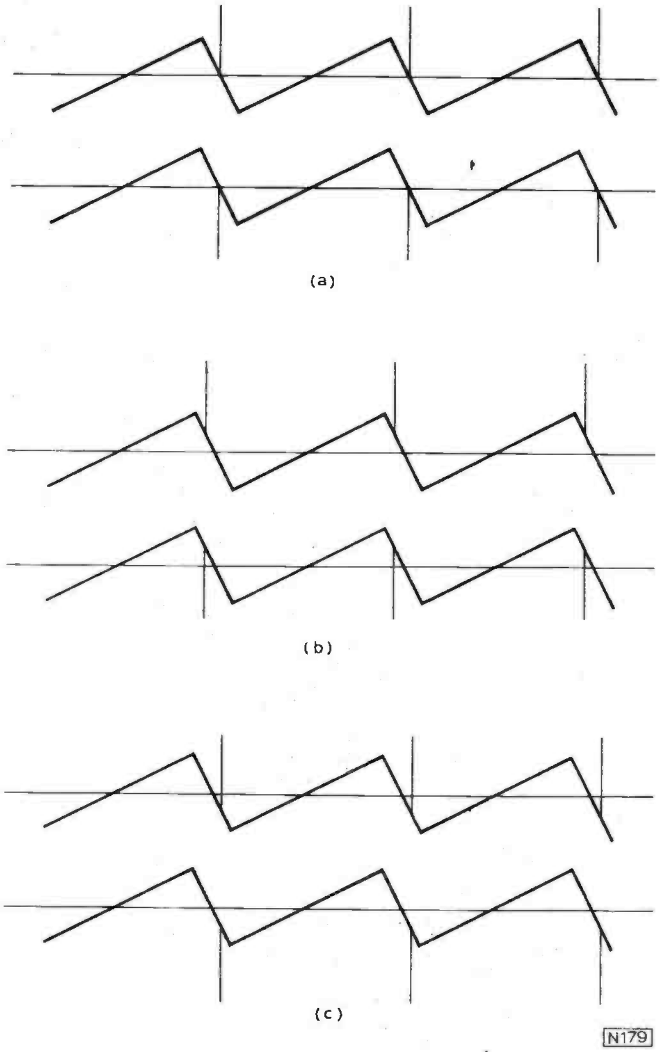


Fig. 9: Changes in waveforms of Fig. 5 with timing errors: (a) Oscillator frequency correct – no d.c. control voltage. (b) Oscillator frequency too low – positive d.c. output. (c) Oscillator frequency too high – negative d.c. output.

Frequency variation

If we try to adjust the oscillator's frequency by means of a preset control, nothing much happens except that the picture moves slightly sideways on the screen. What is happening is that the sync pulses are sliding either up or down the sawtooth's steep slope in an effort to develop sufficient control voltage to keep the oscillator running at the correct frequency. In so doing, the phase of the scanning cycle is changed a little with respect to that of the sync pulses and the picture information, and as a result the picture moves sideways on the screen.

If we vary the oscillator frequency still more, we shall eventually reach a point where the sync pulses slide over the top of the sawtooth. Control action is then lost, and the picture jumps out of sync. If we measured the oscillator's free-running frequency at this point we would find that it was about 500-1,000Hz above or below the correct frequency (15,625Hz). This frequency difference is called the hold range. That is, the hold range is the frequency range over which the circuit will hold the oscillator in synchronism.

Up to this point we have been describing the action of a *phase* discriminator, i.e. the discriminator responds to phase differences between the sync signal and the scanning voltages. But once the oscillator is out of synchronism we need a *frequency* discriminating action to bring it into lock

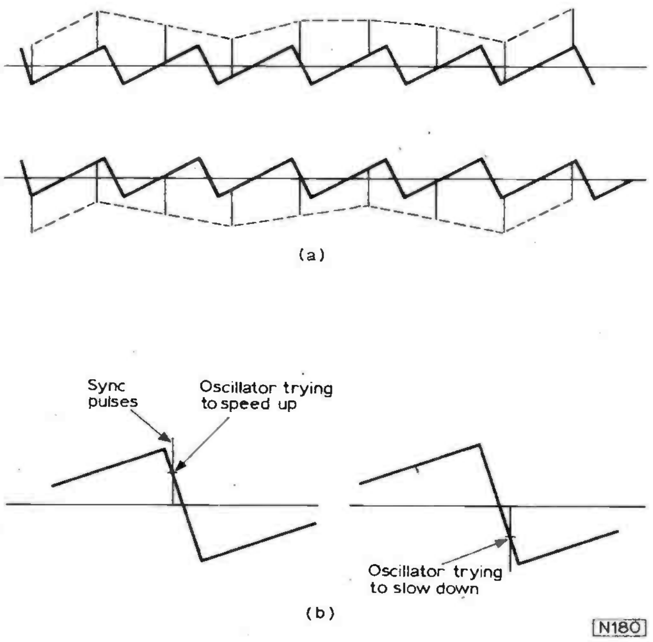


Fig. 10: Waveforms under unsynchronised conditions: (a) Oscillator out of sync and running too slowly. (b) Oscillator out of sync but trying to pull in.

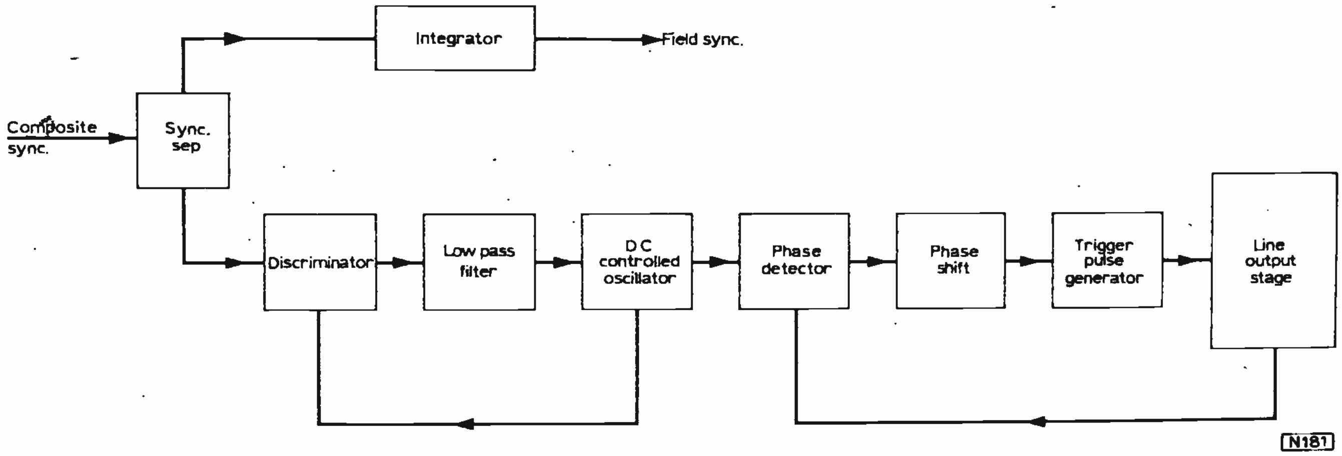


Fig. 11: Block diagram of a typical combined sync separator and flywheel line oscillator i.c. A second phase-controlled loop ensures correct phasing of the line output stage despite changes caused by variations in transformer loading and circuit tolerances.

again. Fortunately, the same circuit will also provide this function: it would be of no use otherwise.

To illustrate this action, what we need to do is to turn the oscillator frequency back again very slowly. After a while we shall reach a point where the slip frequency of the picture in the horizontal direction begins to slow down. Suddenly it snaps into lock again. If the signal, i.e. the sync pulse train, is disconnected and the oscillator's free-running frequency is measured, it will be found to be only about 200-500Hz off the correct frequency. This is the oscillator's pull-in range, i.e. the range over which the oscillator, when unsynchronised, can be brought back into lock. Clearly the circuit exhibits better phase discrimination than frequency discrimination.

With the oscillator unsynchronised, the sync pulses are sweeping through all phases of the sawtooth – see Fig. 10(a). The important action occurs as they sweep through the steep part of the waveform, as shown in Fig. 10(b). When the sync pulses occur in the lower half, the negative correction voltage generated results in the oscillator slowing down still more. This means that the pulses sweep through more quickly, and less correction voltage is generated across the filter network. During the upper half of the sawtooth however the oscillator speeds up and a greater correction voltage is generated as, over successive cycles, more pulses occur in this region. The resultant correction voltage pulls the oscillator into lock. This action is not very strong: hence the pull-in range is much smaller than the hold range.

In some circuits the presence of the line sync pulses on the reverse slope of the sawtooth also has an effect, sometimes helpful and sometimes tending to push the oscillator farther out of synchronisation.

The hold range is controlled to a large extent by the loop gain of the complete circuit and the control sensitivity of the oscillator. The pull-in range is also controlled by these factors, but in addition is strongly affected by the choice of filter component values. Increasing the value of C1 improves the circuit's noise immunity, reduces the pull-in range and increases the pull-in time. The choice of filter component values is therefore a compromise.

I.C.s

In recent chassis the functions of sync separation and the flywheel controlled line oscillator are incorporated within an integrated circuit. This does not result in much cost saving, but reduces the number of components used and generally provides a higher standard of performance. The sync separator is usually noise limited and noise gated – to reduce the effect of noise and interference on the sync pulses – and there may also be two feedback loops in the flywheel circuit. The arrangement is shown in Fig. 11.

Multiple feedback

The first of the two feedback loops corresponds to the one we have just been describing: it consists of a carefully designed flywheel controlled oscillator. The second loop controls the phase of the drive pulse applied to the line output stage, so that any phase difference between the line sync pulse and the line flyback pulse is still further reduced. If you adjust the line frequency control in such a circuit there will be very little picture shift indeed.

The improvement is due to the second loop. The improved phase performance can be very important in a colour receiver, because the line flyback pulses are nearly always used for gating the sync pulses and for generating the burst gating and blanking pulses – in addition to other functions. Burst gating is particularly critical, because the burst is of such short duration, lying as it does on the back porch of the sync pulse. Any phase error in the pulse used for burst gating results in part of the burst being excluded or some unwanted chrominance subcarrier being added to the burst. In either case control of the decoder's reference oscillator may be wholly or partially lost, with consequent ill effects on the picture.

Waveform shaping

A waveform shaping circuit is usually required after the oscillator to convert its output into a train of squarewave pulses having a mark-space ratio of about 26:38μs. This is the waveform needed to feed the line driver stage which provides base current drive for the line output transistor. In integrated circuits the oscillator's output is often converted into a sawtooth waveform: when this is clipped at the appropriate level and amplified a squarewave output whose mark-space ratio can be easily adjusted by changing the clipping level is obtained. A single resistor value normally sets the clipping level.

TO BE CONTINUED

Service Notebook 1

G.R. WILDING

GEC Solid-State Colour Chassis

A GEC Model C2110 (the solid-state colour chassis) had slightly reduced width but reasonable colour with the brightness control set normally, but if the brightness control was advanced farther the picture markedly ballooned. Now picture ballooning in sets of all types usually places suspicion first on the e.h.t. rectifier or tripler, since if this is not able to maintain the correct e.h.t. voltage when the e.h.t. current demand is high the reduced e.h.t. voltage results in increased deflection sensitivity and excessive raster size. In this case however the slight reduction in width threw suspicion on the h.t. rail voltage or the line output stage – in particular the line output transistor. The h.t. voltage was found to be normal at 195V, and as the flying-lead width control was at its maximum setting we decided to change the BU108 line output transistor. This completely cured both the inadequate width and the tendency to balloon, though it was found necessary to make some convergence readjustments on test card reception.

If the field linearity in these sets gradually or suddenly deteriorates first make sure that the output stage mid-point voltage preset control P454 is correctly set. Then check the following electrolytics: the field charging capacitors C457 (47μF) and C458 (22μF), the output stage bootstrap capacitor C462 (220μF), and C452 (4·7μF) which decouples the emitter of the field sync pulse clipper transistor TR451. If the linearity distortion gets noticeably worse as the set's operating temperature increases check thermistor TH451 which is shunted across the emitter bias resistor (R469) of the lower transistor (TR455) in the field output stage.

If field jitter is experienced suspect number one is the thyristor (BR101) field oscillator. On occasions however the trouble is due to the trigger diac D701 in the thyristor stabilised h.t. supply circuit: use an RCA 17000 or ITT V413M here.

Thorn 1500 Chassis Faults

The picture on a set fitted with the Thorn 1500 chassis was completely unstable, accompanied by strong cross-modulation, even with the contrast control at minimum. The main cause of the trouble was obviously excessive signal input, and it appeared that on moving to a new address and transmitter service area a neighbour had retuned the push-buttons and then readjusted the preset contrast and tuner gain controls. The former should normally be readjusted only if the a.g.c. amplifier transistor, the a.g.c. detector diode or the video driver transistor has been replaced. With care however we managed to readjust both presets to give a good picture without any suggestion of cross-modulation, but it then became obvious that most of the verticals had extremely ragged edges, especially in picture highlight areas. On turning the brightness down really low these ragged edges completely vanished.

Now the video signal is capacitively coupled to the c.r.t. cathode, the brightness control setting the cathode bias. So reducing the brightness control setting had done just two things: reduced the working bias on the c.r.t., and indirectly reduced the e.h.t. current. This latter was the vital consideration, and as the set uses an e.h.t. tripler a new one was tried. This produced perfect results.

Ragged verticals are generally due to a fault in the flywheel line sync circuit or the line oscillator, and it is usually necessary to make time consuming component changes in order to find the cause. In this case however the fact that the fault vanished at low brightness levels enabled a rapid diagnosis to be made, once again proving how important it is to spend a few extra minutes carefully noting all symptoms and the effects of operating the controls before embarking on meter checks or component changes.

The following day we were called to attend to another set fitted with the 1500 chassis. This time the fault was a collapsed raster. A new PCL805 field timebase valve failed to restore the picture, and subsequent voltage checks showed that whilst there was normal voltage at the screen grid of the pentode section of the valve the pentode anode was at only about 50V. The cause was a broken leadout wire from the field output transformer primary winding – h.t. was still reaching the anode via the shunt flyback pulse limiting voltage-dependent resistor Z2.

On resoldering the lead and thus restoring the picture the focus was found to be very poor while adjustment of the focus control R121 had no effect. Voltage checks showed that there was no voltage on any of the three tags of the control, due to the resistor (R120, 1·5MΩ) which feeds it from the boost rail having gone completely open-circuit. Replacing this resistor gave normal focus control operation and enabled the picture definition to be greatly improved. The focus was still not 100 per cent, but it is normal with larger sized tubes for the focus to deteriorate before the brilliance level starts to fall, the focus deterioration being most marked in the highlight areas of the picture.

Field Collapse

There was complete field collapse on a Bush Model TV186 (Rank A774 single-standard monochrome chassis) and as a new PCL805 failed to restore the raster the next step was to make voltage checks. Surprisingly, all voltages were found to be correct, and as contacting the triode anode with the test prod resulted in slight movement of the horizontal white line the output pentode section of the valve, the transformer and the scan coils could be ruled out as the cause of the fault. There was very little response when the triode grid was contacted, but this was to be expected since it is the voltage change produced at the triode anode by test prod application here that will result in a pulse being applied to the output pentode section of the valve. We then switched the meter to a resistance range and applied the prod to the triode grid, thus feeding a small voltage to this point. A good response was obtained, so the triode section was also operative, though there was no oscillation. Clearly the fault was in the cross-coupling network between the pentode anode and the triode grid, probably due to one of the three capacitors in this network. The most likely suspect was the high-voltage capacitor connected directly to the pentode anode, but shunting this with a near equivalent failed to produce any response. The culprit turned out to be 2C11 (0·0022μF) which is connected to chassis, thus integrating the feedback pulse. Come to think of it, we have come across the same trouble in the past from this particular capacitor.

Sound, No Picture

A hybrid dual-standard Philips receiver fitted with the 210 chassis had the complaint sound but no picture. As expected, the basic cause was absence of e.h.t. Only the slightest suggestion of an arc could be drawn from the anode of the PL504 line output valve. Since the boost capacitor is connected to the h.t. line, the next step was to remove the PY800 boost diode top cap. The result was a much greater spark at the anode of the PL504 and a reduced size but badly defocused raster on the screen. Naturally our first suspicion

Service Notebook 2

was that the boost capacitor (C2064) was short-circuit so that the boost voltage was not being developed. The capacitor is easily recognisable, being mounted vertically just in front of the ECC82 line oscillator valve. This section of the chassis protrudes over the bottom of the cabinet, so the capacitor can be conveniently tested in situ without withdrawing the chassis. As suspected, a dead short was found. On disconnection however the capacitor was found to be perfect. The measured short-circuit was in fact due to the line output transformer – to a breakdown in the insulation between windings L5022/L5023 and L5024/L5026 (see Fig. 1). Thus the only cure was a replacement transformer.

Bush TV161 Series

The dual-standard monochrome receivers in the Bush TV161/Murphy V1910 series are readily identifiable through their six-button tuner, transistor i.f. strip, bottom hinged chassis and "clip-on" linkage from the tuner to the system switch. The great majority have proved to be quite reliable and give a good picture. The most common complaint is a break in the multiple-section mains dropper resistor which is mounted beneath the timebase panel. This results in loss of either h.t. or heater current depending on which section goes open-circuit. The next most common faults are the wire-wound resistors which provide the various h.t. rails going open-circuit, or the 500μF field timebase valve cathode decoupling electrolytic 3C35 drying up to give greatly reduced height and a severely cramped raster base. This capacitor is easily spotted – it is mounted slightly to the right and above the PCL85.

On occasion however you get weird faults in the transistorised i.f. panel. One point worth bearing in mind here is that the first sound i.f. transistor 2VT5 (BF184) gets its forward base bias from a conventional potential divider on 625 lines but from the cathode of the triode section of the PCL82 audio valve on 405 lines (amplified a.g.c.).

The owner of one of these sets 'phoned to say that he had no sound or picture, but that the mains fuse was intact as the heaters were glowing. Naturally our first suspicion was that one of the h.t. sections of the mains dropper was open-circuit, but on checking with an ohmmeter everything here was found to be in order. On switching on there was ample h.t. at the tags of this resistor, but within a few minutes the h.t. rapidly fell and the PY88 boost rectifier

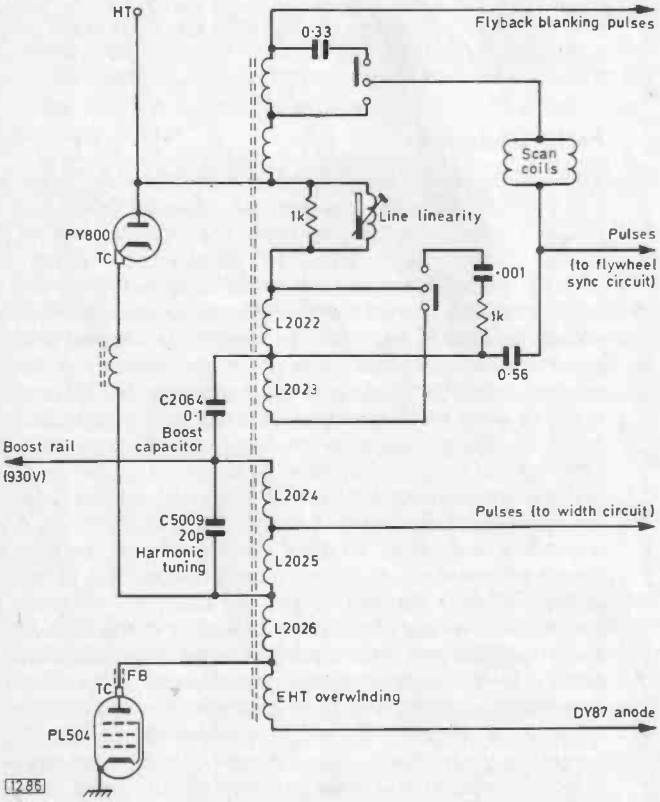


Fig. 1: Line output transformer circuit used in the Philips 210 chassis. This is a conventional desaturated transformer arrangement, with the boost capacitor C2064 connected to the h.t. line via windings L2022/3 and the linearity coil. When the boost capacitor goes short-circuit the result is no raster due to absence of e.h.t. A quick check is to remove the PY800 top cap connection: if the capacitor is short-circuit this should restore some life to the circuit. Alternatively however the problem may be due to leakage between windings L2022/3 and L2024/5. This in fact is quite common with Philips sets of this type.

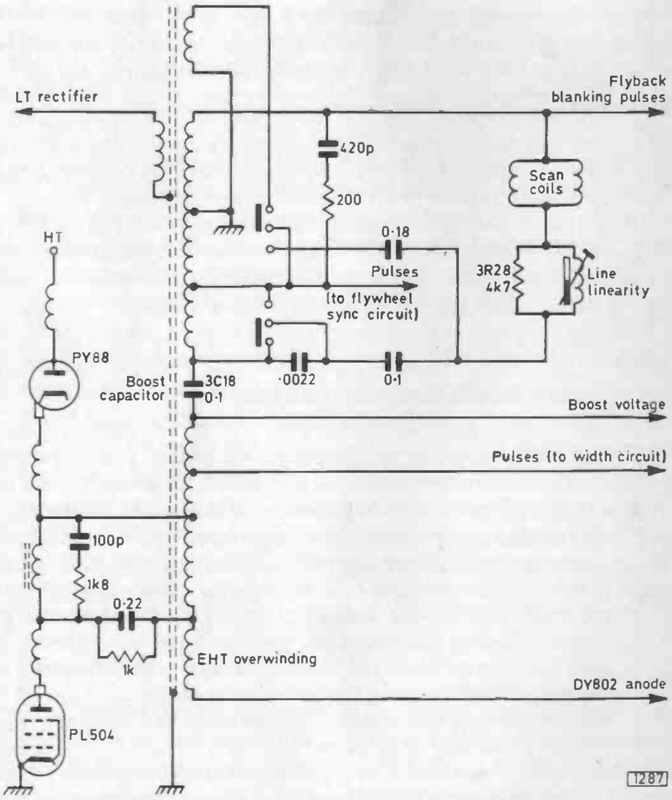


Fig. 2: Line output transformer circuit used in the Bush TV161 series of models. As in many chassis produced in recent years the boost capacitor is returned to chassis, via windings on the line output transformer, rather than to the h.t. line – compare with the arrangement shown in Fig. 1. There will again be no e.h.t. when the boost capacitor goes short-circuit, but in this type of circuit removing the top cap of the efficiency diode (PY88) will not restore life to the stage though it will put the PY88 out of its misery as a result of being across the h.t. line (assuming the fuses haven't blown).

Service Notebook 3

was seen to start to glow excessively hot. If there is absence of line drive both the boost rectifier and line output valve will show signs of strain. The output pentode was quite cool however, and there was very little voltage either at its anode or the top cap of the PY88. One possibility was a heater-cathode short in the PY88, but on switching off the valve was found to be o.k. in this respect.

On checking with the circuit we discovered (see Fig. 2) that this is one of those chassis in which the boost capacitor (3C18) is returned to chassis via windings on the line output transformer. Obviously if this was short-circuit there would be a short-circuit path from the h.t. line to chassis via the PY88 – which accounted for this valve's distress. A replacement restored normal sound and vision – loss of sound was due to the fact that the l.t. supply for the transistor stages is obtained from a winding on the line output transformer. It is perhaps surprising that the mains fuse hadn't blown: probably because the set hadn't been left on long enough.

The boost capacitor used in this chassis is a high-voltage (1·25kV) type encased in a blue and white plastic material and is mounted just above the dropper resistor. Incidentally, though replacements should normally be fitted with the leads soldered to the print side of the panel, where, as in this case, access is awkward it is much quicker to snip off the original component, leaving as much of the lead-out wire as possible, and to solder to these wires. You must do this quickly however – to prevent the heat loosening these leads!

GEC 2000 Series

The various all-valve dual-standard GEC models have proved very reliable, though the linked v.h.f./u.h.f. tuners leave a great deal to be desired. Apart from sound distortion caused by reduction in the value of the 18kΩ and 5·6kΩ carbon resistors supplying the screen grid voltage to the EH90, the most common fault is lack of height.

As usual, the triode anode of the PCL805 field timebase valve is fed from the boost line. The feed in this circuit is via a 1·2MΩ resistor which is mounted to the right of the PL504 line output valve, then the height control and a series 560kΩ resistor which are mounted near the PCL805 on the timebase printed panel. It's the 1·2MΩ resistor that usually increases in value to produce lack of height on these sets.

A Model 2021 which had been serviced only a few weeks previously for this fault came our way recently after the same complaint had again developed. We found that the 560kΩ resistor had been replaced by one of 100kΩ, presumably enabling the raster to just fill the screen. Subsequently however the continued deterioration of the 1·2MΩ resistor at the end of the chassis had resulted in the fault reappearing. Replacing the 1·2MΩ resistor and restoring the 560kΩ resistor to its correct value gave adequate height with the height control set to mid-travel.

For a reliable repair it is essential to trace the real cause of the fault and put it right.

Reduced Sound

The owner of a monochrome set fitted with the Thorn 1400 chassis complained that the sound had suddenly fallen to a low level, and that this had been followed by a smell of burning. On removing the back and inspecting the chassis we found that the sound i.f. pentode's anode feed resistor R78 (1kΩ) was badly discoloured. The valve is a frame-grid type (6F30/EF184) and because of the close electrode spacing in valves of this type the usual cause of anode or screen grid feed resistor burn-ups is a spark-over within the valve. No fault was found with this particular valve however but a replacement was fitted and as no abnormal leakage could be measured between the anode circuit and chassis the set was switched on. Normal sound soon developed, but then gradually faded away as the anode feed resistor started to overheat again. On switching the set off and testing once more a considerable leak was found between the valve's anode pin and chassis. There are two decoupling capacitors, C61 (0·03μF) which is connected to the valve's screen grid to provide neutralisation and C62 (0·001μF) which is connected to chassis. On disconnecting one lead of the latter, a small leak was found.

A replacement cured the fault, but when the capacitor was subsequently tested out of circuit the leakage was found to be almost zero! Obviously it was the application of h.t. voltage that started the leakage, which increased in severity as the leakage current increased the temperature of the capacitor.

Cabinet Scratches

When a French polished or teak finish TV cabinet gets deeply scratched it is most important to try to fill the scratch before colouring or polishing over. To do this I find the professional French polishers' dodge useful – briskly rubbing over the scratch with the kernel of a walnut. The nut is not hard enough to cause further abrasion but usually fills the scratch, while the friction softens and pulls over the top layer of polish. Always worth a try!

Decreasing Width

The following conditions were present on a Pye colour receiver fitted with the 691 chassis: a few minutes after switch on, the width would gradually decrease accompanied by a noticeable degrading of the focus. New line output stage valves failed to improve matters, and while checking the negative voltage at the control grid of the PL509 line output valve the picture suddenly vanished and a wisp of smoke rose from the e.h.t. section. We switched off immediately, and then found that the high-voltage capacitor C219 (170pF) mounted on top of the line output transformer had broken down. This capacitor provides transformer tuning, and is connected from the cathode (top cap) of the PY500 to chassis.

Its working voltage couldn't be established and is not given in the service manual: from its size however it needed to be about 12kV. We didn't have such a capacitor with us so to effect an immediate repair used two 350pF 8kV types in series. This is not the ideal way of achieving the required high working voltage, since the voltage developed across each capacitor will depend on its precise value and insulation resistance. Even if the disparity was 20% however the voltage across each should not exceed 8kV, so the capacitors could be left as an interim measure. No further width reduction was observed after fitting these capacitors. It seemed that prior to its complete breakdown the original capacitor must have started to leak once its temperature rose.

IMPORTANT CORRECTION

The input coupling electrolytic C1 in the fast video amplifier circuit for the Television colour receiver was shown connected the wrong way round in Fig. 1 on page 586 of the October 1975 issue. Connected the right way round, excellent results have been reported. A dim, smeary picture is obtained with C1 connected the wrong way round.

AC THEORY
A step by step approach

Ian SINCLAIR

Part 2

We have seen already how the simple arrangement of a loop of wire rotating in a magnetic field can give an output which is a sinewave. If a second loop of wire is added at 90° to the first, the output from the second loop can be compared to the output from the first (Fig. 1).

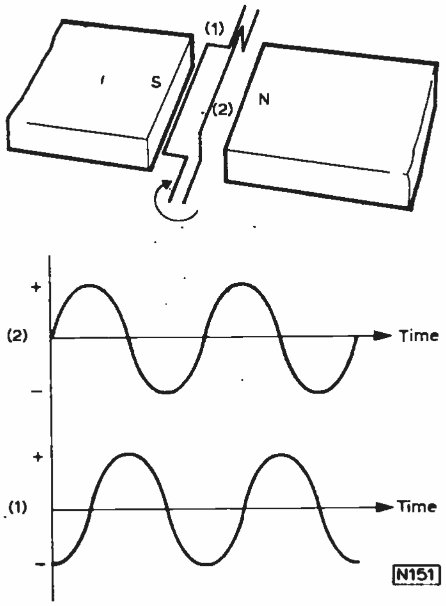


Fig. 1: Two loops rotating 90° apart will produce two sinewaves separated by ¼ cycle, a phase shift of 90°.

Because the loops are 90° apart, the two sinewaves are separated by a quarter of a cycle (remember that 90° is a quarter of a complete revolution, also called $\pi/2$ in some textbooks, because there are 2 π radians in one revolution).

What output would you expect from two loops 180° apart connected together in parallel?

None, the outputs are equal and opposite.

When one sinewave is shifted in this way compared to another, we say that there is a PHASE SHIFT of one compared to the other. These shifts are measured in degrees, as if they were caused by generator loops set at some angle apart, though there are ways of generating phase shifts without involving the generators of the sort which we have described.

How do two sinewaves appear when one has been phase shifted by 360°?

Identical.

There is a major difference between a wave shifted by 180° and one which has been INVERTED. This difference is unimportant for a sinewave, because a sinewave shifted by 180° looks identical to one which is inverted (Fig. 2). This is not true for any waveform which is not symmetrical – which does not look the same upside-down as right-way up (Fig. 3).

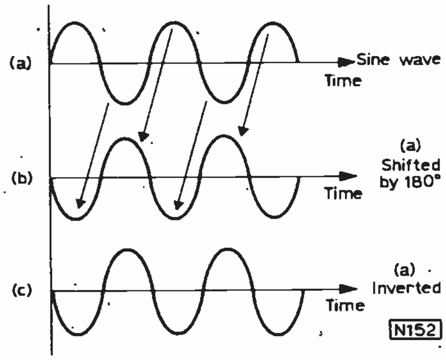


Fig. 2: Phase shifting a sinewave by 180° produces the same effect as inversion.

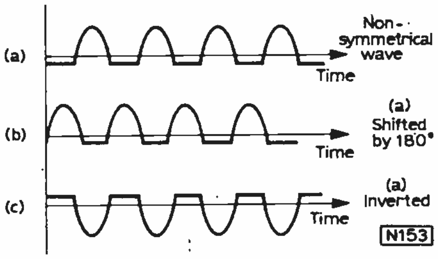


Fig. 3: For a wave which is not symmetrical, 180° phase shift is NOT the same as inversion.

Which of the waveforms shown in Fig. 4 will look the same inverted as shifted 180°?

(a)

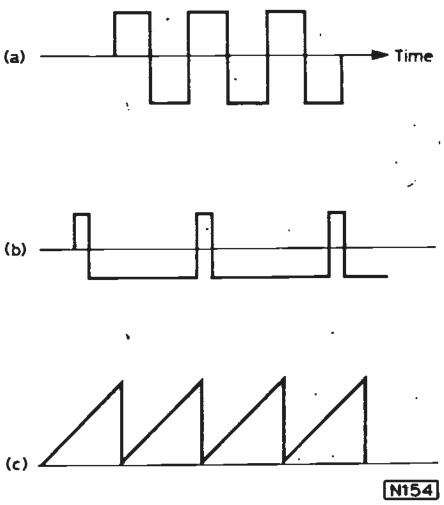


Fig. 4.

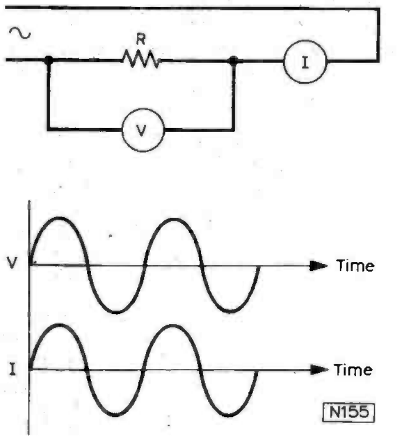


Fig. 5: Phase relationship of current and voltage in a circuit containing pure resistance only.

When an alternating current is applied to a resistor which obeys Ohm's Law, the voltage across the resistor is also alternating and is in phase with the current (Fig. 5). We can use Ohm's Law, just as we do with steady voltages, as long as we use r.m.s. values of V and I (we could also use peak values of both, but this would be less convenient if we later wanted to calculate power).

What signal voltage appears across a 10kΩ resistor when a 2mA r.m.s. signal current flows through it? What would be the peak-to-peak voltage measured on a 'scope?

20V r.m.s., 56·5V p-p.

When an alternating current is passed through an inductor, an alternating magnetic field is set up. During one half-cycle, the inductor will be magnetised with one end a N pole.

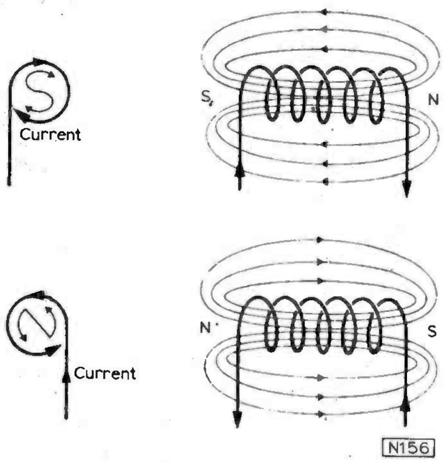


Fig. 6: Magnetic fields around an inductor. (Conventional current flow).

During the other half-cycle, this end will be a S pole (Fig. 6). Lines of force are being generated in one direction, allowed to collapse, generated in the other direction and allowed to collapse again during one complete cycle.

What effect do these changing lines of force cause in any metal which intercepts them?

They induce a voltage.

Since each turn of the inductor intercepts the lines of force, there will be a voltage generated in the inductor because of the alternating magnetic field caused by the alternating current.

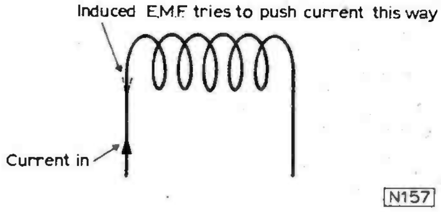


Fig. 7: The induced e.m.f. opposes the direction of current flow which caused it.

This will be an alternating voltage, and it will be in a direction which opposes the current causing it (Fig. 7).

What Law is this?

Lenz's Law.

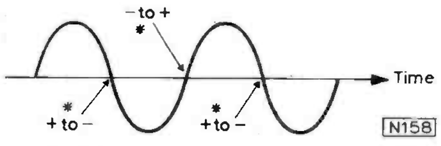


Fig. 8: The current changes most rapidly when it is reversing its direction.

The phase of the induced voltage is important. We know that the maximum voltage is generated by induction when the conductor cuts most rapidly through the lines of force, or when the lines of force are changing most rapidly. In our inductor, there is no movement of the wire, but the lines of force are certainly changing, and they are changing most rapidly at the points marked with an asterisk in Fig. 8, because at these points the current is reversing in the inductor.

When is the smallest rate of change of current?

At the peaks of the sinewave.

The situation so far: when we pass an alternating current through an inductor, an alternating voltage is

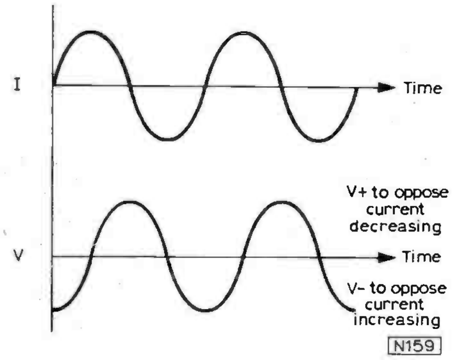


Fig. 9: Relative phase of the current and induced e.m.f. in an inductor.

generated which opposes the current, is greatest when the current is passing through zero, and least when the current is at its positive or negative peak. We can show this in Fig. 9.

What is the phase difference between I and V?

90°.

This induced voltage is trying to pass a current in the reverse direction. To overcome this, we have to apply a voltage slightly larger and of a polarity which will oppose the induced voltage. This is the voltage which we normally measure across the inductor.

If this voltage is exactly opposed to the reverse induced voltage, what is the phase difference between applied voltage and reverse voltage, remembering that both are sinewaves?

180°.

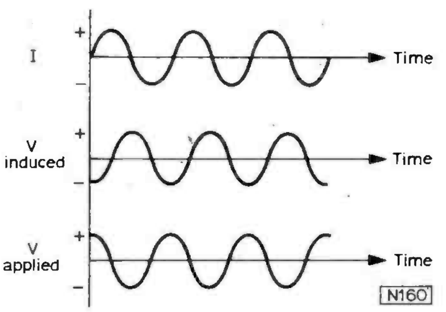


Fig. 10: Relative phase of the current, induced voltage and applied voltage in an inductor.

Now consider the phase diagrams for an inductor, Fig. 10.

What is the phase difference between applied voltage and current, and which is earlier?

90°. V_{App} is earlier, it leads I by 90°.

We have seen that the voltage measured across an inductor has a phase which leads the phase of the current by 90°. What of a capacitor? A capacitor is a device which stores electric charge. If we imagine a capacitor consisting of two parallel plates, one earthed, Fig. 11, we can imagine a charge of Q coulombs taken to the other plate. This causes the other plate to have a voltage V compared to the earthed plate. The ratio Q/V is a constant which we call CAPACITANCE. If the voltage is measured in volts and the charge in coulombs, the capacitance is in FARADS.

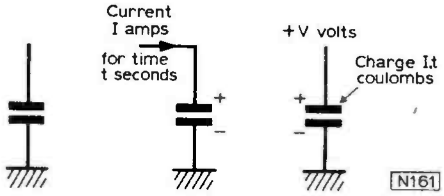


Fig. 11: The energy of the electric charge is stored as an ELECTRIC FIELD between the capacitor plates, just as a magnet stores energy in a magnetic field.

$$\text{FARADS} = \frac{\text{COULOMBS}}{\text{VOLTS}}$$

or $C = \frac{Q}{V}$; also $Q = C \times V$.

Remember $1\mu F = 1 \times 10^{-6}F$, $1pF = 1 \times 10^{-12}F$.

What charge is contained on a 100μF capacitor charged to 300V?

Since $Q = C.V$, charge $= 100 \times 10^{-6} \times 300 = 3 \times 10^{-2}$ coulomb.

This equation, $Q = C.V$ enables us to work out what happens in an a.c. circuit where the voltage across the plates is alternating, Fig. 12. With such a voltage applied, the charge held between the plates of the capacitor must be alternating too. We can rewrite the equation, $Q = C.V$ for changing conditions as:

$$\frac{\text{Change of } Q}{\text{time}} = C \times \frac{\text{change of } V}{\text{time}};$$

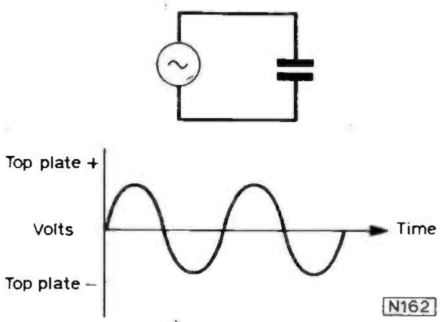


Fig. 12: An alternating voltage applied to a capicitor produces an alternating charge between the plates.

the C stays constant because capacitance should depend only on the shape of the capacitor, not on the voltage applied (this is not always true). But change of Q with time is CURRENT, so that we can write current $= C \times$ rate of change of voltage.

When is the voltage between the plates changing most rapidly?

As it passes through zero in either direction.

We can draw the current wave through a capacitor in comparison with the voltage wave across it, Fig. 13. We find a current wave which is displaced in comparison to the voltage wave; the maximum current flows when the voltage is zero and the current is zero when the voltage is maximum.

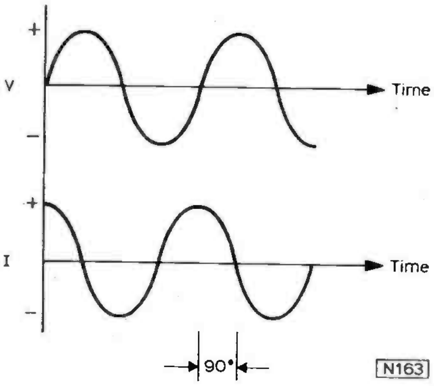


Fig. 13: The current peaks occur 90° earlier (to the left) of the voltage peaks in a capacitor.

How much is the displacement of the current wave?

90° earlier, current leads voltage.

Both inductor and capacitor, therefore, change the phase angle between current and voltage for a.c. applied to them, but in opposite directions. In an inductor, voltage leads current and in a capacitor, current leads voltage. There is a mnemonic for this: C-I-V-I-L. In C, I before V; V before I in L.

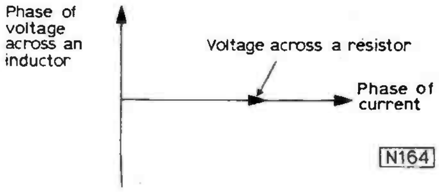


Fig. 14: In a PHASOR diagram we use angle to represent phase and length to represent magnitude of the voltage or current.

Because the phase angles are 90° in the case of a perfect inductor or capacitor (meaning that no resistance is present) we can represent these relations on a diagram, Fig. 14, called a PHASOR DIAGRAM (sometimes wrongly called a vector diagram). The horizontal axis is taken as the current in the circuit, because we have to take something as a constant phase. The phases of voltages across components are also drawn, so the phase of voltage across resistance is drawn on the same line as the current, since the voltage across a resistance is in phase with the current. By convention, phasors rotate anti-clockwise with time, so we draw the voltage across an inductor at 90° upwards, meaning that the voltage across the inductor leads current by 90°.

Where would we draw the voltage of a capacitor?

At 90° downward, since voltage across a capacitor lags 90° behind current.

When we have a circuit made up of a resistor and an inductor in series, the voltage across both will not be in phase with the current because of the action of the inductor. We can find both the voltage and its phase angle by extending the use of the phasor diagram, Fig. 15. Taking the phase of the current as the horizontal line as usual, we draw the voltage across the resistor on this line, because it is in phase. We can find the voltage by Ohm's Law, and we can draw the length of the line proportional to the volts (for example: 1 mm = 1V).

We can also draw a line whose length is proportional to the voltage across the inductor. We shall see later how to calculate the voltage across the inductor by a form of Ohm's Law; the direction of the V_L line must be vertically up. We find that we can add these phasors by drawing the line which is the diagonal starting from O of the rectangle of which V_R and V_L are two sides. The length of this diagonal can be found by measuring the drawing, and it represents the voltage across the two components. The angle between this line and the horizontal line represents the phase of the voltage across both components compared to the phase of the current.

If $V_R = 3$V and $V_L = 4$V, find the size and phase of the voltage across the two.

5V, about 53°.

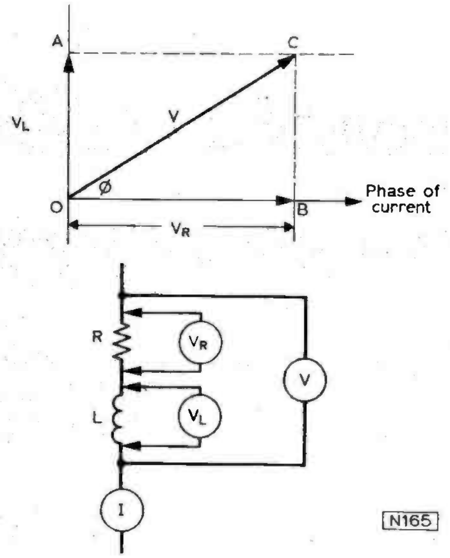


Fig. 15: Relative phase of current and voltages across the various parts of a circuit containing resistance and inductance.

All of this can be done without drawing. The resultant voltage of V_R and V_L is $\sqrt{V_R^2 + V_L^2}$ and the phase angle between current and resultant voltage is the angle whose tangent is $\frac{V_L}{V_R}$.

Tangents of angles can be looked up in any book of mathematical tables. If θ is the angle, $\tan\theta = \frac{V_L}{V_R}$.

If the voltages V_L and V_R are equal, what is the value of the tangent and what is the phase angle?

1, 45°.

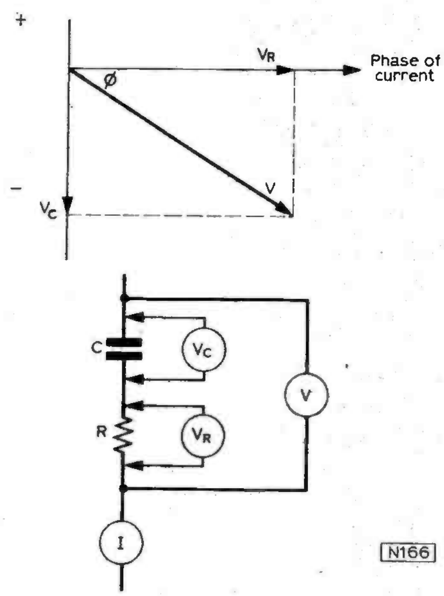


Fig. 16: Relative phase of current and voltages in a CR circuit.

When we have a capacitor and a resistor in series, we can draw the same sort of phasor diagram, Fig. 16. Remember in this case that the voltage across the capacitor, V_C, must be drawn vertically downwards, and is often given a negative sign to distinguish it from inductive voltage drawn in the opposite direction.

Write out the expressions for resultant voltage and phase angle.

$V = \sqrt{V_R^2 + V_C^2}$ and $\tan\theta = \frac{V_C}{V_R}$.

Very often, we find it more convenient not to work in voltages, since we have to calculate the voltage across each component, and we use the quantities RESISTANCE, REACTANCE, and IMPEDANCE.

Resistance we know already. It is the ratio of the voltage across a resistor to the current through it.

$$R = \frac{V}{I}$$

by Ohm's Law. Reactance is a very similar quantity, but for an inductor or capacitor. It is given the symbol X.

$$X = \frac{V}{I} \text{ for } L \text{ or } C.$$

Unlike resistance, reactance is not constant, but varies with the frequency of the a.c. applied. In each case, though, the voltage across a circuit component is the current multiplied by one of these quantities, resistance or reactance. We can therefore stop drawing phasor diagrams in volts and start drawing them in OHMS (symbol Ω), which are the units of both resistance and reactance. We can make all our calculations in ohms, and then convert to volts if we want to later by multiplying by the current.

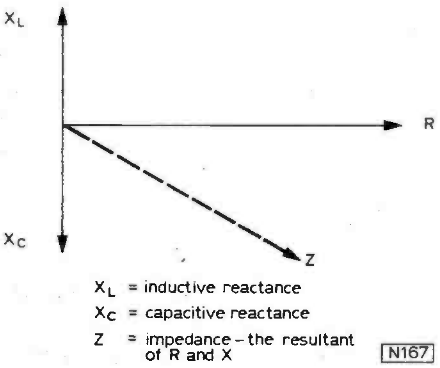


Fig. 17: Phasor diagrams are often plotted in Resistance (R), Reactance (X) and Impedance (Z).

The resultant of resistance and reactance in a circuit is called IMPEDANCE, and is given the symbol Z, see Fig. 17.

$Z = \sqrt{R^2 + X^2}$, using the same method of combining the phasors.

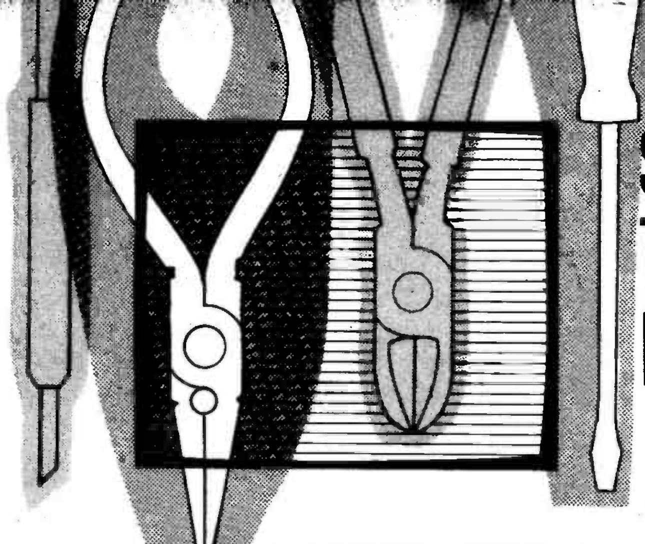
What is the impedance of a 30Ω resistor and a 40Ω reactance in series?

50Ω. Note that it does not matter whether the reactance is inductive or capacitive, the impedance is the same. Only the resultant phase angle will be different.

Later we shall see that the reactance of a capacitor or of an inductor depends on its capacitance or inductance and the frequency of the applied signal.

The value of X_L for an inductor is $6{\cdot}3 \times f \times L$, where f is the frequency and L is the inductance value in HENRYS.

The value of X_C for a capacitor is $1/(6{\cdot}3 \times f \times C)$, where f is the frequency and C is the capacitance in FARADS (*not* μF). In each case, f is in HERTZ (cycles per second) and the figure 6·3 is an approximation to 2π. The 2π comes from the fact that a.c. is generated by the movement of a coil in a circle, π being the ratio of the circumference of a circle to its diameter.



SERVICING TELEVISION RECEIVERS

INDESIT MODEL T24EGB

L. LAWRY-JOHNS

QUITE a large number of these sets are circulating around the country, and if you haven't met one yet the chances are you will. Made by the Italian firm Indesit, the chassis bears a superficial resemblance to our own ITT/KB VC200 chassis though in actual fact there is little they have in common except for the valve types – plus the cluster of skyscraper dropper and smoothing resistors on the upper left side.

Mains Voltage

Now before we start let's make a confession. I still don't know whether these sets were designed for the continental 220V or the British mainly 240V mains supplies. If you think it doesn't matter, I'd just like to say that I consider it does. On the service sheet it says 240V: on the rear cover it can say 220V. In all probability the suffix EGB after the model number means something more than a 6MHz sound i.f., but the heater current still seems a little high as does the h.t., while the valve casualty rate seems to be excessive. As for the failure rate of the line output transformer, well . . . So we now fit a dropper section of between 20 and 33Ω on the top of the main frame, breaking the mains supply lead from the on/off switch assembly to the main panel at 3A (plug and socket), i.e. the lead from the on/off switch goes to this dropper section and a further lead goes from the dropper to 3A. This seems to increase the reliability factor, and is recommended in areas where the mains voltage is well up to the 240V mark. It's our own idea and we could be wrong, but the action does seem to be necessary. An 0·7A RS power resistor is suitable.

Common Faults

As we have just said, the valve casualty rate is pretty high. This in fact is where the majority of troubles occur. The next trouble spot is the supply and smoothing resistors, R901 to R907, also R911, and of course the arch enemy, the line output transformer, which suffers from breakdown of insulation and shorted turns. Add to this the occasional failure of the BF178 video transistor (TR205) and there isn't much more to worry about.

Power Supply Circuits

The mains input is taken to the on/off switch via a 2·5A fuse. A pair of leads from the on/off switch goes to a three-pin plug. The associated chassis socket feeds the heater circuit diode D901 (substitute type BY126 or similar) and the h.t. surge limiter resistor R901 which is about 5Ω.

As far as the heater circuit is concerned, one or two points need to be kept in mind. The output of the rectifier diode D901 is positive and is dropped through a 120Ω resistor (R902) and then applied to pin 5 of the PL504 (not, as you might expect, the PY88). From pin 4 of the PL504 it is applied to the PY88, then to the PCL805 and next to the c.r.t. To put the c.r.t. heater at this potential is no bad thing since the heater and cathode are then very approximately at the same potential – allowing for video signal swings of course. The PCF802 line oscillator valve comes next in line, followed by the PCL86 audio output valve.

From pin 4 of this valve the supply is taken to the junction of a 1kΩ stabilising resistor (R910), a 100Ω smoothing resistor (R908) and the 500μF reservoir electrolytic C914. This is followed by a further resistor and electrolytic, at which point the supply is smooth enough to become the "+I" 24V transistor supply line.

Position of PL504 Heater

Now the one thing that stands out from all this is not the position of the c.r.t heater but that of the PL504. As you may or may not know, efficiency diodes of the PY88 type do on occasions develop a heater-cathode short which normally puts paid to the PY88 heater. Thus the person putting the set right merely finds an open-circuit heater chain, checks the PY88 first by habit, and fits a new one. The trouble is cleared but the cause is not always appreciated since the PY88 is usually the first in the heater chain and does harm to no one but itself. It is a different kettle

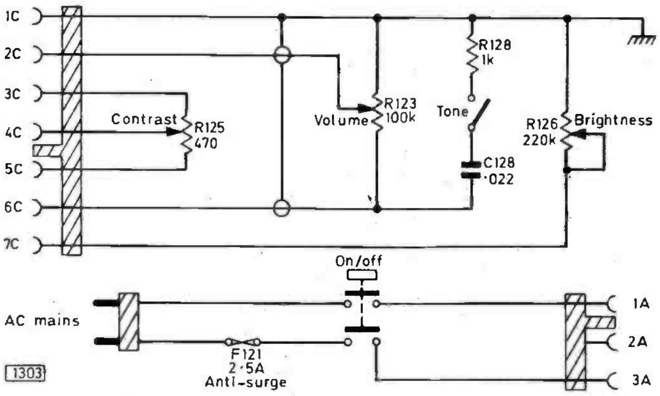


Fig. 1: Mains input arrangement and connections to the main controls.

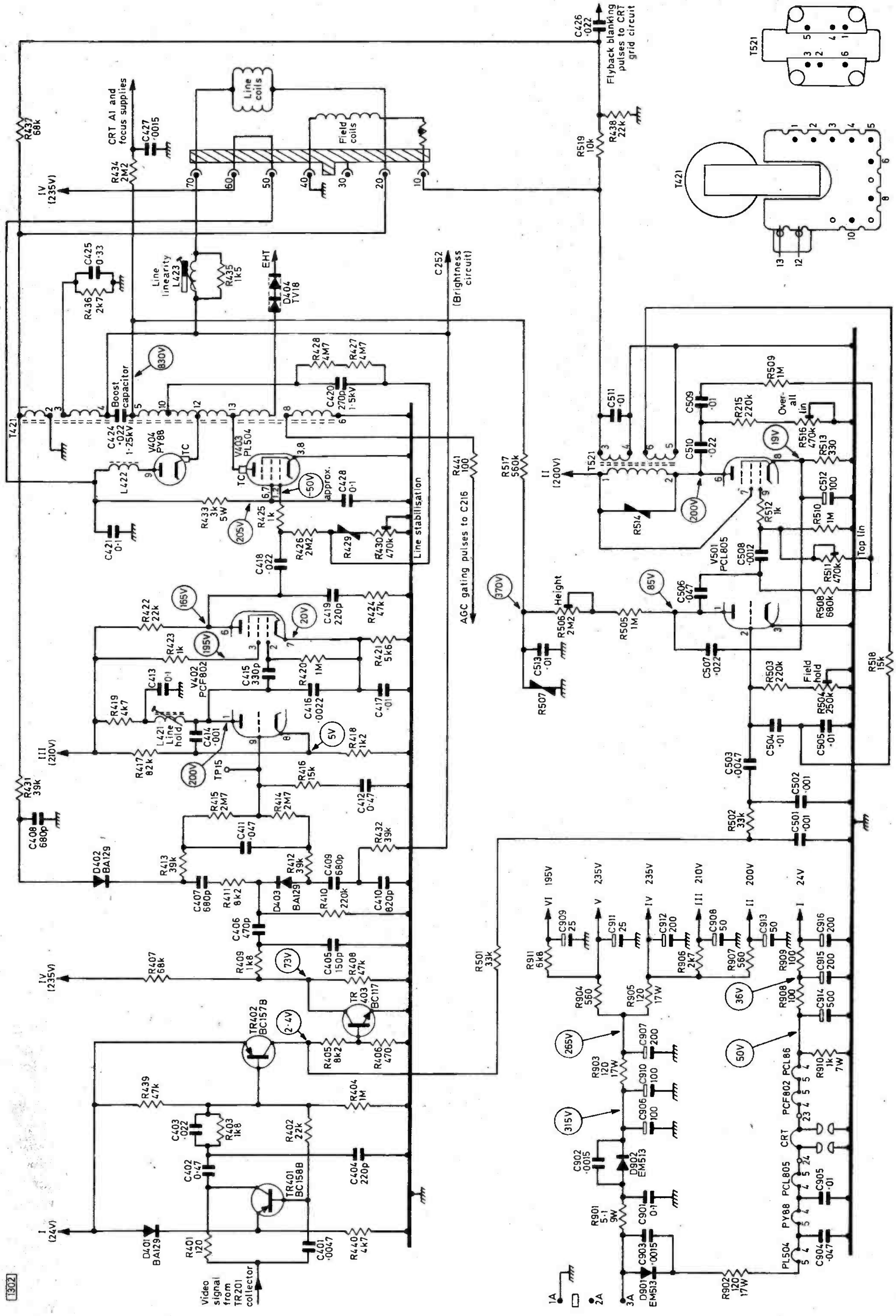


Fig. 2: Power supply and timebase circuits, Indesit Model T24EGB. Voltages shown measured under no signal conditions using a 50kΩ/V meter.

of fish when the PY88 is not the first valve in the chain.

"Mum, the telly's gone off and there's a bright light in the back." The poor old PL504 lights up like a light bulb and may not survive even though the 120Ω resistor (R902) does its best to limit the current. The repairer may not be aware of these circumstances and may only find the heater chain open-circuit due to the PL504 having an open-circuit heater. Replacing this valve may apparently restore normal working – until the line timebase comes into operation when the PY88 emerges from obscurity, shorts out and does it best to murder the new PL504.

The moral of the tale is simply this. Always have a look before you have a wissssh. Or to use the parlance of the country of origin, if the PL504 he is buggered, bugger the PY88 too.

Heaters too Bright

If there are no vision or sound signals but the heaters are glowing too bright, first suspect the heater circuit diode D901. On a cold resistance test it should read low one way and high the other, with the ohmmeter switched to the low ohms (R1) range. If it is low both ways, cut it out and fit a new diode – of the BY126 type or similar. If the diode is not at fault, check the heater line at pin 4 of the PCL86. If a short is recorded here, remove the PCL86. If the fault is still there, suspect C914 and check the condition of R910. If on the other hand the PCL86 is at fault, check the condition of R308 before fitting a new valve. As a matter of fact, always check this resistor when the PCL86 is under suspicion (say for causing distortion), since a defective valve will usually give the resistor a bit of a pasting and result in it changing value, thus passing on to the new valve the strong probability of a short, albeit gay life.

Blackened Mains Fuse

Talking about a short life and a gay one, we often have customers coming in clutching a fuse and asking for a replacement. "My husband said this fuse has gone and that's why our telly doesn't work." One glance at the blackened appearance of the fuse shows that it has met a violent end. We assure the customer that we can supply the required fuse though it will meet an equally unpleasant fate.

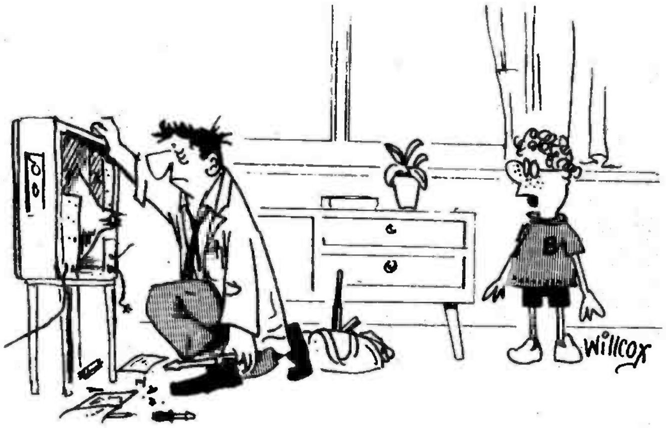
The reaction to this varies. The sensible one is "Oh well, we'll bring the set in so that you can check it". The nonsensical one is "Well sell us a stronger fuse then". When the set does come in, either sooner or later, we go straight for the mains filter capacitor C901 which is nearly always short-circuit.

Simple Fault Finding

Whilst we have become conditioned to expect that each one of these sets that comes in will have a line timebase fault, and that this could well be due to the line output transformer, we often find such expectations unfounded and that the trouble is due to a failure in the h.t. or heater circuitry.

No HT

When one of them comes in with the complaint that it's dead except for the heaters glowing one knows, having taken the rear cover off, which is a different thing to putting it back on again, that the juice is reaching the set, that the on/off switch is all right and that the fuse is intact. Since the heaters are glowing the juice must be at 3A on the board and



"I didn't know the c.r.t. neck was supposed to come off with the scan coils."

almost certainly at the mains end of R901. So the first step is to check that it is also at the other end of R901. If it isn't, change this resistor using a fairly substantial wirewound one of between five and ten ohms.

If the mains is at both ends of R901, check the d.c. at the cathode end of the h.t. rectifier D902. If this diode is open-circuit replace it using a BY127 or equivalent. If there is a healthy d.c. at this point it is likely that R903 is defective and that there is no d.c. at the C907 end of this resistor. Working along these lines the cause of non-operation due to lack of h.t. at any point can be located fairly easily. If some sections of the set are working but not others it's just as quick to work the other way, i.e. to start from where there is no supply and work back to where there is.

Multiple HT Rails

Say for example that the complaint is sound o.k. but the only screen illumination is a white line across the centre of the screen. One would check first at the PCL805 valve base, at pins 6 and 7. Voltage at pin 7 would mean that the supply line is in order from R907: its absence would direct attention to this resistor. Lack of voltage at 6, although that at pin 7 is over 200V, would throw suspicion on the field output transformer T521 – there would be a low voltage at pin 6 due to R514, but this would be nowhere near the correct 200V.

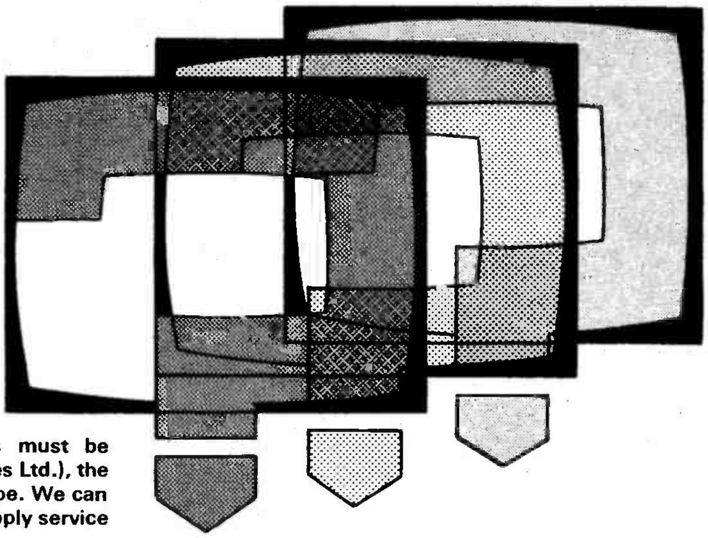
The normal valve and timebase checks should of course be carried out if these voltages are present, but that is not what we are on about at the moment: we are concerned with voltage supplies at various points and the effect of their absence.

Supply to Line Oscillator

Although we haven't met the following fault yet, it is as well to ponder upon the effect of R906 becoming open-circuit. This would shut off the supply to the PCF802 line oscillator valve and result in severe overheating in the line output stage, with the possible demise of the PL504 or PY88. When tracing a fault like this it takes a matter of only moments to disconnect one end of R433, the PL504's 3kΩ screen grid feed resistor. This will stop the overheating and enable checks to be made on the oscillator in order to locate the primary cause of the trouble. There are several smoothing and decoupling resistors in the h.t. supply to this stage and it doesn't take long to check each one as a preliminary step before delving into the stage itself.

CONTINUED NEXT MONTH

Your PROBLEMS solved



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PYE 94

On switching on there is excessive voltage at the DY802 e.h.t. rectifier top cap, causing burning at the top cap and arcing to the line output transformer screening can. The valves in the line output stage, also the transformer and the width stabilising v.d.r., have been replaced but the fault is still present.

The two most common causes of the trouble are either that the PL504 line output valve's screen grid feed resistor (R149, 3·3kΩ 6W) has gone low value, giving excessive screen grid voltage (should be 185V), or that its control grid coupling capacitor C111 (0·047μF) is leaky. Make sure that the e.h.t. lead is clean and correctly dressed and that the receiver is operating on the correct mains tapping. (Pye 368 chassis.)

PHILIPS G22K554

The picture appears to bounce up and down by about $\frac{1}{8}$–$\frac{1}{4}$in. Sometimes the fault occurs following initial switch on, at others when the set has well warmed up. When present the bounce comes and goes at regular intervals. The fault can be removed if the brightness control is turned up.

The symptom is not uncommon on this chassis. It is due to variations in the firing point of the power regulator thyristor D1379 (BT106). The thyristor itself could be at fault, but first check diac D1377 (BR100) which fires it. (Philips G8 chassis.)

HMV 2800

The initial fault with this set was field collapse. This was traced to the field output pentode's cathode bias resistor R103 having gone high-resistance. Replacing this restored a full size picture, but since then the picture keeps rolling upwards when the channel is changed, on change of scene, or a fade out. Substitute valves have been tried without improving matters. In addition there is brilliant flashing all the time – I assume that this is an entirely different problem.

When R103 has to be replaced it is usually advisable to change the associated decoupling capacitor C79 (160μF) at the same time; also to make sure that the valve itself (PCL85/PCL805) is up to standard since the cause of the increased resistance is likely to have been excessive current drawn by the valve. We think your field hold problem should be cleared when these components have all been proved to be o.k. If not, check R44 (47kΩ) the sync separator screen grid feed resistor since this regularly changes value to cause sync problems, then the field sync feed components R49 and C74 and R95/C71 in the cathode circuit of the triode section of the valve. The flashing sounds like failure of one of the sticks in the e.h.t. rectifier tray. The sticks can be replaced individually, but to do so requires some soldering skill. A replacement tray is more satisfactory. (Thorn 1500 chassis.)

KB KV124

This set seems to be in excellent condition but there is one slight fault. When tuning the rotary u.h.f. tuner it is easy to get five out of the six sets of definition gratings on the test card but this produces an annoying buzz on the sound. By detuning, the buzz progressively lessens until it eventually vanishes but by this time only the top two sets of gratings are visible, the previously sharp, clear picture having deteriorated considerably. Sharpening the picture again brings the buzz back of course. There is no sound-on-vision at any time.

Your description suggests that the 6MHz sound discriminator balance potentiometer R111 requires adjustment. This is inside the discriminator transformer which is at the rear left-hand side of the chassis. It is accessible through a hole in the top. Use an insulated tool to adjust it, preferably on a tuning signal, for the best compromise between the test card gratings and minimum buzz. For accuracy, an f.m. signal generator should be used: nevertheless it should be possible to obtain a good compromise on test card. If this doesn't do the trick, check that the discriminator diodes are still matched, and the electrolytic capacitor in the circuit (C103, 6·4μF). These components are in the same can. (ITT/STC VC51 chassis.)

PHILIPS G26K536

The colour on this set is o.k. for a time then the whole picture goes bright red. After varying lengths of time it returns to normal. The grey-scale has been set up recently.

First adjust the red c.r.t. first anode preset control R1901 over its whole range to check in case the track is faulty. Then check whether the red output transistor Tr7332 is conducting heavily when the fault is present – i.e., collector voltage low (should be about 142V with signal). If so, check for dry-joints in the vicinity of the transistor and suspect the transistor itself. (Philips G8 chassis.)

ULTRA 6640

I am having trouble with the line hold on this 16in portable set. The preset line hold control on the flywheel sync panel can be adjusted to get 405 or 625 line lock but not both. The EF80 on this panel has been replaced, also the 16μF electrolytic which decouples the h.t. feed to it. Another problem is that after an hour the picture rises by about an inch at the bottom. The field timebase valve has been replaced without curing this.

The first thing to do is to check that the values of the resistors in series with the hold controls are of the correct value – R57 (68kΩ) on 405 and R61 (100kΩ) on 625. Then check the flywheel line sync discriminator diodes – try replacing them with a matched pair of BA144 gold-bonded diodes. Also check their load resistors R403 and R404 (680kΩ). If there is a tendency to cogging on the test card, reduce the sync separator grid leak resistor R50 from 1·5MΩ to 680kΩ.

To set up the preset line hold control R413 select a 405-line transmission, short the top end of R50 to chassis, and adjust the main 405-line hold control for an almost stationary picture. Remove the short and then check that the picture breaks up in each direction when the hold control knob is turned from one end to the other of its range. If not, adjust R413 until this condition is obtained. Then switch to 625 lines, renew the short across R50 and adjust the 625-line hold control in the same manner. Do not disturb the preset control. If the holds are unstable after doing this, suspect R126 and C95 which are linked to the same line output transformer tag from which the flyback pulses are taken to the flywheel sync circuit.

For the field fault check the components in the cathode circuit of the output pentode (R112 360Ω and C89 100μF). (Thorn 960 chassis.)

BUSH CTV25 (Mk III)

The e.h.t. is low on this set, the spark at the anode of the PL509 line output valve being only $\frac{1}{16}$-$\frac{1}{8}$in. It is even less at the c.r.t. Consequently there is only a haze on the screen. The boost capacitor tests o.k., and there are no burnt components or spots on the multiplier. Is the line output transformer suspect?

The line output transformer could be faulty but the same symptoms will be present if the line output stage is being excessively loaded. We suggest that you first confirm that full drive is present at the PL509 control grid, then if necessary unload the circuit by disconnecting, one by one, the following: the tripler; the PD500 e.h.t. regulator top cap; the boost line feed to the c.r.t. first anode controls; and the line scan coils. If none of these actions restores proper life to the stage the line output transformer is suspect.

USE OF TWO AERIALS

I use two u.h.f. aerials in order to get extra programmes. There is only one aerial input socket on the set however, so to change over the plugs have to be changed. This doesn't seem to be a very good thing to keep on doing: have you any suggestions?

The solution depends on the strength of the signals you are receiving. If they are better than 1mV a passive splitter can be used: this will involve slight loss of gain with both aerials. The alternative is a wall-mounted switch. You should be able to obtain either device from a dealer or aerial contractor.

KB KV001

The picture frequently breaks up, and every time the picture changes hum occurs and continues for quite a while. Sometimes the hum is very loud.

The troubles could be due to the use of an inefficient aerial. If not, for the picture break up proceed as follows: replace the PCF802 line oscillator valve; check the flywheel sync discriminator diodes (D7 and D8, type OA81); reset the line oscillator coil core (behind the PCF802); and replace the 47kΩ resistor (R131) which feeds the triode cathode of the PCF802 (pin 8) from the h.t. line, using a 2W type. For the hum problem retune the left side rear coil core (left side hole) and if necessary insert a narrow tuning tool into the right side hole and trim for minimum buzz. (ITT VC2 chassis.)

DECCA CTV25

The trouble with this set is ripple on the picture, travelling from the bottom to the top, accompanied by constant hum.

The problem is hum ripple on the supply lines, so you will have to check the reservoir and smoothing electrolytics in the power supply unit. We suggest you start with C2707, the 3000μF electrolytic which smooths the –18V line used mainly to supply the i.f. panel. There are several other such electrolytics in the power supply however, and any could be suspect. A less likely possibility is the l.t. bridge rectifier D2703.

PHILIPS 23TG170A

The set works perfectly on v.h.f. but on BBC-2 a few lines at the bottom of the screen will sometimes pull to the left while on a dark scene field hold will be lost. The PFL200 video/sync valve and the two valves (EF80 and PCL85) in the field timebase have been changed, but with no improvement.

The line pulling could be due to the ECC82 flywheel line sync valve V401 being faulty: check also the components feeding its input grid (pin 7) and the value of the anode load resistor in this stage (R403, 27kΩ). Since the sync seems weak generally however check the coupling capacitor (C257, 0·047μF) to the sync separator section of the PFL200, the a.g.c. clamp diode X206 (BA115) in this circuit, and the two electrolytics C255 (20μF) and C254 (250μF) in the video circuit. Prove that R273 (33kΩ) and R272 (10kΩ) which feed the screen grid of the sync separator are o.k. by confirming that the voltage at pin 3 of the PFL200 is 50V or so. (Philips Style 70 series.)

ULTRA 6818

The symptoms on this set are as follows: vision and sound present; high pitched whistle; one or two very bright horizontal bars across the screen; picture torn and otherwise unstable; buzz on sound. When the faults first appeared switching the set on and off would often restore correct operation. This is no longer the case however.

It seems that the output from the regulated power supply is incorrect. Check the receiver's rail voltage – if this cannot be set to 11·5V by means of R104 the regulator is faulty. This could be due to the AD149 series regulator transistor VT21 being leaky, though the other semiconductor devices in the area could also be faulty – the feedback sensing transistor VT22 and the reference zener W17. (Thorn 1591 chassis.)

B and O 3618

The picture is much too bright when the set is first switched on. Adjustment of the brightness control will give a normal picture, but after five to ten minutes the picture lacks brightness and the brightness control has to be turned up again. If the brightness control is not adjusted the brightness gradually reduces over five to ten minutes until it is normal. The 12V zener diode D93 which stabilises the 12V rail used by the vision i.f. stages and the transistor luminance preamplifier stages has been replaced.

The zener diode you mention is certainly the most common cause of this type of trouble. Other possibilities are that the 12HG7 luminance output pentode is defective, or that there is leakage in the c.r.t. first anode supply rectifier C555 (type BYX10) or its 0·0047μF reservoir capacitor C562. (3200 chassis.)

FERGUSON 3619

There are vertical striations spaced evenly across the picture – four dark vertical bars on 625 lines and seven on 405. These result in the picture being quite unacceptable for normal viewing. In addition, although the picture completely fills the screen on 405 lines, on 625 lines there is a wide vertical black bar down the left-hand side of the screen. The valves in the line output stage and the chokes connected to the top caps have been checked and found to be in order.

For the striations, check the line output valve's screen grid decoupler C86 (1μF) and C93 (0·01μF) which decouples the first anode of the c.r.t. Then suspect either the scan coils or the line output transformer. The lack of width could also be due to the transformer, but first check the 625-line scan-correction capacitor C79 (0·1μF) and the line oscillator valve (6-30L2). (Thorn 850 chassis.)

MURPHY CV2211S

After the set has been on for some hours the picture disappears, leaving what appears to be the chrominance signal only, i.e. patches of faint colour are just about perceptible. The sound remains normal. If the set is switched off for ten to fifteen minutes the picture returns, but after this normal operation is possible for short periods only – about half an hour.

There is clearly a defect in the luminance channel, at some point from the luminance detector onwards. The most likely trouble is that the luminance delay line is intermittently open-circuit. Check this and look for dry-joints in this area. If necessary try to locate the fault using gentle heat from a hair-drier, and a freezer aerosol. (Rank A823AV chassis.)

SHARP SU66H

The trouble with this mains/battery portable set is a bright bar travelling down the screen, with line pulling, when it is operated from the mains supply – the battery side is all right.

There are two possible causes of the trouble you mention. The mains input is transformed down and applied to a bridge rectifier, the output of which is smoothed by electrolytics. Either the electrolytics are faulty or the bridge rectifier is defective (probably hot to touch).

DECCA CS2230

The trouble with this set is hum bars, generally travelling from the bottom of the picture to the top though occasionally travelling from top to bottom. Sometimes the hum bars are not present. At times the bars produce horizontal picture pulling.

The trouble is usually caused by failure of the main 400+400μF smoothing block (h.t. supply). This is on the left-hand side of the chassis. Less often one of the l.t. smoothing capacitors C604, C606 is responsible. (Decca 30 series chassis.)

BUSH TV105

The field linearity on this set is very poor, with cramping at the bottom of the picture and expansion at the top. The overall linearity control makes little difference and the top linearity control has even less effect. The height control moves the bottom of the picture only. Both field timebase valves have been replaced.

There is an 0·02μF capacitor (C82) wired between the ends of the linearity controls. This is probably leaky and should be replaced. If necessary check the PL84 field output pentode's 500μF cathode decoupling electrolytic (C89).

KB CK600

The problem with this set is no colour. The fault developed overnight, a good colour picture being present the previous evening. There is a good monochrome picture however. Over-riding the colour-killer action has no effect. I have checked for poor or dry-joints but everything seems to be in order.

Since over-riding the colour killer has no effect, either the colour-killer controlled stage is open-circuit – this is the delay line driver T29 – or the reference oscillator is not working – no reference signal means no chrominance signal detection. We feel the latter is more likely, the suspects in order of likelihood being as follows: the oscillator transistor T38 (must be type BC172C or BC109), the 6·8μF tantalum capacitor which filters the reference oscillator control voltage, the 4·43MHz crystal, or zener diode D36 which regulates the bias applied to the burst detector circuit. If any of the components in the reference oscillator circuit have to be replaced the control loop should be set up as described in the manual. (ITT CVC5 chassis.)

HMV 2659

Operation on v.h.f. is o.k. On u.h.f. however both sound and vision fade away after ten to fifteen minutes, the subsequent noise on both picture and sound being similar to when the aerial plug is pulled out. Switching to 405 lines for about thirty seconds and then switching back restores the 625 sound and picture.

Confirm that the voltage supplies to the u.h.f. tuner are maintained during the fault condition. Check the route of the i.f. output lead from the u.h.f. tuner to the v.h.f. tuner. We have known this trouble to arise due to dry-jointed chokes inside the v.h.f. tuner (both stages of which provide i.f. amplification on u.h.f.). Finally, suspect that one of the transistors in the u.h.f. tuner is faulty. It is difficult to replace u.h.f. transistors, so a service exchange tuner might be the best bet. (Thorn 1400 chassis.)

BUSH CTV1122

The picture on this set is excellent, with plenty of contrast and brightness. After a period of time which varies however there is field collapse – a thin bright horizontal line across the screen. Tap the cabinet and the picture returns and sometimes stays for a long period.

The trouble is due to a poor connection or dry-joint on the field timebase panel – this is on the extreme right-hand side as you look into the back of the set. Check the plug and socket connections, and carefully probe the board looking for loose components, cracks or bad joints. (Rank A823AV chassis.)

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TELEVISION DEC. 1975

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 Decca Model DR20 dual-standard monochrome receiver arrived in the workshop with the complaint of low picture illumination and poor focus which varied with video signal amplitude. On test in the workshop it was found difficult to obtain a display of any sort, though the sound channel was working perfectly. With the front of the set screened from ambient light, a flicker of a picture could be obtained as the brightness control was gradually advanced at a fixed contrast setting, but beyond this critical point the picture would expand and swiftly fade from the screen.

Heater illumination in the DY802 e.h.t. rectifier could not be detected, but on replacing this valve the symptoms remained exactly as before. It was noticed that the line output transformer was running rather warm, but exploration in the line oscillator and line output stages failed to reveal anything amiss. Ultimately, the line output transformer was replaced, the set-boost preset control adjusted according to the instructions issued with the replacement transformer, and the set switched on.

A healthy line timebase whistle soon developed and a second or two afterwards there appeared a very bright picture – the brightness control was fully advanced. The control was found to be working normally, taking the display right back to cut-off. The receiver was then operated on soak for a couple of hours before being returned to the customer.

Several days later the receiver arrived back in the workshop with exactly (or nearly!) the same symptoms as originally – hardly any illumination, and the picture blowing up beyond a critical setting of the brightness control. The difference this time was that at random intervals the picture would appear at full brightness. Sometimes there would be a full brightness picture shortly after switching on, while at other times it would take half an hour or so for a full brightness picture to appear.

This time the line output transformer was not running hot, and during the fade-out periods a hefty discharge could be produced by holding the tip of an insulated screwdriver close to the cathode of the PY800 boost diode or the anode of the DY802 e.h.t. rectifier. This signified that the line output transformer was still providing adequate pulse potential. The e.h.t. rectifier was changed, but exactly the same symptoms remained.

What was the most likely cause of the trouble? See next month's Television *for the answer and for a further item in the Test Case series.*

SOLUTION TO TEST CASE 155
(Page 51 last month)

The oscilloscope check made by the senior technician showed that the inductive element in the h.t. filter was not providing any ripple attenuation.

The reservoir and smoothing sections of the main electrolytic can are separated by a smoothing choke – the conventional low-pass filter configuration. Since the oscilloscope-recorded ripple was the same at both electrolytics it was obvious to the senior technician that the choke was the cause of the trouble. The resistance check showed that it had shorting turns (the particular choke should have a d.c. resistance of 40Ω).

The fault effectively put the reservoir and smoothing electrolytics in parallel; but without the choke there was still insufficient capacitance to attenuate the ripple fully. The bridging test put a third capacitor in shunt. This had further increased the effective reservoir capacitance to a point where it was sufficient to reduce the residual ripple to something like normal despite the absence of the filtering effect of the choke!

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2N3054	0.55
2N3055	0.60

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

MATCHED PAIRS

Type	Price (£)
AC128/AC176	0.52
AC141K/AC142K	0.56
AC187/AC188	0.60
AC187K/AC188K	0.61
AC193K/AC194K	0.71
AD161/AD162	0.95
BC142/BC143	0.70
TIS90M/TIS91M	0.50

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

DIODES

Type	Price (£)
AA113	0.15
AA119	0.09
AA129	0.20
AA143	0.10
AAZ13	0.30
AAZ17	0.12
BA100	0.15
BA102	0.25
BA110U	0.30
BA115	0.12
BA141	0.17
BA145	0.17
BA148	0.17
BA154	0.13
BA155	0.16
BA156	0.15
BA157	0.25
BAX13	0.06
BAX16	0.07
BAY72	0.11
BB104	0.52
BB105B	0.52
BB105G	0.45
BB110B	0.45
BR100	0.50
BY100	0.22
BY103	0.22
BY126	0.16
BY127	0.17
BY133	0.23
BY140	1.40
BY164	0.55
BY176	1.68
BY179	0.70
BY206	0.31
BYX10	0.15
BYZ12	0.30
FSY11A	0.45
FSY41A	0.40
OA10	0.20
OA47	0.07
OA81	0.12
OA90	0.08
OA91	0.07
OA95	0.07
OA200	0.10
OA202	0.10
OA210	0.29
OAZ237	0.78
S2M1	0.22
TV20	1.85
IN914	0.07
IN914E	0.06
IN916	0.10
IN1184	0.92
IN1185	1.10
IN4001	0.05
IN4002	0.06
IN4003	0.07
IN4004	0.08
IN4005	0.09
IN4006	0.11
IN4007	0.14
IN4148	0.05
IN4448	0.10
IN5400	0.15
IN5401	0.17
IN5402	0.20
IN5403	0.22
IN5404	0.25
IN5405	0.27
IN5406	0.30
IN5407	0.34
IS44	0.07
IS310	0.45
IS920	0.07

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

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

LINEAR INTEGRATED CIRCUITS

Type	Price (£)
CA3045	1.35
CA3046	0.70
CA3065	1.90
MC1307P	1.19
MC1310P	2.94
MC1327PQ	1.01
MC1330P	0.78
MC1351P	0.75
MC1352P	0.82
MC1358PQ	1.85
MC1496L	0.87
MC3051P	0.58
MFC4000B	0.43
MFC4060A	0.70
MFC6040	0.91
NE555	0.72
NE556	1.34
SL414A	1.91
SL901B	3.84
SL917B	5.12
SN76001N	1.45
SN76003N	2.92
SN76013N	1.95
SN76013ND	1.72
SN76023N	1.95
SN76023ND	1.72
SN76033N	2.92
SN76227N	1.46
SN76530P	1.05
SN76533N	1.20
SN76666N	0.90
TAA300	1.76
TAA320	0.94
TAA350A	2.02
TAA435	0.85
TAA450	2.70
TAA550	0.55
TAA570	2.02
TAA611A	1.70
TAA611B	1.85
TAA630Q	4.18
TAA630S	4.18
TAA661B	1.32
TAA700	4.18
TAAB40	2.02
TAA861A	0.49
TAD100	2.66
TBA120S	0.99
TBA240A	2.97
TBA281	2.28
TBA480Q	1.90
TBA500	1.99
TBA500Q	2.00
TBA510	1.99
TBA520Q	3.34
TBA530	2.71
TBA530Q	2.71
TBA540	3.21
TBA540Q	3.21
TBA550Q	4.10
TBA560C	4.09
TBA560CQ	4.10
TBA570	1.17
TBA641	2.30
TBA673	2.28
TBA700	2.59
TBA720Q	2.45
TBA750Q	2.33
TBA800	1.75
TBA810AS	1.75
TBA920Q	4.23
TBA990	4.10
TBA990Q	4.10
TCA270Q	4.18
ZN414	1.25

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

DIGITAL INTEGRATED CIRCUITS

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

HARDWARE BASES

Type	Price (£)
DIL8	0.16
DIL14	0.16
DIL16	0.18

MOUNTING KITS

TO-3	0.06
TO-66	0.06

VALVES

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

ZENER DIODES

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

VDR'S, PTC & NTC RESISTORS

Type	Price (£)
E295ZZ/01	14
E295ZZ/02	14
E298CD/A258	7
E298ED/A258	6
/A260	6
/A262	6
/A265	6
/P268	6
E298ZZ/05	7
/06	8

Type	Price (£)
E299DD/P116-P354	all 8
VA1015	50
VA1026	41
VA1033	8
VA1034	8
VA1040	8
VA1053	8
VA1055S	10
VA1077	12
VA1104	35
VA8650	110

RESISTORS

Carbon Film (5%) ea
¼W 5.6 Ω-330k Ω (E12) 1.5p
⅛W 10 Ω-10M Ω (E24) 1.5p
1W 10 Ω-10M Ω (E12) 3p
2W 10 Ω-10M Ω (E6) 5p

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

CAPACITORS

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

MASTHEAD AMPLIFIERS

Labgear uhf group amplifier complete with mains power unit CM6001/PU. Groups A, B, or C/D please specify **£12.65**

Labgear CM6030 WB vhf/uhf ultra wideband amplifier (channels 1-68). Complete with mains power unit CM6001/PU **£18.95**

Labgear CM6019 WB uhf wideband amplifier (channels 21-68). Complete with mains power unit CM6020/PU **£9.85**

PATTERN GENERATORS

Labgear CM6004/PG giving crosshatch dots, greyscale and blank raster on 625-lines. Tuning can be preset for anywhere in Bands IV and V as well as Band III (for relays) **£58.80**

Labgear CM6038 DB Pocket size vhf/uhf generator. Outputs as CM6004 PG above but can be used either on mains or battery **£46.60**

COLOUR/BAR GENERATORS

Labgear CM6037/DB: Dual standard band generator gives standard 8 band colour bars + greyscale step wedge + red raster + centre cross + centre dot + crosshatch + dot pattern + blank raster. Sync output also provided. **£125.15**

VHF/UHF CONVERTERS

Labgear "Televertas" for DX-ing or single-standard receiver use on relay systems. Type 6022/RA **£15.90**

OUR NEW CATALOGUE IS AVAILABLE AT 30p (refundable).

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