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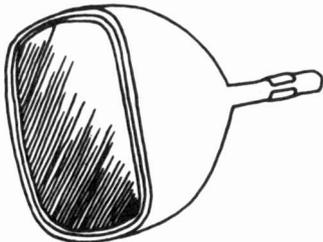
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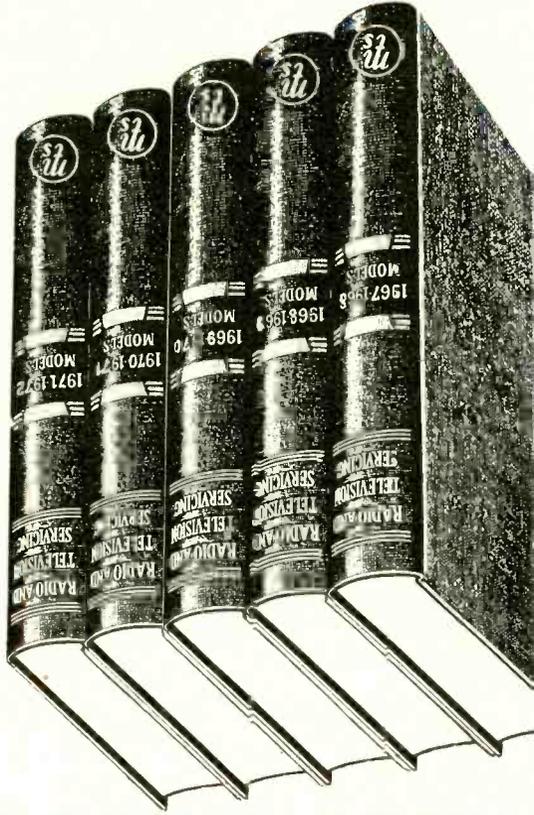
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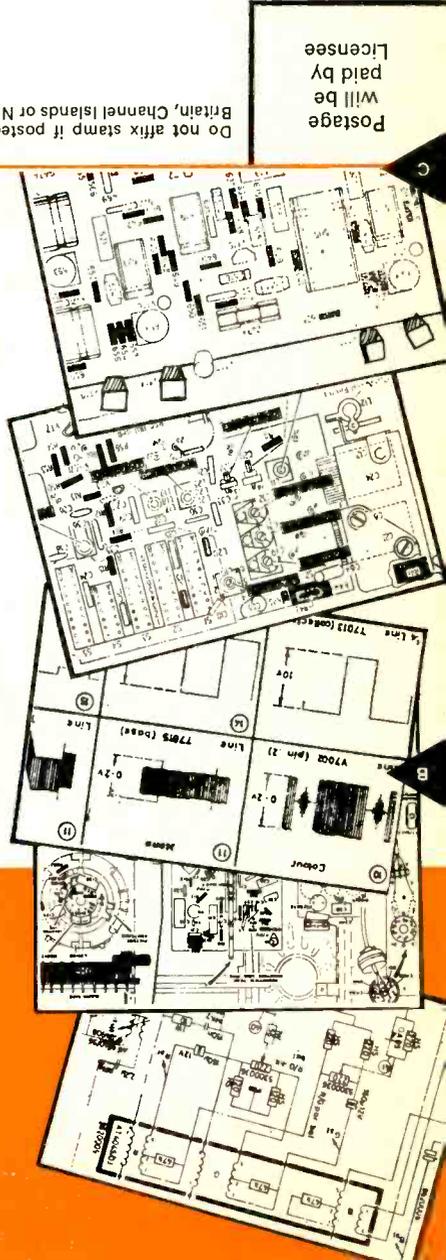
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AC126 17p	AF124 21p	BC145 45p	BCY70 17p	BF309 37p	MAT120 15p	T1543 40p	2N1132 22p	2N2905A 30p	2N3708 8p
AC127 17p	AF125 20p	BC147 17p	BCY71 30p	BF316 75p	MAT121 17p	U746 27p	2N1302 17p	2N2906 25p	2N3709 8p
AC128 17p	AF126 20p	BC148 20p	BCY72 15p	BF317 55p	MF102 43p	V405A 25p	2N1303 17p	2N2906A 27p	2N3710 10p
AC141K 17p	AF127 20p	BC149 17p	BCZ11 20p	BFX29 27p	MPF105 43p	V410A 45p	2N1304 17p	2N2907 25p	2N3711 10p
AC142K 17p	AF139 33p	BC150 17p	BD121 85p	BFX84 20p	OC19 30p	2G301 19p	2N1305 20p	2N2907A 30p	2N3819 40p
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AD140 40p	BC117 35p	BC209 11p	BF185 30p	C444 37p	OC200 25p	2N708 12p			
AD142 40p	BC118 25p	BC212L 11p	BF188 30p	C450 30p	OC201 27p	2N709 45p	AA119 8p	BY130 15p	OA10 22p
AD149 43p	BC119 45p	BC213L 11p	BF194 23p	C720 12p	OC210 27p	2N711 40p	AA120 8p	BY130 15p	OA10 22p
AD161 35p	BC136 30p	BC119 45p	BF195 24p	C722 15p	OC203 25p	2N711 40p	BA116 22p	BY111 32p	OA70 7p
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ADZ12 42-10	BC137 35p	BC319 12p	BF270 35p	C764 60p	OCP71 43p	2N744 17p	BY126 15p	BY129 25p	OA95 7p
AF114 17p	BC139 45p	BCY30 20p	BF271 17p	EC401 15p	ORP12 43p	2N914 17p	BY127 17p	OA5 17p	OA200 6p

DIODES & RECTIFIERS

AA119 8p	BY130 15p	OA10 22p
AA120 8p	BY130 15p	OA10 22p
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BY101 12p	BY126 35p	OA85 7p
BY105 15p	BY127 35p	OA90 6p
BY114 12p	BY128 30p	OA91 7p
BY126 15p	BY129 25p	OA95 7p
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BP00=SN7400	0.15	0.14	0.12	BP51=SN7451	0.15	0.14	0.12
BP01=SN7401	0.15	0.14	0.12	BP53=SN7453	0.15	0.14	0.12
BP02=SN7402	0.15	0.14	0.12	BP54=SN7454	0.15	0.14	0.12
BP03=SN7403	0.15	0.14	0.12	BP60=SN7460	0.15	0.14	0.12
BP04=SN7404	0.15	0.14	0.12	BP70=SN7470	0.29	0.26	0.24
BP05=SN7406	0.15	0.14	0.12	BP72=SN7472	0.29	0.26	0.24
BP07=SN7407	0.18	0.17	0.16	BP78=SN7478	0.37	0.35	0.32
BP08=SN7408	0.18	0.17	0.16	BP74=SN7474	0.37	0.35	0.32
BP09=SN7409	0.18	0.17	0.16	BP75=SN7475	0.47	0.45	0.42
BP10=SN7410	0.15	0.14	0.12	BP76=SN7476	0.43	0.40	0.38
BP13=SN7413	0.29	0.28	0.24	BP80=SN7480	0.67	0.64	0.58
BP16=SN7416	0.43	0.40	0.38	BP81=SN7481	0.97	0.94	0.88
BP17=SN7417	0.43	0.40	0.38	BP82=SN7482	0.97	0.94	0.88
BP30=SN7430	0.15	0.14	0.12	BP83=SN7483	1.10	1.05	0.95
BP30=SN7430	0.15	0.14	0.12	BP86=SN7486	0.32	0.30	0.28
BP30=SN7440	0.15	0.14	0.12	BP87=SN7487	0.67	0.64	0.58
BP31=SN7441	0.67	0.64	0.58	BP91=SN7491AN	0.87	0.84	0.78
BP42=SN7442	0.67	0.64	0.58	BP92=SN7492	0.67	0.64	0.58
BP43=SN7443	1.95	1.85	1.75	BP93=SN7493	0.67	0.64	0.58
BP44=SN7444	1.95	1.85	1.75	BP94=SN7494	0.77	0.74	0.68
BP45=SN7445	1.95	1.85	1.75	BP95=SN7495	0.77	0.74	0.68
BP46=SN7446	0.97	0.94	0.88	BP96=SN7496	0.77	0.74	0.68
BP47=SN7447	0.97	0.94	0.88	BP100=SN74100	1.75	1.65	1.55
BP48=SN7448	0.97	0.94	0.88	BP104=SN74104	0.97	0.94	0.88
BP50=SN7450	0.15	0.14	0.12	BP105=SN74105	0.97	0.94	0.88

BP107=SN74107	0.40	0.38	0.36	BP161=SN74161	1.80	1.70	1.60
BP110=SN74110	0.53	0.53	0.50	BP164=SN74164	2.00	1.90	1.80
BP111=SN74111	1.25	1.15	1.00	BP165=SN74165	2.00	1.90	1.80
BP118=SN74118	1.00	0.95	0.90	BP181=SN74181	2.75	2.60	2.40
BP119=SN74119	1.35	1.25	1.10	BP182=SN74182	0.97	0.94	0.88
BP121=SN74121	0.87	0.84	0.88	BP190=SN74190	3.50	3.25	3.00
BP141=SN74141	0.67	0.64	0.58	BP191=SN74191	3.50	3.25	3.00
BP145=SN74145	1.50	1.40	1.30	BP192=SN74192	2.10	1.95	1.75
BP150=SN74150	1.80	1.70	1.60	BP193=SN74193	2.10	1.95	1.75
BP151=SN74151	1.00	0.95	0.90	BP195=SN74195	1.10	1.05	0.95
BP153=SN74153	1.20	1.10	0.95	BP196=SN74196	1.80	1.70	1.60
BP154=SN74154	1.80	1.70	1.60	BP197=SN74197	1.80	1.70	1.60
BP155=SN74155	1.40	1.30	1.20	BP198=SN74198	5.50	5.00	4.00
BP156=SN74156							

TELEVISION

SERVICING · CONSTRUCTION · COLOUR · DEVELOPMENTS

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JULY 1972

FULL CIRCLE!

For almost two decades the home construction of television receivers has been virtually at a halt apart from a few sets built by a handful of dedicated amateur television transmitting enthusiasts and other experimenters. The heyday of home TV construction was of course the immediate post-war years when thousands of eager constructors converted, adapted and embellished war surplus units to get crude but working television receivers. There arose a cult of the green-eyed VCR97 midget set, which was often enlarged to a green-eyed monster by using magnifying lenses. Such enterprise was cheap and was fun.

Designs then began to appear for home constructed receivers using the conventional 9- and 12-inch tubes of the contemporary commercial products. After a short burst however interest fizzled out: circuitry was becoming more complex and the prices of commercial models were coming down—there was one famous set which retailed at around £35. Home construction was becoming tricky and uneconomic.

PRACTICAL TELEVISION (as we then were) made attempts to rekindle enthusiasm. In 1960 we introduced the *Olympic*, a 405-line "state-of-the-art" model. The designer, D. R. Bowman, followed this up in 1965 with the *Olympic II*, the first we think transistorised television receiver for the home constructor to be published and a pace setter in its time. In 1970 there came a turning point however when Keith Cummins designed and described his single-standard 625-line monochrome receiver: it created an instant and quite remarkable interest and the suppliers of certain parts had difficulty in meeting demand. An important point is that this was a quality receiver and certainly not a cheap project. Interest in TV set construction was maintained through J. W. Thompson's series and now of course we are in the midst of the TELEVISION colour receiver. Although this is a major project and the outlay is considerable it has taken off like a rocket! Nothing has been skimped in the design, yet it will cost less to build than the price of the average commercial receiver—more like the old times in fact!

The designs of the future will become increasingly more sophisticated and involved. But with most of the circuitry incorporated in a few i.c.s even the most complex projects will become a relatively simple matter of assembly. So we could well be on the threshold of another boom in built-it-yourself television: a case of coming full circle!

W. N. STEVENS—*Editor*

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**THE NEXT ISSUE DATED AUGUST
WILL BE PUBLISHED JULY 17**

TELETOPICS



TV FOR THE DEAF

Television could be the ideal information/entertainment medium for the deaf: the only snag of course is the importance of the spoken word to most programmes. But if subtitles could be incorporated with the visual information this drawback would be overcome. This of course would mean carrying additional information in the already crowded channel bandwidth but there is apparently a way of doing this: Paul McGoldrick, a senior lecturer in television engineering at Plymouth Polytechnic, has at any rate devised a way of incorporating the extra information in the transmission and believes the system could be in use within two-three years if the BBC and ITA could be persuaded to adopt it. For reception a decoding unit which would cost about £25—perhaps less—would be needed. On the broadcast side if the authorities agree to install the extra transmitting equipment necessary Paul McGoldrick estimates that studios would be able to add the special caption channel for as little as £100 per machine while the cost of preparing the caption track would be very small if done at the same time as the programme script was being prepared. Paul McGoldrick has been working on the system in collaboration with Southampton University for over two years and reports that it is now a practical proposition. It would be intriguing to know something of the technicalities but no information has been released so far. All we know is that it is suitable for use with u.h.f. transmissions only and that adding the extra channel does not in any way interfere with the normal colour or monochrome transmission.

SATELLITE TV

C. B. B. Wood, BBC engineering information chief, commented at the RTRA annual conference at Bournemouth on the possibility of satellite TV transmissions direct to viewers' homes. This he pointed out is not just around the corner since a satellite powerful enough to transmit to the type of aerial that could be used for an individual installation has yet to be designed. He showed the type of aerial that would have to be used and suggested that its cost along with the frequency converter necessary would be of the order of £100. Unlike most technological fields however—one thinks in particular at present of that monstrous aeroplane—costs in radio and television often have a habit of ending up rather less than expected. Who for example would have anticipated the dramatic fall in colour set prices since the early days of colour in the UK? The fact that the

BBC is working on s.h.f. transmission problems however seems to us a clear indication that in the long run we shall be confronted with satellite TV as an everyday system.

LATEST RELAY SERVICES

The following BBC and ITA relay services are now in operation:

Keighley, Yorkshire TV, channel 61, aerial group C.
Kidderminster, ATV, channel 61, aerial group C.
Pontypridd, BBC-Wales, channel 22, aerial group A.
Rhondda, BBC-Wales, channel 33, aerial group A.
 All these transmissions are vertically polarised.

TV COMPONENT NEWS

Mazda showed for the first time at the international Instruments, Electronics and Automation Exhibition 20 and 26in. 110° colour (shadowmask) tubes. They are of the narrow neck (29mm.) variety. Mazda say that in addition to reduced depth the new system results in superior performance while maintaining the circuit simplicity of 90° shadowmask tubes, the need for complex corner convergence correction having been eliminated. Type numbers are A51-150X (20in.) and A67-150X (26in.). The tubes use a base in which wire leads lie in grooves with ridges between each lead, providing protection for the leads and giving leakage paths. Also on show was a new 15in. monochrome tube, type CME1520/A38-160W. This has a narrow (20mm.) neck making it suitable for use with transistorised deflection circuits. The heater is rated 11V, 75mA and the light transmission of the tinted faceplate is 50%.

Mullard have introduced a new chrominance delay line, type DL50, measuring only 70 × 37 × 7mm (without coils). To obtain this small size the line uses several reflections of the signal. Coils have been omitted to give setmakers complete freedom in designing the matrixing circuitry. The delay accuracy is 0.005μs and the insertion loss at the subcarrier frequency 8 ± 3dB.

A 110° PAL colour receiver designed by the applications laboratories of SGS/ATES incorporates a number of new features. Four i.c.s are used: a TCA500 vision i.f. amplifier giving a gain of 87dB, a TBA360 providing automatic frequency control, a TBA780 intercarrier sound section and a TBA800 audio circuit. A new triple diffused power transistor, type BU115, meets the line deflection requirements of the 110° tube: it has been designed for use in mains-operated sets with a chopper stabilised supply (shades of the BRC 3000 series).

Hitachi have also introduced i.c.s for TV set use. The following five types have been announced: HA1108 and HA1126 providing automatic fine tuning; HA1122 video decoder; HA1118 chrominance amplifier; HA1125 sound system.

VIDEOCASSETTES AND FROZEN PICTURES

Philips have announced their first order for videocassette equipment in the UK: Lanarkshire Education Authority has ordered 60 videocassette recorders which with the associated software will cost over £24,000, i.e. some £400 per machine.

Cartridge Television Inc., developers of the Cartrivision videocassette system, have formed a joint venture with Columbia Pictures Industries Inc. to distribute rental videotape cartridges for individual viewers throughout the world. Programmes to begin with will be contained in the Cartrivision "red cartridge" which provides a playing time of up to 112 minutes, sufficient for most feature films produced today. The red cartridge incorporates a locked rewind system which limits a customer to one showing per rental fee. Admiral, Du Mont, Emerson, Teledyne Packard Bell and Warwick have now been licensed to produce Cartrivision equipment. The headquarters of the new company, Cartridge Rental Network, is at 460 Park Avenue, New York, NY 10022.

Following our note about the RCA "picture freeze" system in May we now hear that Hitachi have also developed a "stop action" TV system. This has a 17 and a 9in. monochrome tube mounted side by side in the same cabinet: the viewer watches the programme on the larger screen but can freeze any one second interval on the 9in. screen by pushing a button. Unlike the RCA system, which uses a silicon storage tube, the Hitachi system uses a magnetic memory disc device as the storage medium. This retains the frozen picture until the stop-action button is pressed to give a new image. We understand that the Hitachi system is already available on the Japanese home market and is to be made available world wide this autumn.

NEW SETS—AND TV LICENCE

The Annual Show time is upon us with the consequential spate of new releases from the setmakers—hard-pressed though most of them are to meet the demand instigated by the budgetary measures of the last year. The extremely competitive BRC 8000 colour chassis has been with us for almost a year now and makes its first appearance in the **Marconiphone** range with the announcement of the Marconiphone Model 4712 at the recommended retail price of £177·80. The set is fitted with a 17in. tube. It's surprising how many people one speaks to who don't realise that colour sets are available at under £200 (under £150 if you build our set!). A lot of thought about ease of servicing seems to have gone into the 8000 chassis: both sides of the printed panels are accessible during servicing while the receiver is operating and the signal panel (i.f., chrominance and luminance) can be hinged out without removing the chassis. We seem incidentally to have missed out recently on some BRC announcements. The solid-state mains-battery monochrome chassis is available in two versions, the 1590 series fitted with 12in. tubes and the 1591 series which have 14in. tubes. The first 14in. tube model is the **Ultra** 6818 (Mazda c.r.t. type CME1402/A34-100W).

The Pye/Ekco/Philips group are also introducing more mains-battery portables. In the **Philips** range comes the TVette 9 (Model 9741) at £64·15 fitted with a 9in. tube. This single-standard model features slider brightness and contrast controls and sockets for ear-phones and an external aerial. Also introduced in the Philips range is a white cabinet version of the TVette 12, at the same price as the existing model—£73·90. In the **Ekco** range comes the 9in. mains-battery Model T545 at £63·25, with slider brightness and contrast controls. There is also a new 22in. Philips colour set, Model 534, fitted with the G8 chassis and carrying the recommended price of £263·50.

There are some new luxury colour models from **Dynatron**. Model CTV13 "Regent" is fitted with a 26in. tube and is housed in a Chippendale style console cabinet in selected mahogany veneers with full-length doors. Recommended retail price is £364·50. It incorporates a remote control system enabling the volume, brightness, channel and colour intensity to be remotely operated—the remote control unit with its cable fits unobtrusively behind the cabinet when not in use. An audio socket is included which will feed into either a tape recorder, a hi-fi system or a suitable deaf-aid amplifier. The same chassis and facilities are available in the Scandinavian style Narvik Model CTV14 at £345·50 with teak veneer cabinet or £349 with walnut veneer cabinet.

And of course there are a lot more imported sets. **Grundig** have now introduced in the UK their 110° 26in. set, Model 5010, with electronic touch tuning system: to select a programme you just lightly brush against any of the preset station selectors—the result is instantaneous channel changing with much increased reliability. A similar chassis is used in the 6010 which has just one visible control, the on-off bar: an ultrasonic remote control unit is used to switch on and off, select programmes and set the brightness, colour and volume levels. The remote control unit is small enough to fit in the palm of the hand. An interesting technical point: the chassis used in these sets is the first known to us that uses a unijunction transistor as the field oscillator. There is also a new monochrome set from Grundig, the portable Model R2010 fitted with a 20in. tube.

New releases from Japan include the **Toshiba** Model 12TB mains-battery portable, fitted with 12in. tube and featuring slider brightness and volume controls, at £79·95. Agents are Hannimex (UK) Ltd., Hannimex House, 15-24 Great Dover Street., London SE1. And three further models from **Sanyo**, the 10T150 (10in. tube) mains-battery portable at £64·95—with optional rechargeable battery pack extra—which replaces the 10T120 and two models fitted with 12in. tubes, the 12T208 mains-battery model at £70·95 and a mains only version the 12T209 at £59·95.

An interesting import from **Europhon** is the Italian "Giano" mains-battery portable which incorporates a varicap tuner, 12in. tube and continuously tuneable f.m./m.w. radio. The styling is distinctive and the recommended price £89·90.

The second phase of the scheme for BEAB safety approval of TV sets has now started: monochrome sets with screen sizes below 17in. are being tested.

The Minister of Posts and Telecommunications has announced that a new type television licence is to be introduced shortly and that some viewers will be asked to complete an application form. It is understood that this is being done as part of the computerisation of licence records.

the surprising semiconductors

PART 1

I. R. SINCLAIR

SINCE the discovery of photoconductivity in the element Selenium over a century ago semiconductors of all sorts have been a subject of fascination to physicists. The results of a great deal of work are only now hitting us because of the time lag between what is called academic research and the application of such research to practical devices. As with so many fields of knowledge the more we learn the more we find still remains unknown. New and sometimes surprising effects are constantly being discovered while effects previously predicted but not observed are at last found to exist. This article deals with semiconductor effects which are less well known or less well understood, i.e. those outside the familiar territory of rectification and the transistor effect. Some of the effects described take place in pn junctions, some in specimens where no junction exists, all are finding applications and making possible new devices which could not have been dreamt of previously.

Seebeck Effect

When any two different metals are joined, whether by welding, soldering or simply by twisting wires together, the different energies of the electrons in the different metals show up as a *contact potential* (Fig. 1) between the metals. This contact potential arises from the tendency of the more energetic electrons in one metal to migrate to the other, leaving one metal with a positive charge and the other with a negative charge. Because the energies of the electrons vary with temperature the contact potential varies with temperature. Raising the temperature enables more electrons to cross the junction between the metals in the "wrong" direction, (towards the negative side) so increasing the contact potential. Contact potentials can be fairly large, of the order of 0.5V in some cases, and this can cause trouble with biasing circuits where inevitably different conducting materials come together.

This is probably one of the earliest discovered and best known of the electrical effects at the junction of two metals. Though it is not as some others are an

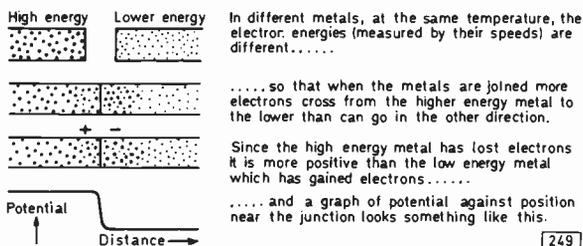


Fig. 1: The reason why a contact potential exists at the junction between metals whose electrons have different energies (measured by their speeds).

effect peculiar to semiconductors its effect on semiconductor use is often forgotten. When we make an ohmic contact, perhaps of an aluminium lead to a semiconductor chip, we are creating another junction at which a contact potential will exist in addition to the pn junction within the semiconductor.

The variation in contact potential with temperature is well known and is used in thermocouples for temperature measurement: it is not however responsible for the temperature effects found in semiconductor junctions. The output of a thermocouple is of the order of a few millivolts per degree C of temperature difference (Fig. 2) between the junctions.

Peltier Effect

If we take a circuit with two junctions (Fig. 3) and pass a current round it from a battery or generator theory predicts that one junction will rise in temperature and that the other junction will cool down. This indeed happens but the cooling effect, called the Peltier Effect, is so small in most materials that it is entirely hidden by the rise in temperature which is always caused when a current passes through a resistor.

Semiconductor junctions however demonstrate the Peltier effect very much better and it is possible to demonstrate the freezing and boiling of water by the two junctions of a semiconductor Peltier circuit when a current is passed through it from a small battery. This is the basis of all-electric refrigeration which might be expected to supersede the cumbersome process of compressing a gas, cooling it, expanding it and then re-circulating it—the basis of the present-day refrigerator. At the moment the price of the semiconductor material alone (the most favoured material is Bismuth Telluride) rules out the use of Peltier cooling for most purposes but this is an application of semiconductors which is worth watching. Already Peltier coolers can be bought "off the shelf" and used where their unique ability to lower temperature in small spaces by purely electric means is essential. The possibility exists of making power i.c.s with integral cooling so that all the heat generated could be harmlessly dissipated in a junction remote from the main i.c. element.

Quantum Effects

If we leave aside the normal rectifying and transistor action of pn junctions and the thermoelectric effects described above we come to a range of curious happenings which are called "quantum effects". The word "quantum" refers to a packet of energy and was the name given by the physicist Planck to the units of energy found in radiation such as light and radiated heat. Quantum physics and its logical development quantum electrodynamics account for the whole of

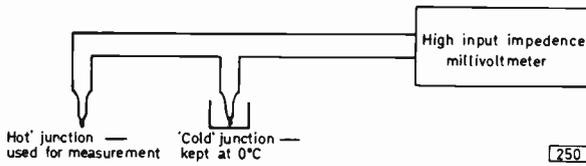


Fig. 2: The use of thermocouples: the above diagram shows the principle only. Modern thermocouples do not use the cold junction, having instead a temperature-compensated circuit which behaves in the same way as the cold junction. If this is not used the other connections in the circuit act as the cold junction and the readings depend on the room temperature.

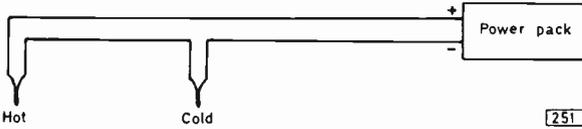


Fig. 3: The Peltier Effect—the thermoelectric effect in reverse. A current forced through the junctions in the "wrong" direction should cause one junction to give out heat and the other to take in heat. With most metals however the effect is too small to be noticed since both junctions heat up because of the passage of current.

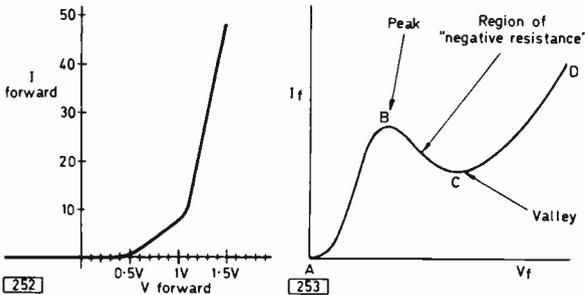


Fig. 4 (left): Silicon junction diode characteristic. Note that there is no forward current flow until the contact potential is overcome. The contact or barrier potential is higher with silicon than with germanium.

Fig. 5 (right): Tunnel diode characteristic.

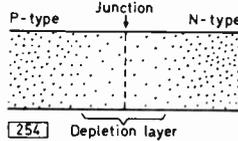


Fig. 6: A depletion layer in which there are relatively few free charge carriers exists at a semiconductor pn junction. Note that this drawing is symbolic only, the dots representing the excess charges (holes or electrons) present as a result of doping. There is no way of indicating in such a diagram the energy levels of the charge carriers (holes and electrons).

observed physics with a fair degree of success along with electrostatics and relativity theory. Two vital points of quantum physics are first that electrons can possess only certain fixed values of energy and no others and can pass from one energy value to another by taking in or releasing fixed amounts of energy; secondly that the change from one energy value to another is not impossible with the "wrong" value of energy but is highly improbable.

The Tunnel Diode

One effect that was noticed in semiconductor junctions at an early stage and could only be explained in terms of quantum physics is called "quantum tunnelling". The normal forward characteristic of a semiconductor diode is shown in Fig. 4: a large increase in current occurs as the forward voltage is increased. The characteristic of a tunnel diode is shown in Fig. 5 and it can be seen that a hump, including a region of reverse slope, has appeared in the characteristic. This region of reverse slope represents negative slope resistance: the region is unstable and any current and voltage condition in this region will switch very rapidly (within nanoseconds) to one of the other possible voltages at the same current. This characteristic enables it to be used as an oscillator. The tunnel diode is used more in microwave circuitry than in domestic TV but the principles of operation are important and should be understood before more recent devices can be discussed.

To start with we have to remember what happens at a semiconductor junction. At a lightly doped semiconductor junction (Fig. 6) such as is used in the normal junction diode there is at the junction a depletion layer, meaning a layer where there are very few free charges. This occurs because at the formation of a junction free charges on each side move across it creating a contact potential and leaving the area close to the junction stripped of most of its free charges. If the areas at each side of the junction are lightly doped the depletion layer is fairly wide in terms of atom size. Its effective width varies with the reverse voltage applied so that there is an effective change of diode capacitance with change in reverse bias, a feature which is used in electronic (varicap or varactor) u.h.f. tuners among other applications.

During conduction the depletion layer still acts as a form of barrier despite the fact that charges are moving across it. When bias is applied to a diode there is an immediate alteration of the energy levels of the free carriers on each side of the depletion layer. This can be represented as shown in Fig. 7(a) where the values of permitted energy (permitted by quantum theory that is) are shown as bands with gaps between them. There will be carriers whose energy values fit anywhere within the bands labelled "permitted bands" but none with energy values corresponding to the "forbidden bands". The application of bias shifts all the bands on one side of the junction relative to those on the other—as Fig. 7(a) shows. The upshot is that in passing from one side of the junction to the other—in the direction favoured by the bias—a carrier will generally move from one permitted energy level to another where the permitted energy value is lower. In doing so the charge carrier will lose some energy—though not necessarily if it moves between equal energy levels, i.e. horizontally across the junction in Fig. 7(a)—and this will appear as heat, microwave or other radiation.

The semiconductor material used for tunnel diodes is relatively heavily doped. Consequently the conducting bands are much closer together. The first result of this is that forward conduction commences at a much lower forward voltage than is usual—compare slope AB in Fig. 5 with Fig. 4. The next consequence is that as Fig. 7(b) shows we can arrange that the top, conduction band on the low-energy side is at around the same energy value as the second permitted band on the high-energy side. This means

that charges will be equally at home in either band with little change of energy.

Classical (pre-quantum) physics would have led us to expect that in such conditions charges should be able to move only from the top band on the high-energy side to the top band on the low-energy side and not from the top band on the low-energy side to the second band on the high-energy side. The reason for the reverse motion being "impossible" is that the electrons would have to acquire enough energy to overcome the bias and move through the depletion layer, and there is no source for such energy.

Quantum physics takes a different view. There is always a possibility of electrons moving in *any* direction, though the possibility becomes very low when the direction in question is against a bias. This possibility is greatly increased however when the electron can land in a band which is at the same energy level as the one which it left. Quantum physics predicts in fact that as the energy bands draw level due to increasing forward bias there should be a reverse flow of carriers, reaching a maximum when the top level on the low-energy side is exactly at the same level as the second level on the high-energy side. This action is termed *tunnelling*: the name sprang from the astonished engineers who first observed the effect and decided that since the electrons could not "climb" the bias barrier they must be "tunnelling" through. This tunnelling action causes the reverse slope portion of the tunnel diode's characteristic—BC in Fig. 5. The current over this part of the characteristic is the forward current minus the tunnelling current.

As the bias is further increased however the possibility of tunnelling becomes much more remote and the characteristic gradually assumes its normal shape again—section CD. Note that in all the descriptions of junction action, the words charge or charge carrier have been used in preference to electron or hole so that the description is general. The tunnel diode was the first "diode" type semiconductor microwave oscillator and as a low-power device is still used. It is capable of providing a wide tuning range. In operation it is of course biased into the unstable, negative resistance region of its characteristic.

"Hot" Carriers

Studies of the effects of high electric fields (volts per metre) in semiconductors began in the 1930s but were mainly filed and forgotten until Ryder and Shockley working at Bell Telephone Laboratories carried out a series of experiments with the semiconductor materials which they were preparing in connection with their work which had already led to the invention of the transistor. When a high field is applied to a semiconductor by sandwiching it between two layers of good conductor with a high voltage between them the charge carriers in the semiconductor material acquire greater energy values. Thus their speeds, apparent masses and their interactions with the various energy waves inside the semiconductor crystal lattice all change. Such charge carriers can have the energy values which we usually produce by heating to very high temperatures. For this reason such carriers are called "hot carriers" although the temperature of the material may be room temperature or very much below it. The study of such hot carriers—particularly hot electrons since it is easier to accelerate electrons to such energies—has led to a new

family of semiconductor devices. Many of these are of great interest for generating microwave energy.

Avalanche Diodes

Avalanche diodes, of which family the *impatt* and *trapatt* diodes are examples, are one type of microwave generating hot-carrier device.

Though the precise construction varies, the principle of operation of an avalanche diode is that a high field is produced, either at a pn junction or at a junction between a doped and an intrinsic (undoped) region. In each case part of the diode structure (see Fig. 8 for example) consists of an intrinsic region. Charges moving through the diode have therefore to pass through the intrinsic region which is of low-conductivity—since it is the doping that produces the free carriers in semiconductor material.

When the device is reverse-biased the field at one junction can rise to a value which produces hot carriers. These high-energy carriers then cause an avalanche: in colliding with atoms they cause a vast number of electron-hole pairs to be created. The electrons are in turn accelerated and cause further carriers to be created. The carriers, created in less than a nanosecond by avalanche action, travel in the direction of the field (electrons to the positive end, holes to negative), leaving the junction with a low voltage across it (because it is conducting) and so a low field. The carriers have of course to pass through the intrinsic layer and reduce the field across it as they go. The net effect of all this movement of charge is that the junction at which the action started is once more depleted of charges. When the intrinsic layer is also drained of charge the process is free to start again.

Impatt Diode

The simplest type of *impatt* (*impact avalanche and transit time*) diode consists of pin layers (Fig. 8) and oscillates at a microwave frequency which depends on how long the charge carriers take to move through the intrinsic layer and how long the avalanche takes to build up. Generally the time taken to cross the i-layer is far longer so that the width of this layer determines the frequency of oscillation, though the size of the microwave tuning cavity in which the diode is placed also has an effect.

Read Diode

The pnin diode known as the Read diode (Fig. 9) has a characteristic very similar to that of a tunnel diode in that a rise of voltage over a part of its characteristic produces a drop in current, i.e. there is a negative resistance region. In this form of diode the avalanche occurs at the pn junction and the carriers are moved rapidly through the n region before reaching the i region. Over a range of voltage therefore increasing voltage simply causes greater depletion of the junction at which the avalanche (which in this diode is *continuous*) takes place so that fewer hot carriers are present and the current decreases. Eventually of course the field can be made so high that the current increases again, even to the extent that further avalanche occurs at the ni junction.

The usefulness of the Read diode is that it has no "natural" frequency of oscillation in the microwave region but will oscillate happily at the resonant

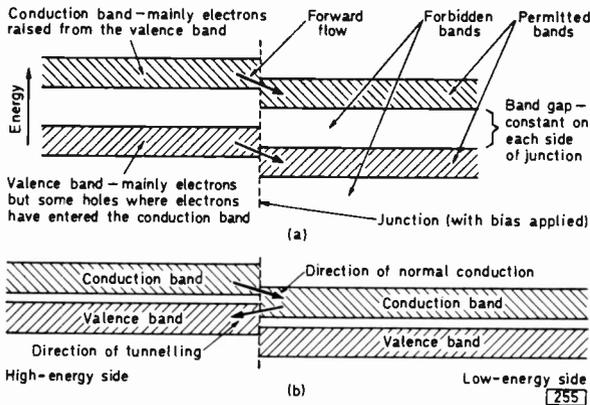


Fig. 7: (a) Energy band diagram for a forward biased junction: the vertical height of each band represents the charge carrier energy values which are permitted. (b) Energy band diagram for a heavily doped junction in a tunnel diode: the tunnelling current is the result of charge carriers in the conduction band on the low-energy side moving into the valence band on the high-energy side.

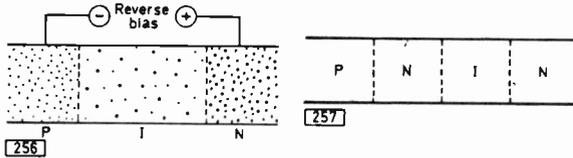


Fig. 8 (left): The impatt diode has an intrinsic (i) layer—an undoped portion with normally very low conductivity, i.e. high resistance. If the reverse bias is sufficient an avalanche effect will arise at one of the junctions, with hot carriers producing a large current flow through the device: this avalanche will however reduce the field which caused the hot carriers so the current flow ceases—until a further avalanche builds up. The result is the generation of microwave oscillations.

Fig. 9 (right): The prin structure of the Read diode.

frequency of any cavity in which it is placed. Despite this advantage its complex structure made it difficult to make and it has been superseded by impatt and Gunn devices.

Trapatt Diode

Bell Telephone Laboratories have announced the trapatt diode which uses an avalanche to generate hot carriers but delays the time between avalanches by “trapping” the carriers as they move away from the avalanche region. This has the effect of making the diode oscillate at much lower frequencies than would otherwise be the case and gives a relatively high-power pulse output. Frequency drifting due to the heat produced and other problems seem to have retarded the development of this device.

Gunn Oscillator

The Gunn effect which was first described in 1963 uses the action of high electric fields in the bulk of a semiconducting material—not at a junction. The favourite material at the moment for Gunn oscillators (named after the discoverer) is n-Gallium Arsenide. A Gunn oscillator consists of a small piece of such material with ohmic (meaning not junction) contacts

at each end. The term “Gunn diode” which is sometimes applied to this arrangement is not correct since there is no junction and no rectifying effect. There are however two regions, an n one and a low-resistance n+ (positive) one.

The Gunn effect had been sought for some time before it was successfully achieved but the precise mechanism of the oscillation was not at the time too clear. It was thought that a negative-resistance region must play a part in the oscillation but the reason for the appearance of the negative resistance region was not understood. As far as we can see at the moment the working of the Gunn oscillator can be described as follows. A voltage is applied between the ends of the device: a steady low voltage causes a steady low current flow but above a certain threshold voltage conduction is no longer steady but consists of charge packets. Above the threshold voltage the energy levels of electrons at the positive (n+) end is raised to a higher band in which they have a higher effective mass and thus lower mobility—they land up in an energy state where they have a large amount of interaction with the atoms in the crystal lattice and this large interaction hinders their normal free movement. This is not an unknown situation in other realms—the first man (Charles Parsons) to use a turbine to propel a ship found that the ship hardly moved despite the fact that the propeller was turning nearly ten times faster than a reciprocating steam engine could have achieved. This in fact was the trouble: the propeller was creating a cavity which the water did not have time to fill. Thus the propeller was simply spinning round in a vacuum! To get back to the Gunn effect, the region of high electron energy is also a region of high field—since the electrons are less mobile. The situation feeds on itself, increased voltage making for less mobility and so less current. This gives us then the negative resistance for which we have been looking.

This accounts for the oscillation but does not account for the frequency of the oscillation observed—a Gunn device will oscillate at a microwave frequency even if it is not placed in a microwave cavity though for the sake of efficiency we would always use a Gunn oscillator in such a cavity. The frequency of oscillation is the result of the movement of the region of high field and negative resistance through the device—at the speed of the low mobility hot electrons. At the other contact the high field collapses and another one is formed at the first contact again. It is then the time taken for the high-field region to move through the device that determines the frequency of oscillation.

The Gunn oscillator is now replacing the klystron as a local oscillator in microwave equipment. As with the klystron the frequency is voltage-controllable but the Gunn device has the great advantages of being solid-state with no fragile glassware, no heaters and much smaller size and mass. The Gunn oscillator is in fact a very cheap microwave source and has been used in experimental s.h.f. (super high frequency) television tuners.

Step-Recovery Diode

There is of course another way of going about generating a high frequency oscillation: that is to start off with a lower frequency signal and to use frequency multiplication. This brings us to another

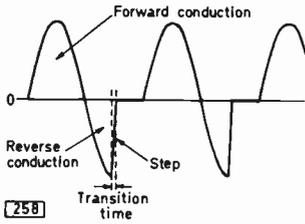


Fig. 10: Step-recovery diode current waveform.

very useful "surprising semiconductor" device, the step-recovery diode. This is a rather specialised form of varactor (variable-capacitance) diode with a characteristic (see Fig. 10) that makes it ideal for use as a frequency multiplier.

The mode of operation of the step-recovery diode is based on the charge-storage characteristics of a varactor diode. The step-recovery diode is driven by an r.f. signal and when forward biased by the signal conducts in the normal manner. Minority carrier (i.e. holes in the n region and free electrons in the p region) lifetime determines the quantity of charge that is stored in the device during forward conduction. With sufficient charge stored there will be appreciable current flow when the applied signal reverse biases the diode—stored holes will return across the junction to the p side and stored electrons will return to the n side. Thus for a period while the stored charge is being removed in this way the diode will be conducting in the reverse direction at a current level similar—as Fig. 10 shows—to that achieved during forward conduction. When all the stored charge has been removed the reverse current flow drops to the normal very low reverse leakage current. In the design of a step-recovery diode long minority carrier lifetime is aimed at—so that the reverse current flow continues well into the reverse bias condition—with a very short transition time—the time taken to switch from the end of the stored charge removal period to the normal reverse bias condition.

This short transition time provides the step in the diode's characteristic and its usefulness since such a waveform is very rich in harmonics. The required harmonic can be filtered out by coupling the diode to a suitable resonant circuit.

The step-recovery diode driven by a crystal oscillator is a simple, reliable signal source that is now in quite wide use. It has been suggested as a suitable local oscillator for use in s.h.f. television tuners.

Schottky Barrier Diode

Charge storage effects are usually unwanted however since they delay the operation of a semiconductor device—for example the speed of a switching diode or transistor. For this reason Schottky barrier diodes are finding application in microwave circuitry—they have been suggested for example for use as the mixer in an s.h.f. television tuner. A Schottky diode consists of a semiconductor (silicon) to metal rectifying junction. There is virtually no charge storage in a Schottky diode and a significantly lower forward voltage drop for a given forward current than in a semiconductor junction. Other benefits are that the elimination of charge storage reduces power dissipation, low reverse leakage current and fewer reflection problems.

The main use of Schottky technology at present however is for high-speed clamping in digital integrated circuits to prevent switching transistors saturating (and consequently taking longer to switch off). The use of Schottky-diode clamped transistors in digital i.c.s enables ECL (emitter-coupled logic) speeds to be obtained with TTL (transistor-transistor logic) dissipations. An ironical point is that one of the biggest problems in the early development of i.c.s was the avoidance of spurious Schottky junctions being formed where the metal connections were made to the semiconductor chip.

Next Month: Electroluminescent Semiconductors

ADAPTING SYSTEM B TV SETS

by R. Trelawne

A NUMBER of letters arrive each month—mainly from service personnel returning from overseas duty—asking for information on adjustments to television receivers brought back from abroad to make them suitable for use in the UK.

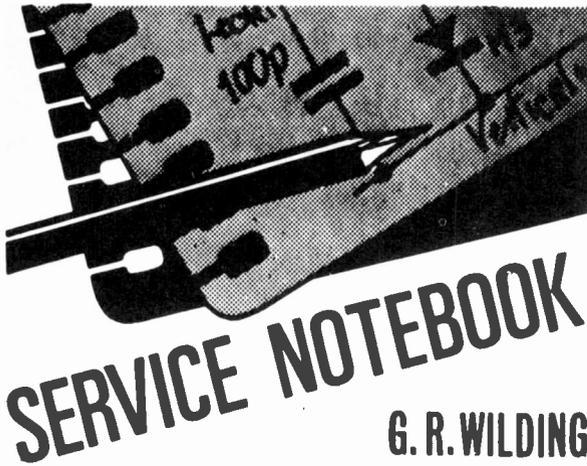
The main complaint is that although good vision is obtained the sound is very poor. This is due to the receiver being intended for use with System B transmissions (the E channels) which have a 5.5MHz sound-vision spacing whereas the system employed in the UK at u.h.f. (System I) has a 6MHz sound-vision spacing. We often find that transistor television sets can be satisfactorily adjusted to suit the UK transmissions but valve i.f. strips can be more troublesome.

The simplest method of adjustment without test gear is as follows. Tune the receiver for maximum vision quality (definition) on the local u.h.f. transmission. Distorted, buzzing sound should then be heard, the buzz changing with variations in the vision signal content. Starting with the f.m. detector circuit, carefully adjust the i.f. cores for best sound quality, working back along the sound i.f. chain to the take-off point adjacent to the video amplifier. No adjustment should be made to the vision i.f. transformers. Valve i.f. strips can be more difficult: it may be necessary

to remove several turns from each sound i.f. transformer to increase the resonant frequency to 6MHz. If anyone with a limited knowledge of television reading this overseas is contemplating bringing such a set back to the UK we feel that it may be wiser to sell the set to someone remaining abroad rather than to bring the set back and then find it extremely difficult to realign.

It has also come to our notice that receivers suitable only for the UK transmission standards are being sold to people leaving the UK for permanent residence abroad. Apart from the different sound-vision spacings, many countries use 625 lines on the v.h.f. Bands I and III—most receivers now made in the UK have only a u.h.f. tuner fitted. Thus we must strongly advise anyone leaving the country not to take a receiver made to operate on the UK transmission standards with them.

A number of UK setmakers have available for people leaving the country export receivers at extremely favourable prices (due to purchase tax concessions). Rank-Bush-Murphy, GEC Radio and Television Ltd., British Radio Corporation and Pye all have available under personal export schemes a range of receivers for use in other countries and we suggest that those interested should contact these sources for further information. We at TELEVISION are always pleased to advise on reception problems and the transmission standards used in other countries. ■



SERVICE NOTEBOOK

G. R. WILDING

No Picture

There was no picture and a slight smell of burning on a Decca Model DR1, the latter due to sparking between the slider and carbon track of the width/set boost preset R171 (Fig. 1). Our first suspicion was that the 100pF 5kV Suflex capacitor mounted close by and used to feed pulses from the line output transformer to the width stabilising circuit had broken down. The circuit diagram however showed that if this had been the case the VDR and R169 would also have shown signs of overload.

Careful inspection of other components in the area showed that R170 the 470k Ω resistor connected from the boost h.t. rail to the live tag of the preset was greatly discoloured. An ohmmeter test then revealed that its value had fallen to little over 150k Ω . Its value had probably reduced over the years and resulted in an undue proportion of the 800V boost potential being developed across the 1M Ω preset. This would in turn cause insufficient negative bias to be applied to the grid of the line output pentode, further increasing its output and therefore increasing the boost potential—all in a cumulative manner. On changing R170 and the badly burnt preset normal operation was restored with the line output pentode seemingly

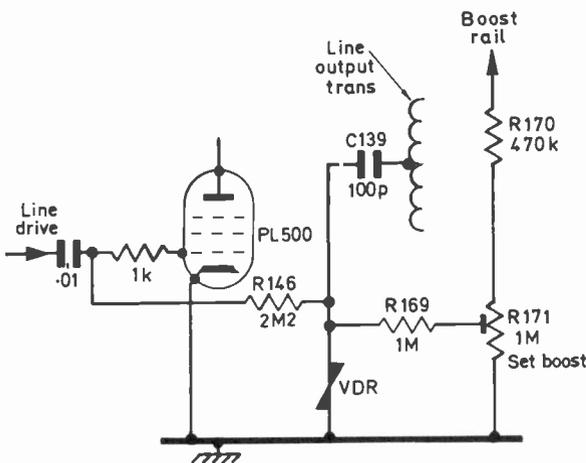


Fig. 1: This width stabilisation circuit (Decca Model DR1) is typical of modern practice. No picture was found to be the result of R170 falling in value.

none the worse for its temporary overload. During a soak test however it was found that tapping the boost rectifier produced an occasional internal spark so this was replaced before returning the receiver to the customer.

Once again checking for discoloured resistors had identified the source of the trouble far more quickly than making meter tests.

Lack of Height and Width

The picture on an all-valve, dual-standard Ekco Model T418 had suddenly contracted in both height and width while if the brilliance control was advanced only slightly past its normal setting the picture size would increase somewhat then disappear—as when an e.h.t. rectifier is low-emission. The cause was clearly inadequate line output and on removing the cabinet back it seemed that there was inadequate drive to the PL36 as the anode was slightly glowing. This hardly seemed like valve trouble but a new PCL84 line generator and PL36 were tried just in case.

Although the grid of the PL36 was negative to chassis the meter reading seemed much less than normal. Even more informative however was the fact that the anode voltage of the PCL84 triode was down from its correct 168V to little over 40V. Of course when any oscillator fails to operate or produces reduced amplitude output the accompanying zero or reduced negative grid bias causes an increase in anode current and thus reduced anode voltage. As the valve was oscillating however this very great reduction in anode voltage was more likely to be caused by a leak in the capacitor feeding the grid of the line output pentode. Accordingly the PL36 was removed and the heater pins on the valveholder shorted together: it was then found that there was almost 30V on the grid pin (5) while the oscillator anode voltage returned almost to normal. On replacing the grid feed capacitor C87 (0.01 μ F) normal results were obtained although it was found necessary to leave the new PL36 in to obtain full scan on 625 lines.

Pulling-on-Whites

Pulling-on-whites, that is sideways displacement of groups of lines that terminate in peak white areas, resulting in test card cogging, was the complaint with an oldish but still very good Ekco T418. This fault is generally the result of restricted bandwidth in the i.f. stages or in the video stage, or component value change in the sync separator stage which reduces its effective bandwidth. The symptoms can also on occasion be caused by ghosting and bad aerial siting. To preserve the rectangular shape of the sync pulse the overall receiver response should be at least 2.5MHz. With restricted bandwidth a peak white signal will not fall (on the 405-line standard) to the blanking level during the front porch period which precedes the sync pulse: consequently the sync pulse will be delayed and the picture information on the following line will be displaced to the right. This sort of trouble does not of course arise with more recent sets which use flywheel line sync.

In the set in question the test card gratings were well defined and there was no sound-on-vision or

—continued on page 419

COLOUR RECEIVER CIRCUITS

GORDON J. KING

ALTERNATIVE IDENT TECHNIQUES

AT THE conclusion of the instalment in the April issue it was promised that the PAL V switching and ident system used in the Rank-Bush-Murphy single-standard chassis would be investigated and it is to this that we now propose to turn our attention.

RBM System

The PAL V switch circuit with its associated bistable is shown in Fig. 1. The bistable circuit consists of the transistors 3VT3 and 3VT4 while the switch consists of the switching diodes 3D9 and 3D10, which are switched on alternately line by line by the antiphase output waveforms from the bistable, and the phasing transformer 3T2. In this chassis it is the V reference signal feed to the V demodulator that is inverted on alternate lines. Positive-going 18V peak amplitude pulses derived from the line flyback pulse are used to trigger the bistable, being fed in via 3C10 and 3C13. Being positive-going they switch on the transistor that is off. 3D7 and 3D8 are the steering diodes. Say 3VT3 is on and 3VT4 off: the cathodes of both steering diodes are taken to a positive potential but as 3VT3 is conducting its base voltage will be much higher than that of 3VT4 which is off. 3D7 will thus have a higher reverse bias applied to it than 3D8 and the next positive pulse will be routed via 3D8 to switch on 3VT4.

The only unusual aspects of this circuit are (a) that it drives two phase switching systems, the PAL V switch shown in Fig. 1 and a burst phasing switch—which removes the alternate line $\pm 45^\circ$ phase swings of the transmitted bursts—and (b) that instead of the usual sinewave a d.c. potential is used for ident control.

The ident d.c. bias is taken from the collector of 3VT11 (Fig. 2)—the same potential is used as the colour killer bias voltage in this chassis. If the bistable switching is correct 3VT11 will be turned hard on (we will see in a minute why this is so) and its collector voltage will rise to almost the supply rail potential of 18V. This potential is fed to the bistable via 3R8 (back to Fig. 1 again) where, under these conditions, it reverse biases 3D6. If the bistable switching is incorrect however 3VT11 will be cut off and its collector voltage will fall to chassis potential. This means that 3D6 will be forward biased and in this condition the bistable triggering pulse arriving at 3C10 will, instead of passing via 3D7 to trigger 3VT3, pass instead via 3D6 and 3C7 to chassis. As a result the bistable will miss a count and its switching will be corrected so that the PAL switch switches the reference signal in phase with the phase alternations of the transmitted V chrominance signal.

To appreciate how the ident potential arises—why 3VT11 switches on or off according to whether the bistable is switching in correct synchronism or not—

we must go back to the burst channel/reference signal generator section. The circuit of this is shown in Fig. 2. It will be recalled that this is the chassis that uses the passive subcarrier (i.e. reference signal) regenerator circuit. The crystal 3XL1 is driven by the gated out bursts and oscillates at 4.43MHz throughout the line period until the next burst arrives to "replenish" the ringing action of the crystal. The crystal acts as a filter, removing the sidebands of the burst signal so that a pure 4.43MHz sinewave is fed to the following amplifier stage 3VT9. 3D11, 3D12 and 3T5 comprise the burst phase switch which acts in a similar manner to the conventional PAL V switch (e.g. 3D9, 3D10 and 3T2 in Fig. 1), removing the burst swings in this case so that the crystal is driven by constant phase bursts.

Now the action of this switch also controls the ident and colour killer operations. How this occurs is shown in Fig. 3. At (a) is shown the received burst signal, alternating $\pm 45^\circ$ about the $-U$ axis on alternate lines. If the switching is correct we get the situation depicted in (b): the burst on line 2 has been shifted to the same phase as the burst on line 1, i.e. we have a constant phase burst signal on every line at the input to the crystal driver stage 3VT8. If the switching is incorrect the situation depicted in (c) arises: here the burst on line 1 instead of line 2 has been shifted by 90° , giving antiphase burst signals which cancel out on alternate lines. This burst cancellation means that we get no reference signal.

To summarise then, if the bistable is switching in correct synchronism the reference signal is produced, if it is switching in incorrect synchronism there is no reference signal. The rest is simple. The post crystal amplifier 3VT9 drives an emitter-follower 3VT10 which provides a low-impedance output. This output is fed via 3C48 to the chrominance synchronous demodulators—via the usual V switch (Fig. 1) and 90° shift network in the U feed—and via 3C49 and 3RV7 to 3VT11 base. We are thus back to 3VT11. When the previously described switching is correct the reference signal appears at 3VT11 base where it is rectified by 3D15. 3VT11 switches on and the positive potential across 3R72 reverse biases 3D6 (ident action) and turns on the chrominance channel (colour killer action). When the switching is incorrect there is no reference signal, 3VT11 is switched off by the positive potential at its base, its collector rests at chassis potential, the chrominance channel is non-conducting and the ident diode is forward biased so that the next trigger pulse is shorted. The bistable then misses a count so that correct switching is restored.

This is a neat and clever system which is accurate in operation. The bistable phase preset, as 3RV7 is called, is provided because although it has been assumed that total reference signal cancellation occurs when the bistable switching is incorrect this is

Fig. 4 (right): Block diagram of the decoder used in the Teleton colour receiver.

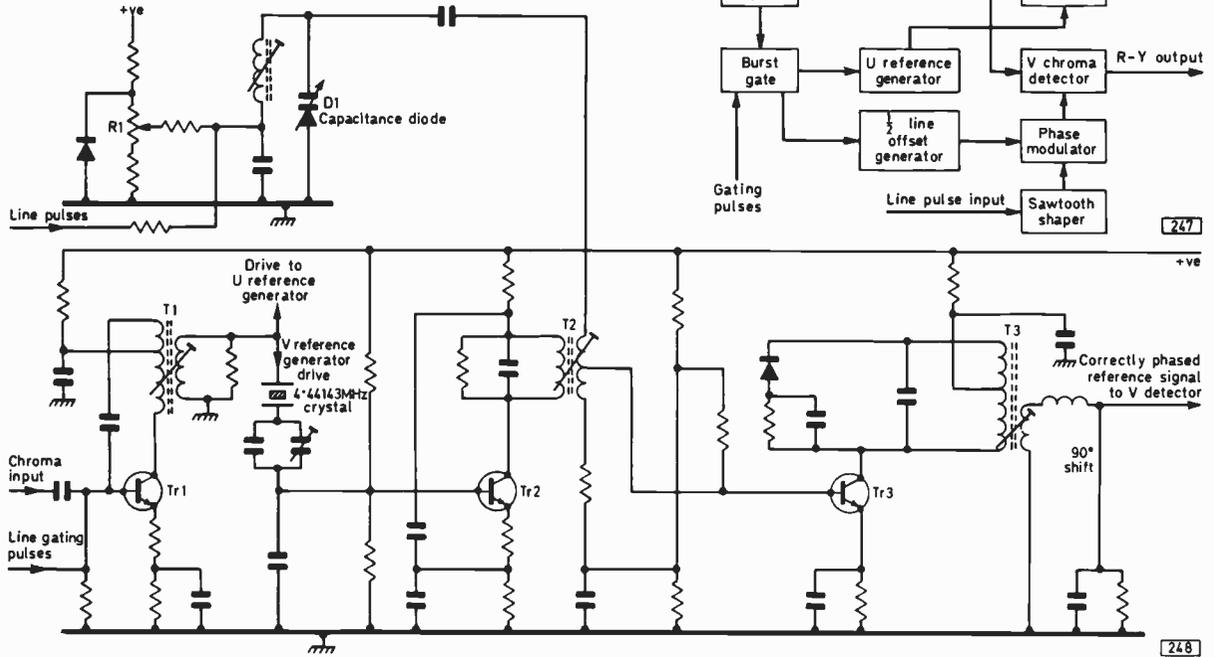


Fig. 5: The V subcarrier regenerator circuit used in the Teleton receiver.

subcarrier regenerator therefore produces a subcarrier along the V axis.

Switching is also used in the chrominance signal channel: a one line period delay line is introduced on alternate lines so that alternate lines of the chrominance signal are repeated, the partnering set of transmitted lines simply being deleted. This gets round the PAL chrominance phase alternations.

The burst and chrominance switching is controlled by an ident signal which is obtained from a "clock pulse check" circuit which effectively counts the pulses occurring during the field sync periods: since the sequence differs between the start of the odd and even fields enough information is present to enable the odd and even lines to be identified.

These techniques effectively cancel the PAL features of the transmitted signal, the receiver being arranged to process the signal in a manner that does not infringe the PAL patents—since at the time of writing Sony have not been licensed to produce PAL sets.

Teleton System

The Teleton (General Corporation of Japan) VX1110 colour receiver is another with a different and very interesting PAL signal decoding department. The relevant sections are shown in block diagram form in Fig. 4. The chroma amplifier feeds the V and U detectors direct but there is seemingly no reason why the set would not work with a PAL delay line and matrix so that the V and U detectors receive phase-insensitive V and U signals as in a PAL-D receiver. The set however operates in the PAL-S manner, i.e. without a chrominance delay line.

The reference signal for the U detector is obtained from a passive subcarrier regenerator circuit which

locks to the average phase by the transmitted bursts, i.e. $-U$. The set however has a completely novel way of obtaining the reference signal required by the V chroma detector. This signal is generated by a stage running at the subcarrier frequency (4.43MHz approximately) plus (could be minus) half the line frequency (i.e. 7.8kHz, which as a result of the phase alternations of the PAL bursts is a sideband of the burst signal).

It is this "offset" reference signal which eventually reaches the V detector, after processing by a phase modulator in conjunction with a sawtooth shaper to neatly provide V phase switching and ident.

The Teleton receiver then is arranged so that its half line offset generator is locked to the burst sideband which corresponds to the subcarrier frequency plus half line frequency, the crystal for this generator being cut to the corresponding frequency of 4.44143MHz. The ident is neatly secured as the half line offset signal assumes a phase common to just that one component of the bursts.

Now exactly one half cycle difference exists between the subcarrier frequency proper and the half line offset frequency over a period of one scanning line. This corresponds to a phase displacement of exactly 180 degrees. Thus by passing the half line offset reference signal to the V detector through a 90° phase delay network the correct conditions are provided for quadrature demodulation. Sadly there is a snag to this. The 180° displacement exists only at the commencement of each line, the displacement altering progressively as the line scan continues. Such a signal could not be used to drive the V detector as it would cause a progressive hue change from the start to the finish of every line.

The Teleton receiver overcomes this problem by using a phase modulator driven by a sawtooth signal (see Fig. 4). In essence the phase of the half line

offset reference signal is changed linearly by the sawtooth signal modulating the phase modulator during each line period so that the 180° relationship between the U and V reference signals is maintained from the start to the finish of every line. The phasing is accomplished by a capacitance-diode.

The circuit in which these operations take place is shown in Fig. 5. The burst amplifier Tr1 is fed with the chrominance signal and line frequency gating pulses so that a signal is developed across its load transformer T1 only during the burst period. T1 secondary drives both the U and V reference signal crystals, the latter ringing at the half line offset reference frequency. The train of 4.44143MHz oscillations is then fed to the base of Tr2 and appears across T2. The phase modulator section consisting of capacitance-diode D1 also feeds into T2 secondary. D1 is back-biased to a value determined by the setting of the preset R1 and reflects a capacitive component across T2 secondary. It is this which adjusts the phase of the half line offset reference signal.

The capacitance reflected across T2 secondary—and hence the phase of the V reference signal—changes linearly through the line period as a result of the sawtooth signal—integrated line flyback pulse—applied to the capacitance-diode circuit. Now over a period of two lines the offset signal has a phase displacement of exactly 360° with respect to the 4.43MHz colour subcarrier: in consequence the phase modulated output from T2 is alternating by 180° line by line, i.e. we obtain (after the 90° shift) a $\pm V$ reference signal on alternate lines so that we get correct PAL demodulation.

NEW AERIALS, CONVERTERS ETC.

J Beam have introduced a new range of universal loft aerials with angle regulator and universal clamp bracket. The PBL6 has a recommended retail price of £2.10, the PBL10 £2.55, the PBL12 £2.95 and the MBL30 £3.80.

Antiference have introduced a new set-top u.h.f. aerial, the Power-Plus, which they expect will increase the use of this type of aerial significantly, giving as it does a gain of 9dB by using a Yagi formation with a double director chain. The recommended retail price of this is £3.75.

A new mast-head amplifier from Wolsey, the Spectrum, can be used singly or in cascade and has an inherent noise level of the order of 3dB.

An up-converter (for feeding piped 625 v.h.f. signals to a single-standard u.h.f. receiver) with low-noise preamplifier giving 4dB gain has been introduced by Teleng who state that it should be mounted on the skirting board and not on the back of the set. Price is £9.50.

Labgear have also added another up-converter to their range, Model CM6022/RA: this incorporates an integral preamplifier and is intended for use in low-signal areas.

A log-periodic set-top aerial, the Tri-Star 4 (Model CM6021/ST), has been added to the Labgear aerial range. Using the log-periodic principle gives a flat response over the entire u.h.f. TV Bands. The "dipoles" on each side of the centre beam are made of continuous strip, giving a distinctive appearance to the aerial. The recommended retail price is £3.

Belling Lee have also joined the ranks of those offering up-converters: their model is called the TVertor.

NEXT MONTH IN

TELEVISION

COLOUR RECEIVER RGB AND AUDIO MODULES

Complete details next month of two of the colour receiver modules—the colour signal matrixing and output board and the i.c. audio output board. This is the first time that an RGB board has been presented to the constructor. The layout is not critical but care is required in the design to ensure stability and accurate black-level clamping. With these two boards we complete the signal side of the project.

SERVICING TV RECEIVERS

The very widely used Thorn/BRC 1500 single-standard monochrome chassis has now had time to reveal its common faults and next month Les will be telling us what goes wrong and what to look for. Many readers have asked us to deal with this chassis.

SINEWAVE LINE OSCILLATORS

You might at first think it odd to use a sinewave oscillator as the line generator stage. Sinewave oscillators have however been used for this purpose for a number of years and have the advantage of much better frequency stability which is particularly important in colour receivers in which pulses from the line output stage are used for various colour signal processing control functions—gating, clamping and so on. Next month Keith Cummins delves into all this and gives a practical circuit for use in his popular 625-line receiver.

PLUS ALL THE REGULAR FEATURES

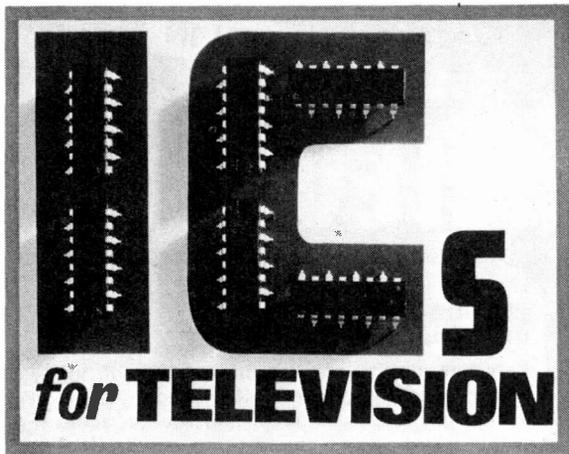
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PART 7

K. T. WILSON

MULLARD TBA SERIES—2

SINCE the last part in this series Mullard have released details of a PAL-D decoder developed in their laboratories in which most of the circuitry has been integrated into four i.c.s.—a TBA560Q which undertakes the luminance and chrominance signal processing, a TBA540Q which provides the reference signal channel, a TBA990Q which provides synchronous demodulation of the colour-difference signals, G—Y signal matrixing and PAL V switching, and a TBA530Q which matrixes the colour-difference signals and the luminance signal to obtain the R, G and B signals which after amplification by single-transistor output stages drive the cathodes of the shadowmask tube. The TBA530Q and TBA990Q were covered in our last instalment: the TBA540Q and TBA560Q and also the TBA500Q and TBA510Q which provide an alternative luminance and chrominance signal processing arrangement will be covered this time.

The internal circuits of the TBA530Q and TBA520Q (predecessor to the TBA990Q—which shows how fast things are moving at present) were shown in Part 6 in order to give an idea of the type of circuitry used in these linear colour receiver i.c.s. The internal circuitry is not however of great importance to the user or service engineer: all we need to know about a particular i.c. are the functions it performs, the inputs and outputs it requires and provides and the external connections necessary. The i.c.s we shall deal with in this instalment are highly complex internally—the TBA560Q for example contains some 67 integrated transistor elements alone. This time therefore we shall just show the immediate external circuitry in conjunction with a block diagram to indicate the functions performed within the i.c.

TBA540Q Reference Signal Channel

A block diagram with external connections for this i.c. is shown in Fig. 1. In addition to providing the reference signal required for synchronous demodulation of the colour-difference signals this i.c. incorporates automatic phase and amplitude control of the reference oscillator and a half line frequency synchronous demodulator which compares the phases and amplitudes of the burst ripple and the square wave-

form from the PAL V switch circuit in order to generate a.c.c., colour killer and ident outputs. The use of a synchronous demodulator for these functions provides a high standard of noise immunity in the decoder.

The internal reference oscillator operates in conjunction with an external 4.43MHz crystal connected between pins 1 and 15. The nominal load capacitance of the crystal is 20pF. The reference oscillator output, in correct phase for feeding to the V signal synchronous demodulator, is taken from pin 4 at a nominal amplitude of 1.5V peak-to-peak. This is a low-impedance output and no d.c. load to earth is required here. The bifilar inductor L1 provides the antiphase signal necessary for push-pull reference signal drive to the burst detector circuit, the antiphase input being at pin 6. The U subcarrier is obtained from the junction of a 90° phase shift network (R1, C1) connected across L1. The oscillator is controlled by the output at pin 2. This pin is fed internally with a sinewave derived from the reference signal and controlled in amplitude by the internal reactance control circuit. The phase of the feedback from pin 2 to the crystal via C2 is such that the value of C2 is effectively increased. Pin 2 is held internally at a very low impedance. Thus the tuning of the crystal is automatically controlled by the amplitude of the feedback waveform and its influence on the effective value of C2.

The burst signal is fed in at pin 5. A burst waveform amplitude of 1V peak-to-peak is required (the minimum threshold is 0.7V) and this is a.c. coupled. The a.p.c. loop phase detector (burst detector) loads and filter (R2, C4, C5 and C6) are connected to pins 13 and 14.

A synchronously-generated a.c.c. potential is produced at pin 9. The voltage at this pin is set by R3 to 4V with zero burst input. The synchronous demodulator producing this output is fed with the burst signal and the PAL half line frequency squarewave which is a.c. coupled at pin 8 at 2.5V peak-to-peak. If the phase of the squarewave is correct the potential at pin 9 will fall and normal a.c.c. action will commence. If the phase of the squarewave is incorrect the voltage at pin 9 will rise, providing the ident action as this rise will make the PAL switch miss a count thereby correcting its phase. A colour-killer output is provided at pin 7 from an internal switching transistor. If the ident conditions are incorrect this transistor is saturated and the output at pin 7 is about 250mV. When the ident conditions are correct (voltage at pin 9 below 2.5V) the transistor is cut off providing a positive-going turn-on bias at pin 7. The network between pins 10 and 12 provides filtering and a.c.c. level (R3) setting. The control connected to pin 11 is set so that in conjunction with the rest of the decoder circuitry the level of the burst signal at pin 5 under a.c.c. control is correct.

The positive d.c. supply required is applied to pin 3 and the chassis connection is pin 16.

TBA560Q Chroma-Luminance IC

A block diagram with external connections for this i.c. is shown in Fig. 2. The i.c. incorporates the circuits required to process the luminance and chrominance signals, providing a luminance output for the RGB matrix and a chrominance output for the PAL delay line circuit.

1V and giving maximum gain reduction at 200mV. The saturation control is connected to pin 13 and the colour-killer potential is also applied to this pin: the chrominance channel is muted when the voltage at this pin falls below 1V. The chrominance output, at an amplitude of about 2V peak-to-peak, is obtained at pin 9: an external network is required which provides d.c. negative feedback in the chrominance channel via pin 12.

The burst output, at about 1V peak-to-peak, is obtained at pin 7. A network connected to this pin also provides d.c. feedback to the chrominance input transformer (connected between pins 1 and 15) to give good d.c. stability. Line and field blanking pulses are fed in at pin 8 to the luminance and chrominance channels: these negative-going pulses should not exceed -5V in amplitude. The d.c. supply is applied to pin 11 and pin 16 is the chassis connection.

TBA500Q Luminance IC

A block diagram with external connections for this i.c. is shown in Fig. 3. This i.c. provides a colour receiver luminance channel incorporating luminance delay-line matching stages, a black-level clamp and a d.c. contrast control which maintains a constant black level over its range of operation. A beam current limiting facility which first reduces picture contrast and then picture brightness is provided and line and field flyback blanking can be applied.

A video input signal of 2V peak-to-peak with negative-going sync pulses is required at pin 2, a.c. coupled. A clamp potential obtained from pin 13 via a smoothing circuit is fed to pin 2 to regulate the black level of the signal at pin 2 to about 10.4V. The smoothing network for the black-level control potential should have a time-constant which is less than the time-constant of the video signal coupling network.

The 3V peak-to-peak composite video output with positive-going sync pulses obtained at pin 3 from an emitter-follower can be used as a source of chroma signal: in Fig. 3 it is used as a source of sync pulses for the black-level clamp, fed in at pin 15. This pin requires positive-going sync pulses of 2V amplitude or greater for sync-cancelling the black-level clamp. The other input to the clamp consists of negative-going back porch pulses fed in at pin 1 to operate the clamp. The timing of these pulses is not critical provided the pulse does not encroach on the sync pulse period and that it dwells for at least $2\mu\text{s}$ on any part of the back porch—clamp pulse overlap into the picture line period is unimportant. A low-pass filter capacitor for the clamp is connected at pin 14 to prevent the operation of the clamp being affected by the bursts or h.f. noise.

The contrast control is connected to pin 5 and is linked to the saturation control so that the two track together. A variation of from 2 to 4V at pin 5 gives a control range of at least 40dB, the relationship between the video at pin 4 and the potential at pin 5 being linear.

An output to drive the luminance delay line is provided at pin 4. This is a low-impedance source and a luminance delay line with a characteristic impedance of 1.2-7k Ω can be used. The delayed luminance signal is fed back into the i.c. at pin 8. Line and field flyback banking pulses and the brightness control are also connected to this pin. The gain of the luminance channel is determined by the value

of the resistor connected to pin 9. The luminance output is taken from an emitter-follower at pin 10, an external load resistor being required. The voltage output range available is from 0.7V to 5.5V. The potential of the black level of the output signal is normally set to 1.5V by appropriate setting of the potential at pin 8. A luminance signal output amplitude of 2.8V black to white at maximum contrast is produced: superimposed on this is the blanking waveform which remains of constant amplitude independently of the contrast and brightness control settings.

A beam current limiting input is provided at pin 6. A rising positive potential at this pin will start to reduce the contrast at about 2V. Further increase in the voltage at this pin will continue to reduce the contrast until a threshold is reached, determined by the potential applied to pin 7, when the d.c. level of the video signal is reduced giving reduction in picture brightness.

The d.c. supply is connected to pin 12 and pin 16 is the chassis connection.

TBA510Q Chrominance IC

A block diagram with external connections for this i.c. is shown in Fig. 4. It provides a colour receiver chrominance signal processing channel with a variable gain a.c.c. chroma amplifier circuit, d.c. control of chroma saturation which can be ganged to the operation of the contrast control, chroma blanking and burst gating, a burst output stage, colour-killer circuit and PAL delay line driver stage.

The chroma signal is a.c. coupled to pin 4, the a.c.c. control potential being applied at pin 2. The non-signal side of the differential amplifier used for the a.c.c. system is taken to pin 3 where a decoupling capacitor should be connected. A resistor can be connected between pins 2 and 3 to reduce the control sensitivity of the a.c.c. system to any desired level. The saturation control is connected to pin 15, the d.c. control voltage range required here being 1.5-4.5V. For chrominance blanking a negative-going line flyback pulse of amplitude not greater than 5V is fed in at pin 14. A series network is connected to pin 6 to decouple the emitter of one of the amplifying stages in the i.c.: the value of the resistor in this network influences the gain of both the burst and the chroma channels in the i.c.

The chrominance signal outputs are obtained at pin 8 (collector) to drive the chroma delay line and pin 9 (emitter) to feed the chrominance signal matrix (undelayed signal). A resistive path to earth is essential at pin 9. The colour-killer turn-on bias is applied to pin 5: colour is "on" at 2.3V, "off" at 1.9V. Chroma signal suppression when killed is greater than 50dB.

The burst signal output is at pin 11 (collector) or 12 (emitter). If a low-impedance output is required pin 11 is connected direct to the 12V supply rail and the output is taken from pin 12. An external load of 2k Ω connected to chassis is required here. The burst gating pulse is fed in at pin 13, a negative-going pulse of not greater than 5V amplitude being required.

Pins 7 and 10 are connected to an internal screen whose purpose is to prevent unwanted burst and chroma outputs: the pins must be linked together and taken via a direct path to earth. Pin 1 is the d.c.

—continued on page 424

THE 'TELEVISION' COLOUR RECEIVER

PART 4

BUILDING THE COLOUR IF STRIP

MANY readers will have taken advantage of our suggestion last month that the components for the i.f. module be ordered in preparation for the construction this month. The first thing to do is to check the components off against the full components list given last month. Any shortages should be brought up with the suppliers.

Some general comments about the i.f. module are appropriate at this point. A great deal of mysticism has arisen about r.f. stages and the circuits handling r.f. and i.f. signals. As with any problem the answers once known seem simple. Unfortunately however few of us are lucky enough to have had the equipment, time and facilities available to be allowed to explore this area in detail.

In this instance we are providing the constructor with a ready made answer and as long as the few points we mention are noted during the actual construction problems should be either non-existent or very minor. Many older hands will already have noticed the general absence from the components list of high tolerance capacitors—there are some but they are relatively few. An even bigger surprise may be that very few of the tuning capacitors are screened off; coils are screened where necessary but not otherwise. All this can be achieved in a modern i.f. strip provided the layout is right and the board is eventually mounted in the right manner in the receiver.

Printed Circuit Board

The necessary care has been taken in designing the printed circuit board for the i.f. module—the one presented is in fact the fourth generation of design and gives—in the prototype—extremely stable operation. The board is available from the supplier listed in the June issue of the magazine but there will be those readers who want to make their own. The same instructions can be followed as given for making the decoder board in the May issue. The board is not quite as long as the decoder one and can be etched in a smaller bath. A great deal more care has to be taken however in marking up the copper before etching. It is particularly important that the chassis areas are left as shown (Fig. 1) and that all the contact points—around the intercarrier amplifier integrated circuit for example—are left the same size and in the same positions. (Fig. 1 is to scale.) Take special care that there are no whiskers of copper left between copper areas after etching because even when these are not connected to anything the inevitable capacitance effects they produce can give trouble.

The various holes should next be drilled. The size for the majority of the components should be 1/32in.

but the holes for the coil bases—not chokes L112, L113, L119 and L120—the transistors, the potentiometers and we would suggest the luminance delay line should be 1/16in. Also make the six 3/16in. holes around the edge that will later be used for mounting the board in the cabinet. The accuracy of the hole positions on this board is of more importance than on the decoder panel but don't develop a fetish about it: put them as close as possible to the markings on Fig. 1 and you should be OK. Notice particularly that the spacing between the pins on the Neosid coil bases is unbalanced: it is vital that these holes are drilled the correct way round so that the coils can be mounted in only one direction.

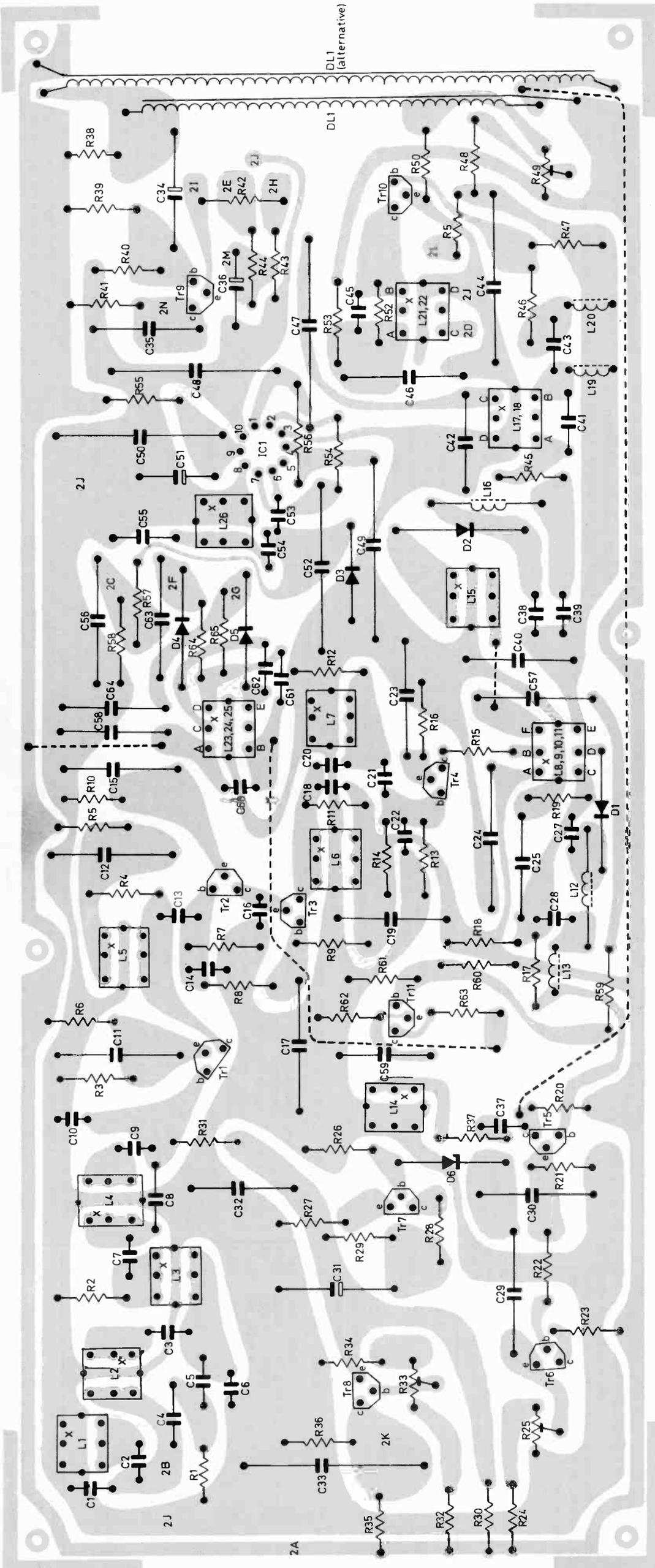
Remember to take care not to exert excess pressure on the hand brace—otherwise the paxolin will split—and always drill from the copper side. When the holes are all made check and double check against the diagram to prevent possible later damage which might be caused by having to drill holes with the other components already mounted.

IF Coils

The constructor will have already obtained a set of coils from the suppliers of Component-Pack No. 6. You will notice from the list that this set is not absolutely complete: just as it would have been uneconomic to have had the transformers in the decoder module wound it would be uneconomic to have three of the smaller inductors for the i.f. module wound. These are L113, L119 and L120: they are constructed on single-hole Ferroxcube formers type FX1242 (in Component-Pack No. 5) and will be described later.

For the constructor who buys the ready-made set of coils only these three have to be wound. We cannot advise you to wind your own i.f. coils unless you have had a lot of experience. Data however is given in Table 1. The formers are all Neosid as are the choke formers used for L112 and L116. L101-L107 and L115, L126 are all straightforward close layer-wound coils with the number of turns and wire gauge as indicated. It will be noted however that L115 uses a larger former and longer core. L112 and L116 wound as chokes are also quite straightforward with the winding ends soldered directly to the lead-out wires of the former. L114 is wave-wound over ¼in. and really requires a winding machine: scramble- or pile-wound this coil would need fewer turns.

L117/118 is quite straightforward with two single-layer windings separated by about 1mm. on the larger 722/4 former whereas L121/122 consists of two wave-windings over ¼in. with L122 wound first on the former and L121 then wound over it. L123 is a



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Fig. 1: Layout of the i.f. board, viewed from the copper print side: all components are mounted on the other side of the board. Although shown in broken line the jumper leads are on this side of the board. Hole sizes are detailed in the text. Connecting pads marked 2A, 2B etc. Coil connection letters correspond with those on the circuit (page 355 last month). X on coil bases indicates the end of closer pin spacing. C126 is mounted in the can with L108-L111. Note that to make the lettering above as clear as possible the board code prefixes have been omitted from the component reference numbers, i.e. C1 above is shown as C110 in the circuit diagram and components list, C10 above is shown as C110 elsewhere and so on.

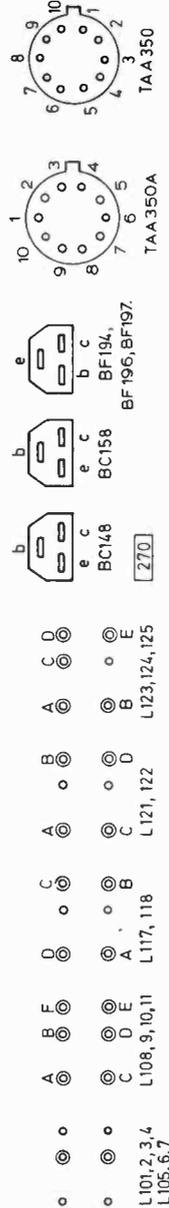


Fig. 2: Main coil base connections, pins viewed from below the base. The encircled pins are those to which the connections are made. Note that the pin spacings are not symmetrical. The letters on the multiple coil bases correspond to the letters on the circuit diagram and the component layout. C126 is included in the same screening can as windings L108/L109/L110/L111 and is supplied with either the ready-wound set or the kit of pieces comprising Component-Pack 6.

was being drilled. Push the can down so that it is flush with the board, bend over the mounting tags and solder to the copper. Then solder the connecting pins. Solder as close as possible to the copper surface, with the heat applied to the side of the pins. After soldering check the continuity of the windings with your test meter.

The two choke inductors L112 and L116 can next

be mounted with the wire ends folded over to drop through the appropriate holes and about 1/16 in. of lead folded over on to the copper, the rest being snipped off. Then mount the resistors and after this the capacitors. Note that C126 (47pF) is already contained in the screening can of L108 etc. Use Fig. 1 as your reference and check particularly carefully the polarity of the electrolytics. Recheck the position of each component before moving on and try to bend the component leads so that the value of the component can be easily read after soldering.

The diodes can come next, the coloured band indicating the cathode end. After these the transistors can be mounted: they should be pushed home fairly firmly so that the lock-fit pins pass through the board to leave sufficient soldering length on the copper side. The usual precautions should be taken when soldering. The base connections are shown in Fig. 3 as is the pin

numbering system on the TAA350 (or TAA350A) integrated circuit which is next to be mounted. Keep the small plastic pin spacer on the base of the i.c. and ease the pins out to form a slightly larger circumference than the actual base. Then insert the leads through the previously drilled holes. It is fairly tricky trying to get all the leads through the drilled holes in one go and a little patience is needed. Don't push the i.c. right down on to the board—it isn't necessary—but don't leave more than about 1/16 in. of lead above the board. Fold over all the leads on the copper side of the board (bend them away from the centre axis of the i.c.) and snip them off to just 1/16 in. or so. The element must then be soldered down but before doing so do check that it has been mounted the correct way round with the tab positioned between the holes representing contacts 1 and 10 for the TAA350 and between those representing contacts 4 and 3 (see

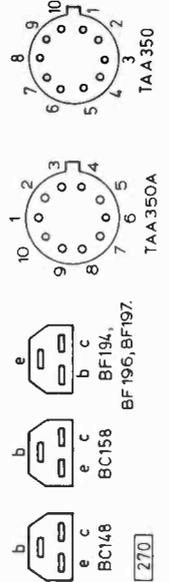


Fig. 3: Transistor and integrated circuit base connections, viewed from below.

Fig. 3) for the TAA350A if this has been supplied in place of the TAA350.

Do not try to solder all the connections to the i.c. in one quick rotation because although the temperature on each lead may be all right the total amount of heat flowing into the chip may be enough to cause damage. Solder one lead at a time, let it cool down fully, then move on to the next lead and so on. Although some readers will disagree with the principle of turning the lead over slightly on the copper side of the board such a procedure does on a multitag component especially give a little mechanical advantage and reduces the chances of a dry joint. Provided you don't over solder the joints there will be little bother in their removal at a later date if this is necessary.

Luminescence Delay Lines

The luminescence delay line can next be mounted. One of three types will have been supplied in Component-Pack No. 5 depending on their availability at the time of publication. One is made by Siemens and is a plastic coated line and is the shorter variety while a second has a white plastic insulation wrap. For the purposes of the project this second one is an "alternative" although the electrical performance of the lines is virtually identical. The third type is the same size as the Siemens one but is completely encapsulated.

The shorter line is mounted using the three holes exactly in line across the board (Fig. 1). At the end that has two connections the outer is the one to the +20V rail. With the longer type line this connection is from a soldered wire on the side of the line and the three holes slightly farther towards the edge of the board are used. We made no reference to this in the hole drilling earlier but would advise that all six delay-line holes are made so that interchangeability of lines in the future—should this be necessary because of failure—will be no problem.

On the longer type line supplied there are four connecting leads with two supply rail connecting points on the sides—one at each end of the line. Only one of these is required and the other should be snipped off close to the body of the line. Check that you are snipping off the correct one by placing the line on the board with the supply connectors on the edge side. The end where only one hole is drilled is the end where the removal should be made.

Mount the line with the three leads through the correct holes, check your connections and solder up. Don't leave the line flat on the paxolin surface but don't leave more than about $\frac{1}{16}$ in. gap.

Although the constructor could make his own luminescence delay line this has never been regarded as very economical to us in terms of the work involved. If you want to tackle this however we would suggest you read pages 3.11-3.13 of the Mullard publication "PAL Colour TV..." (1966).

Final Assembly

All that you should now have left over for mounting are the three Ferroxcube cores. We would suggest that as for the transformers in the decoder these can be stuck to the board adjacent to their lead-out holes using Evoxstik or a little Araldite. Leave them to harden in place overnight and then take the wires

through the holes, clean off the enamel covering carefully with a pen-knife and solder down.

The only remaining thing to be done is to wire four interconnecting leads across the copper side of the board: they are indicated in Fig. 1. Use insulated wire of course and for the two longer runs it is wise to attach them to the board at a few points along their length with a smear of Evoxstik.

The i.f. module is not as heavily loaded as the decoder and there is not really any need to support the board against warping. Just store it in a safe place until you need to use it in the receiver.

Checking Your IF Module

The layout of the components on the board, the polarity of the electrolytics and the diodes, the connections of the transistors and the values of all components should be checked and rechecked against our drawings and, if you care to, against the circuit diagram. When you are absolutely satisfied that all is well make an additional resistance check between the +20V and the earth rails on the printed circuit copper using your test meter. The reading obtained with the meter leads connected in either polarity should be between 650 and 670 Ω . It is also important on this board to ensure that there are no solder bridges across any copper areas and that no point is over soldered.

For the moment this is all you can do unless you have r.f. sources and test equipment. The full alignment of the i.f. module including the a.g.c. and a.f.c. facilities will be described in a later issue. A note about the Alignment Service is given in the "Readers have Asked..." section at the end of this part of the series.

Performance

It is convenient to give details of the performance of the i.f. module at this point because the various requirements discussed in Part 3 will still be fresh in the reader's mind. The results quoted are those from the prototype receiver but it should be possible to obtain the same results from any of the constructed modules providing the circuit layout and the recommended components are used and given that the alignment details are followed.

Of principal concern of course is the achievement of the correct frequency response together with the various rejections quoted as being required (see June issue). The response should also be substantially unaffected by variations in gain as a result of a.g.c. action.

The result for the prototype is shown in Fig. 4. This is the sweep response measured at the luminescence output point (2I in the incomplete receiver). The solid line indicates the response at full gain and the dotted line that at full gain reduction of 45dB. In practice the gain will be between these lines, depending on the gain of the tuner used, the service area field strength and the aerial system.

Of principal note is that the vision carrier point at 39.5MHz is well held at its correct —6dB point over the full gain range and that the main luminescence components up to 5MHz (i.f. of 34.5MHz) are still within 6dB of the centre frequency components. This is well within an acceptable specification particularly as luminescence components up to 4MHz are within 3dB. The flatness of the response is slightly better at full gain although the roll-off down to the carrier point

single-layer winding while 4.5mm. away on the former is the bifilar winding of L124 and L125: the bifilar spacing is one wire diameter so this must be wound with four lengths of wire and then two discarded after the two to be left have been secured to the former adequately with cement. This arrangement is also on the larger Neosid type 722/4 former.

L108/109/110 is the most complex winding. L108 and L109 are bifilar wound together (close bifilar wound unlike L124/125) quite close to the base of the former. The three turns of L110 are overwound at one end of this bifilar wind and this position then defines the earthy ends of L108/L109 (i.e. the end closest to the supply voltage—tags A and C on the circuit and layout diagrams). At the top end of the former is then wound the single layer of L111. Note that in order to accommodate the whole of this arrangement the same screening can has also to include C126 which is internally connected. A suitable mounting position must be determined for this 47pF component so that the can will not foul it. You will note that the larger former is also used for this component.

All the windings used in the i.f. strip must be securely supported, preferably using a material which has no capacitive effect and is not affected by temperature changes. Polystyrene cement is quite good for this purpose but wax should be avoided. Make all the lead connections to the base as short as possible after positively identifying the ends with your test meter. The base connections are shown in Fig. 2—the letters given correspond with the circuit and the constructional data for the coils. The base has also to be glued to the former—as vertically as possible—using something such as Evoxstik. Put the cans over the windings as soon as possible to protect them and nick the bottoms of the cans slightly to secure them until they are mounted on the board. The tags on the outside of the can are not of course folded over at this stage as they will form the chassis connections on the copper side of the board.

All constructors must wind L113, L119 and L120 on the FX1242 Ferroxcube formers (Component-Pack No. 5). The windings are very simply made: pass the wire through the hole, back along the outside of the former and then through the hole again for the next turn. It is not of course possible to get a complete number of turns in this way and it would be more accurate to describe the number of turns (Table 2) as the number of passes of wire through the centre hole. Make the windings quite tight without being so tight as to risk damage to the enamel insulation. Avoid wire kinks and keep the outer wires on one side of the former so that another side can be used for gluing on to the board. Leave a few inches of wire at each end of the winding for the later connections and put a smear of Evoxstik across the outer wires to hold them semi-rigid until the coils are mounted.

Component Mounting

As with the decoder module it will pay you to lay out the components for the board in some order of value or component numbering: there are 156 items to be mounted on the board and it is extremely time consuming and frustrating to have to sort through the complete pile to find for example a 1k Ω resistor when you want it.

Take the usual precautions when soldering, avoid-

Table 1: Main coil winding data

Ref.	Former	Core	Wire (s.w.g.)	No. of turns	Note
L101	722/1	6/900	38	10	7
L102	722/1	6/900	38	8	7
L103	722/1	6/900	38	11	7
L104	722/1	6/900	38	15	7
L105	722/1	6/900	38	9	7
L106	722/1	6/900	38	27	7
L107	722/1	6/900	38	7	7
L108			40	25	7
L109	722/4	6/900	40	25	7
L110			40	3	1
L111			28	9	1
L112	CH2/7/500		47	86	2
L113	see Table 2				
L114	722/1	6/900	42	140	3
L115	722/4	12.7/900	40	30	7
L116	CH2/7/500		47	86	2
L117			42	30	2
L118	722/4	6/900	42	27	4
L119	see Table 2				
L120	see Table 2				
L121			42	50	5
L122	722/1	6/900	38	25	5
L123			38	7	5
L124	722/4	6/900	42	6	6
L125			42	6	6
L126	722/1	6/900	42	35	7

Wire used may be en cu, ess, tna or similar.

All cores for Neosid 722/1 and 722/4 formers are 4 x 0.5mm. and either 6 or 12.7mm. long as indicated in the Table. Chokes CH2/7/500 are by Neosid.

Notes:

- (1) L111 is wound at the top of the former; at the bottom L108 and L109 are bifilar wound at the earthy end.
- (2) Single layer wound, central on the choke: 65 μ H.
- (3) Wave-wound over $\frac{1}{16}$ in.
- (4) Wound with earthy ends together and spaced by 1mm.
- (5) L122 wave-wound over $\frac{1}{16}$ in. L121 wave-wound over L122.
- (6) L124 and L125 are bifilar wound with one wire diameter spacing: L123 is single-layer winding 4.5mm. away from the other windings.
- (7) Single-layer wound.

Table 2: Small inductor winding data

Ref.	Turns	Inductance Given
L113	10	31 μ H
L119	6	9 μ H
L120	6	9 μ H

All three inductors use 38 s.w.g. wire preferably en cu wound on Mullard FX1242 Ferroxcube formers.

ing too much heat on either the copper or the component. Also avoid using an excessive amount of solder—there are quite a few points on the board where a solder bridge could easily occur between copper areas.

We would again suggest mounting the screened coils first. Put them through the appropriate set of holes in the board being careful not to try to mount them the wrong way round. This cannot happen if the asymmetry of the holes was observed while the board

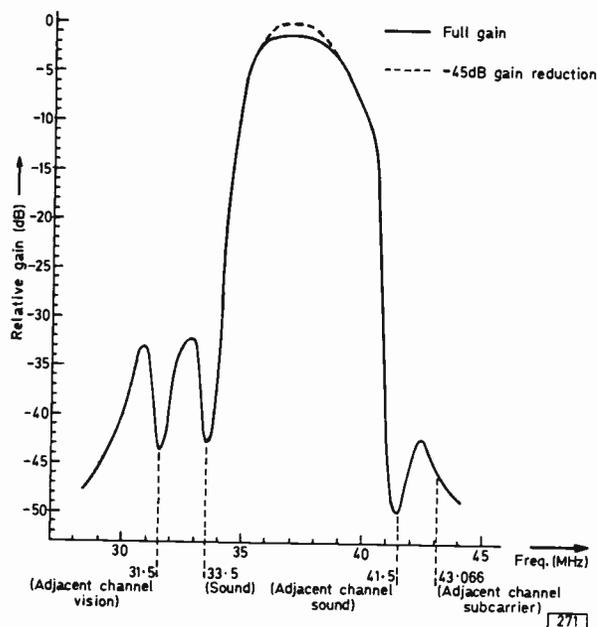


Fig. 4: Amplitude response of the i.f. channel at the luminance output (point 2E).

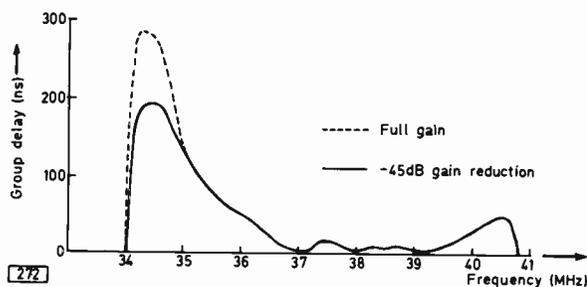


Fig. 5: Luminance channel group delay.

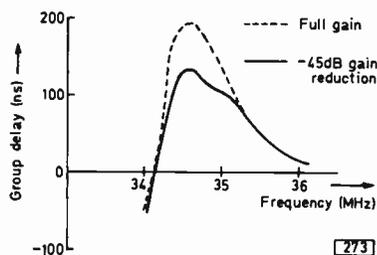


Fig. 6: Chrominance channel group delay.

is slightly poorer. This is the best compromise that can be adopted between these two features. No additional improvement of the frequency response is obtainable without worsening the group delay considerably.

The rejections are important of course and can also be seen in Fig. 4. Sound reduction (necessary for the prevention of visible chroma/sound beat patterning) at 33.5 MHz is -43 dB (our specification was at least -40 dB); adjacent channel vision at 31.5 MHz is rejected by -44 dB; adjacent channel sound at 41.5 MHz is -50 dB down and adjacent channel subcarrier at 43.066 MHz is rejected by -46 dB. There is substantially no response (better than -45 dB down) above 43.066 MHz or below 29 MHz.

A satisfactory frequency response would be of no use if it was not accompanied by a satisfactory group delay characteristic for both the luminance and chrominance outputs. Fig. 5 shows the test results (note that the majority of service workshops are not equipped to make these measurements but the results can be guaranteed if the frequency response has been set up correctly using the correct tuning inductances). As we indicated before disturbances in group delay around the vision carrier point are particularly disturbing but in the prototype such variations were insignificant. Above the vision carrier (i.e. around 40.5 MHz) the delay rises to about 50 ns but this is on the edge of the vestigial sideband response and does not contribute any detectable picture degradations. Inevitably the reduction of group delay effects around the vision carrier affects the other end of the frequency response and at video frequencies above 3 MHz (i.e. below an i.f. of 36.5 MHz) the delay starts to rise quite rapidly to reach a maximum of about 280 ns at full gain and 200 ns at minimum gain (-45 dB). At these frequencies however group delays of this order are quite tolerable whereas 20-30 ns at a video frequency of 0.5 MHz would be unacceptable.

The chrominance output has a slightly different group delay characteristic because of the output coupling and chrominance channel tuning and the result obtained is indicated in Fig. 6. At the subcarrier i.f. (35.066 MHz) the group delay is of the order of 110 ns with reference to the vision carrier i.f. This represents an absolute delay of chrominance with respect to the luminance channel and is part of the 600 ns required in the luminance delay line. The variation of group delay around the subcarrier frequency is seemingly significant but because very little chrominance information ever occurs above 0.5 MHz this is the only range of any real concern. The variations encountered in the upper sideband (35.066 to 35.566 MHz) are only -35 ns and in the lower sideband (35.066 to 34.566 MHz) a maximum of +90 ns (at full gain) and a minimum of +20 ns (at minimum gain). The lower sideband average is around +55 ns and a great deal of cancellation between the upper and lower sideband group delays takes place because of course any individual chrominance frequency component will appear in both sidebands.

About 47 dB of gain control is available from the a.g.c. in the prototype and the overall gain from the input to the luminance output point is 73 dB. Some small variations in this figure can be expected from different transistor samples. The maximum luminance output level is about 4.5 V and the video output level to feed the sync separator (point 2N) is also about 4.5 V pk-pk.

The audio output level (from point 2C) is 23 mV and this is unaffected by a.g.c. variations from minimum to maximum gain. The a.m. rejection measured with 30% amplitude modulation superimposed on the f.m. signal is 46 dB. This offers considerable protection against intercarrier buzz originating in the receiver and can only be increased by increasing the sound drive level to the TAA350. That would only be achieved at the cost of chroma/sound beat patterning.

The chroma output from the a.c.c. amplifier stage is about 100 mV pk-pk measured on the subcarrier reference burst (i.e. about 350 mV pk-pk chroma). The a.f.c. output is sufficient to hold the Mullard ELC1043 varactor tuner but with some other tuners

an additional d.c. amplifier would be required: more mention of this will be made in a later part.

Audio Module Components List

As a starter to next month's construction—the colour matrix and output module and the audio output module—we suggest that readers purchase the components for the audio output stage during the coming month (all in Component-Pack 7). These are listed in Table 3.

Table 3: Components list for audio output module

Component—Pack 7			
IC801	GEL263S1 (PA263)	C801	330nF
R801	330k Ω	C802	2200pF
R802	39k Ω	C803	500 μ F
R803	18k Ω	C804	100nF
R804	150k Ω	C805	50 μ F
R805	39k Ω	C806	5 μ F
R806	22 Ω		
R807	1k Ω		

All resistors are 5%, $\frac{1}{2}$ W carbon film
 100 and 330nF capacitors are 100V metallised poly-carbonate. 2200pF is polyethylene, low inductance. 500 μ F and 50 μ F are 35V electrolytics, 5 μ F is 25V electrolytic. (Note: IEC values of 470, 47 and 4.7 μ F may be supplied.)
 Printed Circuit Board.

Component-Pack Supplier
 No. 7 East Cornwall Components, PO Box No. 4,
 Saltash, Cornwall, PL12 4AL.
 Cost: £2.80 including postage.

Decoder Error

An unfortunate error occurred in the May issue when dealing with the construction of the decoder. The markings given in Table 3 (page 315) for transformers T1 and T5 were incorrect. They should have been as follows:

T1	Primary 5	Mark start as 1 Mark finish as 2
	Secondary 5+5 bifilar	Mark 1st start as 4 Mark 1st finish as 3 Mark 2nd start as 3 Mark 2nd finish as 5
T5	Primary 4+4 bifilar	Mark 1st start as 1 Mark 1st finish as 2 Mark 2nd start as 2 Mark 2nd finish as 3
	Secondary 4+4 bifilar	Mark one start as 4 and finish of same winding as 5. Mark 2nd start as 6 and finish of this winding as 7.

As can be seen the number and types or turns were correct, only the connection markings being incorrect. If you have not yet started construction follow the above instructions for the markings. If you have already completed the transformers and

have them mounted you should proceed as follows:
 T1: Leave connections 1, 2 and 4 as at present. Unsolder the two wires at connection point 3. With a test meter on the ohms range identify which of the two wires is the one on the same winding as that beginning at point 4 and return this wire to point 3. Take the second wire to point 5 and take the wire originally connected to point 5 to point 3 as the second connection there.

T5: Leave connection 1 as before. Unsolder the two wires at connection point 2. With a test meter on the ohms range identify which wire is the same winding as that beginning at point 1 and return this wire to point 2. Take the other wire that was connected to point 2 to point 3 and take the wire that was connected to point 3 to point 2 as the second connection to the earth point. Then unsolder and swap over the wires at points 6 and 7.

Readers have asked . . .

. . . All sorts of questions, some of which we are going to try to answer in this section since if we tried to answer every small point in the hundreds of letters we have received, well the July and August issues for a start would not appear! This is a small, specialised magazine and in consequence has to be run with very limited staff—in fact one full time plus a great deal of help from our sister magazines and our very helpful band of contributors. So please bear with us.

We must also ask you to be patient with the suppliers of components for the colour receiver. At the time of writing this over 1,300 readers have started to construct the set, and it's early days yet. We are not clairvoyant and could not have expected a reaction on this scale. Nor could our suppliers. The parts we are using are all standard so no one will find themselves short of anything. But stocks held by suppliers can rapidly run out with the sort of demand that has arisen and we then have to take our place in the queue at the component manufacturers—along of course with BRC, RBM and all the rest since with the present boom in the television industry shortages are occurring all over the place—ask your local radio and television dealer who has been on quota now for months.

That said let's get on with the queries. No, sorry, we can't supply any advance data. Many readers want information on all the boards for example. The prototype sets use one off boards, hand made. We just haven't had the time yet to prepare final artwork for all the boards which our suppliers will be making available as the project progresses. Other readers have asked for complete components lists. It sounds simple enough, just run off a few and send out. But it isn't like that. Already the design is being altered slightly here and there not because it doesn't work but in order not to use certain components and devices that are proving to be in short supply. For all these and other reasons we are having to proceed at a cautious pace.

Some readers have had difficulty in getting the 38 s.w.g. d.c.c. wire to wind the small transformers on the decoder board. For the decoder a length of 15ft. of double-covered wire is available from East Cornwall Components, PO Box 4, Saltash, Cornwall, at 15p including postage. The same supplier will supply a 5ft. length of 38 s.w.g. enamelled copper wire for the three i.f. deck coils for 7p including postage. If

you want to get lengths to meet both requirements these are available at 18p including postage.

Other readers have had difficulty in getting blank boards of the correct size. A blank decoder board, i.e. one for you to etch yourself, is available cut to size from Servitronix Ltd., 26 Killarney Road, Wandsworth, London SW18 2DX, at 70p including postage. The same supplier will be making the other boards available in blank form—except for the small audio board which is a special one (see components list in this issue). A blank board for the i.f. module is now available at 60p including postage.

Now to some regularly occurring queries:

- (1) *Types of tube that can be used:* Basically any colour tube with a 90° deflection angle can be used. A 22in. Mazda tube was selected for the prototype. Included with the cabinet design details will be the necessary information to enable different tube sizes requiring different front panel cut-outs to be used.
- (2) *Capacitors in the decoder:* 6·8pF capacitors may have been supplied in place of the 8·2pF capacitors specified for C53 and C56. These are within the range of the tuning coils L14 and L15 and are quite in order. 2·2μF capacitors in place of 2·5μF are supplied for C54 and C57. The caption to Fig. 1 (pages 312-3) is wrong: C56 not C54 is mounted in L15 can. The size of the decoder board is 15½ × 5½in.
- (3) *Total number of articles in the series:* It is neither in our interests nor in the interests of the majority of the readers that the series continue through too many issues of the magazine; although we cannot be definite about the exact availability of magazine space for too far in the future our expectations are that the construction of the receiver (including the cabinet) will be completed in the January 1973 issue. Alignment details, the built-in crosshatch generator, an external degaussing coil and complete servicing data for the receiver will extend over another three issues.
- (4) *The Alignment Service:* An announcement about the start of this service will be made in the next issue. In view of the large number of people now known to be building the set a booking service will have to be operated—to prevent the possible arrival of say 400 i.f. modules on the same day and the inevitable delays that this would cause.
- (5) *Readers on foreign soil and using v.h.f. relay services:* Tuner and other details will be given in the appropriate places for use with Irish v.h.f. services, wired relay systems etc. The alignment of the receiver will differ very slightly for those readers in Europe using System G transmissions and details will be available to those readers at a small charge.
- (6) *Use of the earlier delay line DL1:* A number of readers have asked about using the DL1 line in the decoder because they already have one available or because they can be obtained relatively more cheaply than the DL20 line specified. This can be done if the modified circuit shown in Fig. 7 is used. Those components that are left as they are are marked with their original circuit numbers and values. Those that are changed in value are marked with an asterisk. Components marked with a cross are new. The basic changes are: L10, C51, R78 and R79 are not used in the modified circuit. The value of R77 is changed to 150Ω. The 150Ω resistor at the output of the DL1 is a new component as is transformer T. L and L' are built into the delay line (as L8, L9, L11 and L12 are in the DL20). Transformer T is made on a Ferroxcube former type FX2249 (available from the original suppliers of Component-Pack No. 2) and has 5 turns

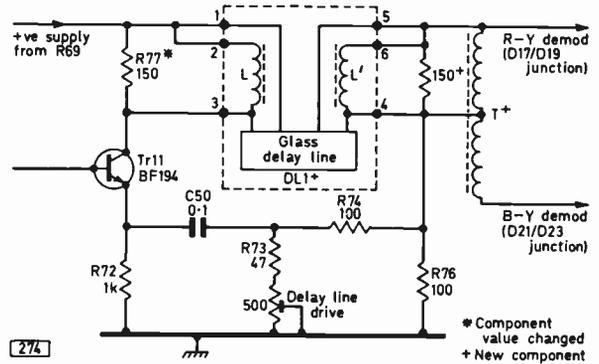


Fig. 7: The earlier delay line type DL1 can be used in the decoder if the circuit is modified as shown above.

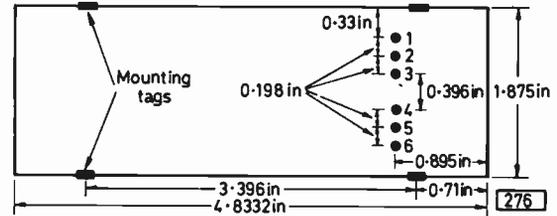


Fig. 8: Delay line DL1 base connections, viewed from below.

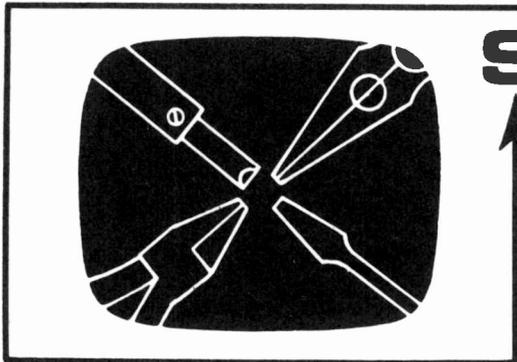
plus 5 turns of 38 s.w.g. wire. At a common end of the windings they are joined to form the connection to pin 4 of the line. The other two ends feed the demodulators. The base connections of the DL1 line are shown in Fig. 8. There has so far been no demand for modifications for using the economy line DL1E.

The DL1 is available from Manor Supplies at £1·95+25p postage and packing (Mail order address: 64 Golders Manor Drive, London NW11). Readers should note that this line is a different mechanical size to the DL20 and small extension pieces must be built on to the printed circuit board if it is to be used; the cut-out for the pin connections will also be different.

(7) *Alternative Components:* Many readers will find that they have been supplied with the ITT type TAU20 chrominance delay line in place of the Mullard DL20 delay line in the decoder Component-Pack 2. This is quite in order, the two delay lines being electrically identical and of the same physical size. The only difference between them is that pins 1 and 8 are omitted on the TAU20, the external connections necessary between pins 1 and 3 and 8 and 6 of the DL20 being made internally in the TAU20. Note also that some of the reference oscillator crystals supplied are marked 4433·619kHz. Again this is quite in order.

The TAA350 i.c. specified in Component-Pack 4 for the i.f. board is now classified as a "maintenance only" type and for this reason the later TAA350A is being supplied to most readers. The only difference with this so far as the constructor is concerned is that the pin connections with respect to the reference tab have all been moved around by three spaces. There should be no difficulty provided the pin numbering shown in Fig. 3 is adhered to, i.e. if the tab is regarded as being between pins 3 and 4 reading clockwise.

Next month: we build two complete modules—the colour matrix and output stages board and the audio output module.



SERVICING television receivers

L. LAWRY-JOHNS

STOCK FAULTS

IT IS often the case that after we have covered a particular model in this series of articles faults come to light that had not tended to develop at the time of writing. The object of the present article is to briefly itemise these faults: the previous articles should be consulted for the circuit and more complete coverage.

BRC 980/981 SERIES

This series was originally covered in the December 1967 and January 1968 issues and includes the following: Ferguson 12in. Models 3639 and 3650 and 16in. Model 3649; HMV 12in. Models 2634 and 2644 and 16in. Model 2643; Marconiphone 12in. Models 4618 and 4621; Ultra 12in. Models 6641 and 6651 and 16in. Model 6653. The faults that have come to light relate mainly to resistors.

If the line oscillator stops working the line output stage will of course overheat, particularly the PL81A line output pentode. The reason for this oscillator failure is frequently a faulty h.t. feed resistor R46 which should be $5.6k\Omega$.

The video stage however is where the majority of the trouble will be encountered. The usual symptoms are a very distorted picture with little or no sync. The culprit is R26, the video amplifier bias stabilising resistor which is connected from h.t. to the video valve's cathode. This $39k\Omega$ resistor changes value pushing the video amplifier way off its acceptable working slope. It is more or less hidden by the video valve and its discoloured appearance can thus escape attention. Nearby is the video anode load resistor R27. The correct value for this is $10k\Omega$ but after a few years' working it is rarely much above $5k\Omega$ which leads to a loss of contrast and incorrect picture tones.

It also pays to check the condition of the h.t. surge limiter R111 (20Ω) and the HT3 dropper R116 ($2.3k\Omega$) and their connection to the print.

BRC 900 AND 950 CHASSIS

For basic information on these consult the April and May 1969 issues and also the August and September 1968 issues. We will not give a list of the models using these chassis as they are so numerous: suffice it to say that it is the chassis which is one horizontal unit with a tapped transformer on the left and the line output section on the right. The latter is screened in earlier models and unscreened in later ones.

In the 950 Mk II chassis the thermistor X3 in the heater chain is omitted, its place being occupied by a wire link. It is the opinion of the writer that this absence of surge limiting can contribute to the early

failure of the tube heater. It is instructive to observe the heater chain at the moment of switching on from cold. We now make a habit of removing the wire link and fitting a thermistor in the X3 position (Radio-spares TH1 or TH3 for example or a VA1026).

A large number of these sets are coming in with the complaint that the sound is OK and that the screen lights up but that there is no sign of a picture. In each case this has been found to be due to the video anode load resistor becoming open-circuit. This is R41, $3.6k\Omega$ wirewound. It is upstanding to the right of the valve.

The very early models use a valve e.h.t. rectifier the holder of which tends to become conductive leading to heavy brushing and thus necessitating replacement. The later models use an e.h.t. voltage multiplier tray which depending upon the type of jelly pot transformer used may contain three pencil type rectifiers or five. The five stick tray is more prone to break down than the three stick one: the final stick seems to decompose at the drop of a hat, giving a "hissy" picture when the brilliance is turned up, one that under the same conditions expands, or simply no picture at all. As the same fate can occur to a replacement tray after a short period of working we are often asked whether there is something in the set which causes this early failure. The short answer is no, unless the width has been set to give too wide a picture (excessive line drive).

The sound output stage can give trouble, the basic cause being a faulty PCL86 valve. The cathode bias resistor R96 may well be damaged and may thus be of lower value than specified (150Ω). It is essential to check the value of this resistor therefore when the PCL86 is replaced.

Another resistor which often calls for attention is the $4.7M\Omega$ one (R22) in series with the slider of the contrast control ($3.9M\Omega$ in early models). This often goes high-resistance causing a grey picture. It is in a convenient position on the rear centre of the chassis. Note that there is a separate resistor (R145) for u.h.f. working on later models.

In the later 1400 chassis ripple on the picture can be caused by a faulty electrolytic (C52, $4\mu F$) which smooths the h.t. feed to the line oscillator and flywheel sync d.c. amplifier.

PHILIPS 210 CHASSIS

The remarks we have made about the sound output stage of the BRC 950 series also apply to these and later Philips models. In this case the sound output valve is a PCL82 and the bias resistor is 470Ω . Don't replace the valve without checking the resistor.

We have also encountered on the 210 series and later models—such as the G20T300 and similar 24in. versions—faults which would appear to be due to defective smoothing. In each case however we have found the trouble to be inefficient earthing of the main electrolytic capacitors. These are in two cans on the right side. Some models have earthing tags wired to a chassis member. In this case an additional lead wired to another part of the metal work has stopped the hum. In other cases one can may be wired as above but the other relies upon the can making earth contact with the metal clamp. This clamp is not always a firm contact and attention to this will clear the fault without further bonding.

Readers should refer to the February and March 1970 issues for further notes on the 210 series.

ITT-KB VC3 AND VC4 CHASSIS

Readers are referred to the August and September 1970 issues for notes on the VC51 chassis which was a development of the earlier VC4. The usual troubles with these excellent sets concern the video stage where the PCL84 internally shorts and cooks up the associated resistors. This is well known and gives little difficulty. The other common troubles include faulty dropper sections where it is essential to identify the mains (a.c.) and the smoothing (d.c.) sections. This is run of the mill stuff and does not cause any undue difficulty.

We have however come across several instances of line hold trouble which has not responded to the usual PCF802 replacement, resistors, capacitors or discriminator diodes (the 47k Ω resistor R131 from h.t. to the PCF802 triode cathode—pin 8—is the most common cause of this trouble). The trouble has only been cleared up in these difficult cases by replacing the PCF802 anode coils L63/L64. We have put this down to intermittently shorted turns although on one occasion the winding went completely open-circuit after some 30 minutes, causing complete loss of line oscillation and consequent overheating in the output stage.

This could apply equally to the Featherlight portable series (VC11 chassis) as the same (or a similar) system is used in these.

BUSH TV161, TV171, TV183 SERIES

In addition to the information given in the April-May 1970 issues we have since experienced quite a bit of trouble with the printed tracks around the upper part of the right side panel. Faulty tracks here can cause a variety of symptoms mainly concerning the height and hold, linearity etc. of the picture.

It is also well worthwhile checking the contact of the line linearity coil 3L7 to the print as severe arcing can occur here, also damage to the shunt resistor R28.

In one or two instances we have come across intermittent severe loss of contrast which has eventually been traced to the first i.f. amplifier transistor 2VT1 (BF167). It seems to go open-circuit so that there is no voltage drop across its emitter resistor R9. This would be an easy one to trace if the damned thing would stay open-circuit, but taking preliminary checks around the a.g.c. circuit (where one would expect to locate the fault) results in the transistor sealing itself up and amplifying normally, perhaps for a considerable time, which is irksome to say the least!

Intermittent fuse blowing on these models can be

due to several factors but in a couple of cases we have met recently the cause rather surprisingly was a hefty flashover from the lower choke L1 (PY88 anode circuit) to the fixing screw in the centre of the panel, the surface of the panel having become conductive between these points. After scraping away the surface we fit a nylon screw in place of the metal one to complete the repair.

PHILIPS 170 SERIES

Reverting to Philips models we have recently had quite a few in with complaints of weak or no line sync. This is normally due to the ECC82 flywheel sync valve (V401) but the resistor to the right of it seems to be failing regularly nowadays. This is R403, 27k Ω 2W (connected to pin 6), and will often be found discoloured. Also check R273 above the PFL200: this 33k Ω resistor is the upper part of the potential divider feeding the screen grid of the sync separator section of the valve and suffers the same fate, also leading to poor sync.

Yet another resistor which gives trouble is R246 (27k Ω) which serves the same purpose in the EF183 (V204) circuit. The symptoms here are poor gain and cross-modulation.

Whilst the servicing articles—in the May-June 1971 issues—covered most other common faults we would, as we are on the subject of resistors, again point to the two 8.2M Ω (R427-R457) resistors in the width circuit: these regularly go high-resistance causing lack of width and poor e.h.t. regulation.

Variation of u.h.f. gain is normally caused by poor contact on the i.f. input plug and socket (v.h.f. is also affected by this to an extent) but we have often found the preset R628 on the tuner panel (u.h.f. sensitivity) to be at fault with poor contact between the wiper and the track.

A horizontal white line which travels down (or up) the screen slowly in a regular manner, perhaps accompanied by a slight hum, should direct attention to the electrolytic capacitors. These are in a pair behind the right side panel. Check the bonding to chassis before replacing, particularly if the effect is intermittent.

PYE 11U AND RELATIVES

Under this heading can be lumped together a large number of models in the Ekco, Ferranti, Dynatron, Invicta, Pam etc. ranges. Many of these sets are coming in with non-operation of the line timebase as the primary complaint. Where the valves—PL36, PY800 and PCL84—turn out to be blameless and there is overheating taking place it will often be found that the trouble is due to leakage through the line drive coupling capacitor C87 (0.01 μ F). Where there is no overheating R108 is the first suspect: this is the 1.8k Ω line output valve screen dropper.

Among the more usual troubles which may be encountered in addition to the complaint which brought the set in are: Lack of height—check the 1.2M Ω resistor R83 in series with the height control. Loss of contrast—check the preset contrast control. Poor linearity—check the PCL85 cathode bias resistor R77 (390 Ω).

See the August and September 1965 issues for circuit and description. Also *Renovating the Rentals* May 1972.

LONG-DISTANCE TELEVISION

ROGER BUNNEY

APRIL has seen an increase in activity. Sporadic E signals of long and strong duration have been noted in various parts of Europe (although unfortunately not by myself!) which seemingly indicates a fairly good season to come—by the time this column is read we should all know! The Tropospherics also gave a marginal lift during the middle part of the month when a reasonably stable high-pressure system produced signals from West Germany, the Low Countries and France for well-placed enthusiasts. The 21st, 25th and 26th seemed to be the better days here for tropics with various French stations at v.h.f. and u.h.f.

The early part of the month seems to have been best for Sporadic E. Lothar Scholt of Ziegelroda, East Germany (GDR) noted TVE (Spain) ch.E2, 3, 4 and RTP (Portugal) ch.E2 on both the 5th and 6th from 1400 onwards with high-quality signals. Also on the 5th Keith Hamer of Derby received strong video signals from RAI (Italy) ch.IA. Back again to Holland where apparently another Sp.E opening on the 8th produced RUV (Iceland) ch.E4. All things considered I feel that the outlook is indeed good.

Usually I feature my own log for the period under review but I thought a slight change might be in order this month. Our other Derby DX expert Garry Smith has sent us a long letter which included his log for the first half of the month. I felt it would be a good idea to feature Garry's log in order to give an indication of the type of reception that is about for much of the time. Consequently Garry's log takes us up to and including the 14th April while mine takes over from the 15th onwards.

- 2/4/72 ORF (Austria) E2a; unidentified patterns on R1—line sawtooth and chessboard (the latter two are probably CST-Czechoslovakia).
- 3/4/72 CST R1.
- 6/4/72 EBU pattern ch.E2 (possibly WG—West Germany—or TVE).
- 8/4/72 CST R1; ORF E2a; TVP/MT (Poland/Hungary) R1.
- 9/4/72 Unidentified ice skating at 1825 R1/E2a.
- 10/4/72 Unidentified news programme R1/E2a.
- 11/4/72 Unidentified programme R1/E2a.
- 12/4/72 EBU pattern E2; YLE/SWF test card E2 (possibly NRK-Norway); TVP/MT R1.
- 13/4/72 EBU pattern E2; SR (Sweden) E2.
- 14/4/72 CST R1 (noted with "normal" card and electronic CS U 01); ORF E2a; TVP/MT R1.
- 15/4/72 DFF (East Germany) E4; BRT (Belgium) E2 (trops).
- 16/4/72 BRT E2.
- 17/4/72 DFF E4 (MS—Meteor shower).
- 18/4/72 BRT E2.
- 19/4/72 SR E2 (MS); BRT E2.
- 20/4/72 WG E2 (Sp.E).
- 21/4/72 TVP R1 (MS); BRT E2.
- 22/4/72 DFF E4 (MS); NRK E2, 4 (long duration Sp.E 0830—approximately 20 mins).
- 23/4/72 SR E2 (Sp.E); BRT E2.
- 24/4/72 WG E2 (MS).
- 25/4/72 DFF E4 (MS).
- 26/4/72 DFF E4 (MS); CST R1; ORF E2a—both Sp.E; NOS (Holland) E4 (trops).
- 27/4/72 TVP R1; CST R1—both Sp.E.
- 28/4/72 CST R1 (MS); BRT E2; NOS E4—both trop.
- 30/4/72 SR E2; BRT E2; NOS E4—both trop.

In addition improvements were noted in Tropospherics at Band III and u.h.f. on the 21st, 25th and 26th with reception of various ORTF stations.

The colour blockboard pattern as commonly used by NOS-Holland is known as the PM5552. It thus joins the

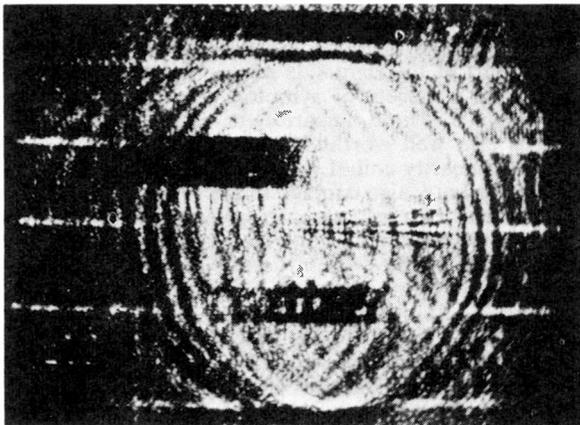
family of other Philips electronic patterns—types PM5544 and PM5540. The blockboard was featured in the November 1971 Data Panel.

Following the confusion about the current RTE (Eire) test card we have new information on the change of patterns announced by RTE to commence last February. D. Ellis-Jones has written from Llangefni, Anglesey, to advise that the PM5544 pattern is being used regularly in addition to the card featured in the May 1972 Data Panel. The PM5544 carries no identification as used by RTE. Mr. Ellis-Jones receives the ch.H Dublin transmitter with good signals in colour using a Decca CTV25 modified for 625-line working at v.h.f./u.h.f.

We have experienced difficulty in the past in obtaining information on the East German television network but a recent letter has provided us with some useful information. Each TV transmitter switches on individually and radiates its own identification slide. The switch on time varies between each station. They are usually on-air between 0700-0730. DFF-1 radiates identification slides for 5 minutes after the station has been in action for 10 minutes. DFF-2 does not usually transmit in the mornings but from approximately 1500 on working days including colour tests until 1800. After 1800 the test card/identification slides occur until 1840, preview of programmes, 1850 "the sandman for children"—we assume this is a form of puppet programme—then 1900 normal evening programmes. Transmitter information: The ch.E11 and E29 Schwerin transmitters are operating at reduced power due to the main aerials being under repair (we assume that things will be back to normal when this is read). The DFF-2 Marlow transmitter uses ch.E24 vertical due to ZDF Hanover ch.E24 horizontal!! Correcting a comment in last month's column, there is *no* transmission in Band V: Marlow cannot transmit on ch.E46 due to Bielefeld ch.E46 (we assume there must have been a plan for Band V operations).

News Items

Belgium: It appears that the PM5544 (!) pattern is being used regularly by BRT/RTB now and carries the identification at the bottom of the card (see letters). The card is used until 15 minutes prior to programme commencement. For the 15 minutes before programmes commence



Spanish television—TVE Madrid, ch.E2—as received on test card in South Africa.

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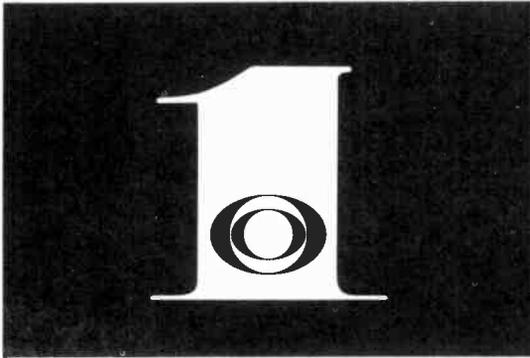
AA119	9p	BC182LB	10p	IS921	8p
AA111	10p	BC183	10p	IS923	12p
AA130	10p	BC183L	10p	ME0404	11p
AAZ13	10p	BC183LB	10p	ME0412	15p
AC107	34p	BC184LC	12p	ME0413	12p
AC126	25p	BC186	25p	ME0462	19p
AC127	25p	BC187	25p	ME2002	8p
AC128	25p	BC208A	14p	ME4003	12p
AC141K	25p	BC212	10p	ME4102	10p
AC142K	18p	BC212L	12p	ME4104	8p
AC153	25p	BC212LA	13p	ME6002	12p
AC153K	22p	BC213L	12p	ME6101	12p
AC175K	36p	BC214	15p	ME6102	13p
AC176	25p	BC214L	15p	ME8001	12p
AC176K	20p	BC250B	14p	ME8003	13p
AC187	25p	BC261	16p	MEF104	34p
AC187K	25p	BC268	11p	MEL11	30p
AC188K	25p	BC308A	17p	MP8112	34p
AC193K	25p	BC317	20p	MP8113	40p
AC194K	27p	BCY21	96p	OA47	10p
ACY20	20p	BCY31	40p	OAB1	10p
ACY21	20p	BCY42	30p	OAR5	12p
ACY22	12p	BCY70	15p	OA90	8p
AD143	45p	BCY71	20p	OA91	7p
AD161	35p	BCY72	15p	OA95	7p
AD162	35p	BCY89	97p	OA200	7p
AF115	25p	BD115	75p	OA202	10p
AF117	20p	BD124	80p	OAZ223	45p
AF121	30p	BD131	75p	OAZ230	45p
AF124	25p	BD132	80p	OC28	65p
AF126	20p	BD135	75p	OC35	50p
AF127	20p	BD175	44p	OC36	65p
AF139	30p	BD181	90p	OC44	15p
AF170	25p	BD184	£1-03	OC45	15p
AF178	55p	BF121	25p	OC70	15p
AF179	60p	BF123	30p	OC71	11p
AF239	40p	BF125	25p	OC74	25p
ASZ17	50p	BF127	30p	OC75	23p
BA102	30p	BF153	20p	OC170	23p
BA145	15p	BF154	20p	R2008	£3-05
BA148	15p	BF160	25p	R2009	£2-05
BA154	9p	BF161	25p	R2010	£2-05
BA155	10p	BF178	45p	SP8385	£1-00
BA163	90p	BF179	30p	TAA700	£2-04
BAX12	12p	BF180	35p	TAD100	£1-03
BAW63	36p	BF184	20p	TBA500	£2-00
BAW65	36p	BF185	20p	TBA510	£2-00
BAW67	35p	BF194	15p	TBA520	£2-05
BB105	37p	BF195	15p	TBA520Q	£2-05
BBY20	37p	BF196	15p	TBA530	£1-08
BC107	10p	BF197	15p	TBA530Q	£1-08
BC107B	12p	BF200	35p	TBA540	£2-00
BC108	10p	BF222	30p	TBA550	£3-00
BC108A	10p	BF224J	15p	TBA550Q	£3-00
BC108C	15p	BF256L	30p	TBA570Q	£1-02
BC109	12p	BF256LC	34p	TBA750	£1-04
BC113	15p	BF536A	37p	TBA750Q	£1-04
BC116	20p	BFV17A	£1-22	TIC46	40p
BC117	20p	BFX37	30p	TIP29A	50p
BC119	30p	BFX84	23p	TIS60M/61M	37p
BC121	25p	BFX85	25p	TIS61	20p
BC125B	25p	BFY50	20p	TIS91	17p
BC136	20p	BFY51	20p	2N404	15p
BC137	20p	BFY52	20p	2N697	12p
BC139	25p	BFY90	59p	2N706	9p
BC142	21p	BSX20	15p	2N708	12p
BC143	23p	BSX60	50p	2N753	10p
BC147	12p	BSX61	35p	2N919	45p
BC148	10p	BT106	85p	2N920	42p
BC149	12p	BU105/02	£2-00	2N1302	17p
BC152	20p	BY126	15p	2N1304	21p
BC153	20p	BY127	15p	2N1306	24p
BC157	15p	BY147	£1-04	2N1307	24p
BC158	12p	BY164	35p	2N1308	24p
BC159	15p	BZY88 series 9	5p	2N1309	24p
BC170	15p	BZY94 series 9	5p	2N3053	20p
BC171	15p	BR100	26p	2N3054	50p
BC171A	17p	BRC4443	90p	2N3055	55p
BC177	20p	BRY39	30p	IN914	6p
BC177B	23p	E1222	40p	IN916	10p
BC178B	16p	E5024	40p	IN4148	6p
BC179	20p	GET102	39p		
BC182L	10p	GET103	25p		

S.C.S. COMPONENTS

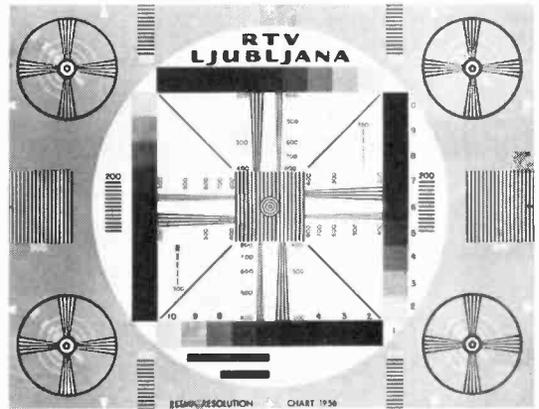
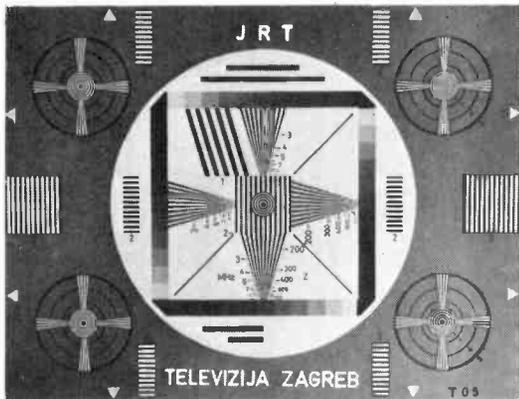
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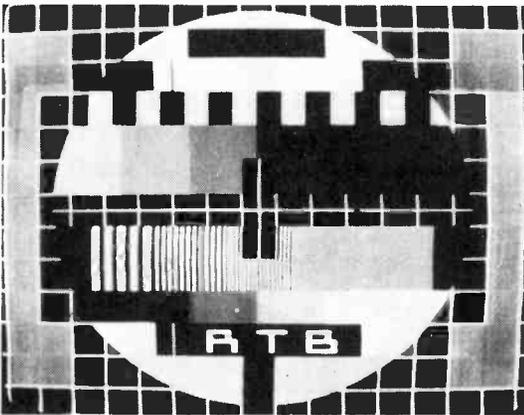
DATA PANEL 12-2nd series



Austria ORF—Osterreichischer Rundfunk. Two test cards are used, either the Telefunken TO5 or the Philips PM5544 (both were shown in Data Panel 3). Identification caption: the first and second chain identification slides are shown above at left and right respectively.



Yugoslavia JRT—Jugoslovenska Radiotelevizija. The Telefunken TO5 test card (above left, for example) is used extensively with appropriate identification. The RETMA card (above right) with appropriate identification is also widely used.



The PM5544 card used by BRT/RTB (Belgium).

Intervision news caption: Rumania Telejurnal.

Photographs this month courtesy of ORF Vienna, JRT, OIRT Prague, Keith Hamer and Garry Smith.

the normal RETMA card is used (either BRT or RTB). *East Germany*: The familiar pattern used by the DFF has changed somewhat: the "DFF Berlin" identification has been replaced with a longer inscription which as reported

before in this column indicates that the Radio DDR sound channel is being relayed ("DDR Fernsehen übernimmt Radio DDR"). This change took place on March 1st. *Norway*: Test card information. PM5544 inscribed "Tele-

verket Norge" is used each weekday except Tuesday from 0930-1700 CET-BST and at 30 minutes prior to programme transmission. This card originates from the PTT. The YLE/SWF electronic pattern inscribed NRK commences 20 minutes prior to programmes. (Note: We have received the PTT version of test card G quite recently—our old friends are still with us!) Evening programme times are approximately 2000-2230 CET-BST; news is at 1755 (week-days) and 2000; children and youth programmes are at 1800. In addition there are normal schools' programmes during the mornings. (Our grateful thanks to Peter van der Kramer, Holland, for the above three items.)

DX-TV Clubs

The WTFDA (World Wide TV FM DX Association) has moved its headquarters from Milwaukee to WTFDA, Box 163, Deerfield, Illinois 60015, USA. The Europese Testbeeldjagers, Diepenbrockstraat 2, Slikkerveer-3210, Holland is now publishing an excellent news bulletin in English. This rapidly expanding club now has many members throughout Europe who actively assist each other and it is to the club's credit that many red-hot news items are quickly passed to the whole membership. Sample copies can be obtained from both of the above organisations—two IRC would be appreciated to cover costs etc.

New Use for Up-Converters

An enthusiast has drawn to our attention the fairly recently introduced types of converter that transfer the v.h.f. spectrum (40-230MHz) to u.h.f. to enable a standard u.h.f. tuner to tune in various v.h.f. transmissions (i.e. to enable single-standard sets to be used with v.h.f. wired distribution systems). We are trying to obtain one to experiment with to note its performance on weak signals and its operation adjacent to strong transmissions. Our u.h.f. expert Graham Deaves has tried out the Teleng Ltd model, type DN6328, which is called the "Super-veter". BRT Belgium ch.E2 was received through the unit quite well and it does seem that such a unit would be of immense use for obtaining reception on difficult channels such as ch.R3, R4, R5 and IC. As soon as we have some convincing results and can recommend such a unit fuller information will be given.

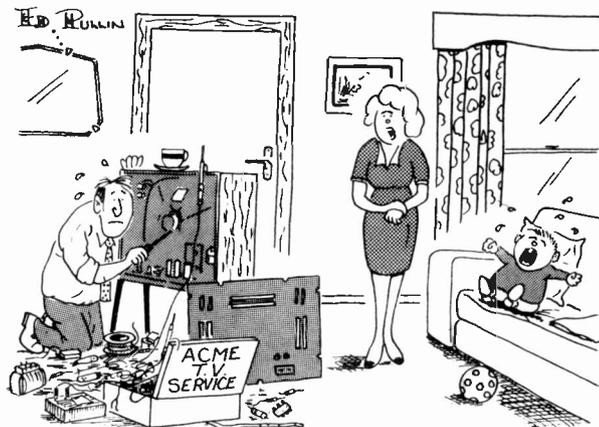
From Our Correspondents . . .

Our mailbag this time seems to be all from overseas! Wallace Roome, Pietersburg—a familiar name to this column—has done it again!!—TVE Spain via the F2 propagation mode in South Africa on ch.E2! Reception

SERVICE NOTEBOOK

—continued from page 397

vision-on-sound. This meant that the i.f. and video circuits were in order so that the cause of the trouble was likely to be in the sync separator circuit. The triode section of a PCL84 is used in this model as the sync separator—feeding the grid of one section of the field multivibrator via an interlace filter and directly triggering the triode section of another PCL84 used as the line oscillator via a capacitive feed to its anode. The anode voltage of the sync separator triode was normal at just over 130V, proving that the h.t. feed resistors were in order, and on examining the stage the cause of the trouble was found to be the 5.6k Ω stand-off resistor connected between the anode of the video output pentode and the grid coupling capacitor to the sync separator. This resistor was found to be almost 30k Ω ! A stand-off resistor is generally



"Could you hurry it—Tom and Jerry're on!"

occurred in the late afternoon for a long period—in fact over several weeks. The signals were strong and suffered from the usual multiple image video. Programmes were also received with at times good quality sound. Wallace wrote on April 5th and signals were still being received. Photographs were enclosed and one of these is shown. All very exciting at some 5,000 miles distance.

A vast quantity of excellent photographs—apparently taken with a focal plane shutter camera judging by certain shading on some shots—has arrived from a new reader in Brussels, Belgium: Dieter Scheiba has been DXing for only a short time but has obtained some incredible results with a simple aerial array and a Nordmende multi-standard receiver. He also included a shot of his local test card—yet again the PM5544, with the identification inscription either BRT or RTB.

Seppo J. Pirhonen at Lahti, Finland, tells us that new aerials, mast and feeder lines have given him improved results, with Sweden being received with ease in Bands III, IV and V. We are familiar with the temperature inversion effect at sunset which gives improved Tropospheric propagation. Seppo gets such weather effects at the extreme, with a temperature drop of 10 deg. C per hour! This however produces excellent reception, albeit rather cold. Unfortunately space is running out so we cannot discuss the interesting letters from Rym Muntjewereff (Holland) and George W. Sharples (Malta). Sufficient to say that both have been very active with Tropospheric reception. George has improved his Greek reception on ch.E5 (reported last month) and with a preamplifier has received even stronger signals from Gwelo, Rhodesia on ch.E2 via F2.

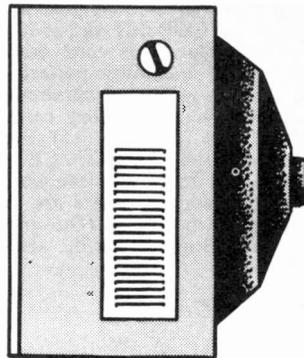
included in this position to prevent the input capacitance of the sync separator shunting the anode load circuit of the video output pentode. If this resistor is of excessive value however it will limit the effective bandwidth of the sync separator by forming with the valve's input capacitance a low-pass filter. This of course is exactly what a grid stopper used with an a.f. pentode is supposed to do—to form with the input capacitance of the valve a low-pass filter so that the unwanted i.f. signal is developed across the resistive element while the wanted a.f. signal is developed across the valve's grid-cathode capacitance. This occurs since the reactance of this capacitance is much lower than the value of the resistor at i.f. while at a.f. the reactive value of the capacitance is much greater than the value of the resistor.

An unusual fault, and one which would not be encountered on more recent sets employing flywheel line sync.

Renovating the RENTALS

CALEB BRADLEY B. Sc.

5 DECCA CTV25 SERIES



AS WE showed last month the cheapest way of getting a good colour set is to renovate an ex-rental model. These Decca dual-standard sets are a timely choice for consideration since quantities have been released by Granada. They are very much "first generation" colour sets, dating back typically to 1967-68. An advantage is that the circuit is entirely conventional and its stock faults known. There are three different versions, each sharing basically the same chassis, as follows:

CTV25 floorstanding: This is the huge set with folding doors pictured last month. The cabinet is in dark rosewood which looks splendid when the inevitable scratches have been polished out while the big speaker below the screen gives as near hi-fi sound as one will get out of a television set. You will need a van to collect it though—the dimensions are 37in. wide × 33in. high × 17in. (cabinet) 24in. (overall) deep!

CTV25 table model: Basically the same 25in. screen set but only 23½in. high, in a light wood cabinet without doors. Overall depth is 21in.

CTV19 table model: Shown in the accompanying photograph this attractive small set has two loudspeakers behind the louvres under the 19in. screen. Slots at each end make it just possible for one person to carry and it is easy to transport by car. At the moment at around £130 it is the cheapest set available. Size is 31in. wide × 19½in. high × 10½in. (cabinet) 20in. (overall) deep.

General Construction

The innards of a 25in. tube model are shown in our second photograph. Compared with a monochrome set the hybrid (valves plus transistors, no i.c.s) chassis seems daunting but things are much clearer when the various units are recognised—see Fig. 1. In the following description left and right refer to Fig. 1.

Mounted on the control panel at top left is the integrated u.h.f./v.h.f. pushbutton tuner. This has an illuminated tuning scale and may be made by Philips (on CTV25 table models, has 6 buttons, may be called "Prestomatic"—ugh!), Plessey or Telefunken (both have 7th button for tuning but only Plessey has the nylon a.g.c. control spindle pointing sideways). The chassis is a flat horizontal frame which carries four printed wiring boards. The i.f. output from the tuner is taken by a coaxial lead to a socket on the *i.f. board*. This board delivers detected video to two other boards: to the *luminance board* which carries a PL802 valve to drive the c.r.t. cathodes and to the *decoder board* which supplies colour-difference signals

to the c.r.t. grids from three PCL84 valves visible in the photograph.

To the right of the decoder board is the *timebase board* which carries the ECC82 field oscillator, PL508 field output and PCF802 flywheel line oscillator valves.

The tall square X-ray screening can at the right contains the line output transformer, GY501 e.h.t. rectifier and PD500 shunt stabiliser valves. The PL509 line output and PY500 boost diode valves are hidden behind the can.

The tangle around the c.r.t. neck is caused mainly by the large number of wires running to the convergence assembly (the three-pointed structure rearward of the white scan coil housing) from the *convergence board*. This board is also hidden by the X-ray screening can and is mounted so that its controls can be adjusted while viewing the screen. On the CTV25 table model access is by withdrawing a long plastic bar to allow a door to be swung open at the side of the set. On other models a captive bolt at top right must be rotated half a turn (use a long screwdriver to reach over the screening can) to allow a front panel to be removed.

The power supply for all this consists of components mounted at the left of the chassis with the mains and h.t. fuses accessible on the mains connector panel.

The boards are positioned a little differently in the CTV19 but they can still be recognised from the above. The luminance and decoder boards are combined into one (no major circuit change) and there is a small audio amplifier board below the convergence board.

Access for Servicing

The chassis rests on two rails. If two black hex-head screws at the rear are removed the chassis can be slid out a few inches for better access to the boards and can be operated in this position. But beware of the turned up brackets at the rear end of the rails—they can rip connecting wires away from the underside of the boards as the chassis is slid out. Therefore lift the rear of the chassis up before sliding it out. Do not allow the right-hand bracket to foul with components under the screened section.

Before attempting to open up the screened compartment the e.h.t. connector must be discharged. Clip one end of a lead to the c.r.t. shield and slide the other end under the connector cover. This ensures that the discharge does not flow through the semiconductor circuits. Unclip the e.h.t. lead and detach its coils

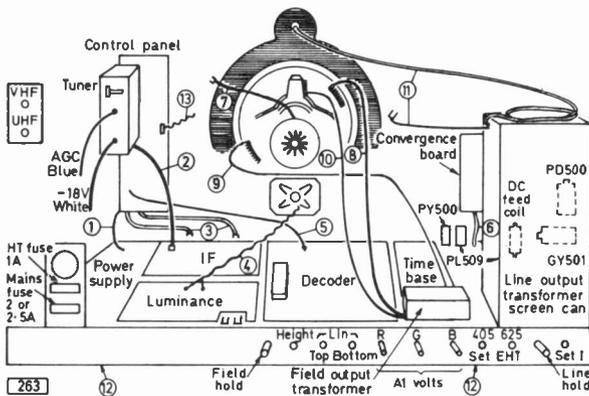
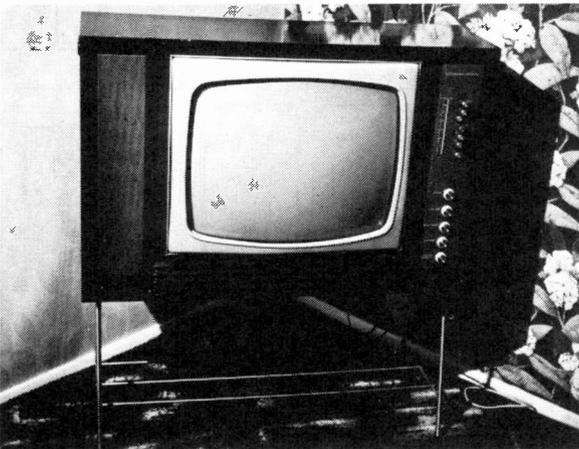


Fig. 1: General layout of the Decca CTV25—compare with the accompanying photograph. To withdraw the chassis disconnect the numbered wires (see text). The CTV19 is similar but the i.f. board stands upright at the left-hand side and the luminance and decoder circuits are on one board.

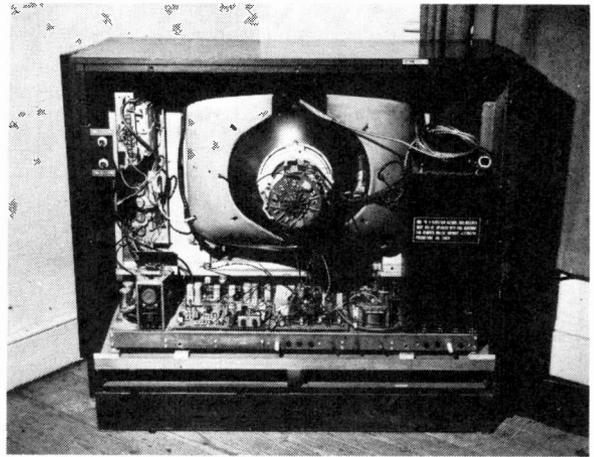
from the top of the screening can. The lead consists of about a yard of coax which forms a capacitor and should not be shortened. The top of the can may now be removed. To remove the main can unscrew the 4BA hex screws at the bottom and pass the e.h.t. and shield earthing leads through it.

It is almost always necessary to remove the chassis from the cabinet to replace components. There are so many connecting leads that it is easy to go astray so we shall list those that should be disconnected. They are numbered in Fig. 1 as follows:

- (1). Black earth lead from control panel to chassis. Unscrew from chassis.
- (2). I.F. output coaxial lead from tuner. Unplug from i.f. board but take care here as the socket is easily broken away from the board.
- (3). Two cableforms from the control panel to chassis. Unplug from rear of chassis. Note for reassembly: only the different lengths of cableform tell which plug should go to which socket.
- (4). 25in. models only. Twisted black/brown pair from audio amplifier on luminance board to speaker. Unclip from board. Polarity on reassembly does not matter.
- (5). Blue wire taking chroma from colour intensity



Appearance of the 19in. model.



Innards of the basic 25in. model: compare with Fig. 1.

- control to decoder board. Unclip from decoder.
- (6). Cableform from convergence board to chassis. Unplug from chassis.
- (7). Detach c.r.t. spark gap socket and unclip its earth wire from the c.r.t. shield.
- (8). Unclip line scan (black coaxial lead) from highest pin at one o'clock on scan coils.
- (9). Unclip field scan (white wire) from highest pin at eight o'clock on scan coils.
- (10). Unclip blue wire from sixth pin down on blue (uppermost) convergence section.
- (11). Discharge e.h.t. connector as previously described. Unclip e.h.t. lead and c.r.t. shield earthing lead.

Unbolt the chassis from runners at (12) and lift out. Avoid flexing the chassis as this can crack the printed boards. On different chassis the boards are held in place by screws or by soldered eyelets and depend on their mounting for connection to chassis.

To remove the control panel only, perform (1), (2) and (3) above. Also unplug (13) the degaussing coil. Pull off the control knobs and remove five hex-head bolts inside the cabinet. When bolting the panel back in place make sure the tuner buttons do not foul the edges of the holes in the perspex trim.

The pilot lamp is 6.3V 0.3A and can be replaced without removing the control panel.

After servicing check that *all* the connections listed have been remade since various degrees of damage can result from forgetting one—e.g. if (13) is not remade a 680Ω 1W resistor goes up in smoke.

Tuner Unit

The tuner is not really a serviceable item and if faulty a replacement can be ordered from Decca, quoting the number fixed inside the cabinet. Note the positions of the -18V supply (white) and a.g.c. (blue) wires in Fig. 1 as these can come adrift. The tuner works—albeit poorly—if they are the wrong way round!

These days it is unlikely that a colour set will be used on 405 v.h.f. so the upper aerial socket can be taped over. The 625 u.h.f. standard is selected by rotating the tuner buttons: pull the Philips tuner buttons out to do this and watch the tuning scale change; with the Plessey and Telefunken tuners rotate the buttons to the one o'clock click position. The system switch solenoids can be taken out and used

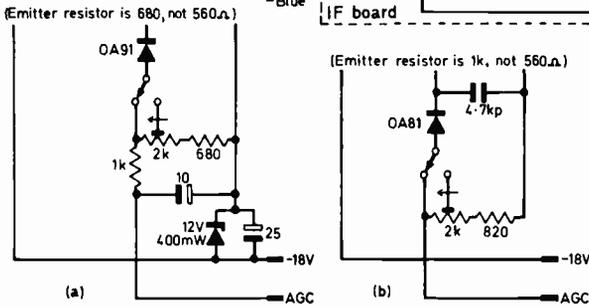
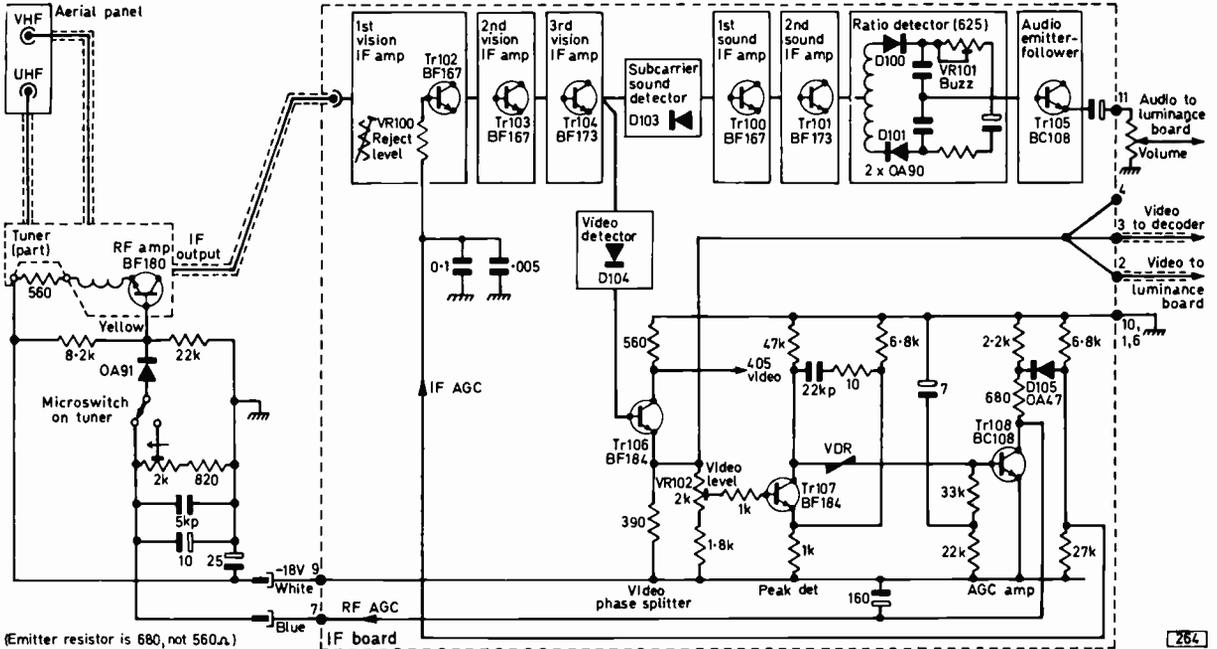
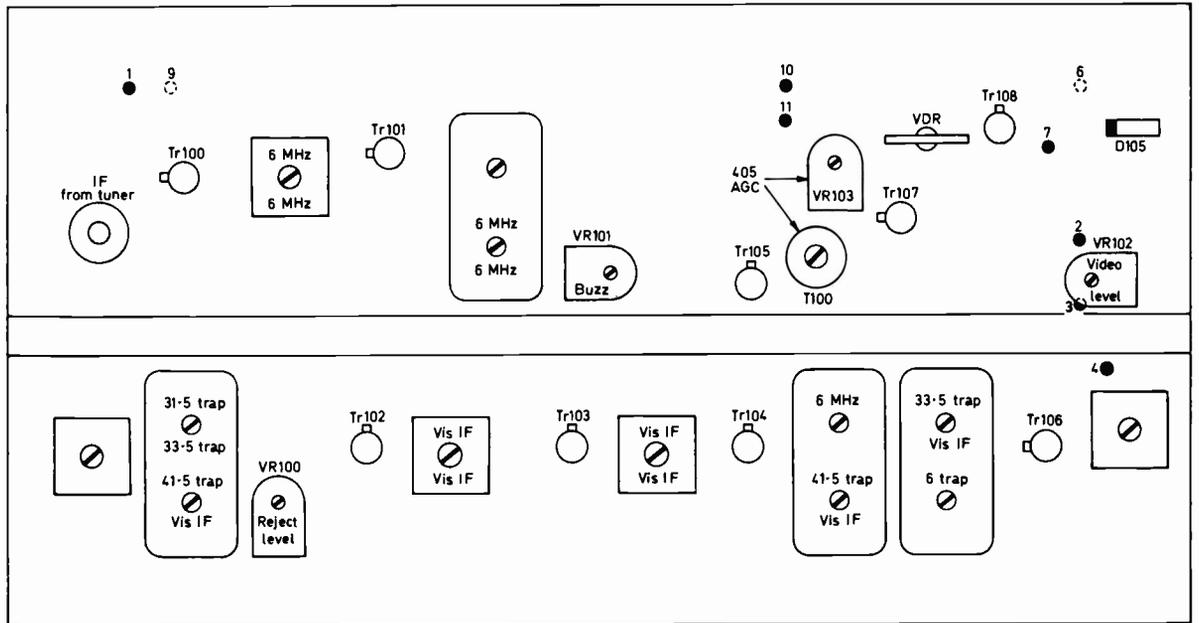


Fig. 2: Basic arrangement of the i.f. board and Telefunken tuner showing the a.g.c. circuit in full. In some models the video phase splitter collector resistor is 1kΩ while its emitter resistor is 560Ω. At the left are shown (a) the alternative a.g.c. tuner feed used with the Philips (Prestomatic) tuner and (b) the a.g.c. feed used with the Plessey tuner. 405-line components are not shown.

Fig. 3 (below): Basic i.f. board layout. Alignment frequencies shown for the upper and lower cores of coils for 625-lines only.



for something useful.

Low gain and a very grainy picture often means failure of the tuner r.f. transistor, a BF180. This transistor can be destroyed by switching the set on with

the tuner lead not plugged into the i.f. board, hence the emphasis on checking all connections. The transistor can be checked as follows. Disconnect the yellow lead which passes across the tuner to the r.f. transistor

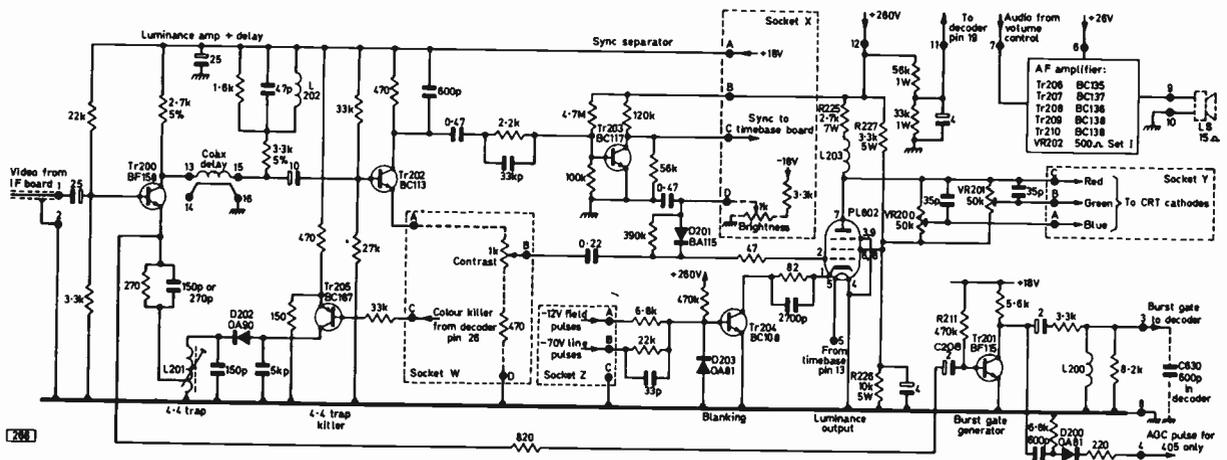


Fig. 4: Circuit of the luminance board. The a.f. amplifier, not shown in detail, is a conventional transformerless type. A later board has a coil delay line and some component variations. The connections to A and B of three-pin socket Z are reversed in some receivers.

base. Use an Avo to measure the resistance between the base and chassis in both directions. The reading should be several kilohms with the black probe to the base and almost infinity with the red probe to the base. If the BF180 has blown it will be obvious. Don't try to replace the BF180 unless you are equipped with (a) a small-bit soldering iron, (b) tweezers and (c) a steady hand. The new transistor must be mounted with exactly the same length and position of leads as the old one or the tuner alignment will be upset. Nevertheless a successful job can be done with care.

AGC Control

The nylon spindled potentiometer on the back of the tuner is an a.g.c. control effective only on the top button (Philips 6th button) on 405 when a micro-switch brings it into circuit. The author finds it useful to wire the control in circuit permanently to deal with any signal overload: it should be kept fully clockwise when normal gain is needed.

IF Board

The response shaping network at the input to the i.f. board, including a "reject level" potentiometer, is aligned along with the i.f. output coil of the tuner so these may need careful adjustment if tuners or i.f. boards are interchanged. Otherwise do not attempt alignment of the vision i.f. stages unless proper equipment is available. The 625 sound (6MHz) coils and discriminator balance potentiometer can easily be adjusted for maximum sound and no intercarrier buzz using any transmission.

The a.g.c. arrangement for 625 is shown in Fig. 2. On 625 positive sync pulses at Tr107 base turn it on so that Tr108 then turns off. Hence forward a.g.c. is applied to the tuner and the first i.f. stage, with D105 limiting the forward i.f. bias. If the blue tuner a.g.c. wire comes adrift and touches chassis Tr108 blows and the result is similar to a faulty BF180 described above.

The video output level is set by VR102 to 2V peak-to-peak for a picture containing white. In practice this control can simply be set for a slightly over-

contrasty picture with the viewer contrast control fully clockwise; if set any higher the signal will suffer clipping.

Luminance Board

The full circuit of the luminance board is shown in Fig. 4. Video from the i.f. board passes to Tr200 which drives a short delay line to compensate for the delay suffered by the colour signals with respect to the luminance signal. The luminance signal then passes via emitter-follower Tr202 and the contrast control to the luminance output valve. The c.r.t. cathodes are direct coupled to the anode. The red gun is driven directly since the red phosphor is least efficient while the green and blue drives are tapped down by potentiometers to allow the colour of whites in the picture to be set neutral.

R225, R226 and R227 in the valve stage are long wirewound types which stand upright on the board and are therefore rather vulnerable. If one gets pushed over the track underneath can be broken. A surprising cause of a weak, smeary picture (but colour content OK) one time was found to be an open-circuit R225: the valve was working after a fashion on the current in R227!

The Y drive potentiometers VR200/1 are cheaply made and sometimes give obvious trouble in use. If the connection between say VR200 and the junction of R227/R226 breaks the d.c. along the track is not constant and the black level of the blue gun changes as VR200 is adjusted.

Line and field blanking are performed by pulses from the respective timebases which turn Tr204 briefly off, biasing the valve off. Ideally the voltage at Tr204 collector should never exceed the few volts needed to bias the valve off. A microsecond's hiccup by the valve however can put h.t. on the transistor and kill it. Usually the transistor goes short-circuit so the only effect on the picture is the appearance of flyback lines.

The contrast control sometimes becomes noisy and unpleasant to use, probably because of the d.c. flowing through it. The replacement must be a carbon type of the correct value (1kΩ) or the sync/video ratio will be upset as Tr202 also drives the sync

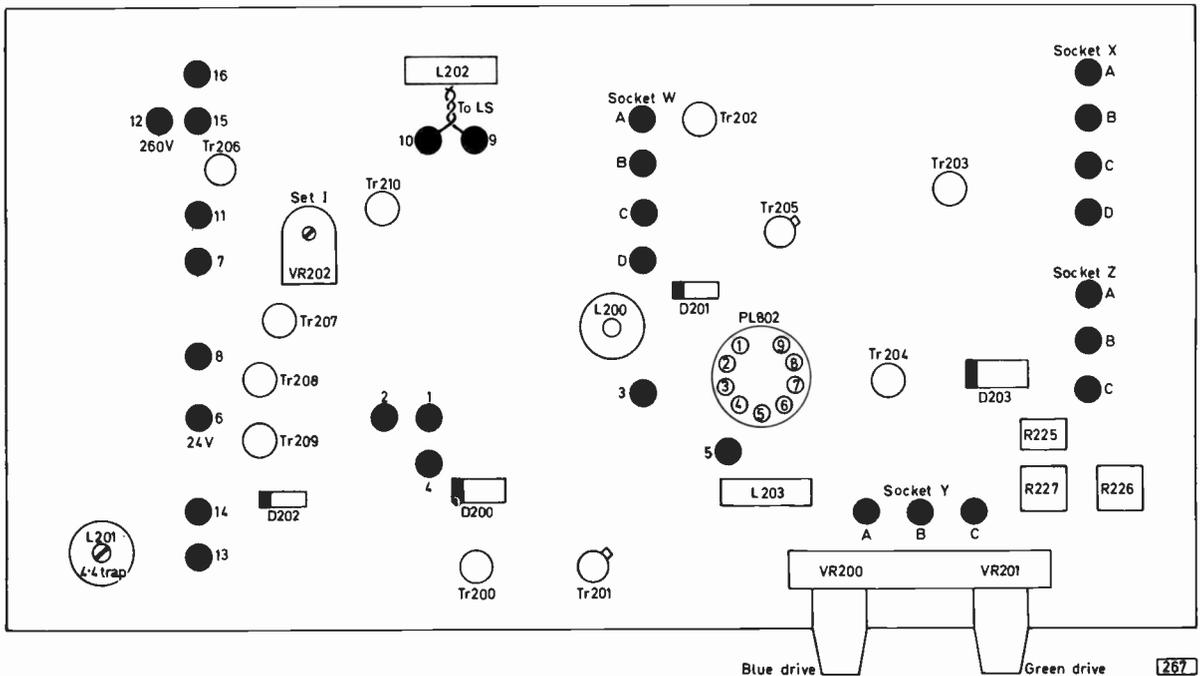


Fig. 5: Simplified luminance board layout.

separator Tr203. All replacement controls need to have fairly long spindles, plastic for safety.

Unlike most colour chassis in which the burst gating pulse is obtained by delaying a pulse from the line output transformer it is here derived from the sync pulse. A result of this is that the colour can be correct without correct line hold. The circuit operates as follows. Positive-going sync tips at Tr200 emitter turn on Tr201. Forward base current charges C208 so that Tr201 is off the rest of the time, i.e. normal sync separator action. When Tr201 turns off at the end of each line sync pulse output pin 3 swings positive at a rate set by the resonant circuit L200/C630 (in decoder) and then swings negative. The positive peak should coincide with the burst and constitutes

the burst gating pulse which is used in the decoder board. This simple arrangement works only if (a) properly shaped sync pulses are present at Tr200 emitter and (b) the base bias resistor R211 suits the gain of Tr201. Any trouble with the burst gating results in no colour from the decoder. The author often replaces R211 with a $1M\Omega$ preset in series with $330k\Omega$ (to protect the transistor) so that the bias can be adjusted for optimum burst gate pulse shape. There is an unoccupied space on the board for a resistor from Tr201 base to earth—in case you think something has dropped off! Note that L200 is not meant to have a core screwed into it.

Next month: Decoder and timebases.

ICs FOR TELEVISION

—continued from page 405

supply pin and pin 16 the chassis connection.

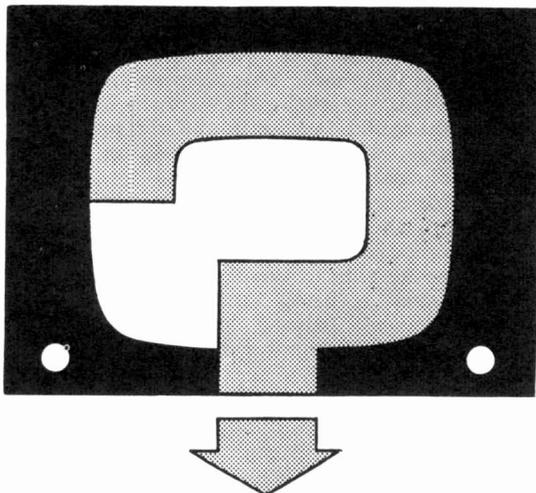
A TBA510 is used in the Grundig 1500/3010 series and also the latest Grundig colour chassis (5010 series) introduced this month in the UK. Grundig continue in these models to favour colour-difference tube drive. The 5010 series uses a TBA510 together with a TAA630 colour demodulator i.c. in the chrominance section and a TBA970 luminance i.c. which drives a single BF458 luminance output transistor operated from a 280V rail.

Conclusion

As this series has been appearing more and more i.c.s have come to be used in television receivers, both monochrome and colour, and more and more i.c.s designed for television set use have been announced. Some of these have been mentioned in recent *Tele-topics*. There seems little doubt that a major increase

in the use of integrated circuits in television receivers is about to occur. Fully integrated i.f. and vision detector sections are already in use (Decca) and this is the likely area, together with the decoder in colour sets, in which integration will most rapidly spread. Elsewhere integrated line and field oscillators using circuits without inductors have been developed and a field output stage in integrated form is now feasible. Line output stages consisting of hybrid i.c. and thick-film circuits have been built and there is a programme of work directed to the integration of the r.f. tuner, using digital frequency synthesisers to provide local oscillator action controlled by signals from a remote point. We seem to have reached the position where the only part of the set which does not attract the i.c. manufacturers is the picture tube itself!

The author wishes to acknowledge the help of Mullard Ltd. in the preparation of this article and also their assistance throughout the series. Thanks are due also to Rank-Bush-Murphy, Plessey and Motorola who have all given valuable help. ■



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BUSH CTV184S

This set lost field scan and the cause was found to be an open-circuit diode—5D11, one of the rectifiers which derives the field timebase supply from the line output stage. After replacing this diode and the lower transistor (5VT12 BD131) of the field output pair satisfactory operation was obtained. Can you advise why the diode failed? After a thorough check of the field output stage everything appears to be in order but the voltages are on the high side.—H. Mayer (Hampstead).

There is no circuit reason why 5D11 should fail. These diodes (BA148) do fail however, quite often due to internal faults. As far as the high voltages are concerned you should adjust the set e.h.t. control on the power panel for 200V and reset the over-voltage protection control in the line oscillator circuit—making both adjustments in accordance with the maker's instructions.

MARCONIPHONE 4703

On switching the set on a ripple appears on vertical lines, sometimes accompanied by a sharp sideways movement. At the same time the pitch of the line timebase whistle alters. The line hold remains locked and the fault clears after about half an hour.—J. Buttershaw (Middlesbrough).

It is difficult to pinpoint the cause of a fault such as this but the trouble is almost certainly in the flywheel sync/reactance section of the line timebase and is probably due to a dry-joint. Disturbing the components around the flywheel sync diodes (W501-2) and the reactance transistor (VT501) should reveal the poor connection.

PHILIPS 19TG171A

The picture suddenly went extremely faint and on switching off a very bright centre spot that lasts for several minutes is left. The picture is just visible in the dark and with the contrast and brightness controls fully up can be made to go negative.—F. Reeves (Barrow).

The symptoms you describe are highly indicative of a faulty tube (with the heater probably shorted so that only 3V is dropped across it). You should however check the PFL200 video amplifier and its asso-

ciated resistors (anode load etc.). If the tube is at fault sharply tapping its neck may temporarily clear the condition.

ULTRA 6654B

There were splashes on the screen and the sound of arcing. This was immediately traced to the e.h.t. rectifier tray which was arcing to chassis and giving its usual smell. A replacement cured the fault and the set ran well for a week after which the e.h.t. rectifier tray again failed. This time the final element was burning. The horizontal scanning, width and sync were otherwise OK but I hesitate to make another replacement in case there is some other fault present. Do you think I was unlucky with the replacement?—J. Winder (Llangollen).

You have indeed been unfortunate in fitting a new rectifier tray which became defective so quickly. This is by no means uncommon however and does not indicate that there is any other fault in the receiver.

PYE 11U

The set operates perfectly on 405 but on 625 the picture and sound drift off—they are perfect for about ten minutes and then drift off for about ten minutes before returning again. The aerial is in order and the raster OK in every respect.—O. Barnard (Fife).

It is usually the u.h.f. oscillator valve that drifts in this way. It is the PC86 at the rear of the u.h.f. tuner.

MURPHY V320

The screen went blank and I discovered that the trouble was caused by the 30P19 line output valve which had burnt out its screen resistor which is taken to a tag on the line output transformer. The valve and resistor have been renewed and the picture has returned but is about 2in. short all round and keeps waving up and down.—T. Chapman (Ilford).

Check the h.t. voltage and the smoothing. Replace the line output valve with a 30P4MR which is the correct type for this set—a 30P19 will not last long in it.

FERGUSON 3640

The screen suddenly went blank though the sound remained OK. A very faint band of light about $\frac{1}{4}$ in. wide can be seen down the centre of the screen in a darkened room. When the fault occurred the sound was left on but after about 10 minutes the fusible resistor mounted on the smoothing choke melted removing the h.t. supply. The line timebase valves have been replaced and there is a very faint line whistle. The h.t. is well down at about 180V.—J. Thomas (Bognor Regis).

Remove the top cap of the PY800 efficiency diode and see if this restores some degree of line output operation: if it does replace the 0.22 μ F (1kV) boost capacitor C101 on the extreme right side. If there is little difference (except of course for the h.t. rising) check C106 (100pF high voltage ceramic) for shorts—this capacitor feeds pulses to the line stabilising circuit. Unfortunately the line output transformer is sometimes the cause of the trouble on this chassis (Thorn 950).

KB WV70

There is complete loss of field hold. By adjusting the field hold control the picture can be made to move upwards or downwards but it will not remain still. The sync separator valve has been replaced and the components between this and the field oscillator examined without the cause of the trouble being revealed.—R. Iffield (Chester).

You do not specifically mention the OA81 interlace diode D2 which should be checked if you have not already done so. If this does not clear the fault replace the sync separator screen feed resistor R65 (330k Ω) as this may have changed value.

DEFIANT 7AF24

The picture is perfectly satisfactory but every 10 to 15 minutes the line hold is lost. The picture can be locked again if the line hold control is very carefully adjusted but the process has to be repeated every 10 to 15 minutes. Although this is an old set it would seem to be worth saving.—T. Smith (Freshwater).

We presume the 6-30L2 line oscillator/control valve has been replaced. If so the next step is to replace the D3-2-1YZ flywheel sync discriminator diodes. Use two separate ones if you prefer, the exact type being less important than the fact that they are a matched pair. Then check the following components in the flywheel sync circuit: R364, R360, R363, C354 and C355.

MURPHY V2016S

The trouble with this set is bent verticals from time to time. The EF184 line oscillator valve has been replaced without making any improvement.—A. V. Clark (Watford).

The contrast control could be set too high and we suggest you first check the effect of reducing this. Next check the electrolytic 3C31 (10 μ F) which decouples the supply to the line oscillator stage. If necessary check the flywheel sync discriminator diodes 3D6 and 3D7. We assume that the aerial is efficient and the signal ghost free.

BUSH TV128

The picture is almost lost. Hum develops and the sound becomes very loud. This happens on a change of scene. Correct reception can sometimes be restored by pressing the tuning buttons in and out, presumably causing a surge. The set is being used on 405.—T. Redman (Dulwich).

The trouble seems to be in the vision only i.f. amplifier stage 2V3 (EF80). Check the valve and its associated components. Also check the vision detector and video amplifier. What is happening is that the vision signal is being lost after the common vision-sound stages, causing loss of a.g.c. which results in increased sound with cross-modulation (hum).

MARCONIPHONE 4618

There is pronounced hum accompanied by flashing on the screen. There are also intermittently large white spots covering the screen, along with a sizzling noise which increases with the brightness. This is more pronounced on channel 1. The main electrolytic capacitor block has been replaced without improving matters. The e.h.t. connection to the tube has also been cleaned but since doing this I get wavy verticals which go sometimes up and sometimes down the picture.—B. Cotman (Braintree).

There appears to be more than one fault present. Most of the trouble is without doubt due to a breakdown in one of the pencil rectifiers in the e.h.t. rectifier tray and the complete tray should therefore be replaced. If the hum and waviness remain you will have to recheck the electrolytics.

INVICTA 7193

We have recently converted this set for u.h.f. reception and get good vision but no sound. Weak sound can be obtained by detuning but the picture is then lost. The EH90 sound detector valve has been changed, also the associated anode and screen resistors. The anode voltage is low at 10V but the output coupling capacitor is not leaky.—R. Tidwall (Maidstone).

The anode voltage reading on the EH90 can be misleading. The weak sound after conversion symptom is common on this chassis (Pye 11U series) and is usually due to misalignment of the 6MHz sound section. We suggest you tune for the finest detail u.h.f. picture and then adjust L28 and T2 for maximum sound.

FERGUSON 3652

The set has developed faint, repetitive ghost lines over one third of the picture, from the right—similar to a water mark. Also the picture starts to wave about slowly from side to side for a short time. The set (BRC 1400 chassis) has been overhauled and any low-emission valves replaced and the aerial checked.—B. Farrow (Mortlake).

The vertical rulings (striations) are probably due due to the 1 μ F electrolytic C115 which decouples the screen grid of the line output valve becoming open-circuit. The waving could be due to a faulty electrolytic smoothing block (C120-4) or a faulty 30FL14 (PCF808) valve.

MARCONIPHONE 4609

There is bad sound distortion on 625 lines only. The set is fitted with the BRC 850 chassis and I would appreciate your views on the likely cause of the difficulty—G. Browning (Doncaster).

Bad sound distortion on 625 should direct attention to the two CG61 discriminator diodes W9 and W10 inside the can L28/L31 and the associated 4 μ F electrolytic C61. Those components are at the front right centre of the top deck.

McMICHAEL MP18

The sound usually disappears a few minutes after switching on. There is generally a clicking sound associated with this. The sound returns after about half a minute, sometimes longer. Sometimes the sound goes very low instead of going completely. The base of the audio valve is badly charred.—I. Penfold (Poplar).

You will have to check the PCL82 audio valve and the associated components—grid coupling capacitor, cathode bias etc. If the fault cannot be initiated and put right by disturbing the components in this stage however check the plug and socket connecting the volume control to and from the i.f. panel. Also check the EB91 on the panel.

HMV 2620

There is permanent cramping at the bottom of the picture on this set (Thorn 900 chassis). With the picture at full height there is no vertical lock but with the picture at three-quarter height lock can be obtained at the end of the travel of the hold control. The voltages on the field timebase valve have been checked and found to be correct. The obvious components—cathode bias, resistors in series with the controls and the linearity feedback capacitors—have been tried without success. The height and linearity controls operate correctly.—K. Schultz (Ware).

There are two suspect capacitors you have overlooked. First C79 (3kpF high voltage) which couples back to the triode grid from the anode circuit of the pentode section and secondly C81 (0.02 μ F) the field timebase charging capacitor. These should be changed.

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TELEVISION JULY 1972

'TEST' CASE

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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.

? The line output transformers of some receivers are shunt fed from the anode of the line output valve via a capacitor, with an inductor connected between the cathode of the boost diode and the anode of the line output valve for carrying the d.c. The inductor is sometimes called a "desaturating coil" since it bypasses the d.c. from the transformer primary, thereby avoiding magnetic saturation.

The GEC/Sobell 2020/1020 series uses this technique. One of these sets recently investigated was devoid of a raster and line whistle with only a small pulse-type spark available at the PL500 anode from the tip of a screwdriver blade. The PL500 and associated PY800 boost diode were both heating up normally, indicating d.c. continuity and at least some degree of emission. A meter test at the control grid of the PL500 also gave a significant negative reading, indicating the presence of normal line drive.

All the small components in the timebase appeared to be in reasonable order, as were the voltages at the

usual test points. As these symptoms are not uncommonly caused by a faulty line output transformer or scan coil unit, attention was next directed to these components. Prior to extracting the transformer for a substitution test however it was noticed that the desaturating coil was running very hot and emitting wax. A test proved that this had continuity and that there was no apparent leakage to chassis.

What was the most likely cause of these symptoms? See next month's TELEVISION for the solution and for a further item in the Test Case series.

SOLUTION TO TEST CASE 114

Page 379 (last month)

Making a meter test at the control grid of the line output valve is virtually the same as connecting a high-value resistor between the grid and chassis. Since the picture steadied under this condition it was apparent to the technician that the valve had no control grid return circuit.

A subsequent test revealed that the v.d.r. used for line stabilising was open-circuit. This was replaced and the picture appeared in steady lock but of reduced horizontal amplitude. The width reduced still further when the receiver was switched to 625-line operation and it was then discovered that the replacement v.d.r. was increasing abnormally in temperature. It was obvious that this was the cause of the failure of the original component. The v.d.r. receives pulses from the line scan circuit. It peak rectifies these to provide the line output valve bias. The pulses are fed via a 2kV 100pF capacitor and this was found to be leaky. Replacement cured the overheating and restored the width on both standards.

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