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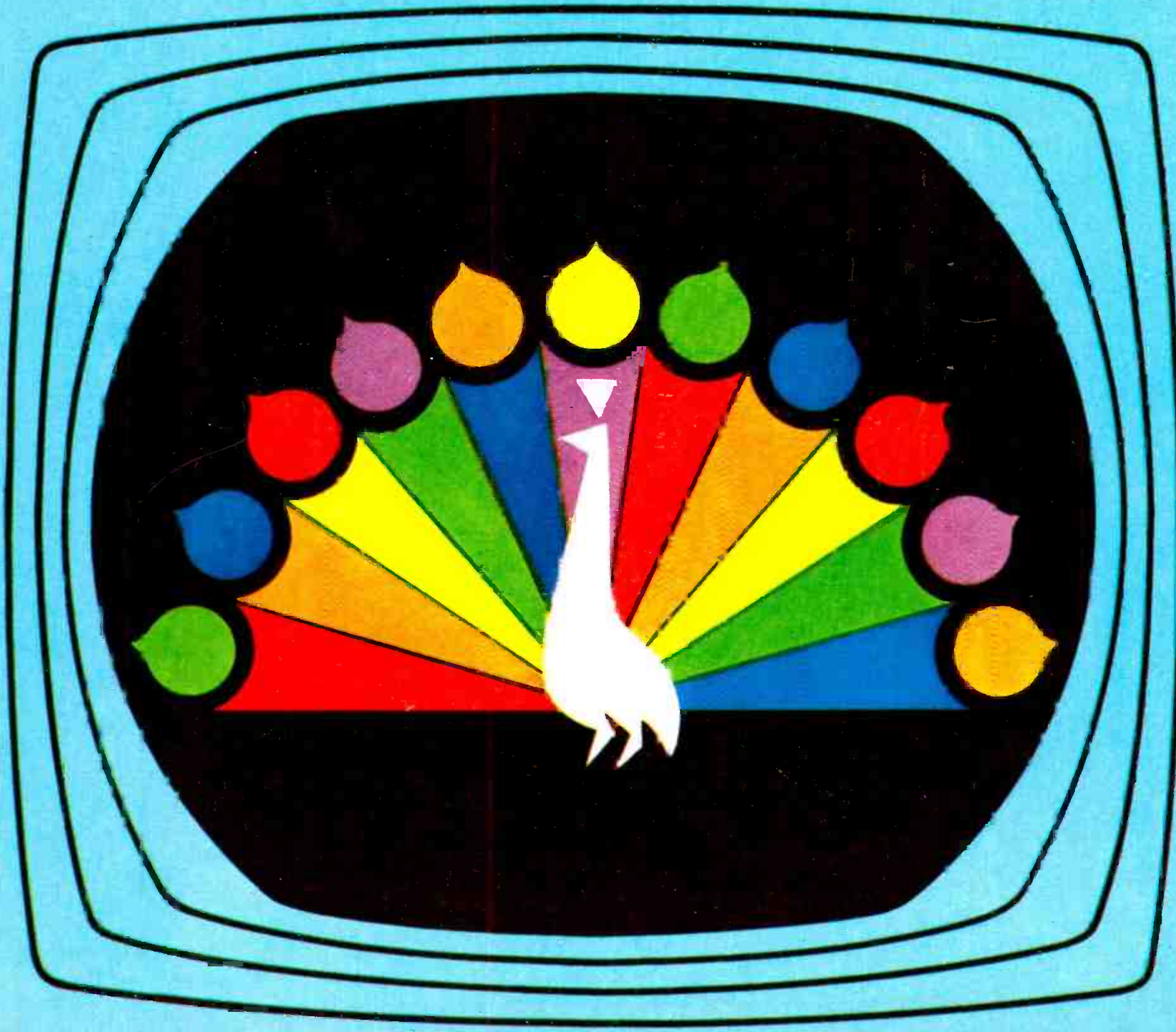

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120	,,	15K	1·8M
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180	,,	22K	2·7M
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270	,,	33K	3·9M
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6F23	·70	EABC80	·31	KT61	·54	PY81	·26
6F25	·60	EB91	·11	KT66	·82	PY82	·26
25L6GT	·22	EBC33	·38	N78	·85	PY800	·35
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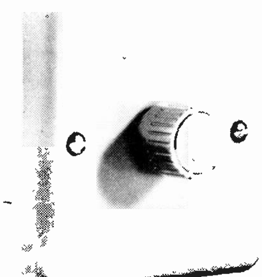

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TELEVISION

SERVICING·CONSTRUCTION·COLOUR·DEVELOPMENTS

VOL 21 No 9
ISSUE 249

JULY 1971

THE QUALITY OF TV

AN aspect of television that has concerned most of us at some time has recently received another airing. In the latest edition of *Film User*, editor Stanley Bowler asserts that the presentation of television is sadly reminiscent of the days half a century ago when the public cinema became known as "the flicks" due to poor-quality prints projected by poor equipment with unstable arc lamps.

On the face of it harsh, unjust words. But he supports his argument by the fact that instead of the granular pattern of early films we now have the image broken up by a line pattern (and, though he does not mention it, the triad mosaic of the shadowmask tube and the presence of Moiré patterning), together with a degradation due to absence of d.c. restoration. We could also add contributory debasements on the home screen such as ghosting, noise, patterning, smear and other phenomena.

A simple home truth often forgotten is that the general public, children and adults, has largely come to accept substandard viewing in the same way that countless listeners seem to be unaware of (or resigned to) sound which is distorted, cut up with sideband splash or otherwise mutilated.

So far as television is concerned previous investigations have concluded that no harm should result from sensible television viewing and that those who begin to notice eye strain are those with latently defective vision which TV viewing simply aggravates and brings to light. (If you think about this it is of course a condemnation of persistent viewing!)

Mr. Bowler points out that little research appears to have been done in connection with the long-term physiological and psychological effects of continuous viewing of unstable images and listening to poor-quality sound. He contends that viewers' eyes and listeners' ears would appear to be put to strain (perhaps unknowingly) in trying to interpret information imperfectly presented.

Although Mr. Bowler is mainly concerned with this in the educational context, in view of the ubiquitous transistor-radio, pop-player and jukebox and the TV-hypnotised orientation of many of our youngsters it might well be a profitable exercise for an authoritative team to investigate the matter in depth. It would be useful to know if in fact the quality of TV is not strained!

W. N. STEVENS, *Editor*

THIS MONTH

THE NEXT ISSUE DATED AUGUST WILL BE PUBLISHED JULY 22

Cover: This month's cover features the NBC Colour Peacock which has been used by the National Broadcasting Company Inc. as a network colour identification sign since the earliest days of compatible colour broadcasting in the USA. It is reproduced by kind permission of the NBC who claim all rights in it.

TELETOPICS

JAP COLOUR INVASION BEGINS

With three colour chassis now either on the market or about to become available the Japanese invasion of the UK colour market is an established fact. And just as in the case of the monochrome market they are attacking from the small-screen end—with some very competitive prices. As we reported in January **Hitachi** have obtained a PAL licence and are now introducing sets to the full PAL-D standard. Under the licence agreement however they are restricted to the sale of only 10,000 sets during the first year. At present available are a 15in. model at £205 and a 17in. model at £219·50. A 19in. model at £239·50 will be available next month.

Sony colour sets—the 13in. Model KV1320 shown on page 247 of our April issue—are now being widely distributed. They feature the Sony Trinitron colour tube with its very simple setting up and are priced at £199. Sony have not applied for a PAL licence and have adopted some interesting techniques in order to overcome this. Basically they have adapted the technique they successfully developed for their low-cost v.t.r. equipment in which only alternate lines of each field are used but each of the selected set of lines is repeated once. For their colour set alternate lines of the chroma signal are used and repeated once. This in effect translates the UK PAL transmissions into an NTSC type colour signal, i.e. the alternate line phase reversal feature of the PAL system is simply deleted. As the chroma definition is relatively unimportant—all the luminance lines which give the basic definition of

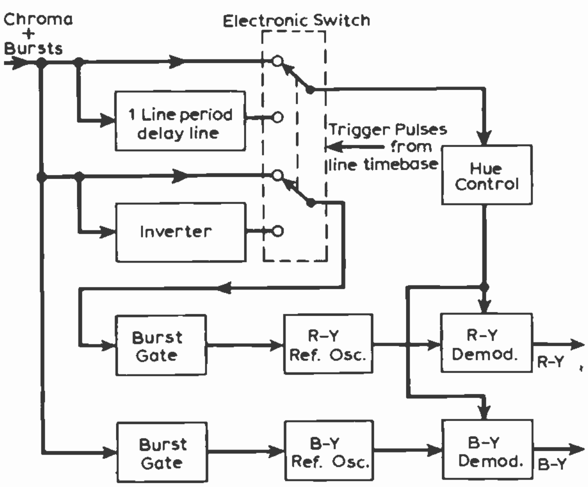
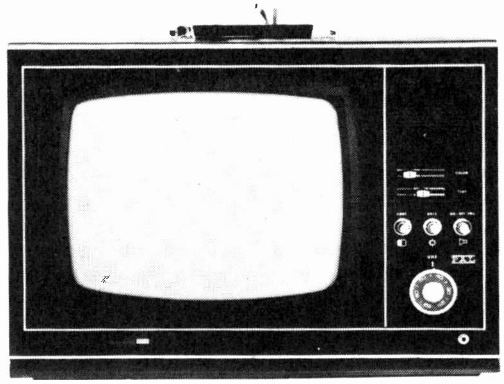


Fig. 1: The chroma signal decoding system used in the Sony Model KV1320.



The Teleton Super Twelve portable colour receiver which is to sell at £179·50.

the picture are used—and the screen size small this stratagem of using only alternate lines of the chroma signal does not noticeably affect picture definition although it does of course lose the advantages of PAL.

The basic technique is shown in Fig. 1. The chroma signal is fed to the hue control and then to the synchronous demodulators via an electronic switch which is triggered by line pulses from the line timebase. Thus on alternate lines the chroma signal goes to the hue control either direct or via the one-line period delay line. In this way one set of alternate lines is repeated while the other set is lost. This same switch is used to assist the phase locking of the R – Y reference oscillator. As can be seen separate reference oscillators are used for the B – Y and R – Y channels. The B – Y reference oscillator is synchronised in the normal way from the PAL bursts—which swing ±45° each side of the – B – Y axis—extracted from the composite chroma signal by the appropriate burst gate. The burst gate in the feed to the R – Y reference oscillator however is fed with a signal which swings ±45° each side of the – R – Y axis as a result of the action of the electronic switch which introduces a phase inverter on alternate lines. There is thus no need for any phase-shifting networks between the oscillators and the synchronous demodulators. What we don't know so far however is how the electronic switching is synchronised—clearly it must be synchronised in some way to the phase alternation of the transmitted signal. This is a feature of the PAL system that is closely protected by the patents so we will be intrigued to discover the techniques adopted here.

The third set, shown to the press a short while ago and due for release next month, is the 12in. screen save time—make money with

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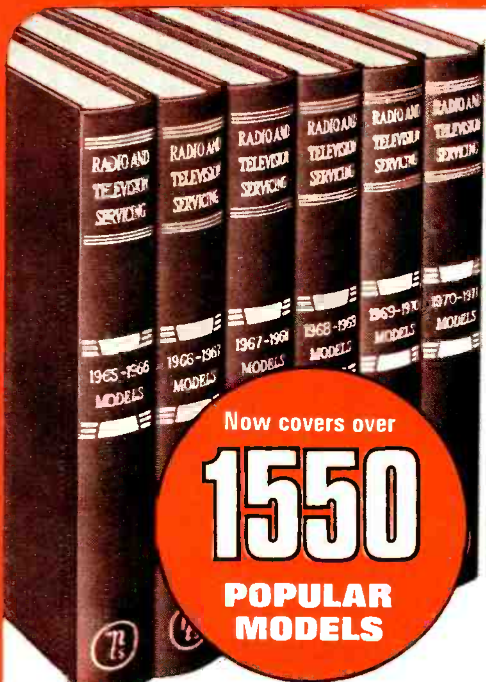

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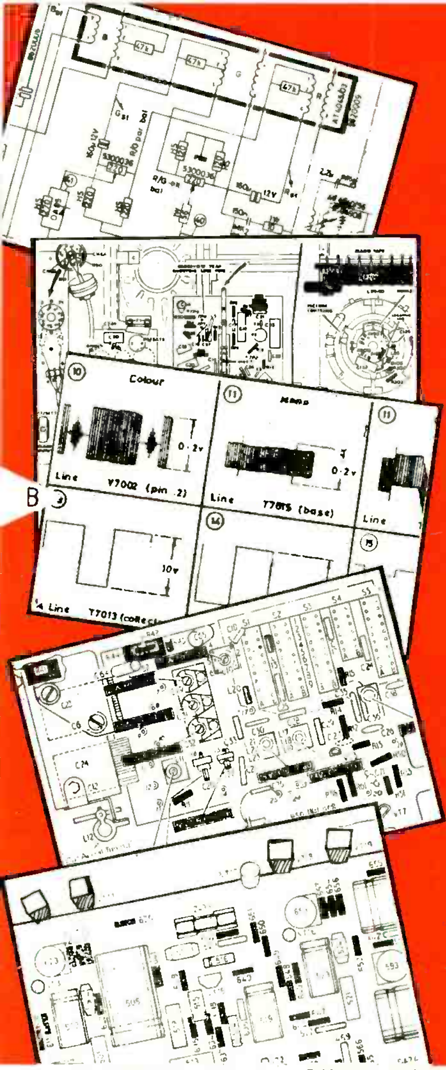

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MONO TV, RADIOS, STEREOGRAMS, CAR RADIOS, RECORD PLAYERS, TAPE RECORDERS—

Aiwa, Alba, Baird, Bang and Olufsen, Beogram, Beolit, Blaupunkt, B.R.C., Bush, Carousel, Cossor, Dansette, Decca, Defiant, Dulci, Dynaport, Dynatron, Eddystone, Ekco, Elizabethan, Ever Ready, Ferguson, Ferranti, Fidelity, G.E.C., Grundig, Hacker, Halcyon, H.M.V., Hitachi, Invicta, Jugo-Elektra, K.B., Klinger, Loewe Opta, McMichael, Marconiphone, Masteradio, Monogram, Motorola, Murphy, National, Newmatic, Nivico, Pam, Perdio, Peto-Scott, Philco, Philips, Portadyne, Pye, Radiomobile, Radionette, R.G.D., Regentone, Roberts' Radio, Robux, Sanyo, Sharp, Smith's Radiomoible, Radionette, R.G.D., Sobell, Sony, Standard, S.T.C., Stella, Stereosound, Telefunken, Teletron, Thorn, Sanyo, Trans Arena, Ultra, Unitra, Van Der Molen, World Radio.

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A

Teleton "Super Twelve" portable model (see photo) which is intended to sell at £179·50. We understand that this set is based on a chassis which has been successfully selling for some time in the US market and has now been adapted for use on the PAL system. It is fitted with a shadowmask tube and is the first simple PAL receiver to appear on the UK market, i.e. instead of electronic averaging out of phase errors between lines the averaging is carried out by the viewer since the display of alternate lines with complementary colour errors leads—because of the persistence of vision effect—to seeing the correct colours. This is of course all right so long as the phase errors are not too great and with its small screen the pictures we saw were reasonable. As in the Sony set separate reference oscillators are used to provide the R – Y and B—Y carriers required by the synchronous demodulators. A multivibrator switch inverts the R—Y reference carrier on alternate lines as in normal PAL practice but we were not told how the switch—since in this case as well a PAL licence is not considered by the makers to be required—synchronises to the correct R – Y signal phase alternation. Tint and colour controls of the slider variety are used and this certainly gives one a nice feel of being able accurately to set the colour conditions.

There is no doubt that the Japanese are making a determined assault on what has recently been a sellers' market and we shall be watching with interest the response of our home-grown setmakers. Will this be, as with transistor portable radios and some small-screen monochrome sets, "if you can't beat 'em, join 'em?" In which case we might soon be seeing "Made in Japan" on the cartons of our familiar UK brands.

SERVICE EXTENSIONS

BBC-1 is now being transmitted from **Hannington** on channel 45 (horizontal polarisation, receiving aerial group E), **Hertford** on channel 58 (vertical polarisation, receiving aerial group C), **Brierley Hill** (Staffs) on channel 57 (vertical polarisation, receiving aerial group C) and **Sandy Heath** on channel 31 (horizontal polarisation, receiving aerial group A).

The BBC's sound-in-sync system in which the TV sound is digitally encoded and inserted into the video waveform during the sync pulse period for use in programme distribution networks is now being manufactured under licence from the BBC by Pye TVT Ltd., Cambridge.

According to the Television Digest Factbook (New York) television is now watched in 131 countries on some 270·5 million sets. The USA leads in the total number of sets with over 92·7 million, just over a third of which are colour sets. The world's most populous countries have little television—there are estimated to be some 300,000 sets in China and 21,000 in India.

SYLVANIA SHOW NEW SHADOWMASK TUBES

New 110° deflection angle shadowmask tubes have been shown by Sylvania at a recent Belgian components exhibition. There were one thick-neck and two thin-neck types and they are some 95mm. shorter than the present generation of 90° types. The use of a thin-neck design of course reduces the deflection power requirements. Two other features are the use of an internal magnetic shield rendering the now familiar external shield unnecessary and the use of a lightweight shadowmask which takes less time to reach thermal equilibrium—present types take about twenty minutes to settle down to give correct convergence.

FIRST QUARTER TRADE RESULTS

The latest BREMA figures show that TV set deliveries in the first three months of 1971 were at 542,000 9% up on the same period of 1970. This increase was due to increased deliveries of colour sets which reached 146,000 during the quarter (compared to 86,000 for the same period last year). Monochrome set deliveries fell slightly to 396,000. UK-made radio and radiogram deliveries were up slightly but there was a slight fall in deliveries of record players.

NEW SETS

Three new sets have been introduced in the **Pye** range. Model CT152 is a single-standard 22in. colour model fitted with the 691 chassis and priced at £292·90. The 150 is a 22in. single-standard monochrome model at £82·45 fitted with the 769 chassis featuring a varicap tuner unit. Model CT121, a 26in. single-standard colour model at £320·50, is also fitted with a varicap tuner unit. It uses the 693 chassis. These new chassis —the 693 and 769—are basically similar to the established 691 and 169 but modified for use with a varicap tuner. We understand that **Rediffusion** are soon to introduce off-air colour receivers. A number of small-screen monochrome models from UK setmakers are also due for release shortly.

EMI, who withdrew from direct interest in the UK domestic radio and television field back in 1957, have bought a 50 per cent interest in the Italian Voxson company which makes monochrome and colour TV sets and other domestic electronic equipment. They have also taken a 50 per cent interest in the Italian Ergon company which makes colour TV tubes.

CCTV SYSTEM FROM PLESSEY

An inexpensive three-channel miniature CCTV system has been announced by Plessey Communications Ltd., Tolworth Rise, Surbiton, Surrey. Each of the three cameras that can be used can be independently selected by push-buttons on the video monitor which has a resolution of more than 400 lines. Scenes illuminated to a minimum of 20lux are clearly shown. The basic system comprising a single camera, monitor, cable and camera mounting bracket costs £250. A range of ancillary equipment including scanner, wide-angle and telephoto lenses is available.

TV SET WALL SUPPORT

The Kayen TV set wall support allows a set to be swung out over tables, desks, etc., and pushed back flush against the wall when not in use. The wall mountings and swing-out arms are of stressed aluminium. The set is held between a plastic covered base and a suction pad which grips the top of the set so that drilling or screwing into the cabinet are not required. Two lengths of wall-mounting beam are available, 762mm. and 1061mm. and the kit is complete with instructions, wall plugs and screws. Price is £13·76 for single units but quantity discounts are available. K. & N. Electronics Ltd., Cordwallis Street, Maidenhead, Berks.

TV TEST REPORT

E. M. BRISTOL

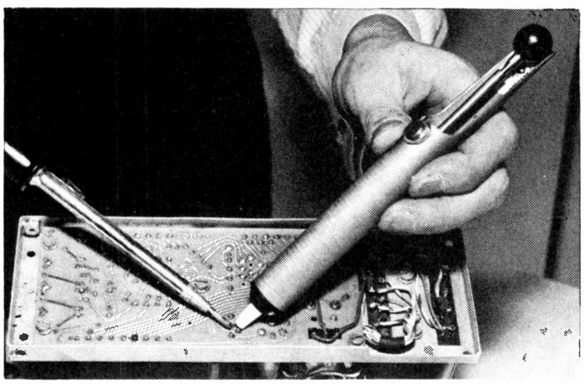
PICARD "ABIKO" DESOLDERING GUN

MOST instruments designed for removing excess solder from printed circuits involve some form of soldering iron with a hollow bit which heats the work up and then removes the solder by suction or pressure along an air pipe powered from a foot pump. These tend to be rather cumbersome and not too easy to use.

The Picard instrument is completely different. In fact it is not a desoldering iron at all but a pump, very similar to a bicycle pump but with a metal body and Teflon nozzle. The push rod is spring loaded by a very powerful spring and to operate the rod is first pushed down the barrel against the pressure of the spring by the small ebonite ball at the end. When fully pushed home it is retained in position by a catch. The pump is then ready for use.

In use the solder must first be melted by a conventional iron. This is one of the many advantages of the solder pump in that there is no waiting for a special desoldering iron to warm up. The nozzle of the pump is then introduced to the molten solder and the button at the top of the barrel depressed. This releases the retaining catch and the rod flies out with considerable velocity, sucking the solder into the barrel of the pump.

An interesting feature is the nozzle. If it were made of metal it would cool the work and probably make the solder solidify. I had some doubts at first however as to whether Teflon would stand up to constant wear and being immersed in molten solder. But these proved to be unfounded. Over a considerable period of workshop use there has been only moderate wear and this has not appreciably affected performance.



The Picard "Abiko" desoldering gun in use.

The wear has been much less than that to a soldering iron bit for the same period of use and replacement nozzles are available from the makers. The aperture at the end of the nozzle is much larger than those of most desoldering irons enabling it to fit over the largest terminal post on a printed circuit. Normally a large aperture means reduced suction but as the suction is in this case developed by the high velocity action of the powerful spring it is ample for removing all solder from the joint.

This is actually the most effective solder remover that I have so far examined. Suction is both powerful and sudden—so much so that it is not always necessary to establish an air-tight fit between nozzle and solder. With most desoldering irons the air vent in the bit must be completely immersed in solder as otherwise air will be drawn in instead of the molten solder. Where the solder is only a thin layer this can mean priming the joint with more solder in order to make an air-tight seal. This is not necessary with the solder pump and although the nozzle should make as air-tight a joint as possible with the work it will nevertheless remove solder even when air is also drawn in.

Because of this the pump can be used on wired solder tags and terminals as well as on printed circuits. This is rarely possible with conventional desoldering irons and greatly facilitates the removal of wires and components from tags as a tag can be sucked completely clean of solder and the wires then unwrapped.

As the tool does not generate heat it can be put down anywhere without the need for a stand. Also of course there is no trailing air line or mains cable. A further point in its favour is that the energy for producing the suction is applied by the operator in advance and stored in the spring. Thus attention is not diverted from the work by the need to operate a foot pump.

In use it is convenient and handy. It would be an improvement for the release button to be farther down the barrel as one naturally tends to hold the pump in the middle and with the release button in its present position the pump must be held at the end. This is however a very minor point and one soon gets used to operating the tool.

The only drawback is getting rid of the solder inside the pump. It is supposed to be ejected from the nozzle when the tool is resprung but it does not do this very well. Small quantities of solder form small blobs which are ejected without too much difficulty but larger amounts tend to splatter over the nylon pump washer and walls. These come off on the return stroke to form thin sheets which will not go through the nozzle. In fact respringing the tool sometimes jams them in the nozzle.

The only solution is to unscrew the nozzle end piece. The solder can then be easily removed. This is not a major operation but does take a minute or so and can be irksome if a number of operations are carried out in succession as the end piece is secured by a number of fine screw threads. A quick-release device here would be an asset—say a bayonet-cap fitting or even a much coarser thread needing only two or three turns for removal.

This is however the most effective solder remover tested so far and prospective users should not be deterred by this point. It can be recommened for both engineer and amateur alike. The price is £4 and the distributors Henri Picard and Frere (34 Furnival St., London EC4).

THE RAINBOW REVOLUTION!

1951-1971 TWENTY YEARS OF COMPATIBLE COLOUR TV

PART 1

I. R.SINCLAIR

The first public tests of the RCA compatible colour system were conducted in July 1951. This was the beginning of colour TV as we know it today and to mark this momentous event the following article presents the technical historical background to colour TV.

IN EARLY July 1951 New Yorkers saw each day in their papers an advertisement about a new colour TV system, the RCA (Radio Corporation of America) colour TV system. The advertisements did not ask readers to drop in at a theatre to view colour TV: such advertisements had appeared before. What was unique this time was the invitation to watch a colour TV broadcast in black-and-white on their own receivers at home. The word they were being introduced to was *compatibility*, and the inventors of the new system were members of a huge team working for RCA who had for many years fixed their sights resolutely on just this target.

To understand what this meant for colour TV we must briefly examine the systems of colour TV which had been used previously. The big problem of colour TV is that it requires more information to be fed from transmitter to receiver than does black-and-white. As well as the position and brightness (or more correctly the luminance) of each part of the picture the *hue* and *saturation* of any colour present must be specified. Hue is the information we loosely call "colour"; it is accurately specified by the wavelength of the light being viewed and determines whether we see red, green, blue or any other definite colour. Saturation we might call "depth of colour". If we take a drop of intense red paint (meaning that of all the light which reaches it it reflects only red) and mix it with progressively greater amounts of white paint the colour becomes paler. We are desaturating or diluting the colour. Most natural colours are heavily diluted in this way. We express this dilution in terms of the percentage of pure colour in the total and call this the *percentage saturation*.

Theory of Colour

The way in which we transmit the extra information on hue and saturation is very closely bound up with the theory of colour and we must look at some of this to understand the methods which have been used to present colour pictures. In 1666 Sir Isaac Newton who was experimenting with glass prisms found that a ray of white light could be split up into a set of overlapping colours by being passed through a prism (Fig. 1). He was fairly certain that the colours were in fact the constituents of white light and not something *added* by the glass, but to be certain he performed two further experiments. First he selected one of the rays of colour and passed it through another prism to see if the process could be repeated (Fig. 2). There was no change this time, indicating that the prism did not create colours but simply separated them when they were already present in mixed form. Secondly he directed his coloured rays to another prism turned the other way round and found that this action reassembled the coloured rays into a beam of white light again (Fig. 3).

Colour Mixing

This discovery that what we call white light is a mixture of all known colours led to a great deal of work being done on colour and colour vision in the late eighteenth and early nineteenth centuries. It was found fairly early on that the sensation of white light did not require a mixture of *all* colours but could be achieved by mixing equal amounts of red, blue and green lights. Because of this these colours were called *primaries* and it was soon discovered that suitable mixtures of these primaries could reproduce the sensation of any colour which could be found naturally as well as a large range which could not be naturally obtained. The process of colour synthesis was born.

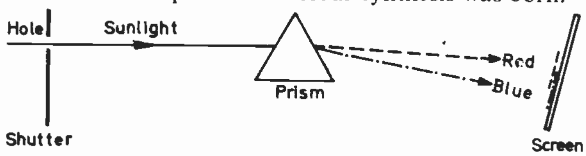


Fig. 1: Newton's first experiment. Sunlight had to be used as no artificial light then known was bright enough. The image on the screen was the shape of the hole in the shutter but with coloured edges.

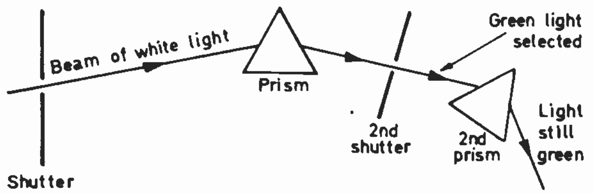


Fig. 2: Newton's second experiment. Once the white light had been separated into colours by a prism it could not be separated further by using another prism. This proved that the colours obtained were not something added to the white light by the glass of the prism.

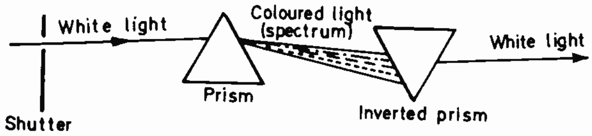


Fig. 3: Newton's third experiment. This showed that the white light split into its component colours by one prism could be reassembled by another prism.

This is by no means the end of the story, for the process of colour vision inside the eyes is hardly understood. The German poet of the early 19th century Goethe showed that a wide range of colours could be seen by mixing two coloured lights which were not in themselves primaries. Many others—notably Dr. Edwin Land of Polaroid fame—have experimented with two-colour systems. Colour effects have also been created by flashing white lights at different repetition frequencies—you may have seen a demonstration of this on a *Tomorrow's World* programme some time ago. These other methods however have the disadvantage that there is more disagreement about the colours which observers claim to see than is the case with three-primary systems. And since the object of a colour system, whether photographic or TV, is to please everyone to a reasonable extent only three-primary systems have stayed in use.

Additive and Subtractive Colour Mixing

When we have decided to use three primaries however we are only at the start of a colour system. We must have a method of creating the colour primaries, a method of mixing them, presenting them in the correct mixture at the correct place etc. One of the first decisions we have to make is whether to use an *additive* system or a *subtractive* one. As the name suggests an additive system obtains each colour by adding three primaries in various proportions (Fig. 4). A subtractive system operates using white light and only two primaries, subtracting various proportions of the two primaries from the white light (Fig. 5).

Subtractive systems are widely used in colour photography but only additive systems have been used for colour TV. Before this statement is challenged let me say that I am talking about light rays and not about electrical signals. Irrespective of the electrical methods used, in every system of colour TV which has been used the light reaching the eye comes from the addition of red, green and blue primaries.

Simultaneous and Sequential Systems

Colour TV thus involves sending out three signals which can control the intensities of three primary light sources at the receiver. Once more we have some choice of method. We can send out all three signals at the same time so that the primary colours at the receiver are activated in the correct proportions together: this is a *simultaneous* system. Alternatively we can transmit the signals in rapid sequence so that the primary colours at the receiver are pulsed on and off in sequence—R, G, B, R, G, B etc. Because of the persistence of vision which is responsible for our seeing a moving dot of light as a raster we in this case

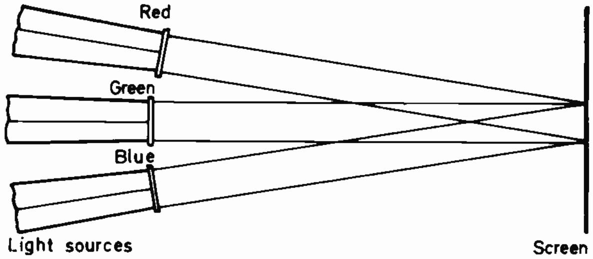


Fig. 4: Additive colour mixing. Sources of red, blue and green light are all directed to the same spot on the screen. The colour seen at this spot on the screen will depend on the proportions of the three primary colours used. Because the lights are added in parallel this is known as additive colour mixing.

see a colour which is a mixture of the repeating primaries. This is a *sequential* system.

In the early days of colour TV simultaneous systems were ruled out completely. A simultaneous system appears to need three simultaneous TV broadcasts, one for each primary. This would require a huge bandwidth for transmission and would also require a receiver with three c.r.t.s whose pictures could be blended together—possibly by projection techniques. It's not impossible but the results are not encouraging.

Sequential systems therefore appeared to offer more hope and here again there were two alternative possibilities. We could transmit the lines of the picture in different colours with line 1 red, line 2 green, line 3 blue, line 4 red and so on (assuming no interlace). This is a line-sequential system. On the other hand we could transmit a complete field in one primary colour, the next field in another primary and the third field in the remaining primary. This is a field-sequential system.

Colour Wheel

Each of these has its advantages and drawbacks. At the time when they were being considered the only method of displaying a colour picture other than by having three separate c.r.t.s each with a primary colour filter in front of its screen and combining the three displays thus obtained was to use the rotating colour wheel invented by Baird. This is a wheel with three "windows" of coloured transparent material which rotate in front of the c.r.t. (Fig. 6). The light colour displayed at any instant depends on which part of the wheel is in front of the tube. If for example the red window is in front of the c.r.t. during a field that field will be entirely red and black. The next

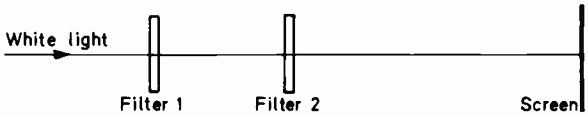


Fig. 5: Subtractive colour mixing. This is a series process in which each colour filter removes a colour from the white light. If the filters remove nothing the transmitted light remains white. If their ranges do not overlap the image is black. If one filter removes blue and the other green, red is seen on the screen. The colour the filters appear to be is called the complementary of the colour they remove and is a mixture of all the remaining colours in the spectrum.

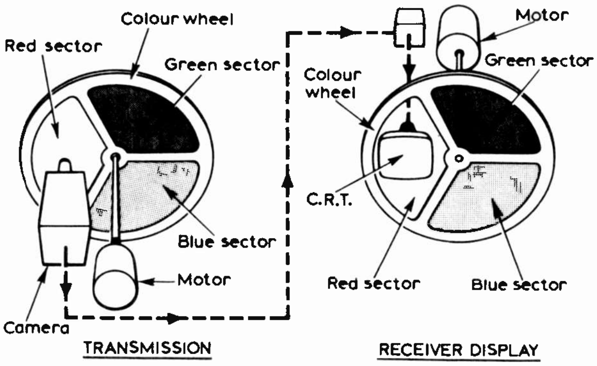


Fig. 6: Principle of early sequential colour systems. The colour wheel was common to all the early sequential colour systems and was the factor which contributed to their downfall. Synchronising difficulties, the high speed of the wheel in line-sequential systems and the non-compatibility doomed such systems to extinction.

field might be transmitted during the time when the green window is in front of the c.r.t. making the next field green-black and so on. Such a system obviously requires good synchronisation between the colour wheel and the transmitted signal. Synchronisation was more easily achieved with a field-sequential rather than a line-sequential signal because of the lower wheel speed.

The line-sequential system incidentally is not entirely dead. Patents have been taken out on the conversion of the PAL signal to a line-sequential one to permit a colour wheel to be fitted to a normal monochrome set for the presentation of a colour picture. Whether this will ever emerge as hardware is another thing but it shows how an old idea can be revived when modern techniques make it more feasible.

Back to History

We must return however to our New Yorkers in July 1951. They had known colour TV broadcast using a field-sequential system since 1948. The picture could not be picked up on a monochrome set because the field repetition rate used had to be much higher than for black-and-white since three primary fields were required to make up one complete colour field. The colour sets for this system used small screens to avoid making the colour wheel too large (its diameter must be *at least* twice the width of the screen), the synchronisation between colour wheel and received picture was poor and breakdowns of the mechanical equipment were frequent. New Yorkers were disillusioned with the marvels of colour TV since to receive the signals from the colour transmitter another and not very reliable TV set which could be used only for colour had to be bought.

Compatible Colour TV

It was at this time that RCA released the results of the most intensive programme of development of any electronic system since radar. And RCA colour was compatible. A few viewers with receivers lent by RCA would see the trial transmissions of July 9-13 1951 in colour while most of New York would have the chance to see them in black-and-white on their own sets, proving that compatible transmissions—capable of being received by a colour set or an *existing* monochrome one—were possible for the first time.

This test of public reaction and the later tests in October 1951 which could be viewed by the public on RCA colour receivers located in theatres throughout New York were crucial to the development of the system. Before a station can start broadcasting in the USA it must receive the approval of the Federal Communications Commission which allocates wavelengths and decides how many stations will broadcast a.m. and how many f.m. At this time the FCC had the task of licensing a successor to the field-sequential system which had been abandoned. Thus RCA had to submit a petition to the FCC proving that their new system met the requirements imposed by the FCC who did not want a repetition of the fiasco of the field-sequential system.

FCC Requirements

When RCA submitted its petition to the FCC for approval of the RCA colour television system on June 25, 1953 it had to show that the system met seven criteria which had been laid down after the failure of the field-sequential system.

The first criterion was that the total signal must be contained within a 6MHz bandwidth so that the existing structure of wavelength allocations in the US could be preserved with no risk of interference between stations using adjacent bands.

The second criterion was that the system should "be capable of producing a colour picture which has a high quality of colour fidelity, has adequate apparent definition, has good picture texture and is not marred by such defects as misregistration, line crawl, jitter or unduly prominent dot or other structures". These are not readily measurable qualities. They depend very much on the impression which the picture makes on the viewer and it was because of this that RCA conducted such extensive and elaborate field trials with questionnaires to test viewers' reactions.

The third point insisted on by the FCC as a result of the field-sequential experience was that the picture should be bright enough to permit an adequate contrast range and capable of being viewed under normal home conditions without objectionable flicker. Nowadays we are accustomed to much higher light outputs from c.r.t.s than was usual in the early 1950s but the RCA colour tubes were in fact quite as bright as current monochrome ones.

The fourth condition was that the receivers must be simple to operate in the home, with no critical registration or colour controls, and must be cheap enough in price to be available to the great mass of the American purchasing public (commercial colour TV could never get off the ground if only a small portion of the public could view it). In these respects the RCA system was certainly superior to the field-sequential system. But as we now know the transmission system does not preserve constant hue when phase changes occur—as they do—in the transmission path. This aspect of colour TV has greatly improved since colour transmission started and has been brought to near perfection with the PAL system (which was developed from the RCA system).

The fifth point was that the transmission system should be capable of operation by trained engineers but without excessive increase of staff, and that the costs of purchase, operation and maintenance of the transmitting equipment should not be so high as to restrict the availability of colour TV. Remember that broadcasting in the USA is in the hands of private companies: no licence fees are charged to viewers so there is not a huge fund of money available to station operators. The RCA system, though technically much more complex than anything which had gone before, could certainly be taken on by the larger stations quite quickly. Most of the extra costs of colour were actually studio costs which the individual transmitting stations bore only indirectly as they bought programmes from those available and networked by the large organisations.

Criterion number six was that the system should not be unduly susceptible to interference as compared with black-and-white. The key word here was "unduly". Though phase changes caused colour shifts the number of times when interference caused complete breakup of picture information was no worse for the colour picture than for a monochrome one.

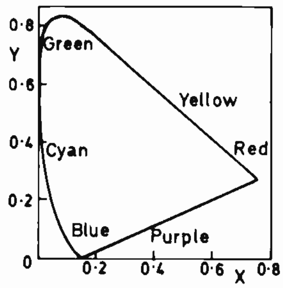
The last stipulation was that the system should be capable of being transmitted over existing landlines and microwave relays or any form of relay system which might be developed. This presented some difficulty as some districts were served with coaxial cables with only a 2·7MHz bandwidth. It was resolved by using a converter which employed a lower frequency subcarrier so that a low-definition signal could still be sent over such cables with most of the colour information present. From the time of the adoption of the RCA system relay cables were replaced where necessary with cables of wider bandwidth.

The National Television System Committee (NTSC) was a body consisting of people with long experience in TV whose aim was to find a colour transmitting system which would meet the FCC requirements within the range of technical possibility. The Committee's job was to investigate proposals and finalise standards rather than to put forward ideas, and it was inevitable that RCA and their partners NBC (National Broadcasting Company) should make most of the running. Some of the painstaking work which was done by RCA in order to shape the standard is worth commenting on. It should be mentioned that RCA had experimented with field-sequential systems in 1940 and rejected them.

Colour Vision

One study group had worked on colour vision. Following work of the International Committee on Illumination (CIE) which had defined the primary colours (not easily obtained from ordinary light sources) capable of being mixed to form any desired colour and which had drawn up the now familiar horseshoe diagram (Fig. 7) showing the location of colours with reference to the three CIE primaries, RCA produced a "colour triangle" (Fig. 8) based on the red, green and blue primaries which could be obtained from known c.r.t. phosphors. Notice that the triangle of reproducible colours lies well within the CIE horseshoe, indicating that fully saturated colours cannot be obtained from the phosphors. Fortunately this is not necessary as natural colours are never so saturated as to require this.

Picking up work by Willmer and Wright (1945) in England the RCA team noted that the human eye is less sensitive to colour in small patches than to black-and-white detail. In a small patch of a picture, with the eye centred on that area, any colour can be



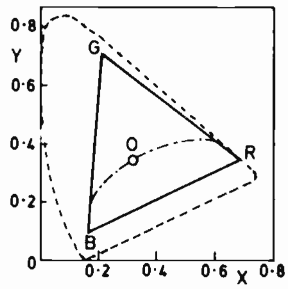


Fig. 7 (left): The colour horseshoe. If we are to produce colours by addition we must start with a set of primary colours to add together. The practical snag is that we do not at present have light sources sufficiently perfect to give all known colours by addition only and have therefore to invent "super-colours" which will do so. On the chart the X axis represents fractions of "super-crimson" and the Y axis fractions of "super-green" to which two enough "super-blue" is added to total unity. For example the point marked purple represents 0·5 super-crimson, 0·15 super-green and 0·35 super-blue. The horseshoe is the line on which all the colours of the spectrum obtainable fit. These are the most saturated colours that can be obtained and the colours normally seen are well inside this line.

Fig. 8 (right): The colour triangle (solid line) shows the colours obtainable with the three primary colours used by RCA. At frequencies below 500kHz any colour within the triangle can be reproduced. At frequencies between 500 and 2,000kHz only colours lying along the curved inner line can be reproduced as they are the colours most easily seen by the eye in such detail. Above 2,000kHz only point O (standard white Illuminant C) can be reproduced. All natural colours still fit well inside the triangle and only very saturated colours cannot be reproduced.

matched by only two primaries instead of the three needed for satisfactorily rendering large areas of colour. The primaries chosen for best colour matching of small areas appear to be a slightly orange-red and a greenish-blue. As coloured test objects are decreased in size the viewer first becomes unable to distinguish blue from grey, then yellow and grey become indistinguishable and finally no colours at all can be distinguished. The last colours which can be distinguished are reds from blue-green.

The RCA engineers therefore concluded that for the finest picture detail only luminance information (i.e. the monochrome brightness information) needed to be transmitted and that a complete range of colour information need only be transmitted for large areas of colour. This step alone was a major one in the history of colour TV techniques.

Dot Interlace and Multiplexing

Another team worked on methods of coding colour information into a form which could be transmitted within the same bandwidth as the black-and-white signal. Interlace is one such method of adding information. It enables us to use a picture transmitted at 25 frames yet presenting the non-flickering effect of 50 fields per second and the principle can be extended to sending extra signals: if we add a signal to the monochrome signal on one field and subtract it on the other it should be unnoticed by the eye. This extra signal can be at high frequency, producing dots

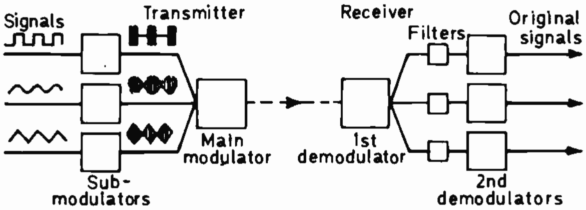


Fig. 9: Principle of frequency multiplexing. Each signal is modulated on to a separate subcarrier, each subcarrier being at a different frequency. The subcarriers are then added together and modulated on to a carrier for transmission. At the receiver the carrier is demodulated and the subcarriers separated by filters and then separately demodulated to give the original separate signals.

on the screen. Such a system is called a *dot-interlaced system*.

Given then that we could possibly add extra signals within the bandwidth of a monochrome signal without causing too much interference, how could this adding be done and how could all the information be carried? This problem had been around for a long time in other forms and was always solved by techniques of *multiplexing*—carrying more than one signal on a carrier. Previously used methods of multiplexing were *frequency division* (Fig. 9) in which each message is carried on a part of a band of frequencies and is separated at the receiver by filters, and *time division* (Fig. 10) in which a part of each message is sent in turn requiring the receiver to be switched in step with the switching from one signal to another at the transmitter. The interlacing technique we have just described is a form of time multiplexing. In addition when a carrier is modulated one message can be carried on each sideband or one message may be used to amplitude modulate and the other to frequency or phase modulate the carrier.

Crosstalk

Any attempt to pour quarts into pint pots as far as fitting signals into a given bandwidth is concerned is liable to end up with interference between the signals, called *crosstalk*. Sometimes this can be cancelled as when interlaced patterns are used, the interference then cancelling in the eye of the viewer. Sometimes the crosstalk may be unimportant, as when it causes such a fine pattern on the screen that it cannot be resolved by the tube or the eye. In many cases however crosstalk will result in severe errors so that we must take steps to avoid it by cutting down the bandwidth of the signals which are multiplexed together. The work done on the eye's sensitivity to colour provided information which enabled the RCA engineers to keep the signal bandwidth low enough to avoid crosstalk.

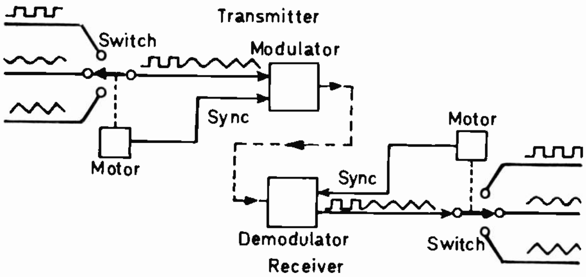


Fig. 10: Principle of time multiplexing. The transmitter and receiver contained synchronised switches. A portion of each waveform is transmitted in turn and in the receiver switched into the correct channel. Provided the switching frequency is higher than the frequency at which changes in the signals occur no information is lost.

The System Takes Shape

By the late 1940s the general form of the system was emerging. There would have to be present a full-bandwidth monochrome signal which would enable black-and-white receivers to present the same picture as before. An extra carrier, at a high frequency to make it less visible, would be added to this and would be modulated by signals corresponding to the colour saturation and hue. The frequency of the subcarrier could be chosen so as to produce minimum interference through the use of dot interlacing. It was suggested that the colour saturation signal should modulate the amplitude of the extra carrier (the subcarrier) and that the hue signal should modulate its phase. A reference subcarrier signal in correct phase should be provided as part of the synchronising signal.

The important points here are that when there is no colour information present the normal monochrome picture is being transmitted so that the system is compatible and that when colour information is introduced it is brought in in such a manner as to cause least interference to the monochrome signal. It is interesting to note that as an alternative to phase-and-amplitude modulation of the subcarrier the RCA engineers considered a system of single-sideband transmissions for each colour signal. This would involve crosstalk which could be eliminated by *reversing the phase of the subcarrier between alternate picture lines*, a technique which later became the basis of the PAL system, though the complication of a delay line was probably not envisaged at the time.

During 1946 and 1947 RCA demonstrated a coding system in which colours were transmitted completely only at frequencies below 2MHz. In the fine detail of the picture above 2MHz mixed red and green signals were sent on the green channel as a monochrome signal. This was termed a "mixed highs" system and the principle (though not the exact method) has survived.

By 1949 RCA were able to show colour pictures which had been coded completely on to a monochrome signal and then separated by a receiver which used three separate tubes (the shadowmask tube was still under development by RCA at this time and was shown to the FCC in March 1950).

The result of all the effort put into the addition of colour information was a set of signal specifications agreed with the NTSC and released on November 26, 1951. These specifications make interesting reading now in the light of modern techniques. They included:

(1) A monochrome signal
$E_Y = 0{\cdot}30E_R + 0{\cdot}59E_G + 0{\cdot}11E_B$ where E_R, E_G and E_B are the outputs from the red, green and blue camera tubes. This specification is still used as it established how white is made up from the available "standard primary colours".

(2) Two colour-difference signals, each of 1MHz bandwidth, one $0{\cdot}61E_R - 0{\cdot}52E_G - 0{\cdot}10E_B$ and the other $-0{\cdot}15E_R - 0{\cdot}29E_G + 0{\cdot}44E_B$ modulated on to the

—continued on page 424

BASIC CIRCUITS FOR THE CONSTRUCTOR 2

J.W.THOMPSON

A 625-LINE IF STRIP WITH VARICAP TUNER AND IC SOUND CHANNEL

THREE-CHANNEL u.h.f. reception is now possible in most parts of the country and the area of coverage is rapidly expanding. There appears however to be a notable lack of enthusiasm on the part of the general public to take advantage of the new channels. In theory 625-line u.h.f. reception is far superior to the old system but in practice the end result is rarely better and often inferior. What goes wrong? We must start right at the beginning with the aerial system which is the most common source of trouble. A large proportion of domestic viewers obtain perfectly reasonable results on v.h.f. with a simple set-top aerial and some of the prejudice against u.h.f. is perhaps due to the fact that indoor aerials never seem to work very well on the new channels, even close to the transmitter. A properly sited roof-top aerial is of course essential for best results.

Dual-standard Compromises

In addition to aerial problems further problems nearly always arise within the receiver itself, especially if this is of the dreaded dual-standard variety. Such receivers are masterpieces of technical ingenuity but are inevitably full of compromises. A typical example of this is the compromise between sound buzz and sound-chroma beat, the balance of which is determined by the depth of sound trapping in the vision i.f. amplifier. A certain amount of trapping (about 40dB) is required to eliminate sound-chroma beat patterning on the picture but unfortunately this leaves very little 6MHz sound signal at the vision detector for subsequent amplification by the intercarrier sound i.f. channel. If the ratio of the vision signal to sound signal at the vision detector is too great vision breakthrough on sound may occur. The level of trapping in the vision i.f. channel required to eliminate vision buzz on sound is about 36dB. The designer thus has little option but to compromise on a sound trap depth of 38dB. Small wonder then that many domestic receivers suffer from buzz or patterns on 625 lines (and sometimes both!).

The other main inconvenience to the user is of a more mechanical nature. I refer to certain types of push-button tuner unit which never reset to the same tuning point on changing channels. Almost as frustrating is the continuous tuner with backlash on its tuning drive mechanism. Thus if vision buzz on sound and smeary pictures are not caused by design compromise they will almost certainly occur through simple mistuning.

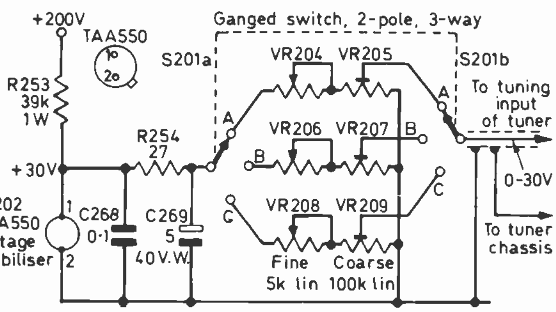


Fig. 1: Tuning arrangements for a varicap tuner.

Using a Varicap Tuner

There are ways and means of overcoming all these difficulties. The tuner problem can be solved by using a varicap tuner (the Mullard ELC1043 varicap tuner is at last in full-scale production and is available to the constructor) while the patterns v sound buzz situation can be considerably improved by the use of a separate sound detector. For those readers who do not know what a varicap tuner is a brief word of explanation will be given. Until recently all u.h.f. tuners have used a ganged variable capacitor for tuning. It is however possible to design a tuner without a variable capacitor as such, using varicap diodes instead. Such diodes, and indeed all diodes to some extent, have a certain capacitance which decreases as the reverse bias applied to the junction is increased. Thus tuning in a varicap tuner can be accomplished simply by altering the voltage applied to the varicap diodes in the tuner. This has the advantage that the tuner control unit is basically little more than a set of potentiometers and switches which may be separated from the tuner itself by almost any distance. The ease of adjustment of this type of tuner has to

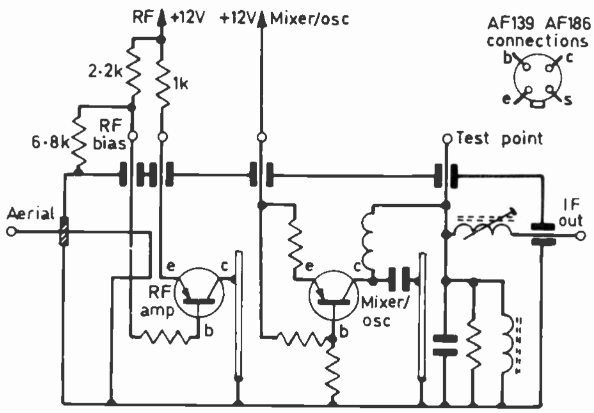
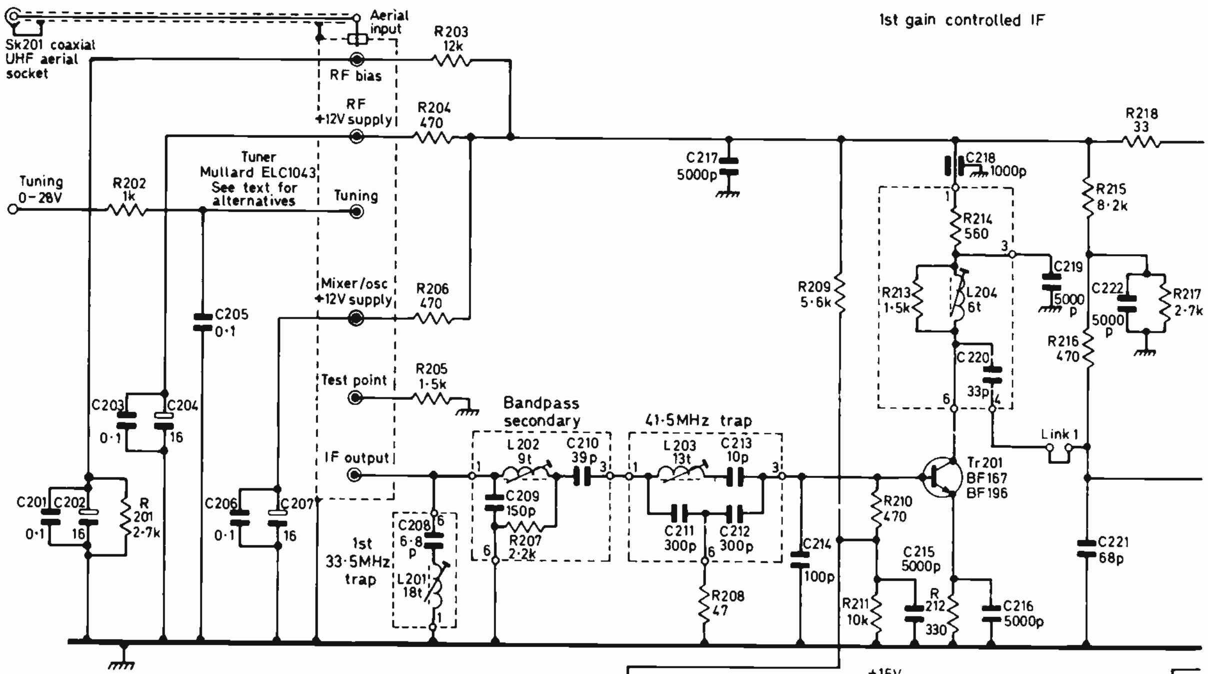


Fig. 2: Basic d.c. and signal paths in a typical "surplus" u.h.f. tuner using germanium transistors. The values of the external resistors are for guidance only and may require slight adjustment for optimum noise performance.



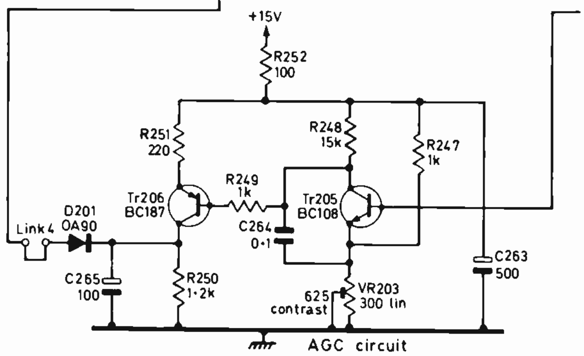


Fig. 3: Complete circuit of the 625-line i.f. strip.

be seen (or rather felt!) to be believed.

A suitable voltage tuning control unit for the ELC1043 is shown in Fig. 1. The integrated circuit type TAA550 is a voltage stabilising device exhibiting an almost negligible change in stabilised voltage with temperature. A 30V 1W zener diode may be used in place of the TAA550 but the temperature stability will be nowhere near as good and the zener will have to be mounted in a very cool part of the receiver. Channel switching is effected by a two-pole three-way wafer switch. Once set the tuning potentiometers should require very little subsequent adjustment. A point concerning layout: it is most important that no hum or other spurious waveform is picked up by the tuning line. In other words, do not mount the tuning controls right on top of the field output transformer! A more elegant type of control unit is manufactured by the German tuner manufacturer Hopt but we understand these are not yet available to individual order.

Circuit Description

The complete circuit of a 625-line i.f. amplifier with sync-tip a.g.c. is shown in Fig. 3. Four composite-signal (i.e. vision, sound and chrominance) stages of i.f. amplification are used, thus giving very high sensitivity even if an insensitive tuner is used. This feature will allow the constructor to use a "junk box" tuner in the interests of economy if he wishes.

The coupling between the tuner and the first i.f. amplifier transistor Tr201 is quite complicated. L202 forms part of a bandpass circuit in conjunction with the mixer output coil (inside the tuner but externally adjustable). The degree of coupling between the two halves of the bandpass circuit is set by C209. The value of this capacitor may have to be changed if a tuner other than the ELC1043 is used. For guidance on this point Fig. 4 shows the three possible conditions of coupling in a bandpass circuit. Increasing the value of C209 *decreases* the coupling. Superimposed on the basic bandpass response are two notch rejection points which are set by L201 the first 33·5MHz sound trap and L203 the 41·5MHz adjacent lower channel sound trap.

After being filtered in this way the tuner i.f. output is fed to the base of Tr201. This transistor is specially designed by the manufacturer to be gain

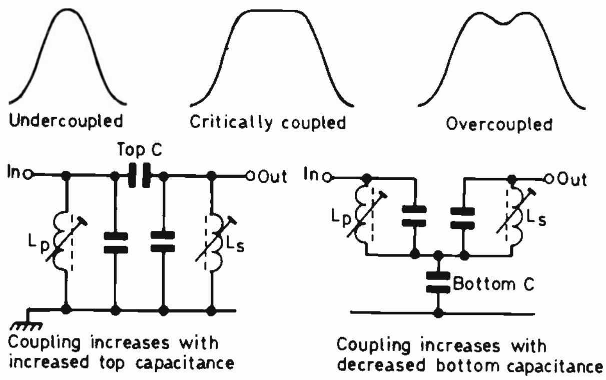
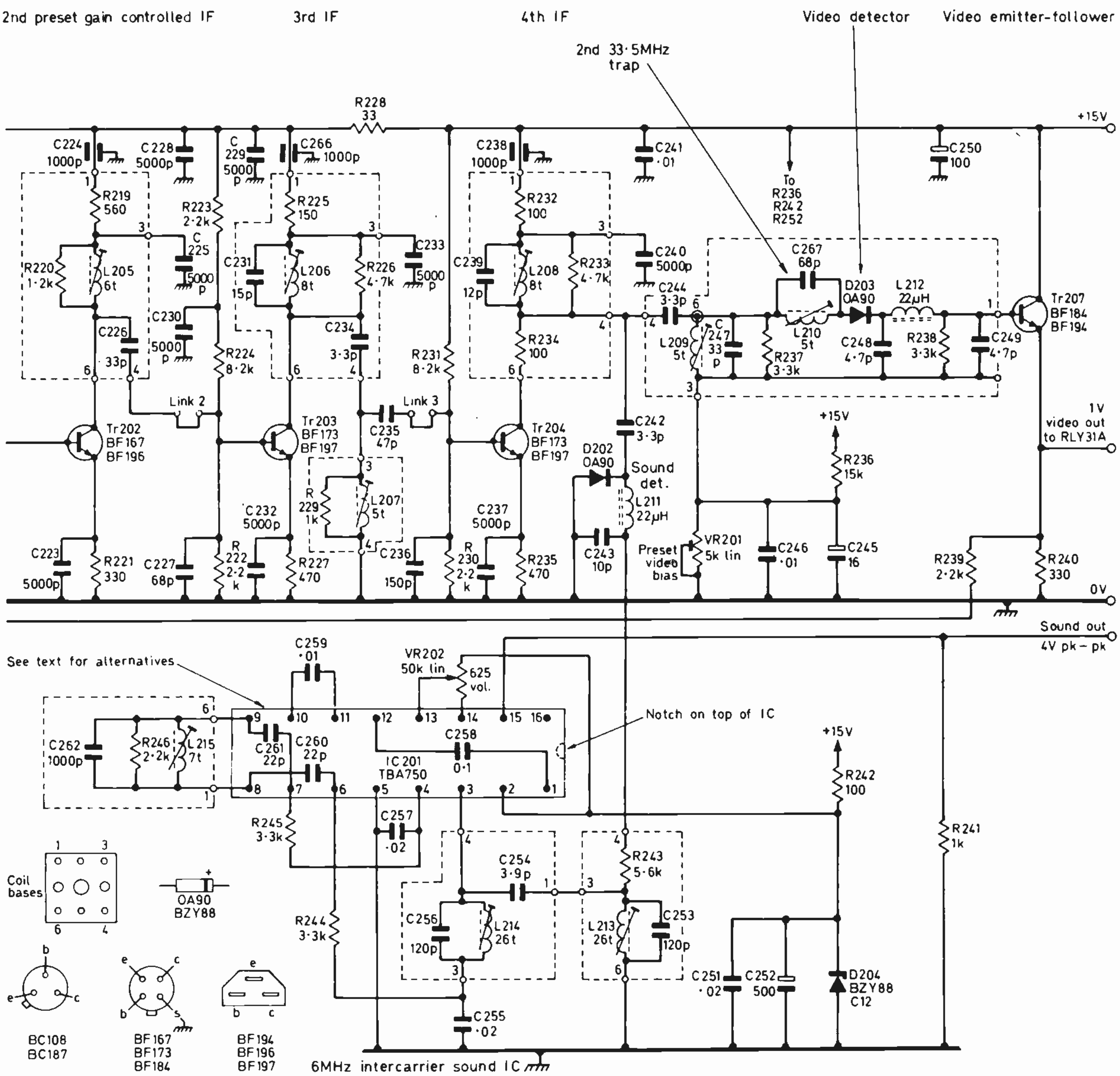


Fig. 4: The three possible bandpass response shapes and two possible types of bandpass circuit.



controlled and its gain falls sharply with increased collector current (forward a.g.c.). The gain is at maximum when $I_c = 4{\cdot}5$mA while at $I_c = 13$mA the gain has dropped by about 45dB (×1/180). The gain will also drop if the collector current is reduced *below* 4·5mA: this is reverse a.g.c. and is highly undesirable in this type of application because it causes drastic changes in the transistor high-frequency parameters. Forward gain control as used in this circuit results in small and acceptable variations in the transistor parameters thus ensuring constancy of response shape

In Tr201 collector circuit a heavily damped coil (L204) resonates with C220 and C221 to give a substantially flat response over the i.f. passband. The signal then passes to the base of Tr202. This is also a gain-controlled transistor but with the gain preset by R217. The value of R217 shown causes forward gain control to be applied such that the gain of Tr202 is reduced by 10dB (×1/3). R217 may be changed to give more or less gain as necessary but reverse gain control must be avoided. The limits on the value of R217 are 2·2kΩ (0dB, i.e. max. gain) and 10kΩ (–35dB).

L205 in the collector circuit of Tr202 is similar to L204 in its effect on the response and the signal is then coupled into the third composite i.f. amplifier Tr203. This transistor is a conventional amplifier, i.e. it is not gain controlled, and the circuit is designed so that unilateralisation is not necessary. The collector load of Tr203 is the primary of another bandpass circuit (L206). Top-capacitance coupling (C234) is used to make the bandpass response slightly overcoupled.

The overall response is finally tailored by the tuned circuits in the collector circuit of the final composite i.f. transistor Tr204. L208 and L209 comprise a slightly overcoupled bandpass circuit with top capacitance coupling (C244). Some of the signal at this point is tapped off via C242 and a 6MHz intercarrier beat is generated by D202 and fed to the sound i.c. through a 6MHz bandpass circuit. All the remaining

★ components list

Resistors:

R201	2·7kΩ	R211	10kΩ	R221	330Ω	R231	8·2kΩ	R241	1kΩ	R251	220Ω
R202	1kΩ	R212	330Ω	R222	2·2kΩ	R232	100Ω	R242	100Ω	R252	100Ω
R203	12kΩ	R213	1·5kΩ	R223	2·2kΩ	R233	4·7kΩ	R243	5·6kΩ	R253	39kΩ 1W
R204	470Ω	R214	560Ω	R224	8·2kΩ	R234	100Ω	R244	3·3kΩ	R254	27Ω
R205	1·5kΩ	R215	8·2kΩ	R225	150Ω	R235	470Ω	R245	3·3kΩ $\frac{1}{10}$W	All ½ watt 5% carbon film, unless otherwise stated.	
R206	470Ω	R216	470Ω	R226	4·7kΩ	R236	15kΩ	R246	2·2kΩ $\frac{1}{10}$W		
R207	2·2kΩ	R217	2·7kΩ	R227	470Ω	R237	3·3kΩ	R247	1kΩ		
R208	47Ω	R218	33Ω	R228	33Ω	R238	3·3kΩ	R248	15kΩ		
R209	5·6kΩ	R219	560Ω	R229	1kΩ	R239	2·2kΩ	R249	1kΩ		
R210	470Ω	R220	1·2kΩ	R230	2·2kΩ	R240	330Ω	R250	1·2kΩ		

Potentiometers:

VR201	5kΩ lin.	VR204	5kΩ lin.	VR207	100kΩ lin.
VR202	50kΩ lin.	VR205	100kΩ lin.	VR208	5kΩ lin.
VR203	300Ω lin.	VR206	5kΩ lin.	VR209	100kΩ lin.

Capacitors:

C201	0·1μF DC	C216	5000pF DC	C231	15pF SM	C246	0·01μF DC	C261	22pF SM
C202	16μF E	C217	5000pF DC	C232	5000pF DC	C247	33pF SM	C262	1000pF P
C203	0·1μF DC	C218	1000pF F	C233	5000pF DC	C248	4·7pF SM	C263	500μF E
C204	16μF E	C219	5000pF DC	C234	3·3pF SM	C249	4·7pF SM	C264	0·1μF PE
C205	0·1μF DC	C220	33pF SM	C235	47pF SM	C250	100μF E	C265	100μF E
C206	0·1μF DC	C221	68pF SM	C236	150pF SM	C251	0·02μF DC	C266	1000pF F
C207	16μF E	C222	5000pF DC	C237	5000pF DC	C252	500μF E	C267	68pF SM
C208	6·8pF SM	C223	5000pF DC	C238	1000pF F	C253	120pF SM	C268	0·1μF PE
C209	150pF SM	C224	1000pF F	C239	12pF SM	C254	3·9pF SM	C269	5μF E 40V.
C210	39pF SM	C225	5000pF DC	C240	5000pF DC	C255	0·02μF DC	DC	disc ceramic 30V.
C211	300pF P	C226	33pF SM	C241	0·01μF DC	C256	120pF SM	E	electrolytic 25V.
C212	300pF P	C227	68pF SM	C242	3·3pF SM	C257	0·02μF DC	SM	silver mica
C213	10pF SM	C228	5000pF DC	C243	10pF SM	C258	0·1μF DC	P	polystyrene
C214	100pF SM	C229	5000pF DC	C244	3·3pF SM	C259	0·01μF DC	F	feedthrough
C215	5000pF DC	C230	5000pF DC	C245	16μF E	C260	22pF SM	PE	polyester 160V.

Semiconductors:

Tr201	BF167 (BF196)	Tr206	BC187	D204	BZY88 C12 zener.
Tr202	BF167 (BF196)	Tr207	BF184 (BF194)	IC201	TBA750
Tr203	BF173 (BF197)	D201	OA90	IC202	TAA550
Tr204	BF173 (BF197)	D202	OA90		
Tr205	BC108	D203	OA90		

Miscellaneous:

Tuner assembly type ELC1043 (Mullard)
L211, L212 22μH chokes (Painton)
14 coil formers 1⅜" × ¼" (Home Radio CR12)
1 coil former (L209/L210) 1⅞" × ¼" (CR14)
14 screening cans (CR13)
1 screening can (CR15)
16 iron dust cores (Z81B)
Core locking compound
Nylon leadthrough tags
36 s.w.g. and 28 s.w.g. enamelled copper wire
S201 2-pole 3-way wafer switch
SK201 coaxial socket

sound signal on the vision i.f. is notched out by L210, C267 so that a relatively pure video signal is detected by D203.

L212 filters out most of the residual i.f. waveform and the video signal passes to the base of the emitter follower Tr207 whose d.c. base bias is set by VR201. A relatively low-impedance video signal is developed across R240 and is of a level suitable for feeding to a sensitive video output amplifier.

Some of the video is fed back to the a.g.c. circuit. Tr205 is biased by the contrast control to conduct only on sync tips and thus produces an a.g.c. voltage which is independent of picture content. This voltage is amplified by Tr206 and then fed to the first gain-controlled i.f. transistor by a special network (adapted from an old Mullard circuit). Under no-signal conditions Tr206 passes no current and Tr201 is then biased for maximum gain by R209, R211 and the series combination of D201, R250. As soon as a signal is present the a.g.c. circuit starts to operate and the voltage across R250 increases. Consequently the current through D201 decreases and the level of bias to Tr201 increases, thus increasing the current in Tr201 and reducing its gain. The process occurs in a split second and settles down very quickly to maintain a constant level of video at the detector. If a very strong signal is present the voltage across R250 increases so much that D201 is cut off and the current through Tr201 is then determined solely by R209 and R211. The gain of Tr201 is thus reduced by 45dB which is the maximum permissible gain reduction. If further gain reduction is necessary it must be accomplished either by increasing the value of R217 or by fitting a suitable attenuator in the aerial lead. A combination of these two methods may be necessary to achieve optimum noise performance.

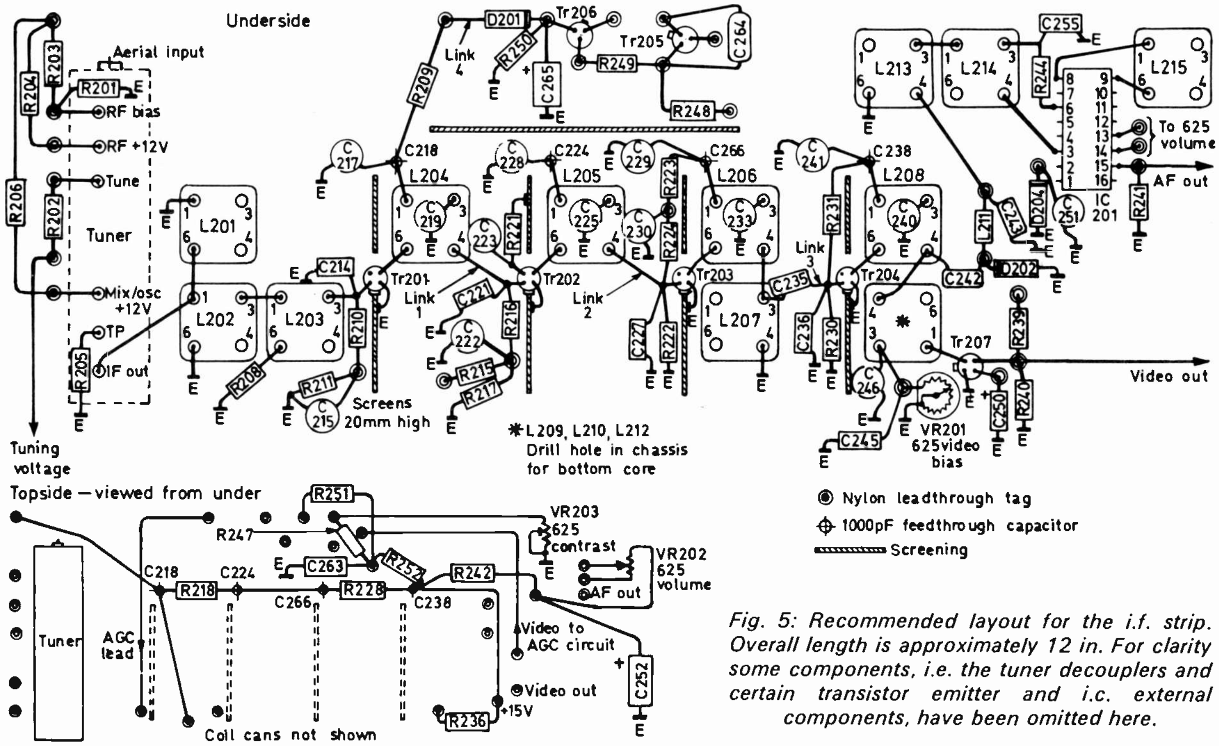


Fig. 5: Recommended layout for the i.f. strip. Overall length is approximately 12 in. For clarity some components, i.e. the tuner decouplers and certain transistor emitter and i.c. external components, have been omitted here.

Construction

It is recommended that the layout plan shown in Fig. 5 is followed as closely as possible. The general principles are the same as those discussed in last month's article: each stage is isolated from the next by a small metal screen with a square hole cut in it for the transistor (this applies only to Tr201, Tr202, Tr203 and Tr204). The sound i.c. should be mounted on its back, i.e. with the printed type number on the case in contact with the metal chassis. It is most important that the hot ends of R244 and R245 (connected to pins 6 and 7 of the i.c.) should be kept well away from the input pin of the i.c. (pin 3) or instability may result. Apart from this the layout is not critical and a complete layout is therefore not given.

Throughout the circuit the wiring should be up to v.h.f. standard and all component leads must be kept short. The chassis may be made of any solderable metal but copper or brass is preferable. The tuner is mounted on the i.f. chassis and a good connection to the tuner chassis must be made: in the case of the ELC1043 tuner the earthing tags provided should be soldered into holes in the i.f. chassis. Care must be taken not to place the i.f.-tuner assembly too close to the loudspeaker in the receiver or microphony may be troublesome. The varicap tuner recommended for the circuit is several times better in this respect than a conventional tuner but one must still not push one's luck too far, especially if one intends to fit a 12in. woofer assembly into the television cabinet. In such a case it would be advisable to mount the entire i.f. chassis as a separate unit on rubber grommets with a thick but flexible earth path to the main chassis.

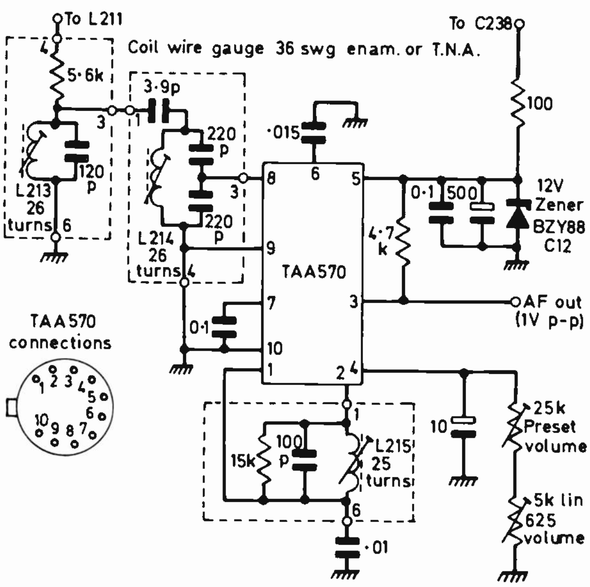
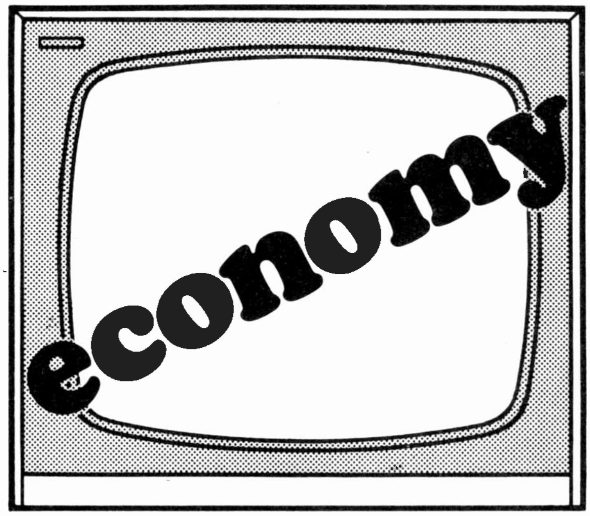


Fig. 6: Recommended circuit for use with the alternative sound i.c. type TAA570.

Component Availability

The Mullard tuner type ELC1043, voltage stabiliser i.c. type TAA550 and intercarrier sound i.c. type TBA750 are available to special order from Gurney's Radio, 91 The Broadway, Southall, Middx. There may be some difficulty experienced initially in obtaining the TBA750 as this has only recently been introduced. If there are any problems in this respect it is possible to use the earlier Mullard type TAA570 intercarrier sound i.c. for which circuit details are given in Fig. 6. The performance is not however as good as that of the TBA750 so that it is worth waiting a little while if necessary.

NEXT MONTH: COIL DETAILS, ALIGNMENT, ETC.



UHF TV

CALEB BRADLEY

TELEVISION rental companies often dispose of their stock sets after only a few years' use so they can be replaced by the latest style models. The used sets are generally offered to bulk buyers in the television trade but some modern dual-standard sets—e.g. the Ekco Model T402, the subject of this article—have recently become available singly from the supplier listed at the end of this article. The sets are offered in untested "as-is" condition. This usually means they are in need of some attention but—at least in the author's experience of reconditioning about two dozen such receivers—are never beyond repair.

The Ekco T402 is a compact 19in dual-standard receiver with good performance on both 405 and 625 lines and has the same chassis as many other Ekco/Ferranti and a few Alba and Aerodyne models of the period 1962-4. This article is intended to help the buyer of one of these sets to get it working as cheaply as possible by pointing out the common stock faults encountered. Most points will apply whether the set is being reconditioned for single- or dual-standard use.

Budget

A set in as-is condition costs £15 plus 30/- towards carriage within the UK. It is worthwhile obtaining a service sheet for information beyond the scope of this article. This will cost about 25p from one of the advertisers in this magazine. Specify the Ekco Model T402 serial numbers over 10,000, or the T407. Although the i.f. strip is fully dual-standard and a v.h.f. tuner is fitted the sets rarely have the u.h.f. tuner fitted. This costs about £5.

Now the cost of repair. The author's experience has been that this has never exceeded £6 for materials and on half the sets was less than £3. If we make a very pessimistic estimate of £3 to £10 repair cost the bill for our economy u.h.f. television is:

	£
As-is Ekco T402	15·00
Carriage	1·50
Service sheet	·25
UHF tuner	5·00
Repair	3·00—10·00
Total	£ 24·75—31·75

This represents quite a bargain for one's work, especially since the working set can be sold for as much as £35.

Mechanical Aspects

The chassis layout is shown in Fig. 1. The signal circuits are carried entirely on the printed board on the left of the tube neck while the field and line scan circuits are on the board on the right. There is a 405-625 slide switch on each board, linked by a bar across the gap in the middle and driven by a cam on the v.h.f. tuner. For single-standard operation the two linkage screws (identified in Fig. 1) can be loosened to prevent the linkage working and the switch set by hand to 405 or 625 as required.

Access for servicing is very easy. First remove the v.h.f. tuner knob by loosening the two grub screws securing it to the tuner spindle. Then unscrew the large nuts at the top left and right of the chassis frame and it will swing out giving access to the wiring sides of the boards. Replacement components are more easily soldered to this side of the boards. When returning the frame to its normal position take care not to foul the wires on the left hand side.

Although the projecting tube face may look like a twin-panel type it is in fact a plain tube (Mazda CME1903) with a perspex bubble face guard. The lower cost will be appreciated if the tube needs replacement. The perspex may be scratched and dirty in which case the author's treatment is plenty of rubbing with Duraglit (or even with fine grinding paste) until the scratches disappear. If the white surround is dirty it is worth scrubbing it with an old toothbrush and some household detergent as this can greatly improve the appearance of the set. Fortunately the cabinet is stained wood rather than one of the plastic finishes common today and scratches are easier to deal with. Vigorous polishing works wonders—Mansion House Dark Polish is very effective for hiding scratches. If necessary there are the other resorts of sanding, painting (psychedelic perhaps?) or covering the cabinet.

On removing the metal cover from the underside of the v.h.f. tuner the coils for a particular channel come into view when the tuner knob is rotated two positions clockwise from the channel setting. It is then just possible to unclip and remove them. Ensure the set is switched off when removing or replacing the smaller (aerial) coil as the unsmoothed h.t. is within finger-straying distance on a tag on L22. Fine tuning by the viewer is done by pushing a screwdriver into a small hole in the side of the cabinet to engage a sprung plastic piece with the fine tuning screw for the channel in use. As the tuner is quite stable this adjustment is not often needed. If necessary the v.h.f. tuner can be removed from the receiver by removing three hex-headed bolts accessible at the back of the chassis around the big h.t. smoothing capacitor C142/143.

The v.h.f. tuner knob frequently shatters at the neck in spite of a metal strengthening ring. The tuner has a standard half-flatted ¼in. diameter spindle and a fairly long-necked knob is need to reach it. If a

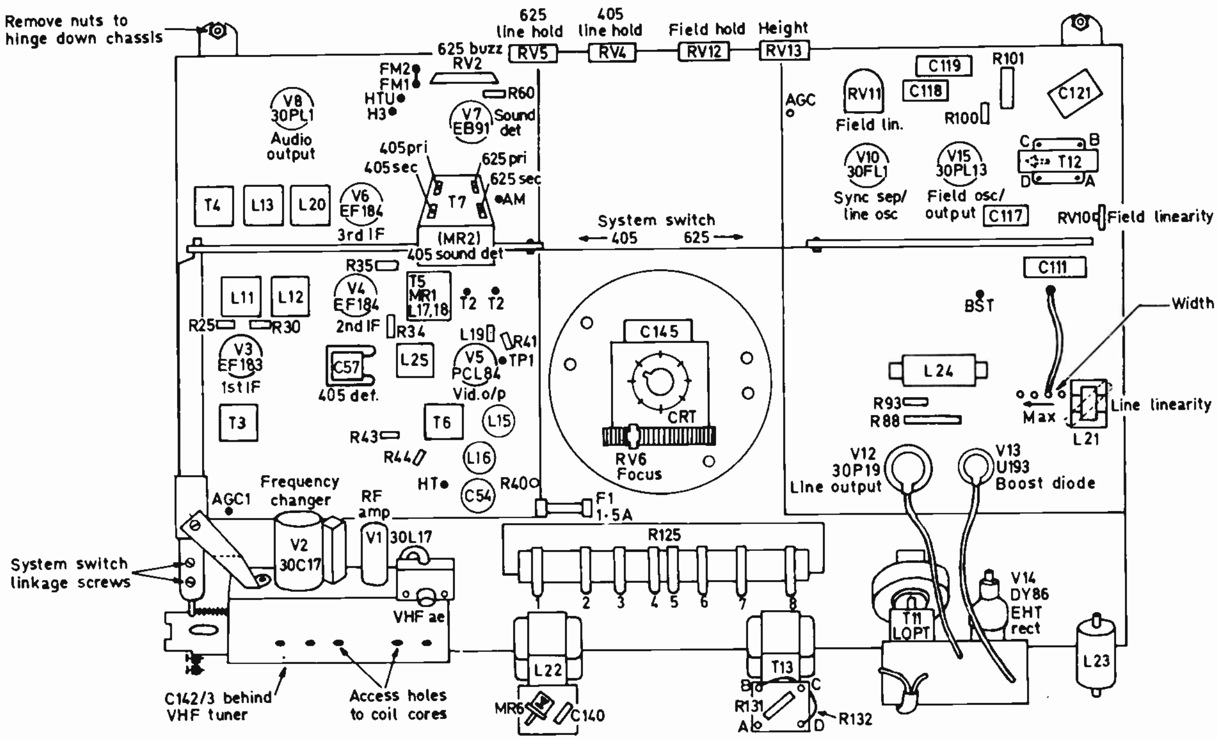


Fig. 1: Rear chassis layout showing components mentioned in the text.

Table 1: Valve data for Ekco Model T402.

Valve	Type	Typical Voltages* Anode	Screen	Cathode	Alternatives†
V1	30L17	165(9)	—	—	(30L15, PCC89, PCC805)
V2P	30C17	172(3)	165(2)	—	(30C15)
V2T		30(6)	—	—	
V3	EF183	180(7)	129(8)	0·15 (1, 3)	6F25 (EF184, 6F24)‡
V4	EF184	200(7)	190(8)	2·5 (1, 3)	6F24 (EF183, 6F25)‡
V5P	PCL84	152(6)	195(9)	7·5 (7)	
V6	EF184	168(7)	170(8)	2 (1, 3)	6F24 (EF183, 6F25)‡
V7	EB91	—	—	—	6D2, D77, 6AL5**
V8T	30PL1	30(1)	—	—	PCL801 (PCL83)
V8P		190(6)	200(8)	11 (7)	
V10P	30FL1	160(6)	60(7)	—	PCE800
V10T		80(1)	—	—	
V12	30P19	—	120(4)	—	PL302 (PL36, 30P4)
V13	U193	190(9)	—	—	PY800, PY81
V14	DY86	—	—	16kV	DY87 (U26, U25)
V15P	30PL13	190(6)	215(7)	17(2)	PCL800 (PCL82)
V15T		75(9)	—	—	

CRT: Cathode 160V (7), first anode 595V (3), e.h.t. connector 16kV.
* Pin number in brackets. † Alternatives in brackets are for emergency use only and may give reduced performance.
‡ Non frame-grid types such as the EF80, EF85, 6F19, 6F23 and 6F26 will often work but with reduced gain. ** Two germanium diodes wired in will work provided heater continuity is maintained.

suitable replacement is not available the broken knob can be rebuilt with Araldite cement. Use the spindle of say a spare volume control as a mould and smear the spindle with grease so that the cement will release easily. It is best to build up the Araldite on a coil of strong wire wound on to the spindle as otherwise the large turning force on the spindle flat may break the unreinforced cement. The final knob must provide adequate insulation against possible mains voltage on the tuner spindle when the set is in use.

A blanking plug expectantly labelled "u.h.f. tuner" is fitted in the side of the cabinet. There is just enough space behind to mount a valve tuner or plenty of room for a modern transistor tuner which is to be preferred in weak-signal areas. The mountings provided are unlikely to line up with most transistor tuners so some ingenuity with woodscrews and spacing pieces may be needed to get a particular tuner mounted. Insert some padding between the tuner body and the flare of the tube if they are likely to come into contact. The hole left when the blanking plug is removed will suit a rotary tuner but some carpentry will be needed if a 4- or 6-push-button tuner is fitted. A knockout hole for the u.h.f. aerial socket is provided in the fibre back.

Initial Inspection

First remove the back and use Fig. 1 to check that all thirteen valves are firmly plugged in and are the correct types. Table 1 lists some equivalents which may be used to get the set going. Check which channel coils are fitted in the v.h.f. tuner and that the system switch operates correctly when the tuner is switched to the u.h.f. position. If necessary loosen the linkage screws and adjust the plate they secure for the right movement.

If nothing is visibly wrong check that the mains taps on R125 are set correctly and plug in. Before anything else double-check that the chassis is connected to mains neutral and not to live. If the heaters do not glow check that live mains is reaching the centre of mains dropper R125 and that both left end (mains to heater chain) and right end (mains to h.t. rectifier) are live as sections of this resistor quite often fail. A break in the heater chain can be located quickly using Fig. 2 as a guide.

Once the valves are glowing some noise from the speaker—particularly when V8 is rocked in its base—indicates that h.t. is present. If the line circuit does not whistle try waggling the system switch by hand as the set is dead when this rests in an intermediate position. Rotating the brightness and contrast controls towards the front of the set should bring a raster to the screen provided the e.h.t. is present. Rotation of the v.h.f. tuner knob between positions where coils are fitted should produce crackles on sound and flickers on the raster if the sound and vision circuits respectively are intact. Similar effects should be produced by touching a screwdriver blade on the centre conductor of the v.h.f. aerial socket.

VHF Reception

The v.h.f. turret tuners in these sets usually have coils for only a few channels and it is not possible to specify these when ordering. Replacement coils are available for this type of tuner or the existing coils can be modified to different channels fairly easily if a good aerial signal is available. A coil can usually be retuned to the channel number immediately above or below the number painted on it simply by readjusting the cores. With a good v.h.f. aerial plugged in first adjust the core accessible through the hole nearest the knob (oscillator coil) until the best picture appears on the screen then adjust the four other cores for optimum sound and vision. Since the cores are brass screwing them *into* the coils lowers the inductance and tunes to a higher channel. Further upward adjustment is achieved by removing a turn or two from the Band I coils or simply stretching the turns farther apart on the Band III coils. Conversely unscrewing the cores, compressing turns closer together or adding turns tunes to a lower channel.

Do not screw a core too far into a coil or the core will fall into the tuner and may be hard to retrieve. Do not unscrew a core so far that it projects from the coil biscuit or it will foul the tuner mechanism and possibly damage the delicate spring contacts.

UHF Reception

The v.h.f. tuner should be fitted with a pair of coils marked u.h.f. These are tuned to the 625 i.f. frequency so that the v.h.f. tuner acts as an extra i.f. amplifier before the i.f. strip proper. The gain improvement is clearly demonstrated by connecting a u.h.f. tuner with and without the v.h.f. tuner in circuit.

If the set is not already equipped with a u.h.f. tuner a standard transistor tuner can as previously mentioned be fitted. Connect the i.f. output lead of the tuner to the special socket provided on the top of the v.h.f. tuner. Connect the tuner h.t. lead to a supply of 10-13V d.c. This is obtained by a dropping resistor from the set h.t. line. A convenient place to connect the resistor is on the back of the i.f. board from the HTU pin to the short piece of unused printed track below. The h.t. lead to the tuner is then soldered to the unused track. A suitable value of resistor is 43kΩ 1W which can be made up from 33kΩ 1W and 10kΩ ½W in series. Check the voltage reaching the tuner and adjust the dropper value if necessary. Note that the earth return for the tuner is provided by the screen of the i.f. output lead. A few u.h.f. tuners require a 1kpF blocking capacitor in series with the centre conductor of the i.f. lead and it does no harm to fit this if in doubt. Ensure that all leads to the tuner are long enough to allow the chassis to swing out properly.

Fault-Finding

Most faults with this set can be traced quickly by the usual servicing procedures. The line oscillator and output stages (a source of embarrassment on several other Ekco models) are reliable, the author having found only one line output transformer failure in all the sets handled. Some faults in the signal and field oscillator circuits are worth mentioning as they regularly occur and can be perplexing.

Very Low Contrast

Check the electrode voltages of V3, V4 and V5 (see Table 1). These valves sometimes draw excessive screen current causing overheating and change in value of the screen feed resistor. New valves of the correct types (V3 and V4 are frame-grid types) will always give an improvement in gain but any of the following resistors should also be replaced if they have changed value: R25 (39kΩ) and R30 (4·7kΩ) V3 screen and anode feed resistors respectively, R35 (4·7kΩ) and R34 (1kΩ) V4 screen and anode resistors, R40 (100Ω) in the h.t. line to V3 and V4, R41 (5·6kΩ) V5A screen resistor and R44 (27kΩ) its stabilising resistor (from h.t. to the cathode circuit). Weak contrast on 405 only should direct attention to V1 on the v.h.f. tuner.

Sound Buzz on 625

The characteristic intercarrier sound buzz which varies in volume with picture content can be reduced by aligning the 625 (6MHz) sound channel. An off-air signal is just as good as a signal generator for this job as the 6MHz intercarrier frequency (i.e. the difference between the vision and sound carrier frequencies) is precisely fixed at the transmitter. Use the correct hexagonal trimming tool to adjust both the

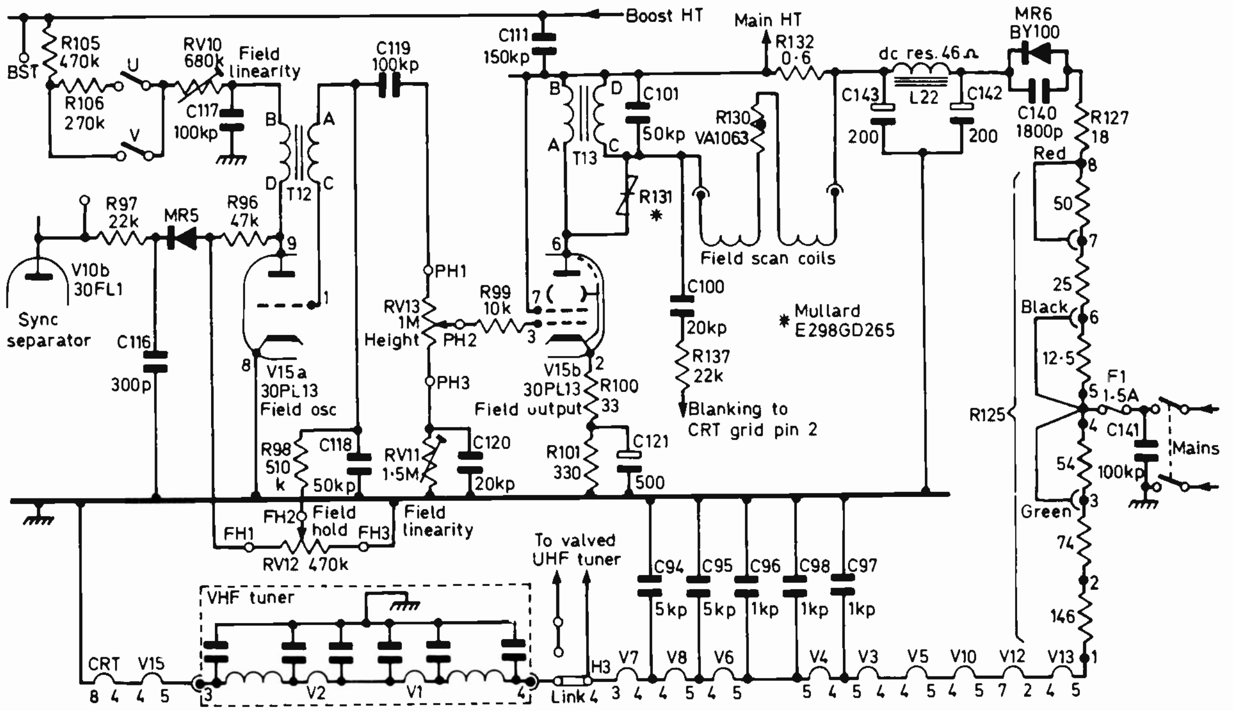


Fig. 2: The field timebase and power supply circuits of the Ekco Model T402. Minor component value variations in the blocking oscillator (V15a) and sync feed circuits may be found in some chassis. C117 charges slowly from the boost rail to give the field timebase waveform. C118, R98 and RV12 control the speed.

upper and lower cores of T6 and the 625 primary and secondary cores of T7 for optimum sound—the last is the most critical. Note that the cores of T7 are correctly identified in Fig. 1 and incorrectly shown in many data sheets for this set. Then adjust slider potentiometer RV2 for minimum buzz and repeat all the adjustments for the best sound.

A heater-to-cathode short in V7, possibly intermittent, sometimes burns up R60 (indicated in Fig. 1). Severe mains hum and/or intercarrier buzz result. The valve should be replaced at the same time as R60 to prevent the fault repeating.

Poor Synchronisation

Poor synchronisation—especially on 625—can be caused by excessively high h.t. voltage as well as the common sync separator faults. Check that the tags on R125 are correctly linked for the local mains voltage.

As the line oscillator is a simple multivibrator (an add-on flywheel sync unit was once available for this set) a poor aerial signal may cause some picture tearing or pulling-on-whites. Some improvement on 405 may be obtained by unscrewing C57 the 405 definition trimmer. This reduces picture definition slightly but may stabilise the line lock. On 625 one must simply provide a good aerial signal and set RV5 (625 line hold) carefully for a good picture.

Field Faults

The best that can be said of V15 in the field timebase circuit (Fig. 2) is that it is not very reliable. Irregular changes in picture height or a horizontal white line on the screen (field failure) can usually be cured by replacing the valve. Severe picture cramping at the top or bottom (in spite of adjustment of the two linearity presets) or foldover are normally the fault of the valve initially but excessive current may have changed the values of R100 and R101 so check these also. Electrolytic C121 at the top right of the set is in a hot position and frequently fails causing greatly reduced picture height. A 250μF component will do as a cheaper replacement.

A periodic (every 20 seconds or more) loss of field hold on 625 at certain times in the evening only is probably due to inadequate smoothing of the h.t. line. The design values of C143 and C142 are possibly only barely large enough for 625 and these capacitors slowly lose capacitance with age. Larger value replacements are acceptable provided C142 is not increased to more than about 350μF—otherwise the switch-on surge through MR6 may be excessive.

If field lock is lost completely check the forward and reverse resistances of MR5.

Vertical Stripes on 625

Ragged vertical stripes on 625, often black with no signal and white when a signal is received, are caused by interference from the line output stage. Sharp points of solder or ragged wiring at the line output valve top cap may be causing corona, or the valve itself may be faulty.

Availability

Ekco T402 receivers are available on seven days' order from RBTV, 82 North Lane, East Preston, Sussex. Only this model is available in "as-is" ex-rental condition. ■

servicing transistorised IF STRIPS

H.K.HILLS

VALVE vision and sound i.f. stages probably give far less trouble than any other section of a TV receiver, the most likely but still rare cause of no output being an internal short-circuit in a frame-grid type valve. Internal shorts also occur in older type valves but due to the closer interelectrode spacing of frame-grid types the incidence of this type of failure in these is higher. On occasion a screen decoupling capacitor may go short-circuit and burn up the feed resistor, or a screen or cathode decoupler may go open-circuit to cause reduced gain, instability or patterning—the exact symptoms depending on the component's position in the circuit—but by and large it is fairly true to say that sound with no vision generally implies a vision detector or video fault while vision with no sound infers a sound detector or a.f. fault.

When a valve i.f. strip does fail to work checking individual anode, screen grid and cathode voltages will indicate the cause, while if an a.g.c. feed is apparently absent or not completely decoupled momentarily shorting the feed point to chassis will clarify the situation without adverse effects. If shorting the a.g.c. feed point increases the gain on strong signals but has negligible effect on weak signals the a.g.c. supply can be assumed to be in order.

Tracing Circuits

Although overall i.f. design varies from one make to another it is a comparatively simple matter in valve strips to follow the signal path from the tuner(s) to the vision detector diode without the aid of a circuit diagram. When tracing faults in transistor i.f. circuits however even the most experienced service engineers need to check the circuit since individual designs vary so widely. In particular depending on the polarity of the l.t. supply and whether pnp or npn transistors are used either the emitters or collectors may be returned to chassis with attendant complete reversal in emitter/collector voltages to chassis—compare for example Fig. 1(a) and (b). This also means that the transistor base potentials will be either slightly less or slightly more than the emitter voltages while—again depending on l.t. rail polarity and transistor type—the a.g.c. potential to chassis may decrease or increase with rising signal strength.

The a.g.c. potential in a valve strip is normally present or appreciable only when the signal strength reaches a significant value. With transistors however the a.g.c. potential is really an increase in the no-signal fixed bias and care must be taken not to short this to chassis when testing. If the emitter is returned to chassis for example shorting the a.g.c. line to chassis could largely or completely remove the base-emitter junction forward bias and the sudden change could cause a possibly damaging surge. If the collector on the other hand is returned to chassis, shorting the a.g.c. rail is almost equivalent to applying the full l.t. supply across the controlled transistor's base-emitter junction and this can completely ruin the transistor.

Great care must for this reason always be taken when measuring voltages in transistor circuits to ensure that test prod application does not inadvertently apply excessive bias to any of the transistors.

Basic Fault Conditions

When breakdowns do occur in transistor i.f. strips—and they are hardly more common than in valve strips—although the voltages and circuitry are so very

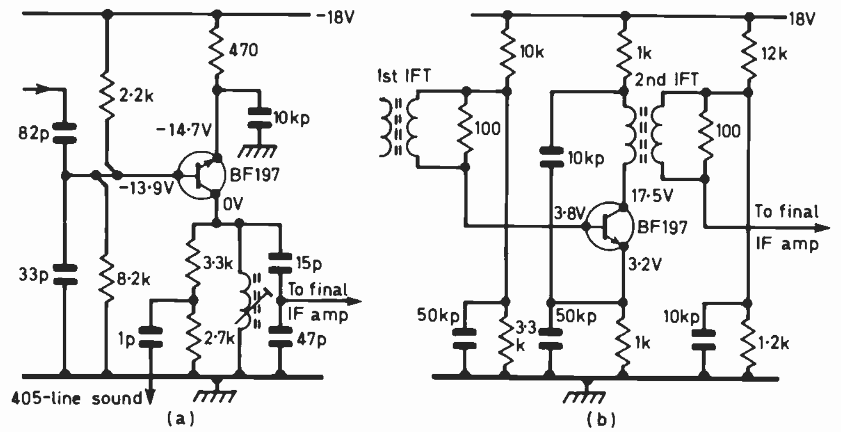


Fig. 1: Contrasting vision i.f. stage circuits both using a BF197 npn transistor. In (a) the emitter is fed from a —18V l.t. line (Pye 368 chassis) while in (b) the collector is fed from a +18V l.t. line (GEC 2047/8 single-standard models). As a result the potentials are completely reversed. Note also that in the GEC circuit the stage is a wide-band amplifier, filtering to provide the required selectivity being effected between the tuner and the i.f. strip.

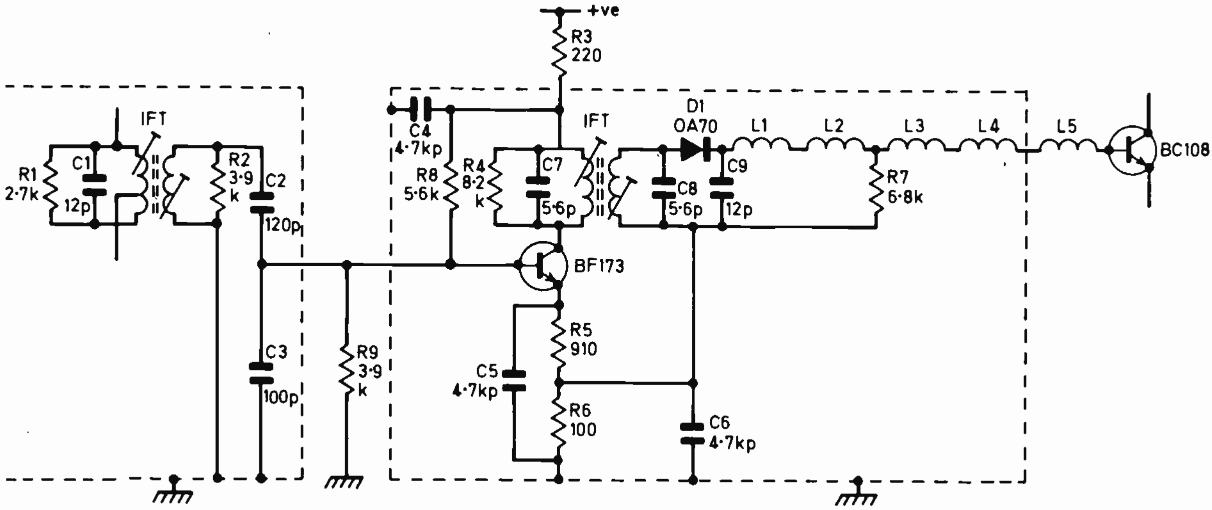


Fig. 2: Representative final vision i.f. stage (Philips 210 chassis). The potential developed at the junction of R5 and R6 provides forward bias for the BC108 video phase splitter, the positive-going output from the detector diode D1 being superimposed on this. Component functions and fault conditions with their associated symptoms are summarised in Table 1 below.

Table 1: Component function and fault guide

Component	*Function*	*Fault condition*	*Symptoms*
R1, R2, R4	IFT loading	o/c: increased gain with reduced bandwidth	Ringing and impaired definition
R3	Collector decoupling and l.t. feed	o/c: no power supplies	No output
R8	Part potential divider biasing BF173	o/c: no forward bias	No results
R9	As R8	o/c: excessive forward bias	Over-run BF173
R5, R6	BF173 emitter resistors	o/c: no BF173 or BC108 emitter currents	No output
R7	Vision detector load	o/c: L3, L4, L5 and BC108 base-emitter junction would form load	Very poor picture, ringing and unstable results
C1, C7, C8	IFT fixed tuners	o/c: increased IFT frequency	Impaired definition and possibly ringing
		s/c: tuned circuits shorted	No output
C2	Part IFT secondary tuning and impedance match to BF173	o/c: no signal feed to C2, C3 junction	No output
		s/c: bias for BF173 shorted out	No output
C3	As C2	o/c: IFT secondary mistuned and mismatching	Ringing and impaired definition
		s/c: bias for BF173 shorted	No output
C4	BF173 collector circuit decoupler	o/c: top of IFT primary not earthed	Reduced gain, possible instability or patterning
		s/c: R3 effectively connected across l.t. supply	No results and R3 burning
C5, C6	BF173 emitter decouplers	o/c: negative feedback introduced	Reduced gain, possible instability
		s/c: no forward bias to BC108	No results
C9	I.F. filter	o/c: i.f. content not removed	Patterning, possibly slight instability
		s/c: D1 output shorted	No results
L1, L2	I.F. filtering and video compensation	o/c: no video across D1 load	No results
L3, L4, L5	As L1, L2	o/c: no forward bias to BC108	No results

different the rare component or transistor failure will still be shown up by a clear-cut voltage indication though of course at a greatly reduced level. For instance, although valve anode and screen voltages in i.f. stages can vary considerably without noticeable effect on the picture, small changes in transistor voltages can reduce the gain enormously.

Should the sound and/or vision i.f. output completely fail first check that all resistors and transistors are running at normal temperature. The small-signal types used for i.f. amplification are designed to run cool so any sign of excessive warmth is a fair indication that the voltage supplies to the transistor or the device itself is at fault.

For example, the forward bias for all types of transistor is generally obtained from the junction of a dual-resistor potential divider shunted across the l.t. supply and chassis. Now although as previously mentioned i.f. strips may be found with either the emitters or collectors returned to chassis the current practice is for the emitters to be chassis connected. Thus if the lower resistor of the base potential divider becomes open-circuit or disconnected from its panel the forward bias will rise to an excessive figure, over-running the transistor. Further if this is a stage to which forward a.g.c. is applied—i.e. the first and sometimes second vision i.f. stage(s)—the gain will also be reduced. This is because the fixed bias for such stages is arranged for maximum gain, any increase in bias increasing the current in the transistor but reducing the gain through forward a.g.c. action. If on the other hand the top resistor is open-circuit or dry-jointed there will be zero forward bias and "no results", while if it has increased in value the forward bias will be reduced again reducing the gain.

Transistor Shorts

While transistors are inherently reliable devices they can develop internal short-circuits if subjected to high-voltage surges as a result for example of flashovers inside the c.r.t. or from e.h.t. arcs. Because of their close link with the c.r.t. the transistors used in video output stages are those most subject to this fault. Similar breakdowns can and do however occur in the vision strip.

When the base is shorted to the emitter the transistor is without forward bias, no emitter current flows and almost the full l.t. is developed across the emitter-collector connections. When the collector is shorted to the base the heavy currents resulting produce large voltage drops across the emitter and collector resistors and all three transistor potentials become very similar. Emitter-to-collector short-circuits produce almost equal voltages at these electrodes with the l.t. supply being proportionately divided between the emitter and collector resistors. An open-circuit at any electrode by preventing collector current flowing results in the emitter-collector potential practically equalling the full rail voltage.

Low Gain

Low gain in a transistor i.f. circuit can be due to many causes—incorrect forward bias, an open-circuit emitter decoupling capacitor, open-circuit collector circuit decoupler, reduced value fixed tuning capacitor misaligning the stage, an open-circuit or reduced value signal feed capacitor attenuating the input or output or a deteriorating transistor — probably one having been subject to a prior overload. Meter checks will soon indicate the cause of incorrect working voltages while suspect decoupling capacitors are most easily checked by temporarily shunting a known good equivalent across each in turn. The precise value fixed tuning and signal feed components can only be checked by exact substitutes but as their failure rate is very low first make sure about dry-joints.

AGC Faults

When it is found that incorrect working voltages are due to incorrect a.g.c. potential it is usually necessary—after ensuring that any gain presets are properly adjusted—to commence testing right back at the video stage driving the a.g.c. amplifier as the d.c. coupling employed will maintain a voltage error right through the system. Transistor a.g.c. systems differ too widely—especially in dual-standard models—for comment here but remember that a.g.c. amplifiers are usually arranged to be bottomed or saturated under no signal conditions and are progressively taken from this point towards cut-off as the signal strength rises by reducing their forward bias. Depending on the circuit configuration of the controlled stages the a.g.c. potential then increases or decreases with respect to chassis as signal strength rises. In either event the net effect is the same—an increase in forward bias to the controlled stages with increasing signal input.

Before measuring the a.g.c. potentials and the no signal/full signal voltages of the controlled stages however check the forward and reverse resistance of all miniature diodes employed. For example in those receivers that use an a.g.c. system based on the amplitude of the sync pulse tips on 625—the general practice in single-standard models — a diode is generally employed to rectify the peak pulse tip excursions and produce a bias which progressively takes the a.g.c. amplifier from saturation with rising signal strength. This diode may be termed "a.g.c. gate"—as in some GEC-Sobell receivers — peak rectifier or a.g.c. rectifier. If it goes open-circuit or even high-resistance it can render the entire a.g.c. system inoperative. This could result in the receiver operating at maximum gain on the strongest signals, causing gross overloading and possibly giving the impression that the i.f. strip is unstable or in need of complete realignment.

Then many receivers, whether employing mean-level or pulse-tip a.g.c., incorporate a series delay diode to hold-off a.g.c. application to the r.f. stage(s) until the signal strength exceeds a predetermined value. Should such a delay diode go open-circuit there would be zero tuner a.g.c. even on strong signals, resulting in sound-on-vision or vision-on-sound due to front-end cross-modulation. On the other hand—depending on the circuitry—if a series delay diode short-circuits the tuner a.g.c. would probably be applied even on weak signals, reducing overall gain and increasing picture grain.

It is important therefore to check all diodes employed in these circuits and the adjustment of preset gain controls, the latter usually varying the delay diode conduction voltage or the rectifying level of a pulse-tip a.g.c. system peak rectifier.

Most a.g.c. or preset gain contols are factory-set and do not normally need re-adjustment unless associated components or transistors are replaced when it becomes necessary to follow manufacturer's instructions. For example the a.g.c. delay control in the latest GEC-Sobell single-standard models must be adjusted so that the base potential of the a.g.c. amplifier-delay transistor is 3·8V on no signal. If this voltage is too high cross-modulation may result while if it is too low grain may be apparent on strong signals.

In the BRC 1500 single-standard series the preset contrast control—which determines the peak rectifier conduction level—must be adjusted so that a strong broadcast transmission or local modulated oscillation of 3-10mV at the aerial socket produces a peak-to-peak display of 110V on a scope connected between the c.r.t. cathode and chassis. Alternatively if a scope is not available the makers recommend feeding an unmodulated 3-10mV u.h.f. signal to the aerial socket and then adjusting the preset contrast control to produce 2·2V d.c. on an Avometer connected between two specified test points.

It will be seen therefore that these preset controls require precise adjustment for optimum results.

Patterning

Though not a common fault background patterning is usually caused by an unwanted frequency producing a varying beat signal within the i.f. passband. The unwanted signal is usually present because of impaired screening or decoupling within the i.f. circuits—particularly in the detector stage—impaired screening or decoupling in the tuner, or on rare occasions a faulty transistor or incorrect d.c. supply which results in high-amplitude signals being misshaped with the production of unwanted harmonics. In some areas patterning may also be due to a strong Band II transmission beating with Band I or Band III signals and some manufacturers supply wavetraps for insertion in series with the v.h.f. tuner to reject the unwanted Band II signal.

Where it is apparent that patterning is a real fault condition, due not to outside interference but developing either in the tuner or i.f. strip, first check that all screening plates and the braiding of all coaxial leads are well bonded to chassis and that any externally mounted decoupling capacitors on the tuner—to l.t. and a.g.c. feed points—have not become disconnected or dry-jointed.

To determine whether the tuner or i.f. strip is at fault the ideal method is to try whichever unit is to hand or can be connected most conveniently. Otherwise, disconnecting the tuner output and injecting a signal from a pattern generator or service oscillator should soon clarify the position.

Testing Transistors

If a transistor is faulty it will of course upset the voltages in the stage concerned. Suspects can however be tested with an ohmmeter by checking their base-to-emitter and base-to-collector forward and reverse resistances. If there is no emitter-collector short-circuit and each resistance ratio is not less than 25:1 with the forward resistance across each junction not more than about 500Ω while the reverse resistance is greater than 10kΩ then the transistor can be assumed to be quite satisfactory. ■

BOOK REVIEW

TV TECHNICIAN'S BENCH MANUAL
By G. R. Wilding
Published by Fountain Press Ltd.,
46-47 Chancery Lane, London W.C.2.
182 pages. Hard covers. Price £2·50.

This latest book in the swiftly expanding Fountain Press series deals concisely with the craft of television receiver servicing under the skilful authorship of George Wilding, a down-to-earth expounder of the mysteries of new and not-so-new circuits whose articles frequent the amateur and trade press and who is well known to readers of TELEVISION.

"Television fault diagnosis is based on three important factors—a good working knowledge of the various circuit sections encountered, an ability to correctly assess the symptoms displayed, and a logical testing procedure," so rightly says Mr. Wilding in his Preface and these factors he fully lives up to throughout his book.

The first nine chapters deal essentially with the various circuit sections embodied in a good cross-section of monochrome receivers, while the final three chapters constitute a colour section which investigates chroma and colour-difference circuits, timebases and power supplies and colour display controls.

Each department of the receiver is introduced by a mini-analysis of function which leads neatly to the clear presentation of fault conditions and symptoms, along with specific and probable causes concluding with recommended corrective procedures. There are however no fault symptom photographs or off-screen oscillograms.

Mr. Wilding's wide and longstanding practical monochrome servicing experience is here dramatically reflected, as also is his logical reasoning in terms of servicing which as I personally know leads him incredibly quickly to the faulty valve or component in the circuit jungle of a defunct receiver (in one example much to the amazement of an American visitor who was monitoring the proceedings and who until then regarded American servicing as second to none—but not any longer!).

Although seemingly written with the professional television maintenance techician most in mind the book nevertheless yields much information of value to the student of television circuits and the amateur repairer, both of whom are normally without ready access to manufacturers' data. In any book of this nature—particularly when the focal points are circuits and fault symptoms—it is always difficult to decide just what not to include when the store from years of experience is vast. George Wilding however can be given credit for prudent selection in terms of delicately balanced tit-bits appropriate to early (and let's face it there are still many of these still active) as well as more recent models.

It was obviously impossible to do more than flutter over the colour television craft in the bounds of the available space and in the fifty pages devoted to this we tend to experience more basic description than the practical guidance given in the monochrome section: but this by no means dilutes the colour value. I was sorry that George failed to investigate the V and U signals since these are fundamental PAL parameters, and I got a bit muddled sometimes between pure chroma (the V and U signal multiplex) and the colour-difference signals (after synchronous demodulation).

These small points apart this a very good book—basic and concise—which I can sincerely and warmly recommend.—*Gordon J. King.*

LONG-DISTANCE TELEVISION

ROGER BUNNEY

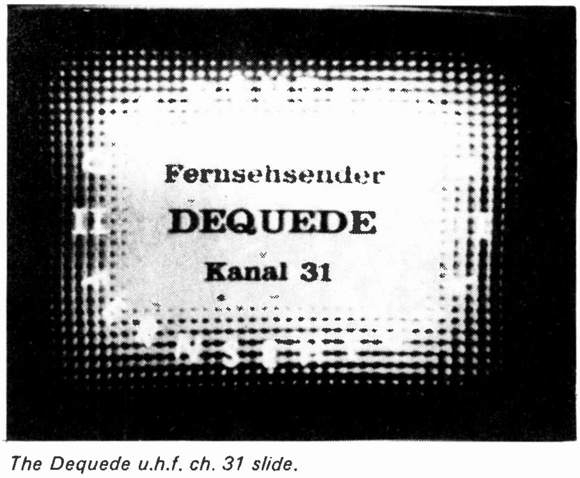
OVER the past few weeks there seem to have been an increasing number of short Sporadic E bursts and generally I've been able to note signals most days. Unfortunately there didn't appear to be an opening around the middle of April, which I had been half expecting. This in itself may not however be a bad sign and I feel certain that this coming SpE season will give improved results over the 1970 season. By the time you read this the season should be well under way, with I hope many strong signals sustained over long periods. If strong signals are noted throughout Band I and into Band II it may be worth having a quick check at the l.f. end of Band III as very occasionally signals do become propagated via SpE at these frequencies. It should be stressed that this is rare but it's certainly worth a minute's check.

April generally showed improving conditions with something on most days. The Lyriads meteor shower gave some strong, short bursts of signal on Band I in the evenings of the 19th and 20th. Tropospherics also gave a lift just after the Easter weekend with the fine weather, and several vigilant DXers managed to receive the coastal Dutch and West German u.h.f. stations.

My own log for the period 1st-28th April is as follows:

1st CT (Czechoslovakia) R1.
7th USSR R1; BRT (Belgium) E2.
9th ORF (Austria) E2a; unidentified pattern—see later.
10th CT R1.
11th West Germany E4; TVE (Spain) E2.
12th BRT E2.
14th Unidentified SpE signal orchestral concert on E2, long duration, suspected of Scandinavian origin (2203-2215).
15th West Germany E4.
16th Sweden E2; DFF (East Germany) E4.
17th CT R1; DFF E4; Sweden E2; BRT E2.
18th BRT E2.
21st BRT E2; also various Northern French tropospherics.
22nd BRT E2.
24th Switzerland E2; BRT E2.
25th Sweden E2; BRT E2.
28th Switzerland E2.

I have introduced a number of abbreviations in the above log—the initials of the transmitting organisations—the object being to save space and make the log simpler to read. I intend to try this method for a few months and would appreciate readers' comments. The country of origin is given along with the initials for each first entry in the log. I usually log no signals of under 5 seconds duration—whether identified or not—unless there are repeated bursts within a short space of time. Incidentally all the BRT Belgium loggings are tropospherics.



The Dequede u.h.f. ch. 31 slide.

I wonder if anyone else has noted a new pattern on R1/E2a recently? I received an unidentified pattern on this channel on 9/4/71 at 0842. This was vaguely reminiscent of the DFF East German pattern but with a prominent series of black-and-white squares across the bottom of the frame. I suspect this may be ORF Austria using a new type of colour pattern. On the 17/4/71 on E2 I noted a short burst of NRK Norway using test card G—they must use this alternately with the new ORF card recently noted in this column.

In the January DX-TV column we referred to Gibraltar Television as having an E6 transmitter with 200kW. The chief engineer Mr. Black has written to us to say that they in fact use 200 watts and that the transmitter is at the foot of the Rock. Our apologies to all concerned—this is going to make its reception at great distances rather more difficult!

We have again noted Caen ch.F2 using 625 lines on test instead of the usual 819-line transmissions. I have written to ORTF (France) to find out exactly what is going on and as soon as I have a reply I will pass on the relevant information. Another query has come to hand about the sighting of a news announcer on E4 with the letters "ok" in the top left-hand corner. In fact the letters are "ak" standing for "Aktuelle Kamera", a news programme from the DFF (East German) network. Incidentally DFF have been noted using identification slides. They first started using them towards the second half of 1970 and I have often seen the distinctive design from around 0830 on some mornings. Each main transmitter radiates its own slide and they are of similar design differing only with location name, channel and programme chain number. Our thanks to Ralf Erler in Parchim East Germany for sending us a photograph of his local u.h.f. Dequede ch.31 slide. This clearly illustrates the type of slide in question. The chain number may be seen either side of the transmitter location name—in this case it is the second chain.

The new transmitter list for all European stations may now be obtained from the European Broadcasting Union, Technical Centre, Avenue Albert Lancaster 32, B-1180 Bruxelles, Belgium. It costs 200 Belgian Francs (approx. £1·60). The 15th edition of this guide includes the main book, six bimonthly supplements and a map. As holiday time is approaching may I suggest that if you or your friends or relations are travelling abroad you enlist their help in bringing back a copy of the local TV Guide from the country they (or you) visit. Such guides are invaluable for identifying programme captions and obtaining typical times, etc.

From Our Correspondents . . .

Garry Smith and Keith Hamer of Derby have passed on some most interesting information relating to Denmark. Apparently the ORF (Austrian) electronic test card is now used by Denmark. It seems that the card does not carry an identification and as Garry comments "there may be confusion now!" With three countries now using this card and only NRK marking their card the E4 identifications between ORF and Denmark could be something of a problem. We will be watching the situation closely for developments.

Following discussion earlier in the year relating to Poland and their TV1 and TV2 programmes, our thanks to Dennis Boniface of Ripon who has sent us some valuable information relating to transmitters in operation for the TV2 programmes: Krakow ch. R2 1kW vertical; Katowice ch. R6 1kW horizontal; Lodz ch. R10 1kW vertical; Warsaw ch. R11 1kW horizontal. The Krakow R2 transmitter may be just possible in good SpE conditions. If they are using the usual Polish-Hungarian test card however we may never know we are in fact receiving them! As the TVP-1 caption is very prominent we must hope that the TVP-2 caption is also as distinctive. Dennis for good measure also tells us that Budapest, Hungary is now on u.h.f. with all of 4kW (horizontal) in colour, on ch. R24. Conditions will have to improve quite a lot for that one!

Our old friend Ian Beckett has been active again on u.h.f. From his Buckingham location he logged both West German and Dutch u.h.f. transmissions during the period 12-15th April. He tells us that Arnhem ch. 50 in Holland is using a new test pattern: across the centre of the card from the left-hand side is the identification "Arnhem Kanal 50" and to the immediate right of this is a small NOS test card.

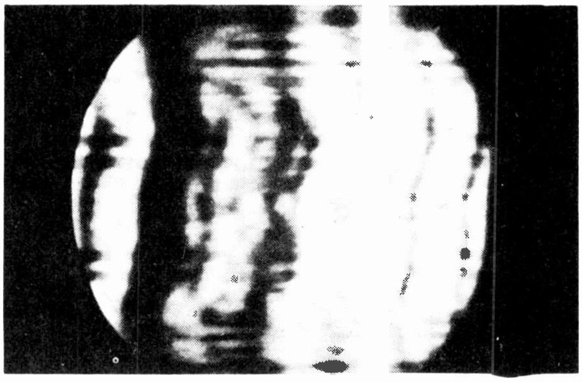
I know that all regular followers of this column will want to join with me and wish Doug Bowers of Saltash a rapid recovery and return to health. I have just heard that he is in hospital—for the second time this year. We hope that Doug will soon be home and back to his normal self. I also gather that earlier this year or at the end of last year he succeeded with the reception of TVE (Spain) in Band III (E7). As soon as I can find out the details of this I will pass them on.

Roy Sheppard has been at it again. From his Amman, Jordan home he reports reception of the well known checkerboard on ch. E2, but with his aerial to the East. This pattern actually has a slight modification. The contrast scales in the second and fourth rows are reversed through 90°, being vertical rather than horizontal. I would guess that this may be from a new, unlisted transmitter in West Pakistan or even India. The time and date was 1330 GMT—18/3/71.

A well known name in these pages over the past few years — A. Papaeftychiou of Palouriotissa, Cyprus — has written to us enclosing an interesting letter from the Chief Engineer of Rhodesia Television confirming his reception in Cyprus of the ch. E2 Rhodesian transmitter at Gwelo. This transmitter is to the south east of Gwelo City—actually lat. 19° 31′ S, long. 29° 56′ E—and covers the midlands of Rhodesia. It has been active for one year as of March, 1971. Our congratulations to Mr. Papaeftychiou for this excellent reception via TE (trans Equatorial skip). He says that the reception was almost daily during the third and fourth weeks in February and the second and third weeks in March with clear audio and vision from near normal to typical multiple images. Time around sunset locally 1800-2000.

We have an exotic photograph this month showing the

Jordanian TV ch. 3 and 6 identification slide.



Typical F2 reception—of Belgium ch. E2 on test card.

Jordan Television ch.3 and 6 identification slide. The building is the El Aqsa Mosque in Jerusalem and the E3 transmitter could just be possible in the UK—it has been received in Germany and Sweden E2 has been received recently in Jordan. Our thanks to Roy Sheppard again for this interesting picture.

New Transmitters

Finland: Jyvaesklae ch.25 600kW horizontal. This is located about 150 miles North of Helsinki and may be just possible with exceptional trops in that direction.
Sweden: Haparanda ch.35 1,000kW horizontal.
Visby ch.E9 has been increased to e.r.p. 60kW horizontal. This is also a possible. It's located on Gotland, an island in the Baltic Sea about 120 miles South of Stockholm.

Sunspot Counts

Predictions of the smoothed monthly counts: April 72, May 69, June 67, July 64, August 61, September 59. Courtesy Swiss Solar Observatory. These numbers show the now rapidly declining cycle.

F2 Survey

I am extending the column this month to include a run down of F2 and TE reception during the now current but declining sunspot cycle and will highlight some of the more important reception items. At this moment in time it seems unlikely that there will be any further opportunities for TV-DX via F2 in the current cycle. Indeed for us in the UK there was never really a climax as far as vision reception was concerned. For many the first signs of F2 activity were various paging stations and other North American communications received both as tuned r.f. and i.f. breakthrough from October, 1967, and most winters since. East European networks have also been noted, mainly forward-scatter link networks associated with space work.

Highlights—unfortunately too few—were reception by Charles Rafarel and Maurice Opie at Bournemouth on the 6th and 9th June, 1968 respectively of 525-line 60Hz signals on ch. A2. The aerial direction was south west and it is thought the signals originated in the North of South America. Almost five months later R. Ballardie in Ayrshire received—via Aurora—525-line ch. A2 signals, probably a Canadian station. Farther afield A. Papaeftychiou in Cyprus has been most successful with both F2 and TE from many parts of Africa. He has confirmed reception—both sound and vision—of Nigeria, Ghana, Kenya and Rhodesia, all in Band I. In South Africa J. Brawn, C. Breiter and W. Ruurds received on two occasions TVE Madrid ch. E2 via F2 on a classic North-South path. Their photograph of this card is remarkably good considering this propagation mode.

Thanks to the WTFDA in Milwaukee we have details of their members' reception, in particular that of Bob

—continued on page 424

FREQUENCY METER

MARTIN L. MICHAELIS, M.A.

PART 3

THE frequency counter section shown in Fig. 5 is a cascade of four 10:1 pulse scalers which operate in the same manner and according to the same truth table (Table 1 last month) as the scaler stages IC5 and IC6 described last month (Fig. 4). Motorola MC838P i.c.s are used for IC5 and IC6 and these are DTL types. For the frequency counter section Bipak BP90 i.c.s are used and these are TTL types. They thus require somewhat lower impedance conditions though the differences are only minor. The pin connections are also different but since these are all specified in Fig. 5 there should be no confusion. An important difference is that the BP90 can be split into two separate scalers with ratios 2:1 (associated with CP1 and Q1) and 5:1 (associated with CP2 and Q2 to Q4). To obtain a 10:1 scaler with truth table as Table 1, Q1 must be strapped to CP2 externally as shown in Fig. 5. This connection is made internally in the MC838P. The rather low value of 180Ω was necessary for R98 to ensure the resting 0 state for proper Q-pulse operation at CP1 of IC9. This is the reason for the emitter-follower Tr17 (Fig. 4) as interfacing stage to provide adequate drive into R98 to reach the 1 state on each Q-pulse.

The Decimal Decoder

A closer inspection of the truth table (Table 1) of the 10:1 pulse scaler reveals that each Q has a definite value related to the number of Q pulses fed to CP. Q1 changes state after receipt of one input pulse, Q2 after receipt of two input pulses, Q3 after receipt of four input pulses and Q4 after receipt of eight input pulses. The logical 1 is represented by a fixed positive voltage so that the addition of the Q values to give the decimal value of any state can be performed by connecting four resistors from the respective Qs to a common meter. The values of the resistors are made inversely proportional to the Q values so that the respective currents sent into the meter are proportional to the Q values. The meter adds the currents, giving a reading proportional to the sum Q value which is the decimal value. The meter scale can be calibrated in ten equal steps from 0 to 9 and after correct setting up the pointer jumps abruptly to the next higher step after each Q pulse is fed to CP. On the tenth pulse it drops back to zero and the meter of the next higher stage jumps one step because this stage has received a 1 to 0 transition at its CP. Each meter reads one digit of the four-digit display.

The diode-resistor cross-couplings between the Qs were found necessary to compensate for slight differences of the 1 state voltages according to the number of Qs actually in the 1 state. Without these compensating networks it was difficult—and for some samples of BP90 quite impossible—to get the marks from 0 to 9 reasonably evenly spaced over the meter scale. In particular 8 and 9 tended to coincide or even fall retrogressively without the diode-resistor compensation. With the latter incorporated the scales are entirely satisfactory with any sample of BP90.

Counter Reset

When the instrument is switched on the meters will give arbitrary readings determined by casual tolerance differences between the i.c.s. It is thus necessary to have some means of setting the meters to zero before commencing a count. It is also necessary to be able to reset the meters to zero after making a count before starting the next one.

For these purposes each BP90 possesses two R (reset) and two S (set) pins. For counting Q pulses via CP all R and S pins must be in the logical 0 state. To reset to zero (all Qs in the 0 state) from any counting state a logical 1 state must be applied to both R pins. The Qs reset at once and counting is inhibited until the logical 1 state is removed again from the R pins. A separate start-stop switch has been provided because to stop via the R pins would stop and reset the counter before there is a chance to take the reading. The R pins of the frequency counters are thus used only for the reset function (in the time counter section we will make use of a combination of the stop and reset functions).

The S pins can be used for setting the scalers to 9 instead of 0 by applying the logical 1 state to them. This facility is used for forwards/backwards counting and as this is not required in the present instrument the S pins of IC9 to IC12 are permanently strapped to chassis. Do not omit these connections as the open-circuit state is equivalent to a logical 1 and thus inhibits counting, the circuit refusing to count if the S pins are not grounded.

Set/Reset Truth Table

The respective R and S pins are actually AND gates so that it suffices to ground one R and one S pin to enable the i.c. to count Q pulses via CP. It is however necessary to apply the logical 1 state to *both* R or *both* S pins to obtain the reset/set and count/inhibit functions. Table 2 shows the truth table for the set/reset pins. In this table X signifies "state is immaterial".

The reset function is obtained with section S3B of the digital-analogue toggle switch on the front panel. In the digital setting all eight R pins of the four stages are grounded via the very low value resistor R91A. This resistor is necessary instead of a direct ground contact to limit the discharge surge current of C63 through the switch to a safe value. In the analogue setting of S3B the logical 1 state is applied to all R pins via R90. C63 charges with a slight delay,

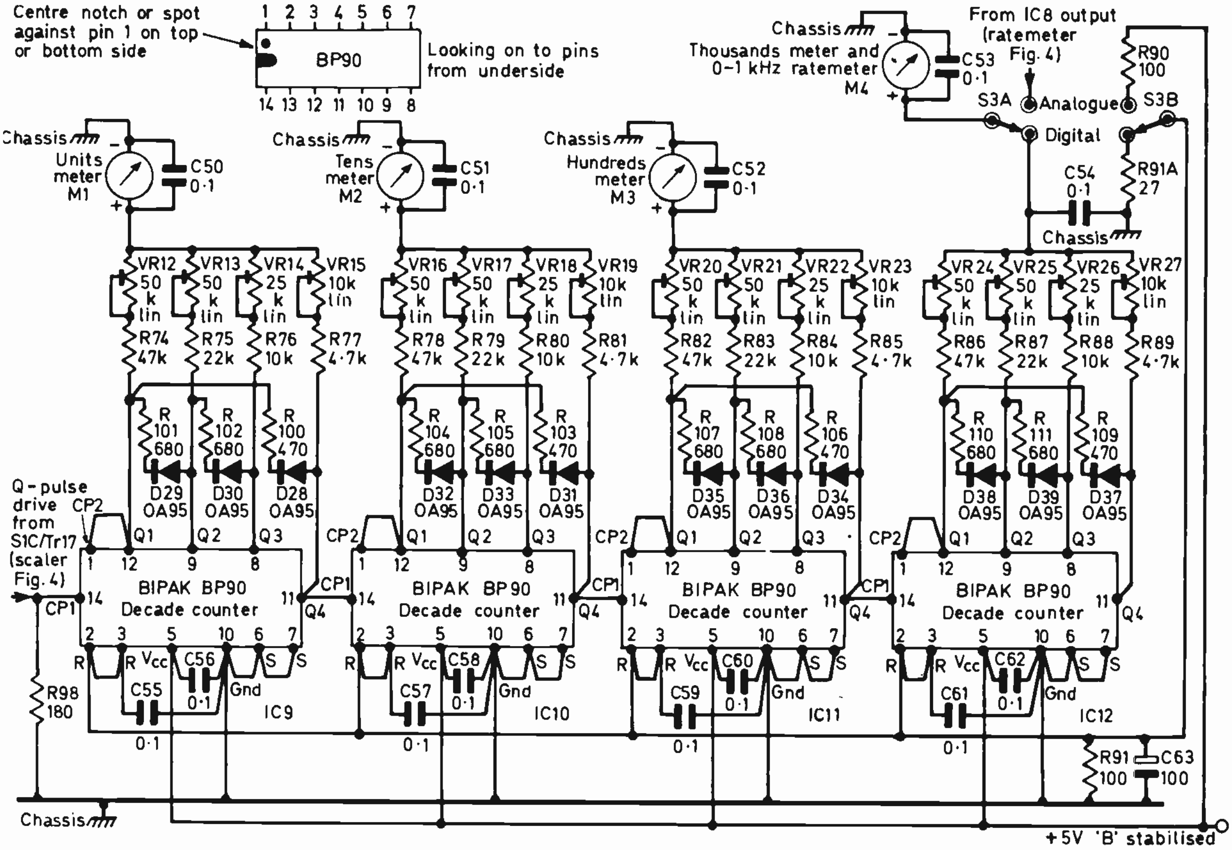


Fig. 5: Circuit of the frequency counter section of the meter.

tiding over any mechanical rebounds of the switch contact of S3B and preventing possible erratic behaviour if C63 were to be omitted.

Digital/Analogue Switching

Section A of S3 switches over the thousands meter from the fourth 10:1 counter stage IC12 (digital setting) to the output of the ratemeter operational amplifier IC8 (analogue setting). The other three meters drop to zero at once when S3 is set to analogue because S3B then produces the reset conditions. IC12 is of course reset at the same time so that the thousands stage meter also reads zero when S3 is returned to digital from the analogue setting. Thus to reset the meters to zero briefly flip S3 from digital to analogue and back. If analogue readings are to be taken leave S3 set to analogue. The thousands meter then reads frequency directly on its second scale and the other three meters remain at zero.

Table 2: Set/reset truth table for BP90 decade scaler

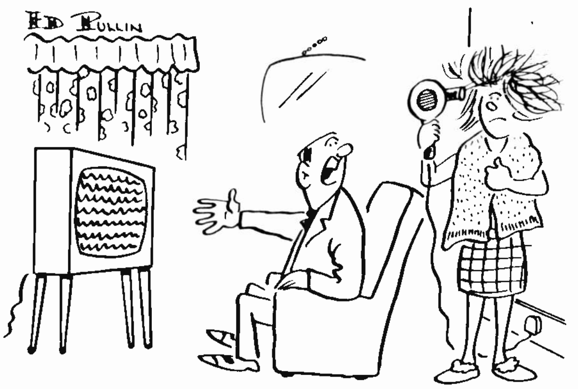
R1	R2	S1	S2	gives	Q1	Q2	Q3	Q4	
1	1	0	X		0	0	0	0	(reset)*
1	1	X	0		0	0	0	0	(reset)*
X	0	1	1		1	0	0	1	(set)*
0	X	1	1		1	0	0	1	(set)*
X	0	X	0	count via CP					
0	X	0	X	count via CP					
0	X	X	0	count via CP					
X	0	0	X	count via CP					
1	1	1	1	not permitted†					

* Counting inhibited. † Erratic.

The Time Counter

Except for the one-second gating of the amplifier section, which can be selected with S5, the time counter (Fig. 3) is a quite separate counting system. Its start-stop switch S1A is mechanically ganged to the start-stop switch of the pulse counter so that pulse counting and timing always start and stop together. The circuitry of the time counter employs stages similar to those already described in other sections of the instrument. The only entirely new device here is the pulse-triggered binary which controls the intermittent counting action.

Rectifier diodes D11 and D12 provide a 100Hz train of positive sinewave half-cycles across the track of VR8 from a full-wave winding on the mains transformer. The full-wave rectifier is used to double the 50Hz mains frequency in order to obtain a decimal value. Tr12 and Tr13 form a Schmitt trigger circuit which pulses the waveform in the same manner as described for Tr5, Tr6 in the amplifier section. Tr14 is the Q-pulse driver interfacing the squarewave output of the Schmitt trigger with the two 10:1 scaler (decade counter) stages IC2 and IC3. These function in the same manner as IC5 and IC6 in the pulse scaler section. Q4 of IC2 gives the 1 to 0 step function on every tenth 1 to 0 transition at its CP1, i.e. once every tenth of a second. Q4 of IC3 gives the 1 to 0 transition once every second.



You could have waited until the party political broadcast!

The two counting positions of the start-stop switch S1 select either the 1/10th second or the one second transitions and feed them to the monostable IC4 which serves the same pulse regenerating function as described for IC7 in the scaler/ratemeter section. The pulse width determining capacitor C39 is however much larger as it has to produce a pulse about 1/30th second long to actuate the electromechanical pulse counter Rly1 via the pulse amplifier Tr15, Tr16. D13 prevents destruction of Tr15 by the surge voltages otherwise developed in the winding of Rly1 at the switching instants. Diode D25 at the monostable input is necessary to prevent a spurious pulse appearing whenever the start-stop switch is actuated. Without D25 one time count is registered by Rly1 as soon as S1 is moved from stop to a counting position. This is unwanted. In the stop setting S1A resets the two time scalers IC2 and IC3 and holds their counting inhibited via the R pins as long as S1 remains in the stop setting. Time counting must start from zero after switch S1 is moved to a counting position and this means a full 1/10th or one second must elapse before the first time count is registered by Rly1. D25 provides the necessary hold-off threshold to prevent IC4 firing prematurely on switching transients.

The Pulse-Triggered Binary

The pulse-triggered binary IC13 is operated with the one-second Q4 output of IC3 in the time counter and produces the alternate-second drive for the gate Tr18 in the amplifier section. The truth table for this device is similar to the set/reset truth table of a BP90 decade counter as will be evident on comparing Tables 2 and 3.

The applications of this device are legion but quite straightforward if the truth table conditions are followed. It is evident at a glance that this truth table is much more versatile than that of the decade counters. The decade counters however consist essentially of four of these pulse-triggered binaries on a single chip with internal connections which produce the 10:1 scaling action. Looking at Table 3 we see that SD (set direct) and CD (clear direct) are over-riding control inputs which respond to d.c. potentials and produce definite Q states irrespective of the other four control inputs which are thus disabled as long as either SD or CD sees a logical 0. The former case sets Q to 1 and the latter case clears Q to 0. $\overline{Q}$ takes up the complementary state in each case but a logical 0 at both SD and CD produces the anomalous but definite condition of inverted $\overline{Q}$, i.e. cancellation of the complementary relation between Q and $\overline{Q}$, a facility which is useful in many advanced logic systems.

When both SD and CD see a logical 1 they give up their master control functions and hand over to S1, S2, C1, C2. The control operation is then complex, consisting of two d.c. components and two step transition components. S1 and C2 must be given definite d.c. logic states as specified for the various possibilities in the truth table. This alone is not sufficient to affect the states of Q and $\overline{Q}$; these change as indicated in the truth table when S2 and C1 then make *dynamic* transitions, i.e. produce a response as indicated after being triggered by a pulse. Combinations of S2 and C1 thus provide the CP inputs while networking S1 and C2 provides the logic determining the scaling factor and SD and CD provide the set/reset functions.

For our intermittent gating we require a 2:1 ratio scaler to produce two-second squarewaves from the one-second time pulses. This simple scaler is realised with a single pulse-triggered binary. S2 and C1, the two pulse-triggered control inputs, are simply commoned as the CP input to which the one-second time pulses are fed in the usual manner from Q4 of IC3. Q is strapped back to the d.c. control input S1 and thus the states of Q and S1 must be the same in the truth table to see the performance of our arrangement. We have made a second such restriction by strapping $\overline{Q}$ back to C2. If the reader cares to look up these conditions in Table 3 he will see that the result is a changeover of the states of Q and $\overline{Q}$ for every 1 to 0 transition fed to S2 and C1. Since these transitions appear at one-second intervals from IC3 Q and $\overline{Q}$ rest at logical 1 and 0 for alternate seconds.

To permit counting Tr18 in the amplifier section must be cut off, i.e. a logical 0 is required as the resting state from the gate drive output of the pulse-triggered binary and this is ensured for the $\overline{Q}$ output with the over-riding d.c. control inputs SD and CD appropriately set. S5 is the mode switch selecting continuous or intermittent counting. For intermittent counting both SD and CD are given a logical 1 from the junction of R112 and R113 so that control is handed over to the S1, S2, C1, C2 control system in the manner already described. To produce continuous counting S5 grounds SD but the logical 1 is left at CD. According to the truth table this inhibits the S2, C1

Table 3: Truth table for general purpose pulse-triggered binary

SD	CD	S1	S2	C1	C2	give	Q	$\overline{Q}$
0	1	X	X	X	X		1	0
1	0	X	X	X	X		0	1
0	0	X	X	X	X		1	1 *
1	1	0	0	0	0		indeterminate	
1	1	1	X	1	X		no change	
1	1	X	1	X	1		no change	
1	1	0	1	1	0		no change	
1	1	0	0	X	1		1	0
1	1	0	0	1	X		1	0
1	1	1	X	0	0		0	1
1	1	X	1	0	0		0	1

* Anomalous but determinate state (Q, $\overline{Q}$ here not complementary). S2 and C1 are pulse triggered. Response is to step transition to the *final* state listed. S1, C2, SD, CD respond to d.c. levels of the specified states. X = state immaterial.

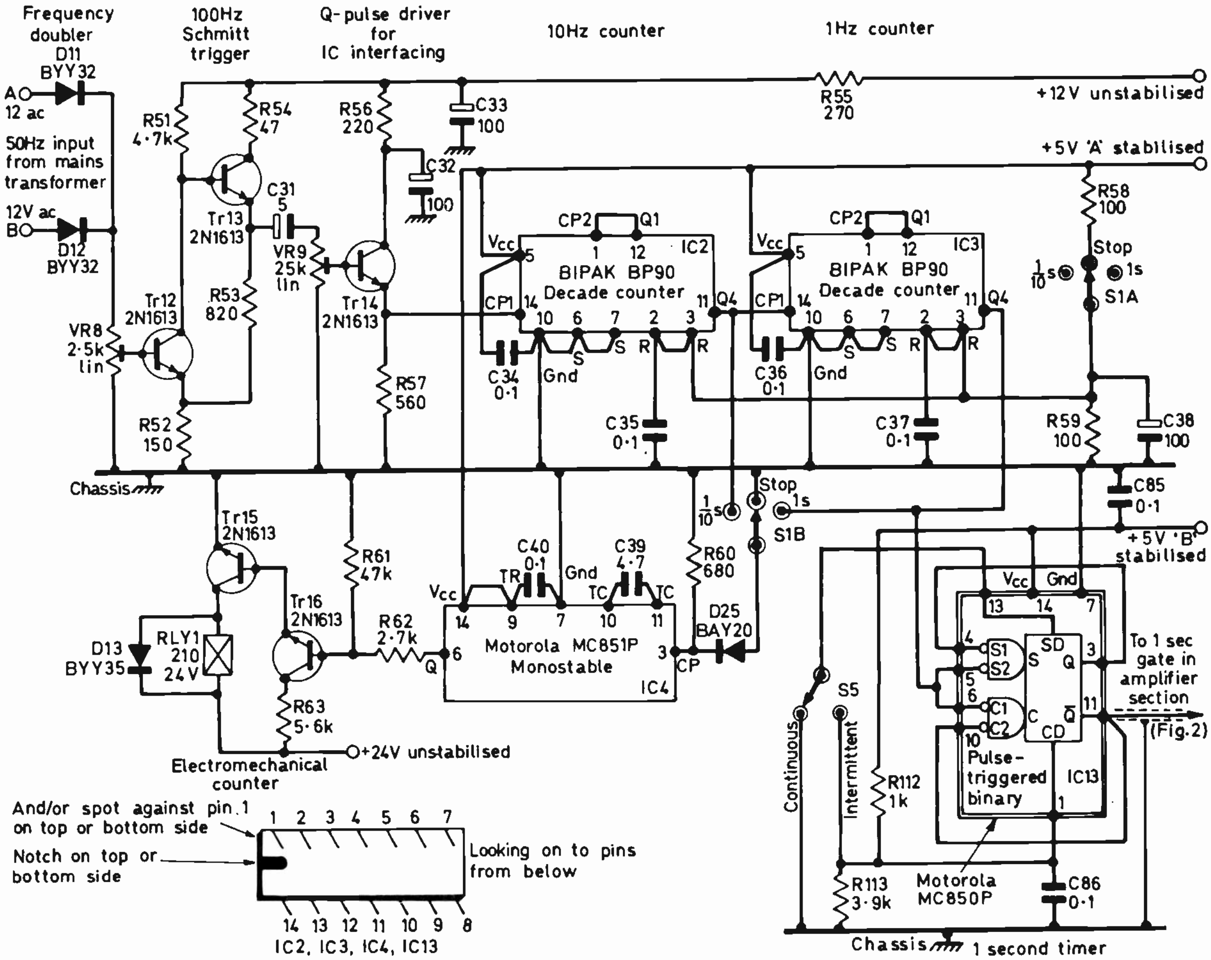


Fig. 3: Circuit of the time counter section of the frequency meter.

pulse-trigger response and forces $\overline{Q}$ permanently into the logical 0 state which holds the gate transistor Tr18 permanently off so that the amplifier output pulses are not shorted out.

Strapping back Qs to d.c. control inputs over one or more stages is the basic method of obtaining the scale-down ratio desired, including odd and prime numbers, in a complex array of pulse-triggered binaries.

Intermittent Counting

One-second timing with the pulse-triggered binary IC13 is very stable and accurate. Resolution is determined by the phase angle jitter of the firing point of the Schmitt trigger Tr12 and Tr13 in the time counter since this determines the instants of the step transitions. Thus it is important to adjust VR8 so that Tr12, Tr13 operate with some overdrive. Triggering then does not take place too near the sinewave peaks but instead on a steep part of the waveform. In this way slight voltage jitter will lead to much smaller time jitter and a resolution of a few degrees phase angle of the mains frequency is realisable. This means that provided the mains frequency itself is stable the one-second timing is accurate to within one or two hundred microseconds so that one-second timed counts of frequencies around 10kHz should be reproducible to within a few pulses. If for example repeated counts of say 9,645Hz on the four meters show greater fluctuation than two or three Hz in the last digit VR8 is probably not giving sufficient drive to Tr12.

In principle the time counter commences from zero when switch S1 is moved to one of the counting positions. There is however a certain delay inherent in the discharge of C38 through R59 before the time counter is enabled so that a count tends to be high if phased so as to take place in the first second after starting. If counting is observed during the first second, stop during the next one whilst the counter is halted and then reject the count by briefly switching to analogue and then back to digital. Now start again. Counting will now take place correctly in the second second. Stop during the third second when the counter halts again. The one-second timing of the registered count is now exact. For all further frequency counts reset and start again. The correct timing phasing will then remain correct automatically.

The pulse-triggered binary has been arranged so that the "incorrect" phasing is always obtained when switching over in the stop setting from continuous to intermittent. In other words the amplifier remains clear and counting commences during the first second. The purpose of this arrangement is to permit an analogue reading in the stop setting so that the range switching can be based on this for the subsequent digital frequency count. Having obtained the analogue reading, briefly switch to counting until the first one-second count comes up and the analogue reading vanishes because the gate mutes the amplifier at this instant. Immediately switch back to stop and then switch over to digital. Everything is now ready for frequency counting in the correct one-second phase.

Constructional Notes

The amplifier section is a high-gain system subject to instability and hum problems if serious departures are made from the specified layout (available on request). This danger, however, has been greatly reduced by avoiding the extremely high-gain which would be necessary to cover all requirements, making use instead of the i.c. preamplifier externally. Thus although not essential it is highly desirable to construct the i.c. preamplifier or some equivalent auxiliary amplifier to give this instrument the full versatility of which it is capable.

Although the pulse and time counter sections do not involve signal amplification and are thus not primarily subject to feedback instability and hum troubles it is nevertheless important to bear in mind that the logic level transitions in these digital i.c.s are *extremely* rapid and contain frequency components up to the v.h.f. range. It is therefore most important to keep active logic connections very short. All capacitors connected to the i.c.s and not expressly mentioned as serving other functions serve bypass functions for the v.h.f. transitions generated inside the i.c.s. These capacitors must be mounted as close as possible to the respective i.c.s, and it is important to use types suitable for v.h.f.

The decade counter i.c.s are capable of operating up to about 30MHz. A small input adapter unit is being prepared for the pulse input. This consists of a few further scaler stages and r.f. tuned circuits at the input end. With this adapter the range of the instrument will be extended for direct digital counting of all frequencies up to the 30MHz end of the shortwave band. The same one-second timing operation will be operative giving direct digital read-out to about four significant figures (resolution of a few kHz at 30MHz) and the analogue function will give direct meter readings of these frequencies. The best digital i.c.s which are commercially available at present can count directly up to about 100MHz so that crystal mixer input stages are required for significantly higher frequencies. However, advanced companies are obtaining promising results with tunnel-diode logic and related devices for high-speed input stages which may ultimately be able to count directly into the GHz range.

COMPLETE PROCEDURE FOR SETTING UP THE FREQUENCY METER

Setting up must be carried out in the following order.

(1) Check that the power supply output voltages are all present and approximately correct. If not first trace and remove the power supply fault or short-circuit before proceeding.
(2) Set VR4 slider to chassis and VR5 to zero resistance (Tr7 emitter to chassis).
(3) Connect oscilloscope and a.f. signal generator to P1, and adjust for 50mV peak-peak input at 1kHz. Turn VR1 to maximum and VR2 to any one stop. Leave a.f. signal generator connected to P1 but transfer oscilloscope to P3. Adjust VR3 to give peak-peak display of 1V amplitude. This should be an undistorted amplified replica of the input waveform.
(3a) If oscilloscope and a.f. signal generator are not available for (3) connect a 1MΩ ½W carbon resistor between junction C10, VR2 and track of VR3 and set VR3 mid-way. This approximates correct conditions.
(4) Disconnect input and oscilloscope and turn VR1 to zero.
(5) Measure the voltage across R36 with a valve voltmeter (about +2V to chassis).
(6) Connect valve voltmeter to Tr7 emitter and advance VR5 until reading is exactly +0·2V higher than for (5).
(7) Connect valve voltmeter to VR4 slider and advance VR4 until reading is exactly +0·2V higher than for (6) i.e. +0·4V higher than for (5).
The amplifier section is now correctly set up.
(8) In the time counter set VR8 and VR9 to zero (sliders to chassis).
(9) Connect oscilloscope to top of VR9 track. Synchronise 2-3 mains periods on the timebase line, e.g. by first touching the scope input with a finger to give stray hum display.
(10) Advance VR8 until a 100Hz symmetrical squarewave display suddenly appears. Amplitude should be about 8V. Advance VR8 further so that the 100Hz squarewave becomes progressively asymmetric with the positive sections narrower but no significant amplitude change. Correct setting is when the positive parts are about one quarter of the width of negative periods.
(11) Now advance VR9 until +3V peak-peak pulses of same waveform as established in (10) are observed at Tr14 emitter.
(11a) If an oscilloscope is not available for (10) find mutual settings of VR8 and VR9 such that slight reduction of either will stop time counting when S1 is set to 1/10s or 1s but counting is steady and dependable in established settings.
The time counter section is now correctly set up.
(12) Switch S3 to analogue. With no input signal adjust VR11 for exact zero reading of M4 after making sure that M4 was mechanically zeroed with the unit switched off.
(13) Feed a 1kHz signal from an a.f. signal generator to P1, turn up VR1 and turn VR2 to one stop. Set S2 to range ×1. Now adjust VR10 for exact full-scale reading of M4 (S3 still set to analogue).
(14) Check by switching S2 to ×10 and ×100 and feeding 10kHz and 100kHz signals respectively to P1. M4 should read full scale in each case. If not the scalers IC5, IC6 are defective or S2 is wired incorrectly.
The scaler/ratemeter section is now correctly set up.
(15) With the unit switched off check the mechanical zero adjustments of all meters M1-M4.
(16) Set VR12-VR27 all midway.
(17) Switch on again and set S3 to digital or momentarily to analogue and then back to digital if already at digital.
(18) Assuming that 500μA meters are used for M1 to M4 all meters should now read about 10-30μA.
(19) Note the following alignment readings:

8	4	2	1
446μA	233μA	127μA	73μA

(20) Set S2 to ×100, connect about 6·3V a.c. to P1/chassis from a small mains transformer (50Hz), switch S3 to digital, S1 to 1s and advance VR1, VR2 until the units meter M1 steps at two second intervals.
(21) Switch S1 to stop, zero the meters by briefly moving S3 to analogue and then back to digital, and then switch S1 to 1s again carefully counting the steps of the units meter (these will probably be irregular and some may be very small or even retrogressive). Return S1 to stop when 8 steps have taken place—before the ninth step.
Adjust VR15 to make M1 read the 8-value of 446μA.
(22) Repeat (21) but stop after four steps.
Adjust VR14 to make M1 read the 4-value of 233μA.
(23) Repeat (21) but stop after two steps.
Adjust VR13 to make M1 read the 2-value of 127μA.
(24) Repeat (21) but stop after one step.
Adjust VR12 to make M1 read the 1-value of 73μA.

(25) Switch S2 to ×10 and then repeat (20) to (24) for the tens meter M2.
Adjust VR19 for 446μA, VR18 for 233μA, VR17 for 127μA, VR16 for 73μA at respective stages of procedure.
(26) Switch S2 to ×1 and then repeat (20) to (24) for the hundreds meter M3.
Adjust VR23 for 446μA, VR22 for 233μA, VR21 for 127μA, VR20 for 73μA at respective stages of procedure.
(27) Leave S2 set to ×1, preferably substitute about 500Hz input at P1 to speed things up, then repeat (20) to (24) for the thousands meter M4.
Adjust VR27 for 446μA, VR26 for 233μA, VR25 for 127μA, VR24 for 73μA at respective stages of procedure.
The frequency counter section and entire unit is now correctly aligned.

Calibration of Meters

The adjustments of VR12-VR27 are sufficiently independent to permit once-through sequence adjustment as specified above without repeats being necessary. Slight mutual shifts are taken into account by the following calibrating procedure:
(1) After the fashion of (20) to (21) let each meter step right through from 0 to 9 to check that the steps are now in regular progression to approximately full scale.
(2) Stop after each single step of each meter, including the drop-back 0 after a 9, and note the exact meter reading of each meter for each step. Compile a table of the readings along the lines of the following one obtained for the prototype:

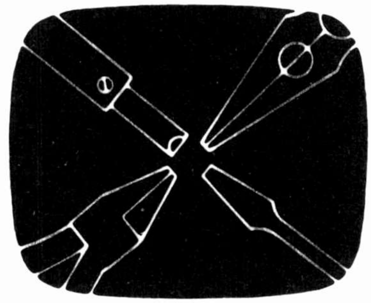
	Units μA	Tens μA	Hundreds μA	Thousands μA
0	22	18	26	26
1	72	73	74	74
2	125	128	128	128
3	172	182	176	178
4	227	233	231	232
5	275	290	279	289
6	327	342	326	330
7	375	397	370	380
8	435	442	449	435
9	486	503	510	500

(3) Open the units, tens and hundreds meters in turn, remove the scale plates and glue a piece of thin drawing paper over each so that the original scale is just faintly visible through the paper. Mark spots 0-9 at the tabulated points and a small dot at the mechanical zero point, and mark the meters units, tens and hundreds as well as 0-9 respectively.
(4) With suitable scaler ranges and the 1/10s or 1s time counter settings count the output frequency of the a.f. signal generator when set in turn to its 50Hz calibration marks from 50Hz to 1kHz. In each case let the units, tens and hundreds meters run nearly full for at least 100 clocked up tenths or whole seconds. In each case determine the exact frequency by dividing the pulse count by the time count. Plot a graph of the true frequency (Y axis) against the scale setting (X axis) of the a.f. signal generator.
(5) Switch to range ×1 and analogue, set the signal generator to exactly true 1kHz according to the graph and readjust VR10 for exact full-scale reading of M4.
(6) Set the signal generator to 50Hz—1kHz in successive steps of 50Hz to the true frequencies according to the graph, and compile a table of the actual readings of M4, e.g. for the prototype:

Hz	50	100	150	200	250	300	350	400	450	500	550	600
μA	15	32	55	80	118	150	180	210	243	272	300	328

Hz	650	700	750	800	850	900	950	1,000
μA	350	380	400	425	446	462	480	500

Slight irregularities are due to irregularities of the original meter scale. These are taken into account in this method.
(7) Now open the thousands meter and affix the new digital and analogue scales according to the tables. ■



SERVICING television receivers

L. LAWRY-JOHNS

GEC-SOBELL 2012-1012 SERIES

THIS is a series of hybrid—part transistorised and part valved—receivers marketed under the GEC, Sobell, Masteradio and McMichael brand names. The models outwardly resemble the 2010 series already dealt with (June-July, 1970) but use completely transistorised tuner units and i.f. panels and of course supply circuits to suit. Model numbers are GEC 2012, Sobell 1012, Masteradio 4011 and 4013 and the McMichael 3011 and 3013.

Transistor Supplies

It is essential to understand the supply circuit for the transistors in order that trouble here can be correctly diagnosed and rapidly dealt with. The heater circuit is through the voltage adjustment sections of the dropper R150 and R151, the thermistor TH2 and then rectifier SR2. This results in the high a.c. being rectified to a much lower rippled d.c. due to the absence of a reservoir capacitor. The heater supply is now at a positive potential but as it not smoothed a normal voltmeter will not measure it accurately. The current passes through the heater chain in the normal way, the tube heater being the last, but instead of then being taken to chassis as is normal in most valved sets the circuit is next used to supply the transistors. Before it can do this it must of course be smoothed to iron out any trace of hum in the sound and vision signals (remember that point).

The smoothing circuit consists of some low-value resistors and some high-value capacitors (C194, C195). The supply is then divided into LT1 and LT2 supplies.

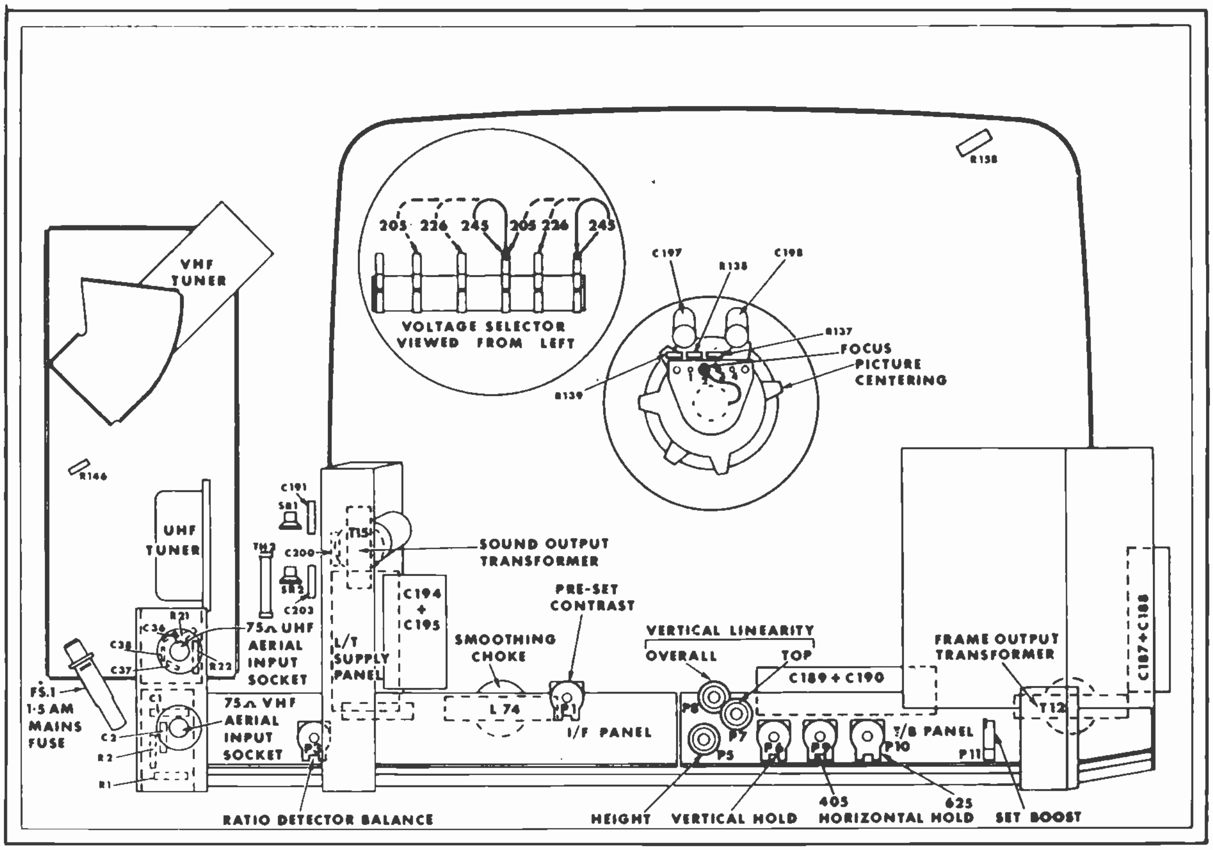


Fig. 1: Rear view of the receiver with the cabinet back removed.

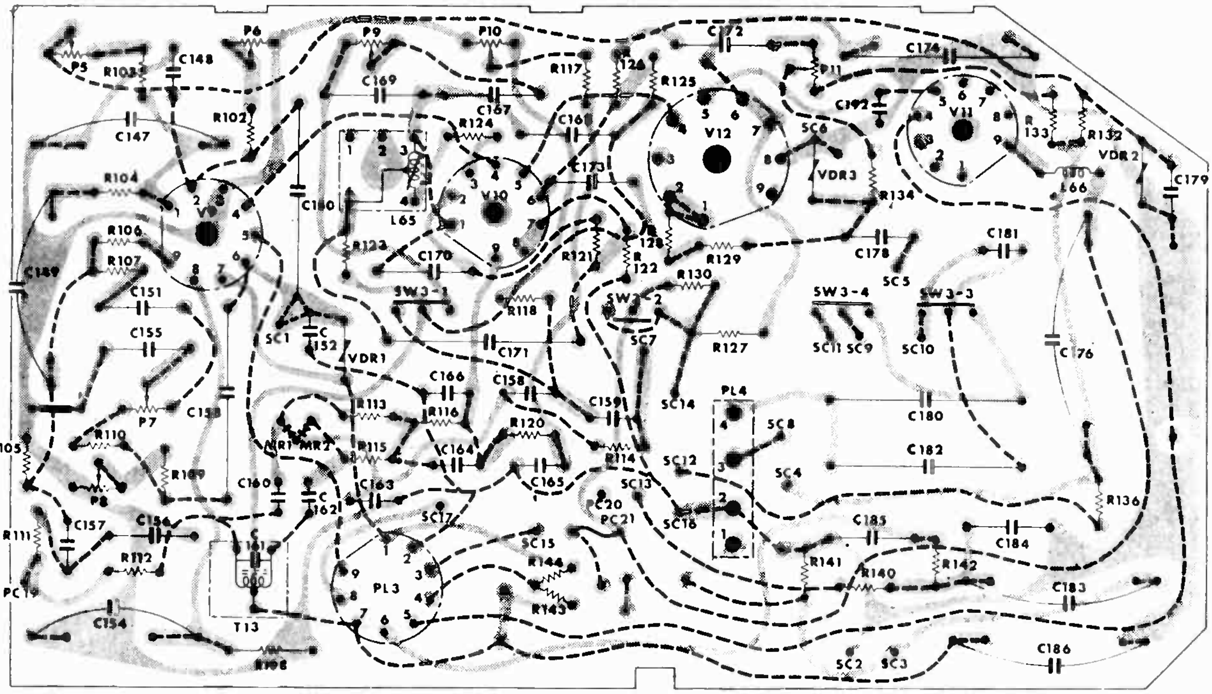


Fig. 2: Layout of the timebase printed board viewed from the tin-dip side.

The circuit also provides an a.g.c. delay voltage which may be varied (local/distant tappings) to prevent crossmodulation effects resulting from too strong signal input.

To prevent surge voltages when the receiver is first switched on diode D8 is connected from this supply to the cathode of the field output valve (point A). This has the effect of killing the transistor supply voltage (as the diode conducts heavily shorting it out) until the PCL85 warms up and a cancelling positive voltage is developed across R108. The diode then stops conducting and the transistor supply is fully operative. Moral: correct field timebase faults before wondering where the sound and vision signals and voltages have gone.

Check the smoothers C194 and C195 in the event of severe hum on the sound and vision reproduction.

Tuner Units

The v.h.f. tuner closely follows the valved type dealt with in the previous GEC article at least from a mechanical point of view, the stripping down procedure being just as awkward. Most often however stripping down is unnecessary as poor contact inside the tuner is due to incorrect location of the slider bar. The travel of this is determined by the indentations on the rotary plate and the small spring at the end of the bar assembly. This should locate squarely on the nut and should not be offset on the thread. This small difference in location makes a good deal of difference in accurate v.h.f. switching.

From an electrical point of view the tuner does not seem to give much trouble except for the occasional failure of the first stage transistor Tr1. Failure here gives rise to very weak and noisy reception on 405 only.

As coverage of the country by the u.h.f. transmitters extends farther the often neglected u.h.f. tuner becomes the more important of the two. Mechanical attention to the smooth operation of the two-speed tuning is essential to avoid the irritating jerk past the required channel (I'll get it on the way back). Lack of use is the main cause of this trouble and time spent freeing the action is well worthwhile.

On this tuner also it is the first stage transistor which fails giving rise to weak and noisy reception on u.h.f. only. Those who have the ability to check the transistor should also have the ability to replace it without disturbing the rest of the tuner. Those who do not have this ability should leave the job to a more experienced person. Replacement of the complete tuner is only a matter of minutes if a spare one is available (it doesn't have to be identical for test purposes) and this is perhaps the best check.

Common Faults

These receivers exhibit mainly the more common faults of the 2010 series.

Weak and Noisy Reception

One of the prime causes of weak signals is a faulty aerial socket. Inspection will usually reveal what is wrong and what is required to put matters right. Merely resoldering across a crack is not good enough: wire it as well.

The next step depends upon the reception standards. If both v.h.f. and u.h.f. can be used the trouble can be quickly identified as being in one of the tuners (if only one system is affected) or in the i.f. stages if both are affected. The trouble can often be due to inaccurate travel of the system switch operating arm from the tuner. If the trouble is in one tuner only and the external voltages are correct it is reasonable to suspect a faulty transistor.

CONTINUED WITH FULL CIRCUIT NEXT MONTH

COLOUR RECEIVER CIRCUITS

COLOUR-DIFFERENCE DRIVE CIRCUITS

GORDON J. KING

LAST month we saw how with colour-difference drive the Y signal is applied to the cathodes of the shadow-mask tube, driving them negatively from black towards peak white and thus establishing the basic brightness *and detail* of the scene, while the three colour-difference signals are applied to the tube grids, driving these positively or negatively to adjust the colouring of the display as required by the scene being reproduced.

The luminance drive to the cathodes has a d.c. datum corresponding to the black level and this is maintained by using d.c. coupling from the luminance amplifier to the tube cathodes. The colour-difference signals however are fundamentally a.c. in character, swinging either positively or negatively as dictated by the information carried by the chroma signal. Nevertheless it is not possible to have the grids of the picture tube floating aimlessly at any odd potential, because the cathode Y drive is operating relative to the grids.

Also of course when there is no colour information the set must operate as a monochrome receiver and these have the grid of the tube "locked" to a steady d.c. potential. Thus the grids must be clamped to a d.c. level upon which the colour-difference signals ride, and each grid has its own clamp.

Colour-Difference Output Stage

Each colour-difference signal has its own amplifier or output stage and since the three are identical description can be based on just one of them. A commonly used circuit is shown in Fig. 1 where the valve involved is PCL84 triode-pentode. The pentode is the colour-difference output stage and the triode the clamp. The signal from the appropriate preamplifier is fed to the control grid of the pentode via the grid stopper R1. Since the stage is interested only in signals within a limited video passband the relatively

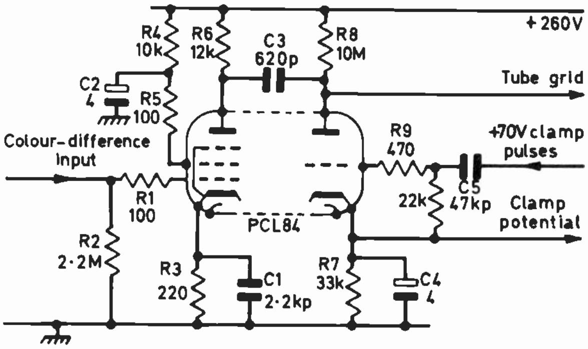


Fig. 1: Pentode colour-difference output stage with triode clamp. With colour-difference drive each shadowmask tube grid is driven by a stage like this.

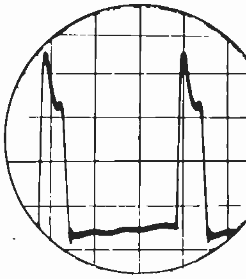
small value cathode decoupler C1 provides the necessary bypass and a degree of frequency compensation. The screen grid is fed from the h.t. rail through R4 and R5 and since the decoupling capacitor C2 is connected to the junction of these two resistors the small amount of video signal developed across R5 gives degenerative feedback here. The amplified colour-difference signal appears across the anode load R6 and is coupled to the grid of the picture tube by C3. This of course is a.c. coupling.

Clamp Action

Clearly if C3 was connected directly to the grid of the tube there would be no bias reference and the gun would tend to drive towards full beam current. The necessary d.c. reference level is established by the clamp triode which works in the following manner. Its cathode is biased positively by the clamp potential which is obtained from the h.t. rail via a resistor of about 56kΩ. This resistor and R7 form a potential-divider which provides the clamp potential across C4. As it stands the triode would pass little current. To ensure that the clamp potential is reflected to the grid of the picture tube the valve has to be driven fully on at regular intervals. This is done at line frequency by the 70V positive-going pulses applied to its grid.

The pulses are generally obtained from the line output transformer and the oscillogram shown in Fig. 2 gives an idea of their nature. Amplitude is between

Fig. 2: Nature of the positive-going clamp pulse used to drive the clamp into full saturation once each line. The pulse is derived from a suitably phased winding on the line output transformer. When the clamp is driven into saturation the clamp potential is reflected at the tube grid.



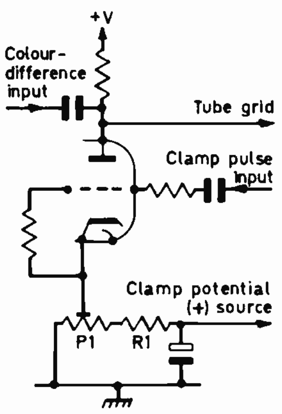
50 and 70V and the effect is that the triode is driven hard into conduction to the extent that it bottoms. This means that the anode will be at virtually the same potential as the cathode. Even though the pulses have a duration of only about 10μsec the clamping potential is maintained during the whole of each line period because the time-constant of C3, R8 is very much longer than the time period of one line. It will be recalled that a line of 625 signal lasts about 64μsec: the time-constant of the coupling capacitor and the triode anode load resistor in Fig. 1 is of the order of 6msec. There is thus virtually no change in clamping potential over the entire line period.

In practice the cathodes of the three clamping triodes are connected together while each grid circuit includes a 470Ω resistor which is connected to the common pulse coupling capacitor (R9 and C5 respectively in Fig. 1).

Owing to the relatively high pulse voltage and the high value of the triode anode load resistors the colour-difference clamps are vulnerable to fault conditions. If the clamp pulses disappear altogether (e.g. due to an open-circuit coupling capacitor or component in the feed circuit) none of the grids of the picture tube will be clamped to d.c. and the Y signal has to operate against a datum which is drifting with the changing colour-difference signals. From the viewer's viewpoint a monochrome picture then loses its black level and colours tend to appear on the greys, while on colour the hues have a tendency to drift in a random manner as the chroma information changes. Since each clamp has its own time-constant components and valve however it is more likely for the clamping action at one grid only to be affected. For example if the value of the coupling capacitor C3 decreases it is possible for the clamp potential to alter over a line period.

Some receivers feature a "clamp set" preset control as shown in Fig. 3. Here the clamp potential is developed across R1, P1 so by adjusting the slider of P1 the clamp potential at the cathode of the triode can be regulated. This clamp set preset is common to all the clamp triodes not to just one of them. Adjustment is commonly made during the grey-scale tracking procedure and since the clamp potential determines the gun biasing it is easy to understand that the preset will affect the black-level setting of the brightness control. The preset is therefore adjusted for beam cut-off at the correct black-level setting of the brightness control. Adjustment might also be necessary in conjunction with the green and blue drive presets to secure the correct rendering of the mid-grey and lighter grey sections of a contrast wedge.

Another scheme sometimes found in the colour-difference output stages is a "tint control" as shown in Fig. 4. It consists in essence of variable negative feedback between the red and blue colour-difference output stages. C1 is the cathode bypass capacitor which is connected to the cathode resistors of the R—Y and B—Y output valves via the preset P1.



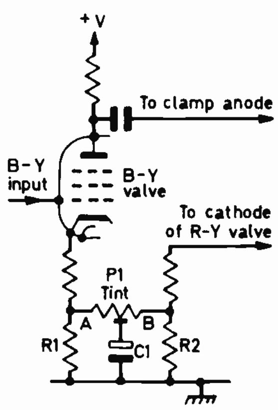


Fig. 3 (left): Clamp stage with preset clamp potential.

Fig. 4 (right): How a tint control can be incorporated to vary the relative gains of the B—Y and R—Y output stages by introducing differential negative feedback.

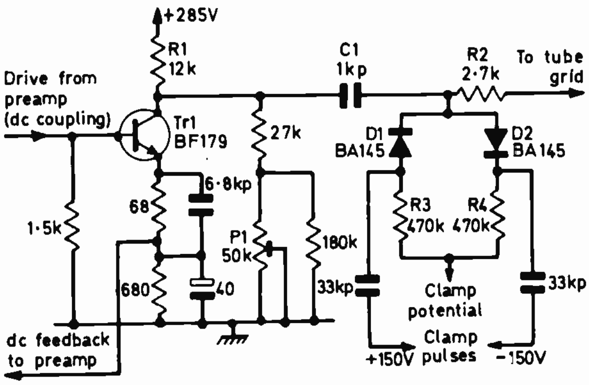


Fig. 5: Transistor colour-difference output stage with diode clamp. A similar circuit is used in the Korting chassis.

Without the capacitor the gain of the stages is of course diminished by degenerative feedback. Thus least feedback occurs at the B—Y valve when the preset is positioned at A, which means that the effective signal gain of the B—Y valve is then greater than that of the R – Y valve. Clearly by regulating the preset the gain can be adjusted differentially between the R—Y and B—Y stages without the d.c. conditions being affected. This makes it possible for the viewer to set the white he prefers on a monochrome input. The control takes the display from a bluish-white through the standard white (Illuminant D) to a sepia-white. Such adjustment is possible on sets without a tint control by regulating the red, green and blue presets on a white raster.

Solid-state Circuits

Sets using colour-difference drive developed more rapidly than transistors capable of delivering signals of sufficient amplitude for such drive. As a result of this the vast majority of sets with colour-difference drive use valve circuits. However, along with the tendency to change to primary-colour drive in recent chassis higher voltage transistors have been introduced and these have now developed to the stage where the majority of sets with primary-colour drive employ them.

Nevertheless one or two solid-state colour-difference circuits were evolved and Fig. 5 shows part of one of them (by Mullard). Here Tr1 is the colour-difference output transistor which is a high-voltage species. The signal fed to the base of this is d.c. coupled from the collector of a lower-voltage BF185 transistor and feedback from the emitter circuit of Tr1 to the base circuit of the driver or preamplifier transistor sets the operating point. The colour-difference signal is developed across the collector load resistor R1 and is coupled to the appropriate grid of the picture tube via C1 and R2 with the drive amplitude being controlled by P1.

The clamping action necessary following C1 is provided by a pair of BA145 diodes—D1, D2—which are switched into conduction at the end of each line period by ±150V clamp pulses from the line output stage. The clamp potential required by the grids of the picture tube is applied through the conducting diodes and resistors R3, R4. The coupling capacitor C1 thus charges relative to Tr1 collector to provide the clamp potential for the grid and this charge holds steady during the line period.

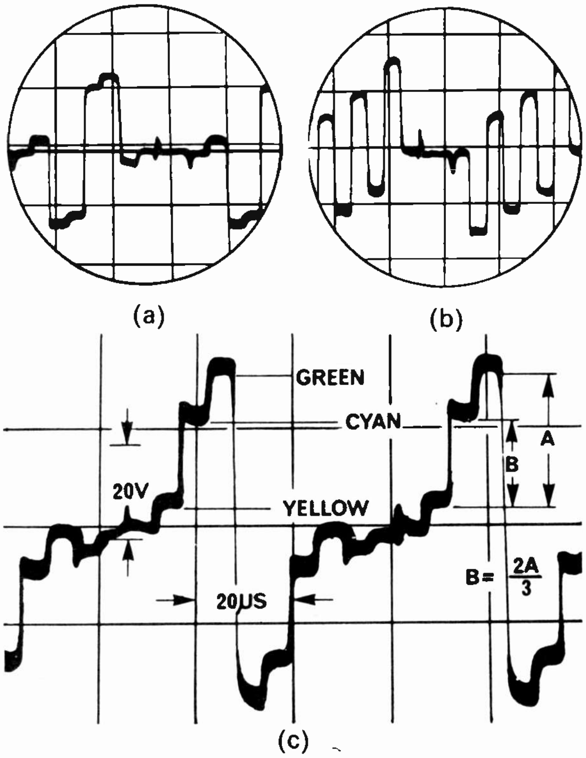


Fig. 6: Colour-difference grid drive signals for the standard colour-bar test pattern, (a) R — Y, (b) B — Y and (c) G — Y. The dimensions given on (c) indicate one way of setting up the G — Y matrix correctly.

Drive Signals

The nature of the colour-difference drive signals seen by the grids of the picture tube is shown in Fig. 6 (again for the standard colour-bar test pattern). The R—Y signal is shown at (a) and the B—Y signal at (b)—compare with Fig. 2 last month. The peak-to-peak amplitude of (a) is about 120V and that of (b) about 200V. These oscillograms were obtained from the anodes of the colour-difference output valves and the amplitude ratio approximates to that required for correct equal-luminance grid drives.

Figure 6 (c) shows the G—Y signal when the G—Y matrix is correctly adjusted. This has a peak-to-peak amplitude of about 102V to give the correct drive condition. The different levels of drive are related to the sensitivity differences between the red, green and blue phosphors used in the shadowmask tube. Amplifier gains in the colour-difference channels approach 800 times (about 38dB) and the drive adjustments in the preamplifiers allow for correct balancing. Fig. 6(c) is interesting because it shows one way of setting the G—Y matrix (as promised last month). The scheme is to adjust the G—Y matrix control until the amplitude between the cyan and yellow steps of the standard colour-bar signal is two-thirds of the amplitude between the green and yellow steps—as indicated on the oscillogram.

Next month I shall be starting on primary-colour drive systems. This will lead in subsquent articles to the circuits of the PAL decoder including some recent chassis which use integrated circuits.

CONTINUED NEXT MONTH

THE RAINBOW REVOLUTION

—continued from page 398

subcarrier. One colour-difference signal was modulated on to a subcarrier at reference phase and the other on to a subcarrier at the same frequency but 90° different in phase. The two were then added, producing a subcarrier modulated in both phase and amplitude. The modulating method is still with us but different colour-difference signals are now used.

(3) The subcarrier frequency should be 3·89MHz. This was reduced later for NTSC use but is higher in the British 625-line system.

(4) Colour phase alteration (CPA) should be used to reduce crosstalk. This is the basic PAL principle and it is most unfortunate that the means were simply not available at the time to make it work in the way which we now use. The system proposed was basically "simple PAL" in which the effect of colour disturbances (interference, crosstalk, etc.) is cancelled by inverting the colour information on successive lines. The eye averages out the result and in theory sees the correct colour. This unfortunately works well only for small errors. With large errors a flickering, downward moving band of colours is seen (later called the "Hanover Blind") and this is probably more annoying than straightforward colour errors. The difference between this and the PAL system we use today is the inclusion in the receiver of a time delay element which enables one line to be compared with the next *electronically*. Using a delay line instead of the eye to carry out this processing provides a steady display of the averaged information.

TO BE CONTINUED

DX-TV

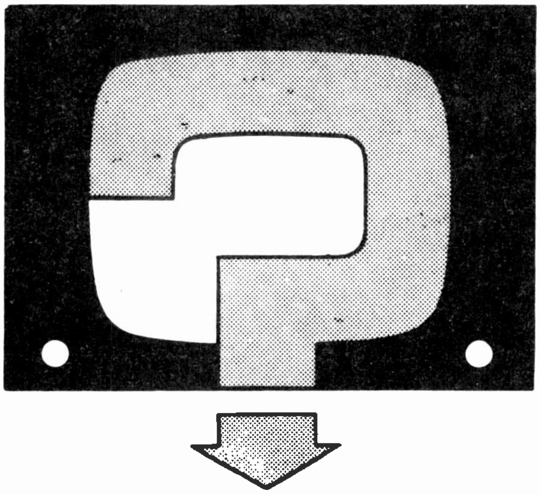
—continued from page 413

Cooper. During his stay in the Virgin Islands he received Lima, Peru A2 and Brazil ch. A2, 3 and 4. His experiences are similar to those of our Cyprus friend—and he comments on the problem of identifying the vision—due to the smearing and ghosting. Often only the sound channel could be used for definite identification. Some of the most spectacular reception recorded was by Glen Hausser who while stationed with the Forces in Thailand received India E4, Pakistan E4, Saudi Arabia A2, Lebanon E2, ORTF and BBC-1 sound—and on one occasion the 45MHz vision buzz. Stations in the USSR, China, Philipines and Korea were also received via F2, TE and multiple Es. Unfortunately for us he has now departed from this location. George Peterson of Ayr, Northern Australia was active in the last cycle and has also been receiving many of the Asian television signals.

The period of October, 1968 is worth comment. From the 24th things started to build up. Daily reception of BBC and ORTF sound was being logged nationwide over the USA, at times reaching up to 48MHz. An amateur in S.W. Africa was noting daily reception of the UK, TVE and ORTF television services up to 60MHz. At the end of October a flare on the sun resulted in the abrupt end to the improving conditions although R. Ballardie came into his own as noted above and Mel Wilson on the Eastern US coast received BBC-1 ch. B1 via the same Aurora.

Those are only some of the happenings during the recent cycle. Unfortunately it all seems to have happened elsewhere. The next sunspot cycle however should peak around the 1979 period so there's not too long to wait!

Our last photograph this month shows typical F2 reception—actually of Belgium E2 on test card. This was taken during the last sunspot cycle—in Spring, 1959—at Truro, Nova Scotia, Canada, by Ron Boyd. Note the multiple images, a characteristic of F2 propagation.



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BUSH TV135

The trouble occurs when a white or bright scene is being transmitted. The field will then not hold but corrects itself when the scene changes. There is also a weaving effect on certain vertical objects. Most of the time the picture jumps slightly at the top and bottom but at other times the set is perfectly stable (on normal shots).—J. Fieldfare (Reading).

The trouble you are experiencing is usually due to a fault in the video amplifier circuit. Check the PFL200 valve and the 1μF capacitor which decouples the screen grid of the video amplifier section. Also check the 4μF capacitor which decouples the screen of the sync separator section.

HMV 1848

About a month ago the picture began to get very bright at the bottom of the screen. Now after waiting for the set to warm up after switching on the picture comes on but disappears almost as quickly leaving a blank screen. The EY86 lights up when the set gets warm and then goes out, the PL81 getting very hot. The line output stage valves have been tried in another set and seem to be OK.—D. Horne (Portsmouth).

The trouble is the line oscillator stage. There are two PCF80 valves just to the right of the line output transformer. The first is the sync separator and the second the line oscillator. Check the latter.

STELLA ST2315

From new this set on 625 lines has had very bad patterning when tuned so that the 5MHz test card bars show clearly. The patterning disappears when the receiver is detuned but this of course results in loss of definition. There is no sign whatsoever of this trouble on 405 lines.—B. Smartt (Colchester).

There is a coil can on the extreme front left side containing two cores (L2554/L2558 in the input to the first i.f. amplifier transistor). Adjust the nearer core for minimum patterning.

MURPHY V879

There is a black bar about 3in. wide on the left-hand side from top to bottom. The PL36 and PY88 have been replaced without making much difference and there does not seem to be a conventional width control.—D. Gaintree (Cambridge).

First centre the picture by means of the shift magnets on the tube neck immediately behind the deflection coils. The width is adjusted with the line stabilising control 3RV6 which is on the lower right-hand side. Check this preset control and the associated resistors.

EKCO T433

There is no e.h.t. The line output valve glows red hot and there is very little line whistle. The PCL84, PCF80, 30P19 and PY81 valves have been replaced. Removing the 30P19 top cap produces a bit of spark. The h.t. is OK.—R. Trelawne (Aldershot).

First remove the e.h.t. rectifier top cap to prove that this valve is not shorted internally. Then if the overheating continues remove the PY81 top cap and if this restores some e.h.t. replace the boost reservoir capacitor.

GEC BT302

This set has a good raster which goes brighter following a click. There is no sound or vision. Thermistor R75 in the heater line and V6 are both overheating.—J. Metcalf (Stalybridge).

Your trouble appears to be oscillation in the i.f. strip. Check the screen decoupling capacitors of the i.f. valves—to pin 8 of the Z329 valvebases.

KB WV90

There is a very grey picture on v.h.f. (the 405 contrast control has no effect) although on u.h.f. the picture is very good and the 625 contrast control is operative. I have changed the tuner and i.f. valves without obtaining any improvement.—G. Wilcox (Oldham).

First check the 4·7MΩ resistor in series with the slider of the 405-line contrast control. If this is OK check the v.h.f. tuner unit and video amplifier bias. The relevant part of the video bias to check is the 180Ω resistor to chassis and its shunt 350μF electrolytic capacitor. If these are OK check the v.h.f. tuner unit voltages.

HMV 2633

The picture disappeared, the sound faded away and a few moments later smoke started to rise from the back of the set. The set was switched off, the back removed and the set switched on again. After the valves and tube had heated up bright flashes could be seen through the line output transformer plastic cover suggesting that the transformer had burnt out. Before replacing it is there any other component that should be checked?—G. Hollywell (Southwold).

We doubt whether any other component could cause the effects described with the possible exception of the 100pF ceramic C106 which feeds flyback pulses to the width stabilising circuit. Check the condition of this capacitor and the width control preset.

BUSH TV125U

This set now fails to give a reasonable picture although a good aerial is in use. Both u.h.f. and v.h.f. pictures lack contrast but the sound is OK and a check of the alignment indicates that this is reasonable. If the brightness is turned up the contrast is suppressed and the picture goes white nearly all over. Valve changes have made only marginal improvement. The picture seems to be free of noise and interference effects and the definition and picture dimensions are reasonable although there is a tendency for the line hold to slip on changing stations.—V. Frazer (Watton).

Check the value of the 10kΩ anode load resistor of the upper left PCF80 video amplifier valve. This resistor regularly changes value giving the symptoms of poor contrast with an increase in the brightness level.

EKCO T284

About 1½ minutes after switching on R92 in the line scan coil circuit begins to cook up. The associated capacitors have been tested and seem to be OK, but if the scan coil socket is removed R92 no longer overheats and there is plenty of spark at the tube anode. With the socket replaced only a small raster—occupying about half the screen—is obtained. This balloons and disappears when the brilliance control is advanced, and at the same time the 30P4 appears to be over-run, taking on a blueish glow.—L. Cadman (Ripon).

A frequent cause of this trouble is failure of the line linearity choke, the coil of which slips down its former to short to chassis. A quick repair can usually be made by slipping plastic foam beneath the coil.

QUERIES COUPON

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TELEVISION, JULY, 1971

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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.

A Thorn 950 chassis had the symptom of drifting line hold. Each time the set was switched on from cold it was necessary to adjust the line hold control to secure proper sync, and after the set had warmed up the line would drift again making further readjustment to the hold control necessary.

A common cause of this kind of symptom is drifting characteristics of the line oscillator valve but in this case valve replacement failed to cure the trouble. Another cause is change in the value of the resistive and/or capacitive elements of the line generator with rising temperature. But after replacing all the components involved in fixing the line timebase frequency the trouble was exactly as before.

Indeed all the components critical to the line frequency were substituted to no avail. In desperation the service technician made one more test, leading ultimately to similar tests in parts of the circuit removed from the line timebase, and eventually came up with a solution to the problem.

Have you any idea of the tests he might have made leading to a cure? See next month's TELEVISION *for the solution and for a further Test Case item.*

SOLUTION TO TEST CASE 102

Page 378 (last month)

It will be recalled that a green hue troubled the picture of a Ferguson 2000 series receiver on monochrome. It is of course true that the grey-scale tracking accuracy is dependent on the matching of the transfer characteristics of the three guns of the picture tube. This is achieved by adjusting the drive and first anode presets.

The grey-scale tracking was however found to be correct. Another cause of the colour contamination on monochrome of the type described last month could be trouble in the colour-difference channels, notably in the clamping stages. The Ferguson 2000 series differs from some receivers in that it employs transistors and primary-colour drive. Nevertheless clamp transistors are used, and the line pulses activating them pass through diodes. Testing proved that the 30V line pulse was failing to reach the G−Y clamp transistor simply because the diode through which it must pass was open-circuit. Replacing the diode (OA91) completely cured the trouble.

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