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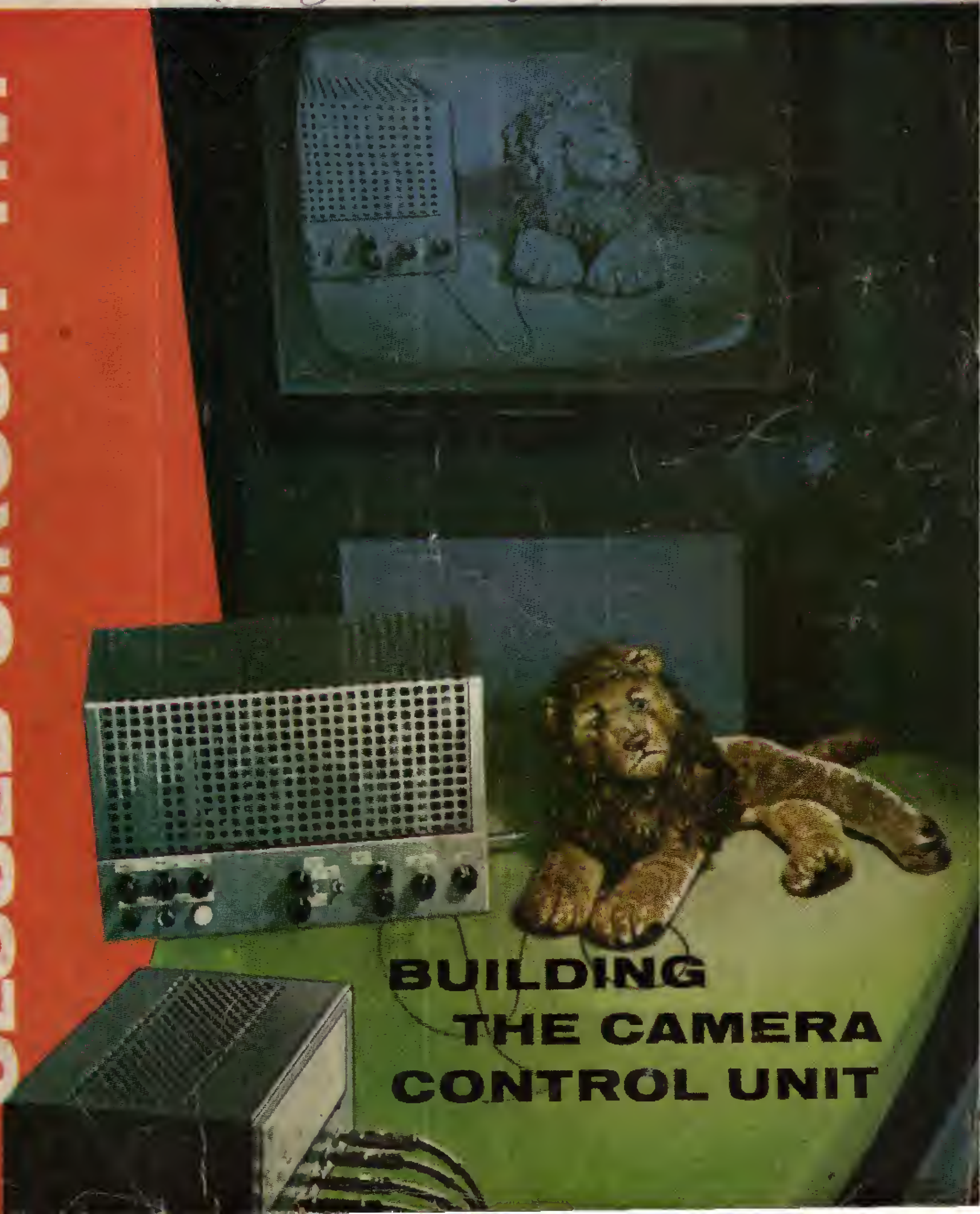

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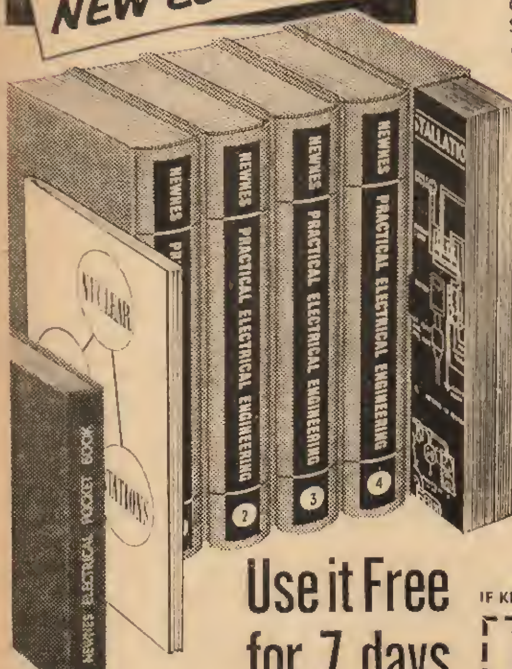

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Practical Television

AND TELEVISION TIMES

VOL. 14, No. 159, DECEMBER, 1963

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Contents

PASTURES NEW

THERE is a latent instinct in many men which drives them to conquer mountains, explore unknown territories and attempt what might superficially appear to be the impossible. The reasons may be divers and complex, but the spirit of adventure is strong—it could be thirst for knowledge, curiosity or (to be cynical) the escape from sheer boredom!

In its particular sphere, television has produced its quota of explorers, both professional and amateur, clear headed or vaguely probing, many of whom have contributed something to the sum total of what we now know about television.

There are still, of course, many fields in which the amateur TV enthusiast can find an outlet for his personal explorations. In particular, the field of amateur TV transmitting can be very rewarding, for here, the territory (as the speculators say) is "ripe for development".

To transmit TV on the allocated amateur frequencies one must, of course, be licensed, but this is no reason why others should not take an active part. In this issue, for instance, we publish details of a suitable converter with which, in conjunction with a standard domestic TV set and special aerial, the enthusiast can tune to the amateur frequencies.

This not only provides a new source of interest for TV fans but can be of great value to those carrying out transmitting experiments. For with the limited number of active amateur transmitters, viewers reception reports can be of material benefit—more than, in fact, those sent to most short wave amateur transmitting stations who are usually fully aware of the range of their signals owing to the enormous numbers of fellow amateurs active on most bands.

Another new sphere of activity is evident in the realm of TV DX on the broadcasting bands. Whereas, in the very early days, the enthusiastic radio fan called in his neighbours to listen to 2LO on his crystal set, and a later generation boasted of "picking up New York on the short waves", so through the years the stage has been reached where enthusiasts are pulling a new white rabbit out of the hat—displaying TV pictures from the Continent.

This is not to suggest that we are decrying short wave listening, either to amateur or broadcasting stations, but short wave DX has now reached a quite sophisticated and highly developed stage so far as the more popular amateur bands are concerned. On the other hand, TV DX has the mystery and appeal of being largely unknown. Here, even the experts have much to learn, and the field is wide open for anyone with enthusiasm and a little initiative.

If, then, you want to "get with it", why not try your hand at these relatively new aspects of television?

Our next issue dated January, will be published on December 19th.

TELETOPICS

New BBC Transmitter for Lancashire

THE recent decision of the Postmaster General to allocate certain television channels in Band III to the BBC has made it possible for the Corporation to go ahead with its plans to improve reception of BBC TV in areas of Lancashire which have previously been served only by the Holme Moss transmitter and which have often been subject to severe interference from Continental stations. Until now it has been impossible for the BBC to supplement the Holme Moss transmissions because of the restricted number of channels available in Band I and so a new station is to be built which will operate in Band III on channel 12.

The new station will be built on Winter Hill, which is also the site of the ITA channel 9 station. The permanent BBC installation should be complete by 1965, but to improve reception over part of the proposed area, a temporary station will be built so that transmission on channel 12 can start at the beginning of next summer. This temporary station will use an aerial mounted on the present ITA mast at Winter Hill.

For viewers in the area of the new station, this shared-site arrangement will have a considerable advantage because in many cases their existing Band III aerials will give satisfactory reception of the BBC transmissions without any need for redirectioning.

Eventually the Band III transmissions will serve Fleetwood, Blackpool, Preston, Blackburn, Southport, St Helens, Liverpool and the Wirral Peninsula. The temporary station, however, will have only limited power, but channel 12 reception should be possible in Blackpool and Liverpool and over a substantial part of Mid-Lancashire.

BRITISH EQUIPMENT FOR MALAYSIAN TV

IN December this year, Malaysia's first television service is scheduled to begin transmissions in the Kuala Lumpur area. The Malaysian Ministry of Information and Broadcasting whose task the organisation of the new service it was, has ordered much of the studio and outside broadcast equipment from EMI Electronics Limited.

Included in the contract are two image orthicon camera channels, vision and sound mixers and ancillary equipment for a medium sized studio, a complete master control installation and an outside broadcast vehicle equipped with three image orthicon camera channels.

COLOUR TV IN CANADIAN HOSPITAL

COLOUR television pictures of recent operations performed by surgeons of the Toronto Western Hospital, Canada, were transmitted over a closed-circuit network to a TV projector in a room eleven floors above the operating theatre. Here, medical students were able to follow the surgeons' handling of the operations as a Rank Cintel projector reproduced the television pictures on a 4ft 6in. by 6ft screen.

The object of installing the equipment was to evaluate the potential of CCTV for providing first-hand views of operations without the need to crowd students into the theatres.

A TV camera in the theatre televised the picture from a mirror placed in position above the operating area. Electronic-correction circuitry reversed the mirror-imaged pictures and passed the signals on to control equipment located in an observation room adjacent to the theatre. From here the colour signals were passed on to the projector and then to the screen, where the resultant pictures showed details of the operation much magnified.

"Television/Telephone" Demonstrated

EQUIPMENT named the "Video Telephone" and manufactured by Pye Telecommunications Limited was demonstrated recently at London's Business Efficiency Exhibition. This equipment allows a normal telephone conversation between two people to be accompanied by a two-way television link.

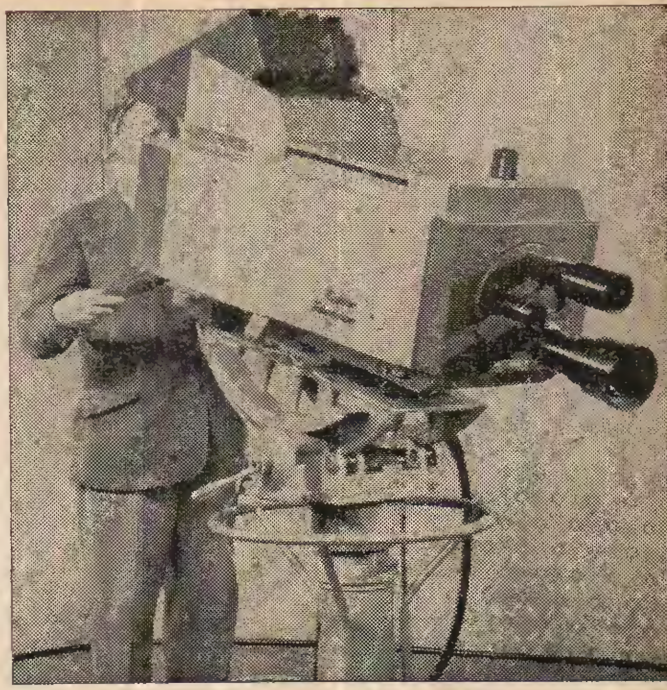
In use, a miniature television camera incorporated in the equipment relays a picture of the user to the 19in. screen of the other party's unit. The conversation is reproduced over a loudspeaker at each end of the link.

This system can incorporate up to ten extensions and the automatic exchange can handle up to five two-way audio/vision links at the same time.

COLOUR AND CCTV AT BERLIN FAIR

DEMONSTRATIONS of both colour and closed-circuit television equipment made by the Marconi Company Limited, were given at the recent German Industries Fair in Berlin. From a complete colour television studio, for instance, set up and operated by the Company in the British Pavilion, colour pictures of interviews, fashion shows, etc., were relayed to receivers installed around the exhibition buildings.

On the steel industry's exhibit too, Marconi TV equipment was in evidence. This time, however, a monochrome CCTV system was shown relaying pictures of essential information to a steelwork's control cockpit, which had been installed for the exhibition. Here three monitor screens in the cockpit showed visitors typical pictures of authentic applications in a modern British steelworks.



The Marconi colour television camera channel, type BD. 848, which was demonstrated at the German Industries Fair in Berlin recently.

HIGH RESOLUTION TUBE FOR TELECINE EQUIPMENT

A NEW high resolution vidicon camera tube (type 9677) made by EMI Electronics Limited, will mean better quality pictures from filmed television material, when used in telecine equipment. Material which has been recorded on film, to be inserted in live programmes, will thus be comparable to the pictures taken from the studio cameras.

One of the first companies to order the new tube is Tyne Tees Television Limited, who are to use them in all their telecine equipment.

The advantages of the new tube will also become apparent with the advent of 625-line transmissions, when the high vertical definition of the tube will give considerably better picture quality than standard vidicon tubes, when used in studio cameras.

1225-line Closed-Circuit TV Installation

"NIMROD" is the name of a nuclear research machine at Chilton, Berkshire, in which nuclear particles are accelerated to enormous speeds. Surrounding this machine is a "doughnut", 160ft. in diameter, through which these particles travel several million times a second.

To present the Harwell scientist working on the new machine with a method of comparing pictures of the electrons travelling through "Nimrod", A.I.D.S. Limited have installed a closed-circuit television system employing eight cameras situated at strategic points around the "doughnut".

It was required that a single monitor screen should present the pictures from the eight cameras in eight horizontal strips, and so a very-high definition system was essential. Accordingly a 1225-line system was designed by A.I.D.S. Limited in consultation with the Harwell authorities and since its installation has provided much valuable information for the running-in trials of the machine.

Industrial Television on Show

THE acceptance of television aids in industry continues to increase and the third Industrial Photographic and Television Exhibition, held in London during November, helped to illustrate just how widespread is this acceptance.

The wide variety of CCTV demonstrations and exhibits gave an idea of the scope of television in industry and among these exhibitors was Beulah Electronics, who for the first time demonstrated to the public their new transistorised television camera kit.

Other demonstrations included closed-circuit telecine and developments in industrial TV in the USSR were also given considerable attention.

a television Deaf-aid

THIS SIMPLE PIECE OF EQUIPMENT WILL HELP THOSE HARD OF HEARING TO LISTEN TO TV SOUND COMFORTABLY AND SAFELY

By K. Royal

THOSE who are unfortunate to have impaired hearing often have difficulty in enoying a television programme and become singularly unpopular by turning up the sound by an extra 6dB or so. An ordinary deaf-aid is not at all successful for listening to television or radio sound, since the microphone of the deaf-aid picks up not only the sound from the loudspeaker of the set but also sound reflected from the walls and ceiling of the viewing room and this, along with acoustic coloration endowed by the characteristics of the room itself, results in the sound from the deaf-aid earpiece being very much confused.

Slightly better results are possible by locating the deaf-aid microphone as near as possible to the loudspeaker, but with television this usually means viewing the picture far too closely, which could cause eye trouble.

To assist keen viewers whose auditory responses are somewhat below normal, the author has been carrying out a series of experiments on television sound channels, and in this article is explained the best, and most inexpensive, way of solving the problem for, at least, 90 per cent of hard-of-hearing viewers.

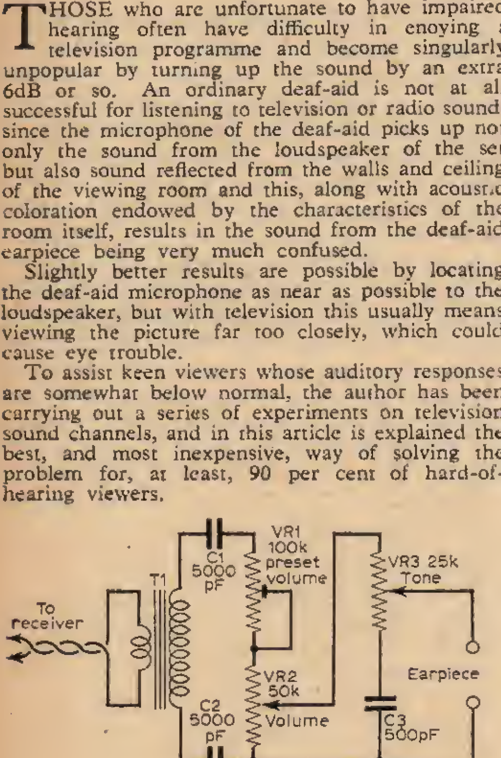


Fig. 1—The circuit of the deaf-aid. Note the low resistance winding (secondary) of T1 is connected to the set.

Experiments commenced by trying to devise a method which would completely eliminate any electrical connection to the television set. A small transistorised amplifier was constructed, working on batteries, and to this was coupled an inductive pick-up loop. The loop, in turn, was orientated on the cabinet as close as possible to the speaker transformer in an endeavour to induce sufficient audio signal into it, but was far from successful.

The loop picked up not only audio from the transformer but also hum from the power circuits and buzz from the frame timebase, and after these unwanted signals had been amplified by the transistor stage the output from the earpiece was far from pleasant. Various types of screened and partially screened pick-up loops were then tried and while a distinct improvement in the signal/noise ratio was obtained, the idea had eventually to be abandoned since the results could not be duplicated from set to set.

Another scheme of modulating the sound onto a very low-level carrier-wave generated by a transistor oscillator at the receiver was next put into action. A small transistorised receiver was used to pick up this signal, and the resulting audio was fed through a frequency - connected audio amplifier to an earpiece. This worked extremely well, but proved to be very costly. There was also the legal angle, since the modulated oscillator in fact represented a small sound transmitter, and it would seem that this kind of transmission is not allowed as there is the possibility that it may get out beyond the bounds of the house and cause inteference on nearby radio or television sets. This point is being investigated at the present time and if some definite ruling with the Post Office can be obtained, then a further article in these pages will give greater details.

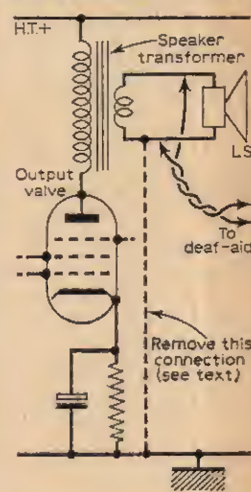


Fig. 2—Showing how the deaf-aid is connected to the parent set.

Isolation

All along, the development has been for total isolation between the parent receiver and the earpiece, for modern receivers represent a potential source of danger to users of devices and circuits connected to the inside of the set. This is because the metal chassis of the receiver is invariably connected *direct* to one side of the mains supply, and if this happens to be the " live " side a person making simultaneous connection with this and an earthed object would really be in trouble — aggravated, of course, by the " live " connection being made to the head (e.g., via an earpiece or associated wiring).

However, if extra special care is given to isolation, the danger outlined above is eliminated. The rest of this article, therefore, describes a deaf-aid system which requires a direct electrical connection to the receiver, but which is perfectly safe and isolated from the mains supply in more than one way.

Circuit

The circuit of the deaf-aid is shown in Fig. 1. Transformer T1 serves two purposes, it steps up the voltage at the speech coil of the internal loudspeaker to a suitable value for operating the

LIST OF COMPONENTS

COMPONENT	MAKE	APPROXIMATE PRICE
Ivory or Brown Plastic Box List 2031	MK	2s. 6d.
Ivory or Brown Frontplate List 3830	MK	1s. 6d.
Midget Speaker Transformer (T1)	Radiospares	7s. 6d.
Two Midget Volume Controls (linear) (VR2 and VR3)	Radiospares	7s. 0d. (the two)
Two Single Earpiece Insulated Sockets	Radiospares	1s. 0d. (the two)
Slider Preset (VR1)	Radiospares	1s. 6d.
Hi-K Midget Ceramics (C1, C2 and C3)	Radiospares	2s. 3d. (the three)
Wire, etc.		3s. 6d. (as required)
Earpiece		10s. 0d.
TOTAL APPROXIMATE COST OF PARTS £1 16s. 9d.		

earpiece after allowing for the attenuation of the tone control, and furthermore it isolates the receiver from the earpiece. Further isolation is given by capacitors C1 and C2.

VR2 is the ordinary manual volume control, and VR1 is a preset volume control which can be adjusted when the parent receiver is set for normal volume and with the manual control at mid-range. The tone control is continuously variable and really acts as a treble-cut control in conjunction with C3. This is extremely useful for securing optimum intelligibility, as the auditory frequency response varies somewhat between persons with impaired hearing and the tone control allows for individual setting of response.

Connection to Parent Receiver

Fig. 2 shows the basic circuit of the output stage of most television sound channels. The primary of the loudspeaker transformer is connected between the anode of the output valve and the h.t. line while the secondary connects across the speech coil of the speaker.

On some receivers the speech coil is connected at one side to the chassis of the receiver. This may or may not be important, and to achieve optimum mains isolation for our purpose it is best if such a connection can be eliminated. This can be done without ill effect provided the other tag of the speech coil or transformer secondary does not go back into the set as a negative feedback loop. If it does, then the connection must remain otherwise instability and sound distortion may result.

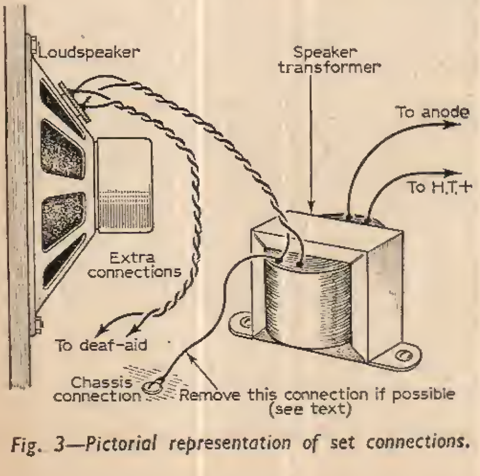


Fig. 3—Pictorial representation of set connections.

Fig. 3 shows the arrangement in pictorial form. The speaker transformer may not be mounted so accessibly on the chassis as the illustration suggests. Nevertheless, the connection to its secondary can easily be followed from the speaker tags, working backwards and other negative feedback or earth wires will be identified at the same time.

Fig. 4 shows how the complete unit can be mounted in a small electrical box. The box used by the author is List No. 2031 by MK Electric Limited and the matching frontplate is List No. 3830, both readily available from electrical shops.

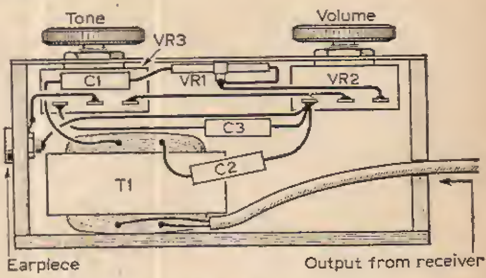


Fig. 4—A suitable method of constructing the deaf-aid.

The earpiece — which should be a medium- or high-impedance component — is connected through two sockets, while the lead to the set actually emerges through a hole in the side of the box. The reason for the latter is to ensure that there are no exposed pieces of metal — such as plugs and sockets — which, in the event of a fault in the parent receiver (or a chassis-connected secondary winding on the speaker transformer due to the need for maintaining negative feedback), could become " live " and give an electric shock to the user.

There is, of course, no danger whatever of the wearer of the earpiece ever getting a shock since it is isolated twofold from the set by T1 and by C1 and C2. A good quality, ivory (or other colour as may be required) plastic-covered two conductor cable should be used between the unit and the set,

—continued on page 113

CIRCUIT PRACTICE AND DESIGN PRINCIPLES FOR

OSCILLOSCOPE TIMEBASES

BY
M. L. MICHAELIS

CONTINUED FROM PAGE 85 OF THE NOVEMBER ISSUE.

NATURALLY, the ultimate timebase circuit which one trims up by oscilloscope observations using a temporary Miller Transitron, and which will finally be substituted into the oscilloscope, need not itself be a Miller Transitron. It can be whatever variant of the circuits introduced in this article which one may desire and consider most suitable for the envisaged purpose. It is hoped that this article has brought out the relative advantages and disadvantages of the various available circuit types sufficiently for the reader to be able to choose and design his own circuits according to his needs.

Regarding the small diodes specified throughout this article, the author would strongly recommend one universal type as shown on the circuit sketches, namely the Type S36 (Intermetal) which is marketed by the Brush Crystal Co., Southampton. This diode will tolerate an inverse voltage of 350V, at least 20mA forward current, and has low capacity and thus good high-frequency performance. Apart from this, there is at present little purpose in using other semiconductor devices in the main stages of oscilloscope timebases, because of the very high voltage amplitudes (hundreds of volts) required for satisfactory deflection on an electrostatic c.r.t. Transistorised oscilloscopes would preferably have to resort to magnetic deflection c.r.t.'s, which can use transistorised timebases because transistors can supply the low voltage high current signals for magnetic deflection much more easily. However, high voltage transistors have also been developed, which would be usable in transistorised oscilloscopes with electrostatic deflection. But these devices are by no means generally common, and the general reader is advised to keep to valve circuits when building oscilloscopes at present; this will certainly be simpler and cheaper. It is far easier to get a timebase for electrostatic deflection, after the fashion of circuits described in this article, to operate well over the large range of frequencies required in a general purpose oscilloscope than it is to design a set of magnetic deflector coils to give uniform performance over the same frequency ranges.

The Phantastron Delay Generator

We already, in the first article of this series, (in PRACTICAL TELEVISION) illustrated the sort of arrangement of basic circuit bricks in an advanced modern oscilloscope by discussing a double beam strobing scope as example. In this arrangement the first beam operates on a normal timebase as described so far in this article, synchronised or triggered as desired. At the same time as this normal timebase commences its run, it triggers a delay generator, now to be described, which then produces a new trigger, delayed upon the main timebase start by any amount manually adjustable from zero to the full time of the main timebase. The delayed trigger spike output then triggers off a second timebase, called the strobe timebase, operating the second beam or second c.r.t.

The strobe timebase is designed to run very much faster than the main timebase, so that it operates during a tiny portion of the main timebase, selectable at any position of the main timebase. However, being of full amplitude, it fills the whole diameter of the c.r.t. screen, and thus displays a greatly magnified version of the small portion of the main timebase selected.

Both the strobe and the main timebases use circuits as described in this article; the new circuit item we require here is a device for producing an output trigger spike a definite and manually-variable time later than an input spike. A popular arrangement, again using an adaption of the basic Miller Integrator for this purpose, is the *Phantastron* shown in Fig. 15(a). This differs from the basic Miller circuit in that a very large cathode resistor is used instead of none at all. Also, the screen is fed normally, but without bypass capacitor. There is nothing to prevent considerable screen current in the resting state, giving considerable voltage drop across the cathode resistor, sufficient to bias off anode current at the suppressor whose leak is returned to chassis.

The circuit rests in this state until a positive trigger spike is applied to the suppressor, sufficient to lift it to anode current cut-on. This produces a large Miller-step, as not only has this to drive the grid down through the grid-base range, but also it has to drive the grid down through the high resting cathode voltage. The result is an appreciable initial start of anode current, which is diverted from the screen in addition to the great reduction of screen current due to the negative step at the grid. Consequently there is a sharp positive rise at the screen in immediate response to the input trigger at the suppressor. Thereafter a normal Miller-run takes place until the anode voltage bottoms. As usual, the grid can then rise suddenly, being no longer checked by feedback from the anode. The anode is bottomed, i.e can take no more current, thus the increased cathode current due to the rising grid must go to the screen, causing a sharp rise of screen current as soon as the anode has bottomed. This means a sharp drop of screen voltage at the end of the run. The increased screen current means that the cathode voltage returns to a high value and cuts off the anode current, returning the circuit to the resting state until another trigger arrives.

The Phantastron thus gives a positive-going squarewave response pulse at the screen, in response to a positive input trigger spike at the suppressor, and gives a Miller-run at the anode during the same time. The latter is not required as output, but establishes the required delay. By choice of C and R in the usual way, the time of run can be selected, and thus the duration of the screen squarewave pulse is selected. This fixes the time of delay of the end of the screen squarewave in relation to the start coinciding with the input trigger. Differentiating the screen squarewave after the manner already learnt in Fig. 12 then yields the leading and ending edges of the pulse as spikes of respectively opposite polarities. A clipper diode circuit after the fashion of Fig. 10 removes the positive spikes, leaving the negative ones, which are the required delayed output trigger train, delayed on the input train by a time determined by the adjustable Miller-run speed of the Phantastron. Fig. 15(a) shows the differentiation and clipping too; furthermore, the undifferentiated squarewave may be applied, at reduced amplitude, to the grid of the main timebase beam or c.r.t. It there slightly increases the brilliance of the main timebase trace for the duration of the run of the strobe timebase, thus unambiguously "marking" the portion selected for magnification on the strobe timebase.

Decoupling

If at any stage of fitting together the various bricks discussed in this article to form a composite circuit, mutual interference is experienced by back reaction through the coupling, interposition of a cathode-follower is the simplest solution and is almost always successful.

The operating point of the cathode follower is important, and must suit the signal polarity. Positive signals are passed without difficulty even when no particular arrangements for bias are made, i.e. when the grid leak is simply returned to chassis. Proper passage of negative or mixed polarity signals requires some form of bias arrangement on an h.t. bleeder, as shown in Fig. 15(b), or its equivalent. The time-constant of the grid leak and coupling capacitor should be very much greater than the duration of the signals to be dealt with, otherwise differentiation takes place.

Polarity Inversion

If the polarity of trigger spikes is opposite to that required at the subsequent consumer, e.g. if the negative train phantastron output is unsuitable as it stands because positive triggers are required to operate the strobe timebase, then the circuits of Fig. 15(b) and Fig. 15(c) can be used for polarity inversion.

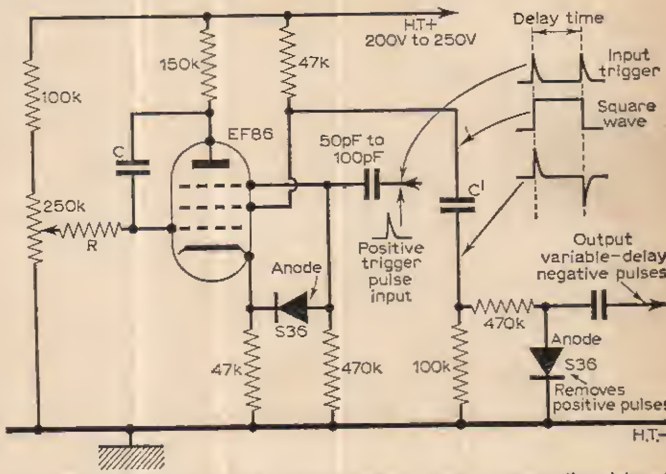
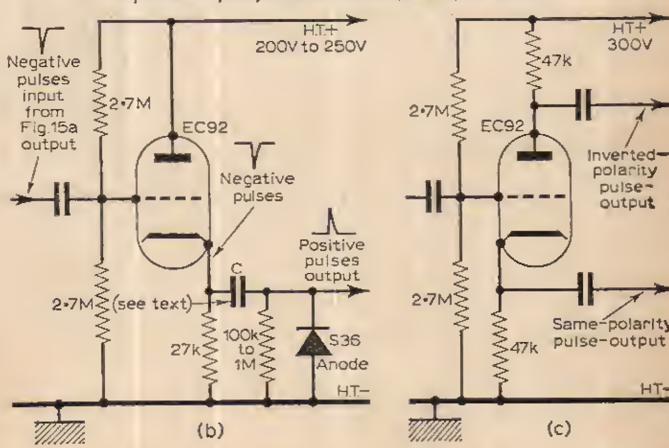
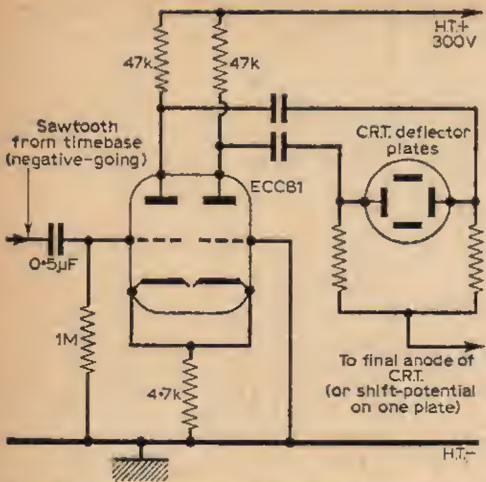


Fig. 15—Delay generation for strobe-timebases, giving output spikes delayed a definite time in relation to input spikes: a (above)—the basic Phantastron delay generator; b and c (below)—two methods available for voltage spike polarity inversion. The circuit (b) is shown for negative input spikes, which are inverted to positive output spikes. The diode must be reversed if positive inputs are to be inverted to negative. The pulse phase-splitter circuit (c) operates equally well on either polarity of input.





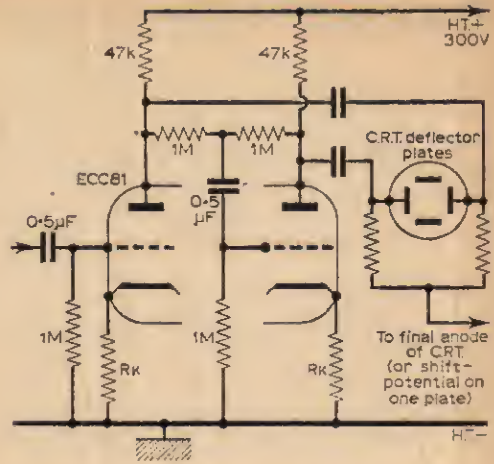


Fig. 16—Paraphase amplifiers for symmetrical deflection: a (left)—long-tailed pair; b (right)—floating-grid amplifier.

Fig. 15(b) uses a cathode follower driving a negative peak clamp to chassis potential, after the fashion of the basic clamps introduced in Fig. 11. This obviously inverts the spike polarity through the clamp. The conditions for successful performance are a very low forward-resistance of the diode (valve diodes are generally unsuitable, as they have too high a conduction resistance), so that C can charge up on a single, or on a very few, spikes; the resistor in parallel with the diode must create a time constant together with C which is very long compared to the duration of individual spikes, but short compared to the interval between successive spikes. These conditions may turn out to be rather critical, yet the advantage of the circuit is ability to perform at reasonably low h.t. voltages. An alternative circuit, much less critical, is the conventional split-load phase splitter, familiar from audio amplifiers, as shown in Fig. 15(c). This requires a higher h.t. voltage to avoid dangers of overloading on pulse drive.

Cathode Ray Tube Drive

To avoid defocusing and uneven focus over the screen area, it is necessary to use symmetrical (push-pull) deflection in high quality oscilloscopes. This places equal and opposite voltages, with respect to the final anode of the c.r.t. on to each deflector plate of a pair, so that the mean voltage remains that of the final anode.

Fig. 16 shows the two commonest forms of para-phase (phase-splitting push-pull) amplifiers found in oscilloscopes as the final stages subsequent to the timebase or signal amplifier. The simple phase-splitter of Fig. 15(c) is not generally used for deflection output stages because of its lack of amplification and its inability to produce total

—continued on page 129

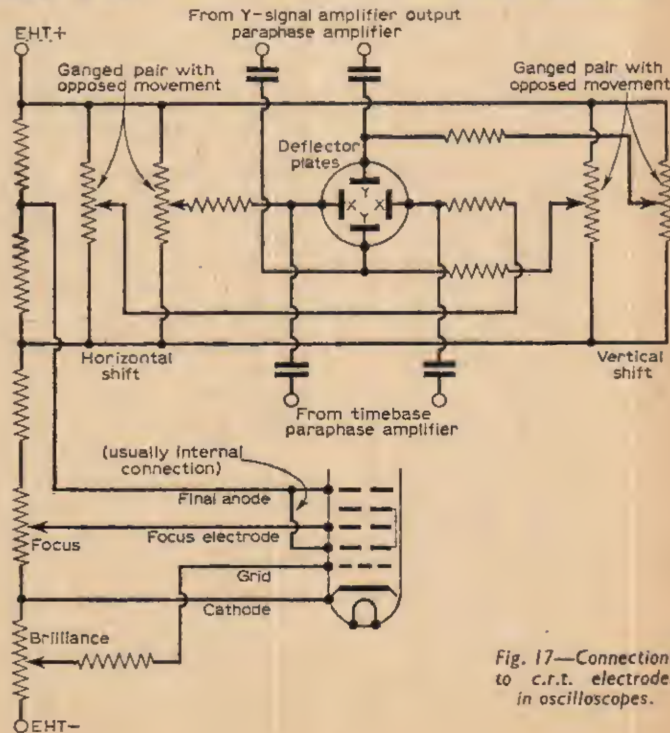


Fig. 17—Connections to c.r.t. electrodes in oscilloscopes.

PRINCIPLES AND PRACTICE OF COLOUR TELEVISION

PART 6

By G. J. KING

CONTINUED FROM PAGE 71 OF THE NOVEMBER ISSUE

LAST month we saw that the mono or luminance signal (signified by Y′, the dash showing that gamma correction has taken place) is obtained by adding together red, green and blue signals in the proportions 0·3R′, 0·59G′ and 0·11B′. The Y′ signal is equivalent to the monochrome video signal as transmitted over an ordinary black and white television system.

We also saw that all the colour information can be obtained from two colour-difference signals, R′-Y′ and B′-Y′; the G′-Y′ green colour-difference signal being obtained from the process of *decoding* at the set end of the chain. We thus have two channels in a colour television system, the luminance channel which gives all the information on the mono aspect of the picture and the colour channel which gives information only on the colour aspect of the picture. If the picture is all greys, then there would be no colour information or signal.

The problem under discussion this month is how both the luminance and colour information is transmitted on a single television carrier. The problem would be simplified, of course, if it were possible to use two carriers, one for the luminance information and the other for the colour information; but this would be wasteful of radio spectrum and could not be tolerated.

We have rather a similar state of affairs with regard to stereo broadcasting. We can get the stereo effect by employing two independent radio circuits, one for the right-hand channel and another for the left-hand channel. This technique is, in fact, adopted in one of the stereo tests conducted by the BBC. Here one channel is the television sound channel and the other channel a v.h.f.-f.m. channel. This method needs two receivers.

With the GE-Zenith system, also the subject of BBC test transmissions, *one* carrier or radio channel is used to carry *both* audio channels. This is accomplished by a process of *encoding*, which is the same as that used at the transmitting end of a compatible colour television system.

Encoding

With stereo sound we have only two sets of modulation to deal with, but with colour television three sets of modulation are required, two for colour and one for mono. In practice, the two colour signals modulated in a rather complex manner are sent along to the modulator of a colour transmitter with the Y′ signal. This is the basic process of encoding, the carrier then being modulated with the complex colour signal in rather the same way as it would otherwise be modulated with the less complex black and white video of a monochrome system.

Probably the best way of understanding the method of encoding is to look at a simplified block diagram of the transmitting end of a colour television system, such as shown in Fig. 23.

The colour camera gives out its three signals corresponding to red, green and blue. These are corrected for gamma (see last month) and produce R′, G′ and B′ signals which are fed to the matrix.

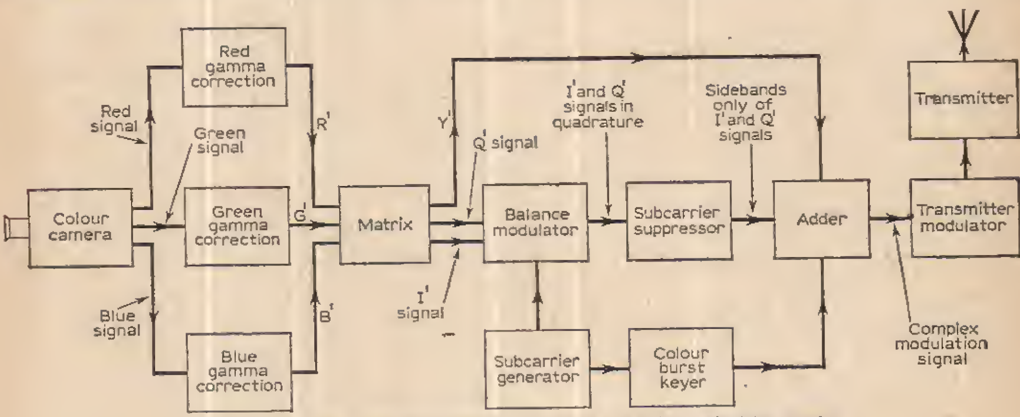


Fig. 23—Block diagram of the encoding system at a colour television station.

The matrix adds the three colour signals to produce Y′ at its output along with two more signals related to the colour-difference signals. These are termed the I′ and Q′ signals (the dashes again signifying that they have undergone gamma correction.)

The I′ and Q′ signals are modified versions of the red and blue colour-difference signals (R′−Y′ and B′−Y′) respectively. Sometimes the actual colour-difference signals themselves, or very close representations of them, are used instead of the I′ and Q′ signals. However, for the best colour reproduction some modification of the basic colour-difference signals is desirable, as we shall see later.

Thus, the matrix gives three outputs, the Y′ signals and the I′ and Q′ signals, the latter two being concerned with the colour and the former with black and white (luminance). The Y′ signal is taken straight out and fed to an " adder " while the I′ and Q′ colour signals are applied to a rather special type of modulator. This network modulates the I′ and Q′ signals on to a subcarrier by a process known as " quadrature modulation " The subcarrier associated with the I′ signal is 90deg. out of phase with the subcarrier associated with the Q′ signal, and it is this consistent phase difference, handled by balanced modulators, that facilitates this kind of modulation.

There is really only one subcarrier generator, the phase difference between the two signals applied to the I′ and Q′ modulators being maintained by special networks. More will be said about this method of modulation later.

The modulator thus gives an output which consists of a subcarrier upon which are carried both the I′ and Q′ colour information in quadrature, as shown in Fig. 23. This signal is passed through a subcarrier suppressor, which deletes the subcarrier itself and leaves only the sidebands of the I′ and Q′ signals. These sidebands are applied to the adder along with the Y′ signal.

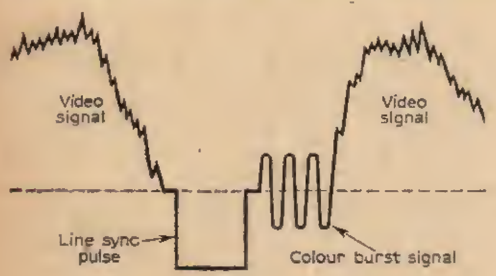


Fig. 24—Showing how the colour burst signals are carried on the back porch to the line sync pulses. The colour burst signals are used to synchronise the "reference oscillator" which puts the subcarrier back on the I′ and Q′ signal sidebands at the receiver before these signals can be demodulated.

Colour Burst Signal

Also applied to the adder is the subcarrier signal via a " colour burst " keyer. This keyer is synchronised to the signal in such a way that bursts of subcarrier signals are applied to the adder only during the back porch of the line sync signal, as shown in Fig. 24.

At this juncture it must be understood that the colour burst signal does *not* carry colour signal modulation. Its purpose is solely for synchronising the phase of a " reference generator " at the receiver. We shall see later that to "decode " the colour information at the set end an oscillator is needed whose frequency and phase match those of the subcarrier signal at the transmitter. The colour burst signals achieve this purpose.

The complex modulation signal, consisting of the Y′ signal, the sidebands of the I′ and Q′ signals and the colour burst signals, is fed to the main modulator of the transmitter and this modulates the mono and chroma information on the v.h.f. or u.h.f. carrier wave.

I′ and Q′ Signals

We must now get to know a little more about the I′ and Q′ signals. It has been told that the red and blue colour-difference signals are not always transmitted as they stand. It is usual for the sending end to tailor both their bandwidth and amplitude. With the NTSC system the amplitude of the B′-Y′ (blue colour-difference signal) is approximately halved while that of the R′-Y′ (red colour-difference signal) is reduced by about 14 per cent.

We know that in a mono television system the horizontal definition of a picture is a function of the bandwith of the system. If the bandwith is up to about 3Mc/s on a 405-line system, then we can discern the 2·5Mc/s lines (and sometimes the 3Mc/s lines as well) of Test Card C. The horizontal definition in that case would be good.

The vertical definition is a different thing, since that depends upon the number of scanning lines (see " The Principles and Practice of Television ", PRACTICAL TELEVISION, December, 1962).

Colour Definition

The degree of definition in colours varies with the colours. The three primary colours and their combinations are distinguishable by the eye only in relatively coarse detail. In terms of frequency, the eye can define detail in three colours up to about 0·5Mc/s and in the orange-red and blue-green (cyan) ranges up to an equivalent of about 1·5Mc/s. Detail equivalent to a frequency above 1·5Mc/s is perceived in black and white only . . . not in colour!

This means that the colour signals can be fully accommodated in a bandwidth of 1·5Mc/s. Filters at the transmitter allow the basic colour signals to pass up to 0·5Mc/s, the orange-red and cyan signals up to about 1·5Mc/s and the mono signals up to the full bandwidth of the system (e.g., 2·7Mc/s 405 lines and about 4·5Mc/s 625 lines).

If the colour channel of a colour receiver is switched off, reasonable mono definition remains; however, if the mono channel is cut, the poor relative colour definition makes it virtually impossible to distinguish the form of the picture.

Colour Vector

A very simple colour vector diagram is shown in Fig. 25. Here it will be seen that the B′—Y′ signal differs in phase from the R′—Y′ signal by 90 deg. This is really a function of the quadrature modulation, described in earlier paragraphs. Now, these two colour-difference signals, apart from being adjusted in amplitude, are also adjusted in phase so that they become the I′ and Q′ signals.

Fig. 25—Colour vector diagram. The I′ and Q′ signals differ in phase from the associated red and blue difference-signals by 33 deg.

The vector in Fig. 25 shows that the I′ signal is pushed 33 deg. ahead of the original R′—Y′ signal and that the Q′ signal is advanced by the same amount relative to the original B′—Y′ signal (still retaining the 90 deg. phase difference between them, of course).

This 33 deg. phase shift to change the colour-difference signals to I′ and Q′ signals puts the chroma signals in a position in the colour vector where they are most "sensitive" to the "standard eye". That is, the phase advance provides a slightly better reproduction of colours than would be the case if the signals were left in the colour-difference positions on the vector.

Some colour sets are not really able to do full justice to this artifice, and they simply "see" the colour signals as if they were suitably tailored colour-difference signals. Nevertheless, the results are perfectly acceptable.

The Q′ signal, which corresponds to the colour-differences in the magenta-via-white-green areas, modulates the subcarrier up to about 0·5Mc/s while the I′ signal, which corresponds to colour differences in the red-via-white-cyan areas, modulates the subcarrier up to about 1·5Mc/s, the modulation of the two signals being 90 deg. apart, as shown by the vector.

If there is no colour information in the scene, the colour signal output is at zero (centre of vector, corresponding to "white"). If there is no red or cyan towards blue, the I′ signal output is zero while if there is no green or magenta colouring, the Q′ signal output is zero. Colour saturation is shown by the length of the vectors. Zero length (centre of vector) is complete desaturation or, in effect, white. In that case, the set would run on the Y′ signal only, as on a monochrome scene.

The subcarrier generator (see Fig. 23) at the transmitter produces two subcarriers. Upon one is modulated the I′ signal and upon the other the Q′ signal. While the two subcarriers have the same frequency (since they are effectively derived from the same source), they differ in phase by exactly 90 deg., as already intimated.

Quadrature Modulation

Quadrature modulation is not an easy thing to put over in a semi-technical article, but a study of Fig. 26 should help the problem. At (a) we have three waveforms. The dotted-line waveform corresponds to the Q′ signal subcarrier, the broken or dashed-line waveform to the I′ signal subcarrier, and the full-line waveform to the combination of these two subcarriers.

One thing that is definite is that the frequency of the Q′ and I′ subcarriers is perfectly matched. Another thing that is definite is that the phase of the Q′ subcarrier differs by 90 deg. from the phase of the I′ subcarrier. This is revealed on the "degrees" scale at the bottom of the diagram.

This phase difference can be shown by a vector, as at (b); both the amplitude and the phase of the combined signal being governed by the amplitudes of the Q′ and I′ signals. This vector has much in common with the colour vector in Fig. 25, as comparison will show.

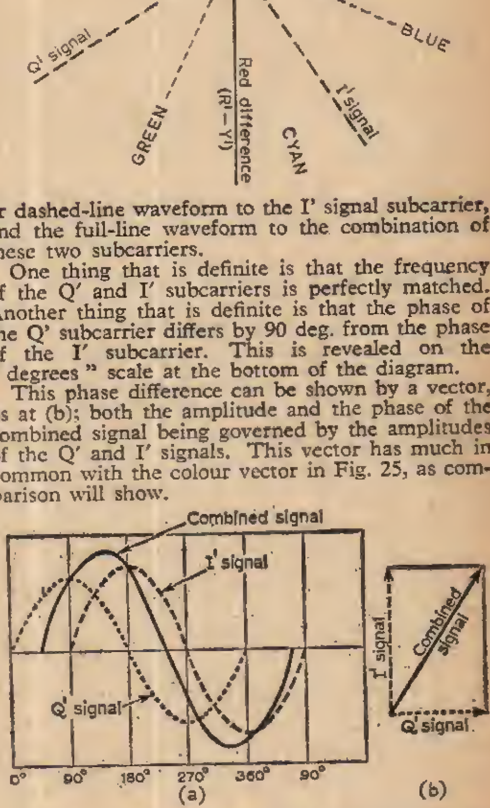


Fig. 26—Diagram in explanation of quadrature modulation. See text.

The full-line combination signal of the I′ and Q′ signals is that which appears at the output of the balanced modulator and which is fed to the subcarrier suppressor (Fig. 23).

The 90 deg. phasing aspect of the NTSC colour system is all important, for random changes of phase will cause the colour vector (Fig. 25) to rotate relative to the colour areas and put the colour rendering in error. It is said that the maximum phase error that can be tolerated on the NTSC system is in the order of 5 deg.

Random phase changes can occur due to propagation of the v.h.f. or u.h.f. signals over difficult or fringe area routes, and due to poor design of a coaxial relay system, for instance.

TO BE CONTINUED

OPERATION AND FAULTS IN THE V.F. CIRCUITS

Video Troubles

by D. Elliot

THE video stage of a television set includes the vision detector, the video amplifier and the coupling from the video amplifier to the picture tube. In all but some of the very latest dual standard models there is a d.c. path all the way from the detector to the cathode of the picture tube, as can be seen from the basic video circuit in Fig. 1.

The D.C. Path

Here the d.c. path is from the vision detector diode GD13, through R1 and L1 to the signal grid of the video amplifier valve, from the anode of that valve, through R2 to the cathode of the picture tube. This means that whatever happens to the voltage developed across the detector load resistor R3 it will be reflected direct to the picture tube cathode.

The vision detector diode can be considered as having an anode and cathode as an ordinary diode valve (the arrowhead being the " anode "). This, then, causes the rectified i.f. signal voltage across the load R3 to rise in a positive direction. On 405-line vision signal the load voltage rises with increase in white content of the picture, from a nominal value as fixed by the black level of the signal.

A rising positive voltage on the control grid of the video amplifier valve causes a corresponding rise of current in the anode circuit and through the anode load R4. This in turn results in an increasing volts drop across R4, which pulls down the voltage at the anode (and at R4-L2 junction since L2 has a very low resistance). Thus we have *falling* voltage at the anode, which is passed on direct to the tube cathode through R2.

Now the picture tube itself is biased in such a way that at black vision level the beam current is cut off, resulting in zero illumination. The tube biasing is achieved on most sets by the brightness control. Some models have a supplementary automatic control worked by a light-dependent resistor (or light cell) in the brightness control circuit, but the manual control is needed to set the correct bias initially.

Brightness Control

At black signal level a certain value of positive voltage, with respect to chassis, exists at the tube cathode, as reflected from the anode of the video amplifier valve. The tube grid is variable from zero voltage (or a little above) to the h.t. line voltage (or a little below). Thus it is possible to make the tube grid equal to or less than the voltage at the cathode. This, of course, gives zero bias and progressively more *negative* bias as the brightness control is turned down. Zero bias gives maximum illumination (e.g., maximum beam current) and as the negative bias at the grid is increased, so the beam current is decreased and the illumination reduced until beam current cut-off, when the illumination ceases altogether. At signal black level, therefore, the brightness control should be adjusted just to the point of beam current cut-off.

From that point on, the ilumination on the screen is controlled essentially by the video signal. A white-going signal at the grid of the video amplifier valve, as we have seen, will make the tube cathode go *less positive*, which is the same as the grid going *less negative*. The tube is thus pulled away from beam current cut-off and illumination appears on the screen corresponding to the white level of the video or vision signal.

Actually, of course, the signal does not change slowly, as the foregoing explanation may imply, but it changes between various grades of black and white sometimes extremely swiftly to give a large number of black, white and intermediate white transitions along a single line, and sometimes less swiftly when there are fewer basic picture elements or black/white transitions along a line scan.

Two Conditions

A video stage is, therefore, concerned with two conditions. One is the static or relatively slow-changing d.c. condition and the other is the condition of rapid change of d.c. (up to 3Mc/s or more) arising from the active video signal.

The static and slow changing condition is demonstrated simply by adjusting the brightness control with the aerial removed from the set and the contrast control turned right down. If all is well with the d.c. condition the brightness of the raster should be adjustable from zero to maximum over the normal range of the brightness control.

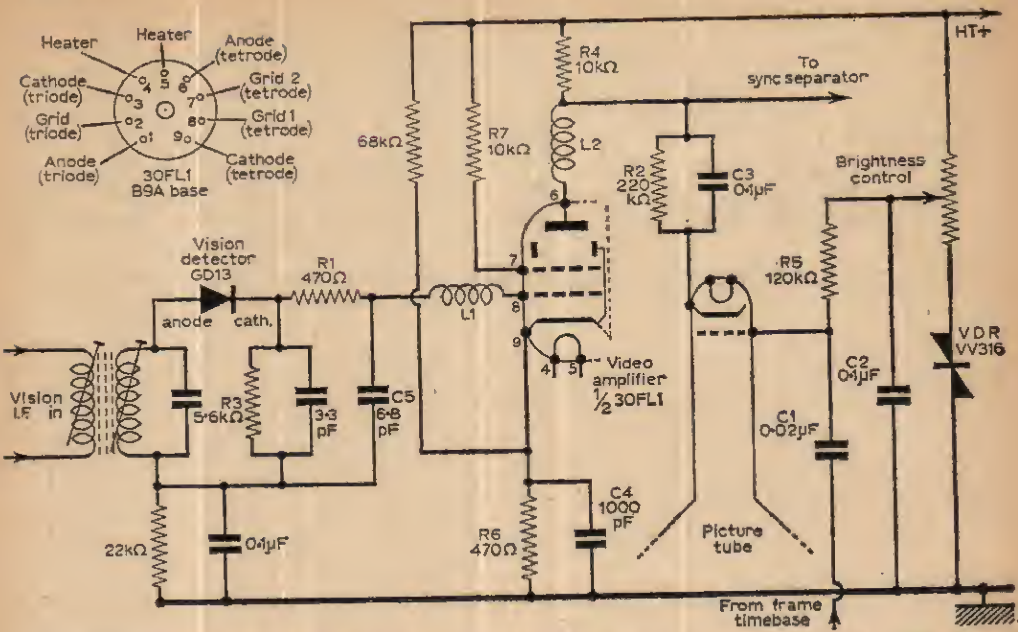


Fig. 1—Basic video stage of 405-line receiver. Note the d.c. coupling from the vision detector to the cathode of the picture tube. The video stage has to be concerned with both d.c. and transient changes of level up to 3 Mc/s or more.

Faulty D.C. Condition

Many faults in the video stage prevent this normal action and either make it impossible to extinguish the raster or to obtain a fully bright raster. In some cases such a fault may not affect the video signal condition, while in others it may. Take the classic symptom of "uncontrollable brightness". This obviously signifies that something drastic has happened to the d.c. condition to prevent beam current cut-off even at minimum setting of the brightness control.

A well-known cause is a short-circuit between the heater and cathode of the picture tube. On most sets these days the heater is at chassis potential so that such an inter-electrode short "kills" the positive voltage at the tube cathode. This means that the grid is highly positive with respect to the cathode at any setting other than zero on the brightness control, and even at zero setting the tube fails to be biased negatively, so brightness remains on the screen at all settings of the brightness control.

Any fault which drastically reduces or deletes the positive voltage at the tube cathode will give this symptom to some degree. On some models the cathode of the vision interference limiter diode valve is connected direct to the tube cathode circuit, making exactly the same symptom possible should the diode develop a heater/cathode short. Before this was fully understood the tube was often condemned, later to be refitted again when it was discovered that the symptom was present with the replacement tube. Ultimately, of course, the fault was cleared by replacing the diode.

The same state could arise from the brightness control or circuit going open-circuit at the "earthy" side. This would retain the tube grid almost at h.t. line potential at all settings of the control, thereby making it impossible to secure beam current cut-off. In Fig. 1 a voltage dependent resistor is used in the "earthy" side of the brightness control, but in other sets an ordinary resistor may be used or there may not be a resistor here at all, the bottom of the control going direct to chassis. The voltage dependent resistor gives a degree of brightness compensation should the h.t. line voltage vary for some reason or other.

Instability

Instability in the vision i.f. stages could result in a high amplitude oscillatory signal across the vision detector diode. This would be rectified by the diode and quite a strong positive voltage would be developed across the load R3 and applied to the control grid of the video amplifier valve. This, then, would pull the voltage at the valve anode right down, and conditions similar to those described previously would result. In addition, the valve screen or anode may be seen glowing due to the heavy anode current, and the anode load R4 may well start smoking. This resistor would also get very hot from a heater/cathode short in the tube or interference limiter diode.

Flyback Suppression

On most recent models pulses from the frame timebase are applied to the grid of the tube to ensure that beam current cut-off takes place during the frame flyback period, as a means of suppressing the flyback lines which may otherwise occur on the picture when the brightness is set above normal.

On the circuit in Fig. 1, the pulses are fed to the grid through C1, and R5 (between the slider of the brightness control and grid) acts as a load to these pulses and prevents them being attenuated by C2. Sometimes C1 serves also to isolate the tube grid from the frame timebase h.t. supply. Thus, apart from upsetting the suppression function, a leak or short-circuit in C1 would clamp the tube grid to h.t., irrespective of the setting of the brightness control, which is another possible cause of uncontrollable brightness on modern sets. Note that some dual standard models also feature a similar suppression arrangement from the line timebase.

Zero Illumination

We have now pretty well exhausted the possibilities of uncontrollable brightness, but equally as bad is " zero illumination ". This symptom may have its origin elsewhere in the set (such as e.h.t. failure, tube failure, misplaced ion trap magnet and so on), but it can also happen due to the tube grid failing to rise less negative, so as to pull the tube out of beam current cut-off, when the brightness control is advanced.

Typical faults are short in C2 (locking the tube grid to chassis while the cathode is positive); fault in brightness control potentiometer; extra high positive value on tube cathode. This condition is aggravated by a low emission video amplifier valve, and in certain circuits this is sufficient to make the cathode more positive than the grid even at the maximum setting on the brightness control. A break in L2 would also put the tube cathode at full h.t. line voltage and give conditions similar to a low emission or open-circuit valve. Similarly, an open-circuit R6 in the cathode or, indeed, any fault that would cut off video amplifier valve anode current is likely to produce the symptom to some degree.

If the anode voltage of the video amplifier valve is removed due to one of these fault conditions, the screen grid would tend to take much more current than normal, resulting either in the screen grid glowing red hot or the screen feed resistor smoking (or both).

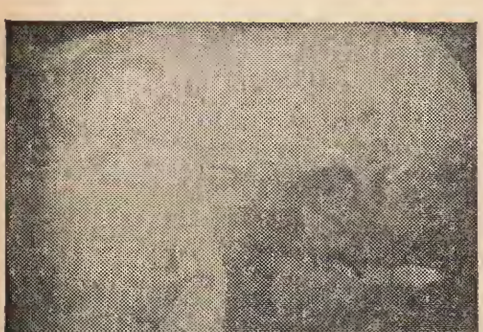


Fig. 2—This symptom can be caused by "ringing" in the video amplifier due to poor damping across a response correcting inductor, such as L2 in Fig. 1.

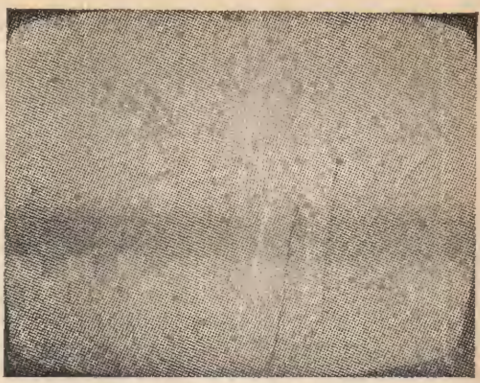


Fig. 3—An unusual picture of low video drive. This was caused by a break in the i.f. filter inductor, L1 in Fig. 1. Only capacitive coupling between the windings being retained.

Tube Bias

There are two methods of checking the bias on the picture tube. One is by making two voltage measurements with respect to chassis, one from the cathode and other from the grid and then subtracting the latter from the former at any required setting of the brightness control, the answer being the *negative* bias on the grid. The other is by connecting a voltmeter between the cathode and grid pins on the tube base (negative lead to grid). The reading will then be the negative grid bias, and it should be adjustable by rotating the brightness control. To avoid excessive error in reading a meter of, at least, 20,000Ω/V should be employed and it should be set to the 200 or 250V range d.c.

Tube Fault

On sets employing flyback suppression, the load resistor R5 may have developed across it a potential, positive at the grid, due to a gassy or otherwise faulty picture tube. This potential tends to counteract the negative bias and may affect the range of brightness control or, under extreme conditions, prevent beam current cut-off. If suspected. the trouble can usually be proved simply by putting a short-circuit across R5. This will neutralise the suppression feature, of course, but if the control of brightness is restored to normal, the tube is probably responsible. But to be doubly sure C1 should be disconnected, for, as we have seen, a leak in that capacitor could give a similar symptom.

Faulty Signal Conditions

While the d.c. condition may be correct, a fault may be present which shows up only on the picture signal or which prevents rapid changes of tube cathode voltage, such as is necessary to produce rapidly changing levels of brightness along a line scan to " paint " the picture detail of one line.

In order to respond to rapid changes of signal (e.g., voltage) level, the video stage must have a wide bandwidth. For 405 lines a bandwidth of 3Mc/s is required for the best definition, while 5Mc/s is required for 625 lines and the higher definition of this system.

There are several highly technical factors which determine the bandwidth of the video stage. The mutual-conductance (gm) of the video amplifier valve in conjunction with the value of the anode load resistor is one. Another is the value of the detector load resistor. Shunt capacitance is also a very important factor, for if there is too much of this, some of the higher frequency vision signal is lost due to attenuation. There must always be some shunt capacitance, of course, and this is why it is necessary to employ relatively low values for the load resistors (to compensate for the shunt capacitance). Low value loads means small gain unless the gm of the valve is high, which is why it is necessary to use valves with high gm in video stages.

It is also necessary to correct the response of the video amplifier from d.c. to the top video frequency (about 3Mc/s on 405 lines) to compensate for certain other shortcomings of the system. High-frequency correction, for example, is given by L2 in the anode circuit. This, in conjunction with stray capacitance, tunes towards the top of the video spectrum, where the amplifier response is normally falling off, and gives an artificial lift to the gain of the amplifier at that frequency. Such an inductor as L2 is sometimes shunted by a resistor to avoid too peaky a response, and if the resistor is too high or open-circuit "ringing" may occur, giving an effect similar to that shown in Fig. 2.

Increase in value of one of the load resistors will not only impair the high frequency response of the stage (making it impossible to resolve the higher frequencies gratings of Test Card C) but also increase the gain towards the low-frequency end, often giving smearing and black flaring after a black on a white background.

Modern receivers purposely attenuate some of the low-frequency video signal to reduce the effects of aircraft flutter and for other technical reasons. In Fig. 1 low-frequency attentuation is given by C3 in the tube cathode circuit. Most of the d.c. is deleted, anyway, on sets using a mean-level vision a.g.c. system!

Frequency compensation is also given in the cathode circuit of the video amplifier. C4 is usually selected to give the best overall response after consideration has been given to the other compensating features of the circuit.

A value of about 1,000pF gives full gain at the higher frequencies, where the reactance is low, and progressively reducing gain as the frequency decreases as the result of increasing negative feedback due to the increasing reactance. Thus, if C4 goes open-circuit the response would be affected, and the general gain of the stage would fall.

L1 between the vision detector and the video amplifier control grid, in conjunction with the 6·8pF capacitor C5 and the input capacitance of the valve, acts as an i.f. filter. The i.f. signal is prevented from gaining admittance to the amplifier where its presence would be likely to cause pattern interference.

Fig. 4—Peak white suppression, where the white parts of the picture tend to shade grey, can be caused by a low emission video amplifier valve or increase in value of the screen grid feed resistor.

L1 sometimes goes open-circuit and severely reduces the video drive to the picture tube. The picture may not be cut off completely, but may appear as shown in Fig 3. In some models the sync performance (e.g., vertical and horizontal holds) may be impaired. Similar effects can be caused by a bad vision detector diode.

Peak white suppression can also occur both in the diode and in the video amplifier, giving the effect as shown in Fig. 4. This sympton is akin to the black spotter control on some sets being too far advanced. However, if the spotter control is fully anti-clockwise and the fault persists, the video amplifier valve and the detector diode should be checked in that order. An increase in value of the screen feed resistor, R7, can also cause the trouble. ■

TV DEAF-AID

—continued from page 103

and then the unit can rest on a table or on the arm of the chair of the deaf-aided viewer, who may then conveniently adjust both volume and tone as required.

Setting up

The unit should be set-up in the following manner. After connection to the parent receiver, the receiver volume control should be adjusted actually during the course of a programme for the normal listening volume as required by the viewers without hearing shortcomings.

The person needing the aid should then set his manual control to mid-range and adjust the slider preset volume control, in conjunction with the tone control for the most comfortable listening level.

The top may then be put back on the unit and the main volume and the tone controls used normally during a programme. Alterations to the settings of the deaf-aid controls will not, of course, affect the volume of sound delivered by the loudspeaker in the receiver; but an alteration of volume of the set will call for a corresponding adjustment of the deaf-aid's volume control. ■

A CLOSED CIRCUIT TV *Camera*

By E. McLoughlin

PART THREE: THE CAMERA CONTROL UNIT

CONTINUED FROM PAGE 87 OF THE NOVEMBER ISSUE

THE control unit contains the main video amplifier circuits, the scan circuits and an r.f. section delivering a composite output signal acceptable at the aerial sockets of any normal domestic TV receiver without modification. It also contains all power supplies for operating its own circuitry and the associated vidicon camera unit described in the previous article of this series.

Together with the vidicon camera unit, the control unit provides a complete basic closed circuit televison link, giving displayed pictures of acceptable sync, stability and definition. The author has found that the stability on a 22-inch TV receiver screen is sufficient to allow photographic exposures of many seconds without blurring of resulting photos due to jitter. Resulting photographs enlarged to normal print or postcard size have a definition hardly distinguishable from the ordinary run of direct snapshots. Moreover, the displayed images on the TV receiver have sufficient definition to allow exact observation of the pointer and every scale division on the scaleplate of a typical multimeter, under conditions where the multimeter is so televised, that at least six scaleplates could be accommodated on the screen area. Thus serious uses for multiple remote display of several meters, counters or other instruments are immediately possible with CCTV equipment as described in the present series.

Simplifications

The prototype design has been laid out for 625-line operation, with a modulated r.f. output signal resembling the CCIR standard sufficiently closely to permit, in general, satisfactory display on an unmodified CCIR domestic receiver. The principal differences in detail from the true CCIR standard waveform amount to the omission of line pulses during the frame return period, the omission of all black-level porches and the lengthening of line and frame pulses to correspond approximately to the total duration of pulses and porches together in the standard waveform.

It must be emphasised that the omission of more complex waveform generators giving a more closely standard waveform is here deliberate, so that the simplest possible basic unit giving definitely usable pictures of well-acceptable quality results, with a minimum of expense.

At the same time, the complete design, especially controls and plug connections, has been evolved in such a way that the same control unit will be usable with other picture pick-up heads which are planned to be the subject of future articles, and also permits external connection of an additional waveform generator chassis. (This will form the subject of another future article, and will allow the optional insertion of black-level porches and line pulses during the frame flyback, giving improved rigidity of receiver lock.)

Scan Amplitude Controls

The control unit design published in the present article differs from many commercial units of

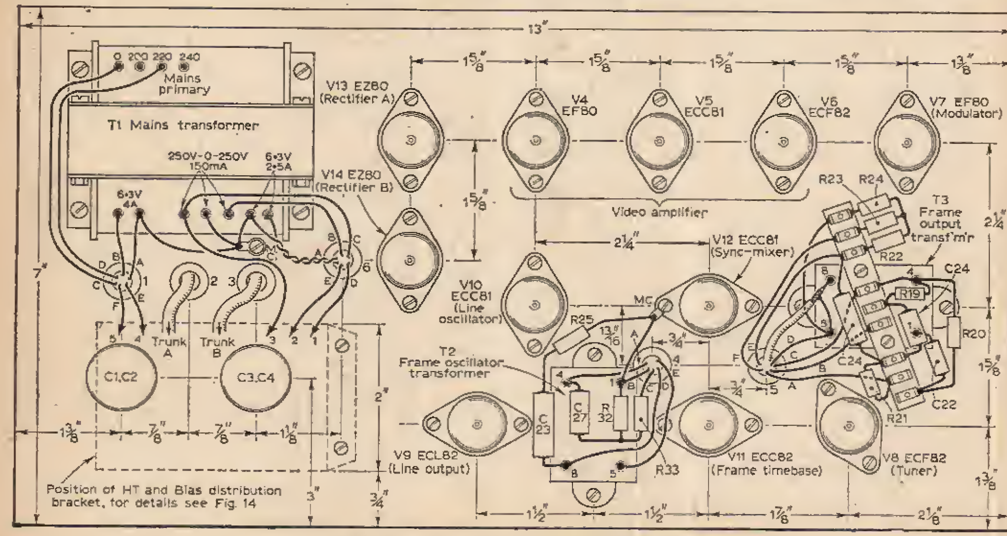


Fig. 12—Above-chassis component layout.

TYPICAL CALCULATION OF REQUIRED VALUE FOR C8

About 10–20 turns of connecting wire round three fingers as test *coil*, secured with two pieces of insulating tape. Inductance need not be exact or known. Solder provisionally between junction C1/R4 and chassis. All three valves in place, but *no* power supplies.

Measure resonant frequency of test coil then with grid-dip meter.
Result for Prototype . . . . 14 Mc/s. . . . (i)

Repeat with coil removed and wired to a known ceramic capacitor of same capacity as approximate estimated Vidicon Target Strays.
Result for Prototype (16pF capacitor) . . . . . . 13 Mc/s. . . . (ii)

Repeat with known capacitor approx. 3 times as large.
Result for Prototype (56pF capacitor) . . . . . . 7·6 Mc/s. . . . (iii)

C_{TARG} = Total Stray Capacity in Vidicon Target Circuit
C_O = Self-capacity of Test Coil
Formula: $\frac{C_A}{C_B} = \frac{f_B^2}{f_A^2}$; where f_A, f_B are two resonant frequencies of same coil with two *total* capacities C_A, C_B respectively.

Applying to (ii) and (iii) above:

$$\frac{C_O + 56}{C_O + 16} = \frac{(13)^2}{(7{\cdot}6)^2} \text{; gives } C_O = 4{\cdot}6\text{pF approx.}$$

Applying to (i) and (ii) above:

$$\frac{C_O + C_{TARG}}{C_O + 16} = \frac{13^2}{14^2} \text{ and } C_O = 4{\cdot}6\text{pF ; gives } C_{targ} = 13{\cdot}2\text{pF approx.}$$

Compensation rule to be satisfied (see Fig. 1):

$$C_{TARG} \times R1 = C8 \times R6 \quad \text{(C's in pF; R's in k}\Omega)$$

$$\text{Thus } C8 = \frac{C_{TARG} \times R1}{R6} = \frac{13{\cdot}2 \times 56}{0{\cdot}27} \text{pF} = \text{approx. } \mathbf{2700pF}$$

Value for L1

Repeat as above, but Test Coil from V2 anode to chassis in (i), top end of R7 thereby open-circuit. Result is C_{an}, the total anode stray capacity of V2.
Result for Prototype ...... C_{an} = 14pF

Compensation rule to be satisfied (see Fig. 1):

$$L1 = 0{\cdot}414\, C_{an}(R7)^2 \mu\text{H, gives here } L1 = \text{approx. } 30\mu\text{H}$$

Wind three layers, 35 turns each, 32s.w.g. enamelled copper wire, PVC tape between layers, on 10MΩ 1W carbon resistor. Check L-value by measuring resonant frequency with known capacitor, using grid-dip meter. If N is required correction-factor, rewind with $\sqrt{N} \times 105$ turns.

TABLE 1 *(Refer to Camera Head article last month.)*

similar purpose in an important feature, namely in the presence of scan amplitude, linearity and frequency controls on the front panel instead of internally as presets. In general, a vidicon tube should be scanned with a raster of constant size throughout the serviceable life of the tube. However, for amateur experimental purposes, this point need not be taken too critically.

There are many instances where it is extremely useful to be able to alter the scan geometry *temporarily*. This should then be for periods as brief as possible for satisfying the envisaged purpose, the controls thereafter being returned to normal. The "normal" positions could be clearly marked on each control.

With the simplified sync waveform used in the basic equipment, picture stability on the receiver can be dependent on vidicon frame scan amplitude setting, partly because the frame amplitude setting reacts directly on the sync and blanking generator in the circuit used and partly because the receiver may depend upon pseudo-porches generated via the video-waveform from the camera under conditions of proper scan amplitude adjustment.

Sudden changes of frame scan amplitude may well set the picture rolling on the receiver, requiring readjustments to the frame hold controls. Line hold is more stable in the face of sudden changes of vidicon scan width. In general, precise adjustments to the scan controls contribute greatly to picture stability on the receiver, this being another vital reason for fitting all controls directly on the panel. The third reason is concerned with the desired general universality of the control unit, for subsequent diverse uses with other pick-up units and ancillaries.

Plug Connections

Two main considerations led to the adoption of completely separate plugs and sockets for all waveform and power feeds, instead of multiple connectors.

The first consideration is that of greater ease in obtaining plugs and sockets, standard items being usable in the arrangement employed. The second consideration involves the resulting greater freedom in optimum disposition of connecting leads in the sub-chassis wiring and the greater versatility of subsequent interconnection with future ancillary units, enabling different leads to be taken to or through the respective new units. In short, the value of the equipment for general experimental purposes is enhanced by these measures.

P4 and P5 may, of course, be combined to an 8-pole type if desired, but the use of two separate 3-pole-plus-earth sockets is probably better. The type of socket found on Grundig tape recorders for radio, record and playback was used in the prototype, though any small 4-pole type of socket will do, provided it is adequately screened.

COMPONENTS LIST

Resistors:

R1	25kΩ 2W w.w.	R19	2·2MΩ
R2	100kΩ	R20	2·2kΩ
R3	25kΩ 2W w.w.	R21	220kΩ
R4	1kΩ 5W w.w.	R22	2·2MΩ
R5	12Ω 1W	R23	15kΩ
R6	3·3kΩ 1W	R24	15kΩ
R7	10kΩ 1W	R25	10kΩ
R8	10kΩ 1W	R26	470kΩ
R9	5·6kΩ 1W	R27	470kΩ
R10	1·5kΩ	R28	1MΩ
R11	8·2kΩ 1W	R29	100kΩ
R12	10kΩ 1W	R30	270kΩ
R13	220kΩ	R31	100kΩ
R14	47kΩ 2W	R32	4·7MΩ
R15	27kΩ 2W	R33	100kΩ
R16	100kΩ	R34	100kΩ
R17	50kΩ 5W w.w.	R35	8·2kΩ
R18	2·2MΩ 1W	R36	15kΩ

R37	2·7MΩ	R58	100kΩ	R79	6·8kΩ
R38	1MΩ	R59	39kΩ	R80	18Ω
R39	39kΩ	R60	47Ω	R81	3·8kΩ
R40	150kΩ	R61	270kΩ	R82	470Ω
R41	10kΩ	R62	1MΩ	R83	15kΩ
R42	1·8MΩ	R63	47kΩ	R84	2·2kΩ
R43	15kΩ	R64	10kΩ	R85	100kΩ
R44	47kΩ	R65	10kΩ	R86	1MΩ
R45	10kΩ	R66	2·7kΩ	R87	270kΩ
R46	75kΩ	R67	270kΩ	R88	2·7kΩ
R47	390Ω 1W	R68	47kΩ	R89	12kΩ
R48	2·7kΩ	R69	1MΩ	R90	1·5kΩ
R49	1·8kΩ	R70	10kΩ	R91	10kΩ
R50	470kΩ	R71	10kΩ	R92	10kΩ
R51	75kΩ	R72	10kΩ	R93	47kΩ
R52	47kΩ	R73	1MΩ	R94	6·8kΩ 1W
R53	10kΩ	R74	10kΩ	R95	68kΩ 1W
R54	1MΩ	R75	2·2kΩ	R96	22kΩ
R55	6·8kΩ	R76	1MΩ	R97	470kΩ
R56	39kΩ	R77	1·8kΩ	R98	1·2kΩ
R57	820kΩ	R78	27kΩ		

All carbon, ±10%, ½W unless otherwise stated.

Potentiometers:

VR1	100kΩ	VR5	1MΩ
VR2	100kΩ	VR6	50kΩ
VR3	250kΩ	VR7	100kΩ
VR4	1MΩ	VR8	10kΩ

All linear law.

Capacitors:

C1, C2 } 50+50μF electrolytic 450V
C3, C4 } 50+50μF electrolytic 450V

C5	8μF elec. 350V	C19	100μF elec. 35V
C6	2μF elec. 350V	C20	8μF elec. 350V
C7	25μF elec. 350V	C21	8μF elec. 350V
C8	8μF elec. 350V	C22	0·05μF 500V
C9	8μF elec. 350V	C23	0·25μF 500V
C10	8μF elec. 350V	C24	1500pF 500V
C11	25μF elec. 350V	C25	0·25μF 500V
C12	16μF elec. 350V	C26	0·02μF 500V
C13A	1μF elec. 350V	C27	0·025μF 500V
C13B	1μF elec. 350V	C28	0·02μF 500V
C14	25μF elec. 350V	C29	0·2μF 500V
C15	25μF elec. 350V	C30	0·05μF 500V
C16	8μF elec. 350V	C31	330pF cer. or m.
C17	8μF elec. 350V	*C32	0·33μF 500V
C18	0·1μF 500V	*C33	0·068μF 500V

C34	50μF elec. 35V	C53	0·1μF 500V
C35	1500pF cer. or m.	C54	100μF elec. 12V
*C36	0·068μF 500V	C55	100pF cer. or m.
C37	680pF cer. or m.	C56	0·05μF 500V
*C38	0·068μF 500V	C57	100pF cer. or m.
*C39	0·068μF 500V	C58	47pF cer. or m.
C40	3300pF 500V	C59	68pF cer. or m.
C41	2200pF 500V	C60	20pF cer. or m.
C42	2700pF 500V	C61	1000pF cer. or m.
C43	3300pF 500V	C62	100μF elec. 12V
C44	3900pF 500V	C63	0·01μF 500V
C45	4700pF 500V	C64	0·05μF 500V
C46	8μF elec. 100V	C65	47pF cer. or m.
C47	0·1μF 500V	C66	20pF cer. or m.
C48	180pF cer. or m.	C67	80pF cer. or m.
C49	1000pF cer. or m.	C68	0·005μF cer. or m.
C50	0·02μF 500V	C69	0·01μF 500V
C51	0·1μF 500V	C70	0·01μF 500V
C52	0·2μF 500V	C71	0·1μF 500V

*See text for alternatives if specified values are difficult to obtain. All capacitors paper except where indicated.

Variable Capacitors:

TC1 50pF trimmer TC3 1–3pF trimmer
TC2 2–12pF tuner (s.w. type)

Transformers:

T1 Mains transformer. Tapped primary. Secondaries: 250–0–250V 150mA; 6·3V 4A; 6·3V 2·5A

T2 Frame osc. trs., 7AB/1005 }
T3 Frame o/p trs., 7AB/1021 } (E.M.I. Electronics).
T4 Line o/p trs., 7AB/1013 }

Inductors:

L1 L.F. smoothing choke 15H 80mA
L2 L.F. smoothing choke 15H 80mA
L3 Line oscillator coil PLC752 (E.M.I. Electronics)
L4, L5, L6, L7 } see table 1 L8, L9 } see table 2

Valves:

V4	EF80	V8	ECF82	V12	ECC81
V2	ECC81	V9	ECL82	V13	EZ80
V6	ECF82	V10	ECC81	V14	EZ80
V7	EF80	V11	ECC82		

Diodes:

D1, 2 Silicon 350V (Brush S36)
D3 Selenium E250 C50 D4 Zener 18V 10mA
D5, 6 Silicon 350V (Brush S36)

Miscellaneous:

P1–P3 Coaxial sockets
P4–P5 3-pole plus earth tape recorder type sockets
P6–P8 Coaxial sockets. P9 Earthed mains connector.
P1 7V 0·3A pilot lamp. F1 1A fuse
S1 D.P.S.T. toggle switch
S2 Wafer switch, 1 pole 5 way

Eleven B9A valveholders. Nine Valve creening cans. Nine small knobs. Mild steel chassis 7in. x 13in. x 3in. Steel cover. Aluminium for screens. Ten grommets 2in. dia. Tagstrip, wire, etc.

Camera Cable:

30 yds. coaxial cable. 15 yds. 3-way screened cable Eight coaxial plugs. Four tape recorder type 3-pole plugs. P.V.C. tape.

Aerial Cable:

Desired length of coaxial cable. 2 coaxial plugs.

Mains Cable: 3-core cable and plugs.

Screening

Total screening of the entire CCTV equipment is of paramount importance. This is to prevent entry of medium and longwave broadcast signals, v.h.f. signals or other interference and to prevent radiation of any internal scan or v.f.o. signals. All cables between camera head and control unit must be screened, *including* the power and focus lines.

It is advisable to fit a TVI filter and general broadcast interference suppressor in both leads of the mains cable near to or in the plug fitting P9, although experience with the prototype has shown that this measure may be dispensed with if the mains feeds from P9 to the mains transformer are well twisted and laid in the corner of the chassis, and if the mains transformer has a good screen between primary and secondary.

P9 itself was, in the prototype, the kind of fitting often found on electric kettles and clothes irons, so that detachable mains leads of such appliances may be used. The advantage of such a connector is the fine earth connection therewith achieved, which is essential for safety and reliability with this equipment. Any other type of approved detachable three-pin connector may be used. Under no circumstances *whatsoever* is twin-flex permissible for the mains connection; three core power cable with proper three-pin power plug is essential.

Mechanical Construction

Considerable heat is developed in the control unit, furthermore the unit is quite heavy, so that a flimsy aluminium cabinet would not give the necessary electrical and mechanical stability.

A stout aluminium chassis and cover-hood may certainly be used if desired, but a mild steel unit offers the best solution. If making this up oneself, the metal parts should be welded rather than bolted together, as the former method leads to better electrical continuity over long periods with mild steel.

A long solder tag should be bolted to the chassis at all points marked "MC" in the wiring diagrams, arched over, and its other end *soldered* to the chassis. A frame of bare tinned copper wires can then be soldered between these earthing arches. This gives more reliable earthing to chassis than the use of bolts alone. Soldering to chassis should be performed with a heavy wattage soldering iron *prior* to mounting of any components. Subsequent soldering to chassis is not possible, on account of the very great heat necessary, which would melt neighbouring components.

It is essential to use approved multicore solder (NOT plumber's solder and acid fluxes) for the heavy solder joints to chassis to avoid subsequent corrosion effects.

A straightforward box type chassis is used and the dimensions will be seen from Fig. 12 and Fig. 13. Compartment screens of sheet aluminium are used for the video and r.f. sections, and the sub-chassis is closed by a lid which is attached to the turned-over bottom edge with 8 self-tapping screws. This bottom lid is fitted with four small rubber feet, to avoid scratching any furniture upon which the unit may be stood.

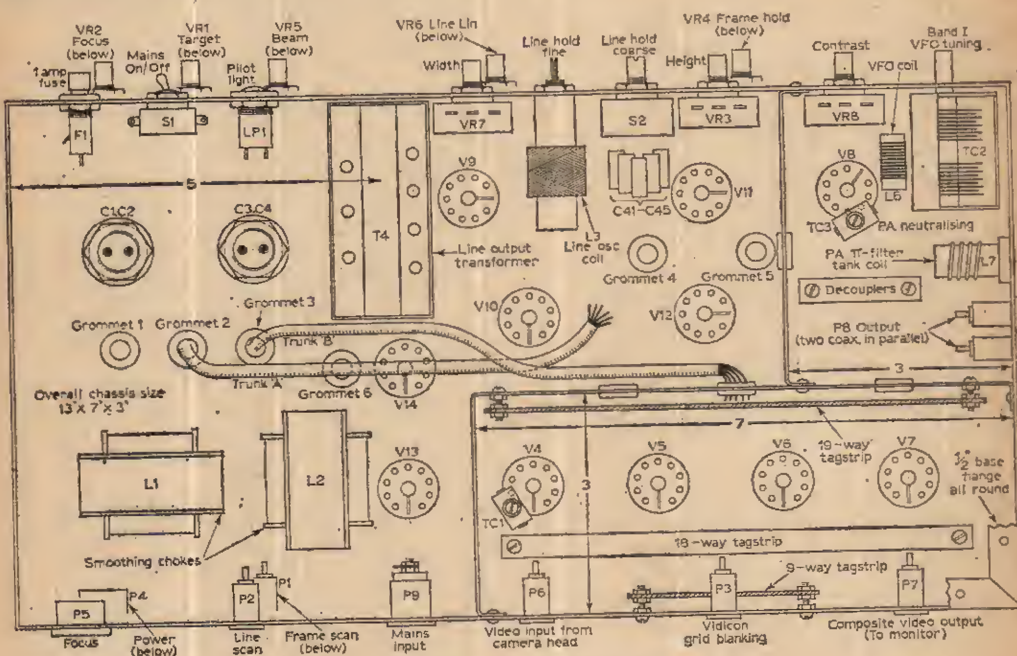


Fig. 13—Underchassis layout.

TO BE CONTINUED

RECEIVING EQUIP

TWO-VALVE CONVERTER AND 16-ELEMENT STACKED AE

By B. W. Smith (G3LGJ/T)

AMATEUR television receiving equipment usually consists of a converter which feeds an ordinary domestic television receiver on an unused Band 1 channel. Few amateurs completely build a receiver for amateur use, understandably so, considering the abundance of suitable, cheap, second-hand television receivers available.

THE CONVERTER

The converter works on the same principle as the Band III converters which made an appearance in 1957 when the ITA stations opened. The particular unit described in this article is for the most popular and lowest frequency amateur television band, 425 to 445 Mc/s or 70cm. This frequency is changed to a Band I channel frequency so that the converter output can be connected directly into the aerial socket of a domestic television receiver. Although a simple circuit is used the receiver will be capable of a very good performance.

General Circuit Description

The circuit diagram of the converter is given in Fig. 1. The 70cm signal feed from the aerial is coupled into the mixer circuit L4, C3. L4 is a quarter wave resonant trough tuned by VC2 at one end.

The local oscillator V1 is a 6J6 double triode in a push-pull Colpitt's circuit, using half wave lines tuning the anodes, instead of the more conventional coil. The frequency of the oscillator is varied by a split stator capacitor C2 connected across the end of these lines. The oscillator voltage is inductively coupled into the mixer trough by the coupling loop L3, where it is mixed in the crystal diode mixer D1 to give the frequency conversion.

Because there is no amplification of the 70cm signal at 70cm or in the frequency conversion stage, a good low-noise intermediate frequency amplifier is required, before taking the signal to the television receiver. V2 provides this necessary amplification, and is operated as a grounded grid triode

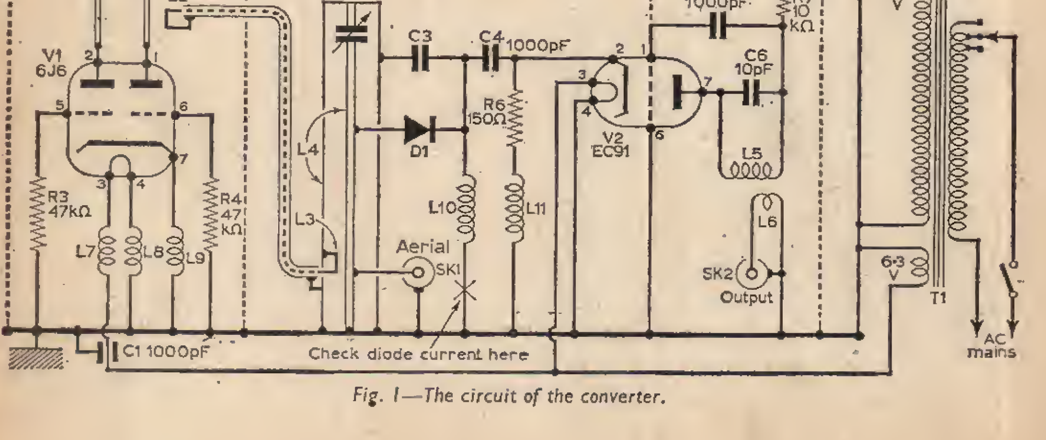


Fig. 1—The circuit of the converter.

MENT FOR 70 cm

AL ARRAY

amplifier. This circuit was chosen because (a) very good signal-to-noise ratio can be obtained, (b) the circuit has only one tuned stage making it easy to align, and (c) the mixer diode output impedance will match into the input impedance of the amplifier.

An r.f. amplifier stage is not used in this circuit because very few valves can improve on the signal-to-noise ratio that can be obtained by the converter (i.e. they may amplify the signal, but amplified valve noise is also added to the signal). In fact it is possible to make the signal-to-noise ratio worse with an amplifier than without. The signal-to-noise performance of a diode mixer at 70cm is better than most triode or pentode mixers, and gives the whole receiver a reasonable performance.

The gain of the converter is made up in the i.f. amplifier V2. For example, consider an amateur transmission sound carrier on 432Mc/s and vision carrier on 435·5Mc/s. The local oscillator when tuned to 378·75Mc/s by C2 will give an i.f. signal at a frequency of 53·25Mc/s (sound) and a vision frequency of 56·75Mc/s, both of which can be received on channel 3.

A power unit for operation from an a.c. mains is incorporated in this design. This need not be built

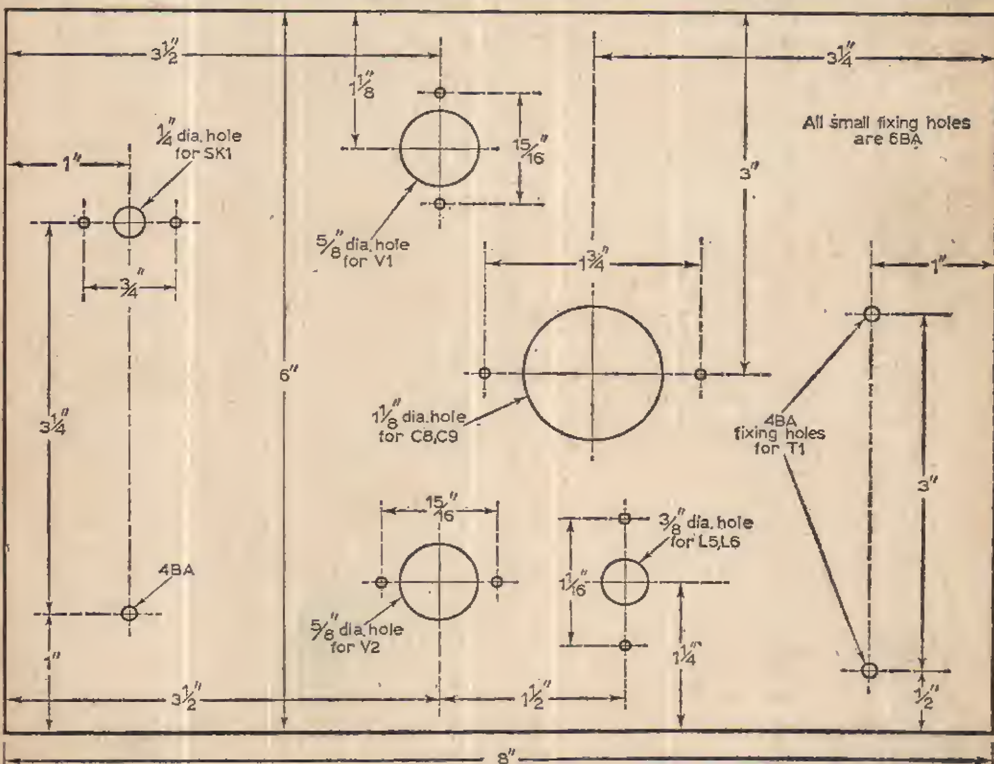


Fig. 2—A chassis drilling diagram.

of course, if an alternative source of h.t. and l.t. power is already available. Power requirements are 200V 20mA and 6·3V 0·75mA.

Construction

The converter is built on a standard 8in. x 6in. x 2½in. aluminium chassis, and this leaves plenty of room to spare. Fig. 2 shows the dimensions of the fixing holes for the various components. Aluminium sheet is used for screening the 6J6 oscillator section and the anode circuit of the i.f. amplifier as indicated in Fig 3.

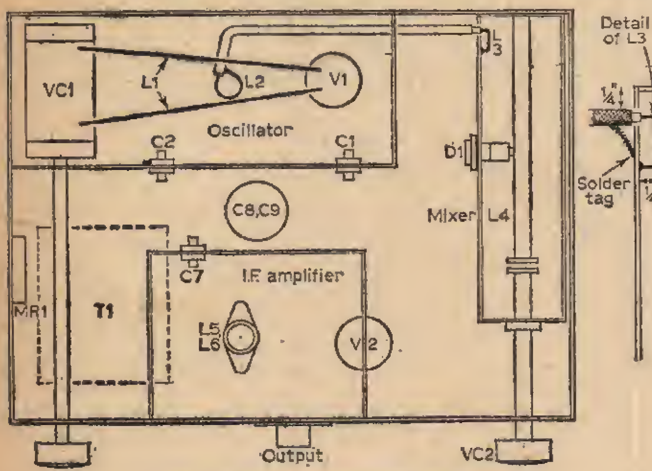


Fig. 3—An underchassis view of the unit.

The construction can be split up into four main parts: mixer circuit, local oscillator, i.f. amplifier, and the power unit.

Mixer Circuit

Fig. 4 shows the layout of the mixer line. The trough L4 is conveniently made from 18 or 20s.w.g. brass sheet bent to form an open rectangular box of the dimensions shown, the corners of the trough then being soldered.

The mixer line itself is made from ¼in. outside diameter copper tube with a ½in. diameter copper disc, about 1/16in. thick, soldered concentric with the tube across one end. The other end of the line is soldered to one end of the trough, so that the line is in the middle of the trough.

The mixer tuning capacitor VC2 is made by soldering a ½in. diameter, 1/16in. thick copper disc concentrically on to the head of an 0 B.A. countersunk bolt 2in. long.

The coaxial aerial socket SK1 is fitted ¾in. from the earthy end of the line opposite the open side of the trough. The main chassis is also drilled to take this socket, and the latter, when fitted, will clamp the mixer line to the chassis. The inner connection of the coaxial socket is soldered (using a large soldering iron) or clamped to the mixer line.

The mixer diode D1 is connected to the line 2¼in. from the earthing end (see Fig. 5). The diode spigot clip is made from the inner connector of a coaxial socket, soldered into the line.

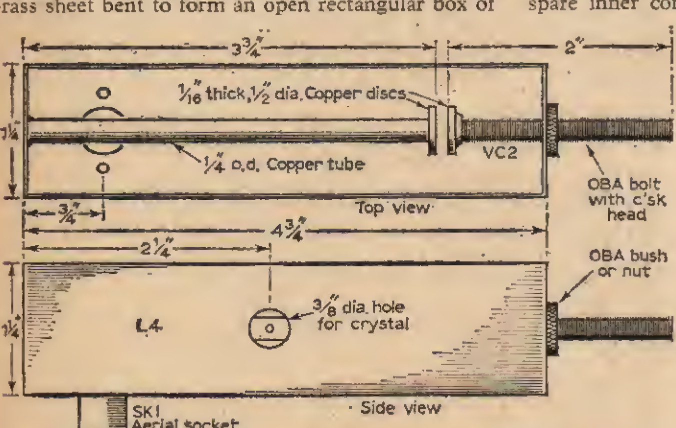
C3 is a ¾in. diameter brass disc about 1/16in. thick, drilled ¼in. to take the silicon diode as a push fit. A 1/32in. thick ¾in. diameter mica washer spaces the brass disc away from the side of the trough when assembled to give the correct capacity. See Fig. 5.

Local Oscillator

The oscillator injection loop L3 is not critical and is made by removing the braiding from a coaxial cable for about 1½in. The coaxial cable enters the mixer trough about ¼in. up from the bottom earthy plate, the outer braid is earthed using a solder tag as near its entry as possible. The spare inner conductor is bent to form a loop ¾in. long standing away from the wall by ¼in. and running parallel with the mixer line. The end of the conductor is earthed to the wall.

The anode lines of V1 (which comprise L1) are 3in. long and are strung between the tuning capacitor VC1 and the anode pins of the valve holder. The rotor of VC1 must not be earthed, otherwise circuit unbalance could result with spurious oscillations. R1 and R2, which serve as r.f. chokes at 70cm, are tapped on to the centre point of their respective line.

The oscillator output coupling loop L2 is made by removing 1½in. of braiding from the other end of the coaxial cable and folding the inner conductor back on itself, and finally soldering the end to the braiding. This loop



"Trough" is made from 18 or 20 s.w.g. Brass sheet bent to form an open box with the corners soldered

Fig. 4—Construction details of the mixer trough.

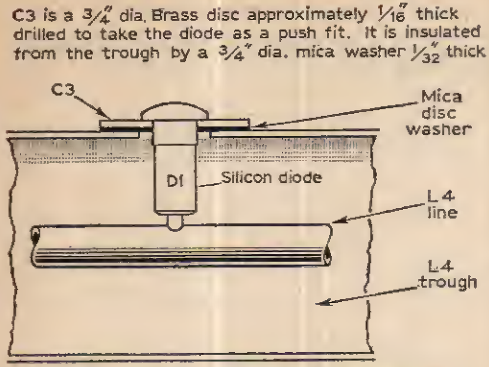


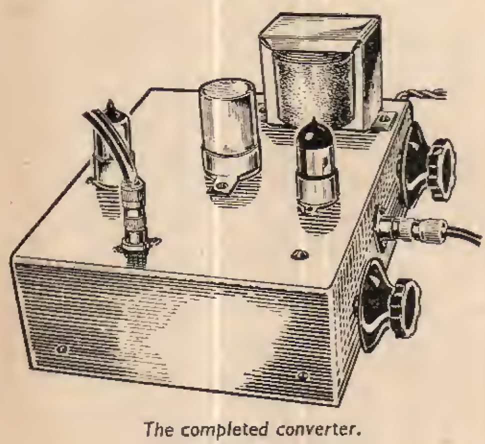
Fig. 5—Section of mixer line at D1 tapping point.

should be supported about ½in. away from the L1 lines and near the centre of their length.

The h.t. and heater leads to V1 are filtered by using feed-through capacitors (C1 and C2) to connect these supplies through the screens. If this type of component is unobtainable, an ordinary ceramic capacitor can be used in its place.

I.F. Amplifier

The i.f. output from the mixer diode D1 is coupled to the cathode of V2 by C4. L10 provides a d.c. return path for the mixer diode current with-



The completed converter.

out shorting out the i.f. signal. When setting up the converter a milliameter can be inserted in the earthy end of L10 to measure the diode current.

All the grid pins on V2 valve holder should be earthed at the holder mounting bolts. This and the addition of a screen around the anode circuit will reduce the likelihood of amplifier instability.

Power Unit

The power unit is of very straight-forward construction.

The mains transformer is mounted on the top of the chassis. All leads from T1 must be fed

COMPONENTS LIST

Resistors:

R1	10kΩ	R5	4·7kΩ
R2	10kΩ	R6	150Ω
R3	47kΩ	R7	10kΩ
R4	47kΩ	R8	1kΩ 5W

All 10%, ½W except where otherwise stated.

Capacitors:

C1	1,000pF ceramic, feed-through
C2	1,000pF ceramic, feed-through
C3	See text and Fig. 5
C4	1,000pF ceramic
C5	1,000pF ceramic
C6	10pF ceramic
C7	1,000pF ceramic feed-through
C8, 9	16+16μF electrolytic 350V
VC1	11+11pF split stator, ceramic endplates
VC2	See text and Fig. 4

Miscellaneous:

D1	Silicon diode, CV102, CV103, IN21 or BTH CS2A
V1	6J6 or ECC91
V2	EC91
MR1	Contact cooled metal rectifier, 250V 30mA
T1	Mains transformer. Output 200V 25mA; 6·3V 1A
SK1, 2	Coaxial sockets

INDUCTOR DATA

L1	Two 3¼in. lengths of 14 s.w.g. copper wire. H.T. feed connected 2in. from VC1 end.
L2	1½in. length of exposed coaxial inner bent round to form a loop and connected to braiding. Fitted between L1 wires and adjusted for D1 current of 100 to 500μA.
L3	¾in. length of exposed coaxial inner, end of which is connected to trough wall (see Fig. 3).
L4	See Fig. 4.
L5	8 turns of 24 s.w.g. enamelled copper wire close spaced on ⅜in. diameter Aladdin former.
L6	2 turns of 24 s.w.g. p.v.c. covered wire wound on top of L5.
L7, L8, L9	8 turns of 26 s.w.g. enamelled wire on ¼in. former.
L10, L11	30 turns of 34 s.w.g. enamelled wire on ¼in. former.

directly to the underside of the chassis through grommetted holes.

All other components are fitted below the chassis. The contact cooled type rectifier MR1 is bolted to one side of the unit as indicated in Fig. 3.

Alignment

The converter should be connected by means of coaxial cable to a suitable TV receiver set on channel 1, 2 or 3—depending on which is unused in the particular district. The receiver must have plenty of sensitivity, i.e. hiss on sound and snow on the raster when the gain controls are turned fully up.

The mixer diode D1 should not be inserted until V1 and V2 stages are checked.

First it is preferable to check the local oscillator and set it roughly on frequency. The frequency is most easily checked with a calibrated absorption wavemeter adjustable from at least 370Mc/s to 390Mc/s. This instrument should be loosely coupled to L1.

Alternatively, by using a 100kΩ resistor connected directly from one of the grids of V1 to earth via a milliameter, which will now measure grid current voltage of V1, the wavelength can be measured, using Lecher lines. Tune for successive dips in the grid voltage and then measuring the wavelength.

V2 can be aligned to the correct frequency by adjustment of L5 while listening to the sound and looking at the raster on the TV receiver. A point will be found where the hiss on the sound goes through a maximum and another position where there is maximum noise on the raster. L5 slug should be positioned midway between these two maxima. If it is necessary to use channels 4 or 5 as the i.f. frequency, a brass slug will be required to tune L5 to resonance in place of the iron dust slug.

When these two stages have been tuned a 0—5 milliameter should be connected at X, shown in the circuit, and the mixer diode D1 connected.

Important: Note that diode currents in excess of about 4mA can damage the diode.

With the oscillator set to about 385Mc/s tune the mixer line to resonance, i.e. maximum diode current, and then rotate this control one-third of a turn anticlockwise to correspond roughly with the signal frequency. This position will be roughly about one to two turns anticlockwise from the position where the capacitor shorts out and will give a starting point for the 70cm band.

It is most important that the mixer tuning should be roughly right as the tuning on this stage is quite critical and signals will be missed if it is off tune.

If a 70cm transmitter is available the mixer stage can be set on frequency simply by loosely coupling the transmitter output into it and tuning for maximum diode current (watch carefully for excessive current).

A noise generator can be utilised at this stage to ensure that all circuits are on tune.

Operation

Now has come the time to connect the 70cm aerial to the converter. Unless the oscillator tuning has been calibrated, a rough guide to find the 70cm band is to set VC1 about half meshed. Mixer line resonance should give a slight increase in noise and car ignition type interference will be received if the location is near a road.

Harmonics of the TV receiver local oscillator will probably be found when tuning; these can be recognised since they will still be present when the aerial is disconnected. Several other carriers from nearby TV receivers may also be picked up with the aerial connected.

The best time to try reception on 70cm is obviously when it is known that there is somebody transmitting on the band. The band is usually well populated during contests and during good propagation conditions. It may be possible to arrange for a local amateur to give a test transmission. Once the converter is aligned and working it is only a question of locating the nearest amateur TV operator and arranging for some test signals to evaluate the signal strength.

THE 70cm AERIAL

The aerial is an important link in the equipment and the 16-element stack array to be described is the smallest array that can be used for serious amateur television work. A stack array has been chosen in preference to the yagi aerial since it has a wider operating frequency range and can be assured of giving a good performance without tuning up.

16-Element Stack Array

This aerial is composed of eight half-wave dipole elements and eight reflector elements arranged in two vertical stacks of four pairs of elements each. These two stacks are mounted side by side with elements in alignment and a small space between the inner ends of the dipoles. Each pair of aligned dipoles can now be considered as forming a full-wave dipole and will have a high impedance at the centre. These dipole elements are fed by a high impedance balanced feeder, the feeder wires being crossed so that the individual dipole elements are all in phase.

The main dimensions of the beam and the arrangement of the phasing wires are shown in Fig. 6.

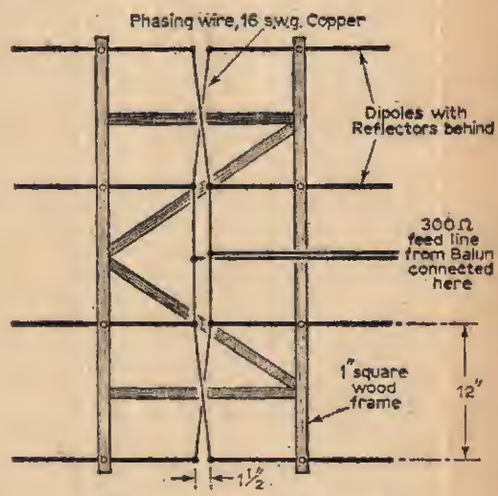


Fig. 6—16-element stack array.

The phasing wires are 16s.w.g. copper wire and this is wrapped round the appropriate end of each dipole element and soldered. The 300Ω feed line is connected at the aerial midpoint marked X-X in Fig. 6.

Fig. 7 shows an individual reflector and dipole element mounted at their midpoints on a ⅜in. diameter brass tube boom separated from each other by 5½in. There are eight of these pairs. The reflector and dipole elements are ⅛in. diameter brass rod, the reflector being 13½in. long and the dipole element 12½in. long.

The ⅜in. diameter booms are clamped into 1in square hardwood supports by self-tapping screws in two sets of four each. These sets are then set side by side as in Fig. 6 with end separation between the dipole elements of 1½in.

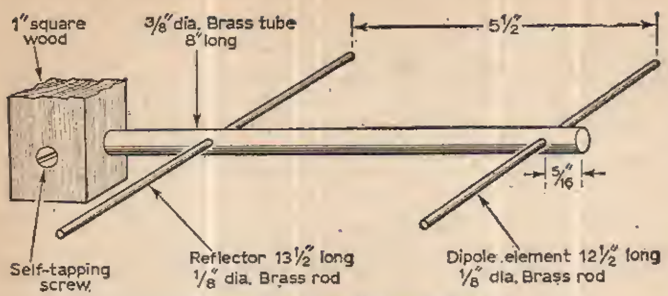


Fig. 7—Details of one pair of aerial elements.

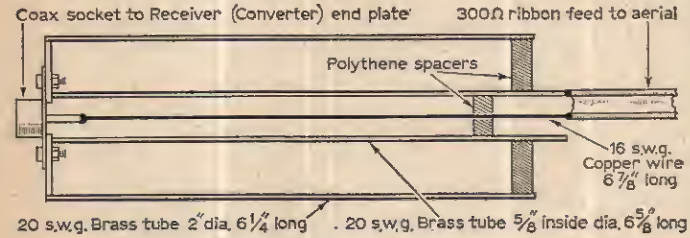


Fig. 8—Cross section of matching Balun.

Matching Balun

To match the 300Ω feed line to the coaxial cable, a balance-to-unbalance transformer is required. Such a device (generally referred to as a "balun") is easy to construct as described below.

A cross-section of the matching balun is shown in Fig. 8. The outer 20s.w.g. copper or brass tube is 2in. diameter and 6¼in. long, having a brass disc end plate soldered on one end. A ⅝in. inside diameter 20s.w.g. brass tube 6⅝in. long is soldered to the midpoint of the end plate to lie concentrically inside the larger tube. The coaxial socket is fitted as shown to the end plate and 16s.w.g. wire soldered to the socket spigot.

A polythene spacer is used to support the inner wire near the end and another polythene spacer is used to support the inner tube in the larger tube.

This balun should be mounted near the feed point of the aerial with the socket upward to prevent water entering the balun, using the end plate or the outer tube near the end plate for fixing. Do not connect or earth anything near the open end of the balun. 300Ω ribbon feed is used to connect the balun output to the aerial. The feeder length should be 11¼in. (an electrical $\frac{1}{2}\lambda$) or an exact multiple of this, e.g. 22½in., 33¾in., etc. But in any case do not use more than 2λ of feeder.

Low-loss coaxial cable must be used to connect the aerial to the converter, and to minimise signal losses in the cable the cable length should be kept as short as possible. Aerialite make a suitable 75Ω coaxial cable for the u.h.f. bands: catalogue No. 500 Super Aeraxial. This cable has a loss of 4dB per 100ft. Ordinary TV cable can have losses of 10dB per 50ft. run at 500Mc/s, which means that only one-tenth of the power is transferred for every 50ft. of cable.

Because of its very narrow beamwidth, the aerial must be rotatable and should be mounted on a mast as high as possible, at least to clear the rooftops. The higher the aerial the better the results. The best v.h.f. sites are on hilltops but few amateurs find themselves in these situations, so the most must be made of one's own particular QTH by careful positioning of the aerial. ■

SERVICING TELEVISION RECEIVERS

By L. Lawry-Johns

No. 96 THE RAYMOND F93 AND BEETHOVEN B94

WE have received many requests from readers for information on these receivers, which carry no indentification numbers and sometimes (apparently) no maker's name.

Although quite old, there are large numbers of them still in use and service information is not always available. Therefore we will present the circuit and diagrams as complete as possible.

The Raymond F93 is a 17in. table model, the F100 a 14in. table model with the F100C a console version of this. The Beethoven B94 and B99 are equivalent to the F93 with the B94c a console version. Models B95 and B98 are 14in. table models.

Tube Replacement

The 17in. versions use a Mullard MW43-64 magnetically focused tube and the 14in. sets have electrostatically focused AW36-21 tubes. The MW43-64 may be replaced by an MW43-69, the AW36-21 by an AW36-20. No alterations are necessary in either case. The circuit is quite conventional except, perhaps, for the use of a flywheel sync circuit and the use of a single PY82 valve as the h.t. rectifier. A conventional turret tuner is used with the usual coil circuits (the studs of which require polishing from time to time) and the oscillator coil core is adjusted from the front.

Fuses

There are three fuses fitted, two in an obvious position on the left hand side, one in each mains supply lead, the third being solely concerned with the line output stage in the h.t. supply to the PY81 anode and PL81 screen. This fuse is situated on the line output transformer panel.

Usual Faults

Mainly, most faults seem to occur in the line oscillator and output stages. Complete loss of picture and raster should first direct attention to the screened compartment on the right hand side.

Listen for the rather obvious line timebase whistle. If it is audible, the fuse F3 will be found intact, and the PL81 and PY81 are probably in order. Check for e.h.t. at the side of the tube and at the top cap of the EY86. If present at the latter but absent at the tube, check the EY86 by replacement. If there is little or no voltage at the EY86 top cap, but the whistle is present but subdued or strained, switch off and remove the EY86 top cap or the side clip of the tube.

If upon switching on (after a few minutes—not straight away or the PY82 may spark over and blow a fuse) the line whistle becomes more normal and a vigorous spark is obtained, it may be assumed that the EY86 is internally shorted and it should be changed. If there is no change, check the PL81 and the 0·05μF boost line capacitors. Also check the 1·8kΩ screen feed resistor to pin 8 of the PL81 valve base.

If, however, the PL81 is overheating, check the ECC82 line oscillator which may not be driving the PL81. Also check the width control, which is a compression trimmer, and associated 1,000pF and 150pF capacitors, one of which could be shorted or leaky.

If there is no whistle at all, check F3 before checking the above valves and components.

Line Hold

If the picture cannot be resolved horizontally and is a jumble of horizontal lines, or if a picture can be resolved by the control but cannot be held, check by replacement, the ECC82 line oscillator, set VR7 (hold) control midway and adjust L14 for a locked picture. Do not disturb L15 which is the stabilising coil.

Should the trouble persist, check the hold control VR7 which often changes value. The correct value is 250kΩ. Also check R99 220kΩ. L14 is the preset line speed coil. It is adjusted from above, behind

V18, to suit the fitted ECC82 valve so that the front VR7 has adequate range. This and L15 should not be confused with the line linearity coil L16 which is accessible from below the chassis near V16 (ECC82) and adjusts the left-to-right relationship of the line scan.

L15 rarely needs adjustment and unless an oscilloscope is available this coil core should not be altered. If sync is weak and unreliable check V15 (PCF80).

Lack of Width

With complaints of insufficient width check the h.t. voltage which should not be much under 170V. The full d.c. output of the PY82 is, or should be, 180V. Replace the PY82 if the voltage is low. Then check the line timebase valves V16, V17 and V18 and resistor R107 1·8kΩ. Check CV1, C96 and C97 if necessary.

TO BE CONTINUED

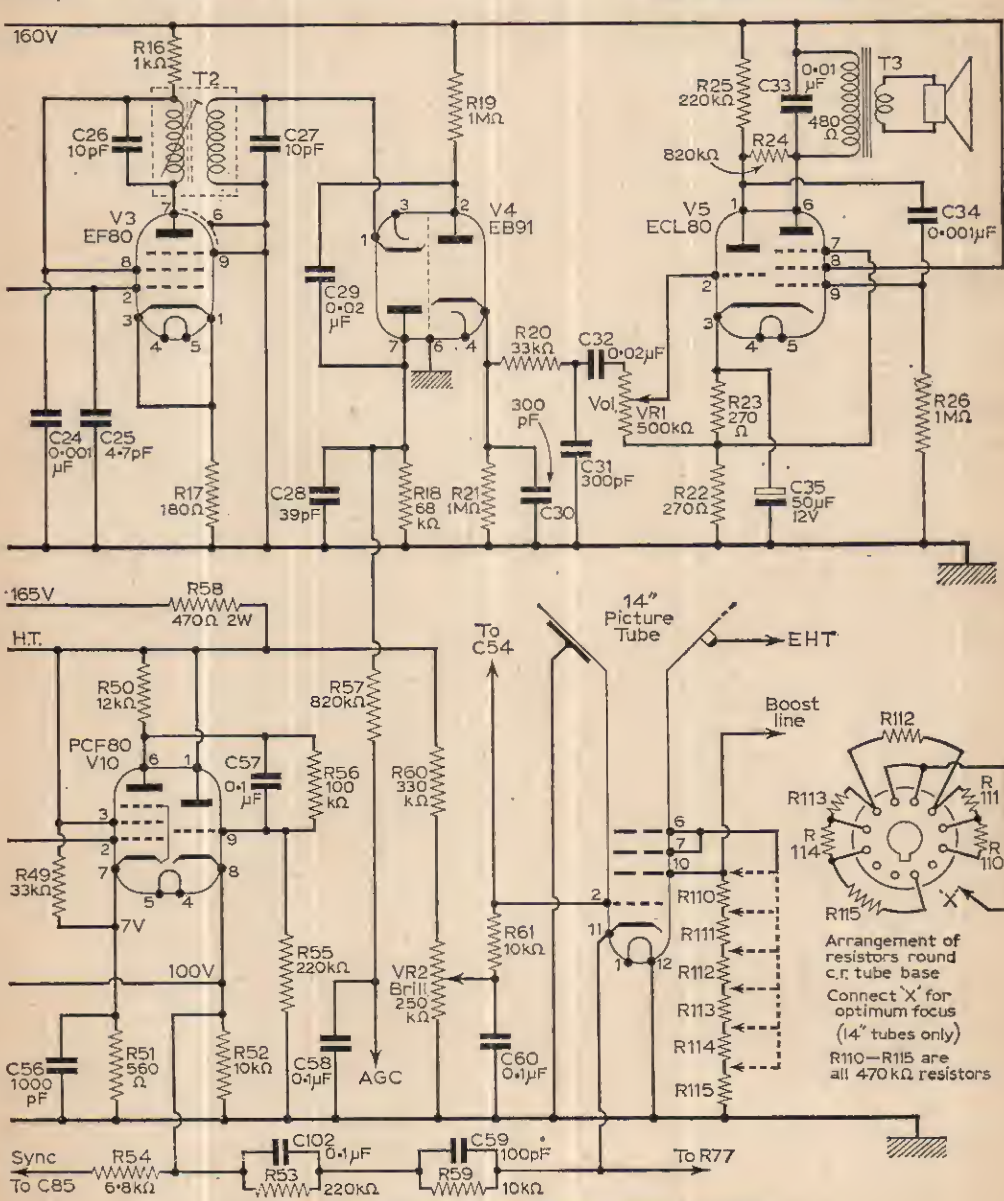


Fig. 1—The sound channel, video amplifier and c.r.t. circuits.

A MONTHLY FEATURE FOR DX ENTHUSIASTS

DX-TV

by Charles Rafarel

CONSIDERING the question of receivers, let us examine the Continental TV systems, and how they differ from our 405-line system. Most European countries use the 625-line CCIR system, which will be available here when BBC-2 opens, although the earliest date in many areas for BBC-2 is 1965.

TV systems fall into two categories for vision transmission, (1) as a positive or (2) as a negative-going signal. In the positive modulation system, a peak white picture is produced by the maximum power output at the transmitter and a black screen represents zero signal output. With a negative going picture the opposite applies, with maximum power at black and zero signal at peak white.

The sound channel may employ amplitude or frequency modulation. A further complication in receiving Continental TV pictures and sound together, is due to the fact that the spacing between the sound and vision channels varies considerably with different systems and countries. Ways and means of "sorting out" this spacing difficulty by the simplest means will be dealt with in a future article.

So that we can see what is really involved, here are the various systems tabulated:

The various channels in service in Europe are designated "B" for British, "F" for French, "E" for West Europe, "R" for East Europe, etc. Two more snags arise here for the signal frequency of, say, Channel B2 is not the same as for E2 because each system has its own special frequencies, which we have to learn in due course.

Country	Lines	Modulation	Sound	Sound/Vision Spacing
Britain	405	Positive	A.M.	3·5 Mc/s.
France	819	Positive	A.M.	11·15 Mc/s
Belgium, Monte Carlo, Luxembourg	819	Positive	A.M.	5·5 Mc/s
Belgium	625	Positive	A.M.	5·5 Mc/s
Western Europe (CCIR)	625	Negative	F.M.	5·5 Mcs/
Eastern Europe (OIRT)	625	Negative	F.M.	6·5 Mc/s
Italy*	625	Negative	F.M.	6 Mc/s

** Also certain Irish transmitters and future BBC-2 network.*

Also the sound channel of a particular transmitter may be on the l.f. side of the vision frequency, while with a different transmitter and channel it may be h.f. This can be very confusing at times!

Beginners, particularly in Southern England, are advised to direct their first reception attempts from the Continent towards France. In order to get a *picture only, of a sort*, no modifications are necessary to a 405-line receiver provided that it will tune throughout all of Bands I and III. However, most French transmitters are horizontally polarised and aerials should be accordingly arranged on the lines given last month.

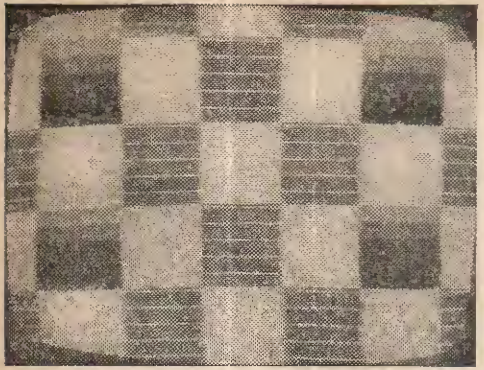
First of all tune in a local BBC or ITA transmitter on the normal aerial and check that the line lock control is in the optimum locking position for the 405-line picture. Then transfer the receiver to the horizontal DX aerial and be prepared to slew this through a *wide* arc in a general southern direction whilst the set is progressively tuned through Bands I and III.

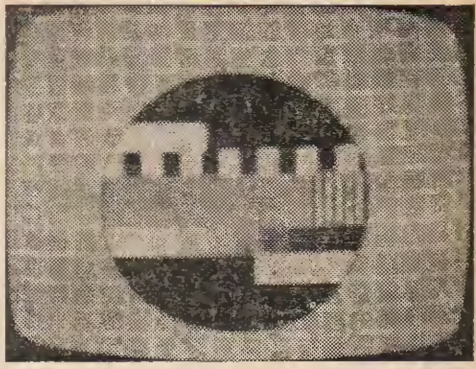
Given reasonable conditions and a little luck, it may be possible to resolve out of the background "hash" two complete pictures side by side and divided by a vertical black bar. If so, you will have your first DX. The French 819-picture is approximately twice the line frequency of the 405-line picture ($2\times405=810$). Near enough at reasonable signal levels to lock in on a flywheel sync receiver. We will shortly discuss receivers and modifications to get rid of your "double vision".

NEWS ITEMS

(1) *On u.h.f.*, LOPIK (ch.27) AACHEN and DONNESBURG (ch.37) and LINGEN (ch.41) have been successfully received in East Anglia, the first two by more than one viewer. RTF/UHF opening is being eagerly awaited.

(2) *Nicosia, Cyprus* (E2) has been received and identified in Austria and East Germany and is a "possible" here. Some of us have had a mystery test card already that could be this one.





Here are two screen photos of test cards which baffled reader R. J. Blaney. The one on the left we have identified as an N.T.S. (Dutch television service) at Lopik, Holland, operating on channel 27. Power is 250kW (vision), 50kW (sound). This test card is identical with that used by N.T.S. stations in Bands I and III.

With the test card shown on the right, we can only confirm that this is a standard West German type as used by the D.B.P. (Deutscher Bundes Poste). It could be Aachen on channel 37, Lingen on channel 4 or Lingen on channel 24.

DX REPORTS

We are always interested in hearing from TV DX enthusiasts and hope you will write in from time to time with news. This month we had a letter from reader R. J. Blaney of Billericay, Essex. He has been interested in the subject for 18 months and uses a 23in. export 625-line receiver which has a reversing switch for negative or positive modulation and a switch for 625/819-lines.

His first DX signal was Lousa, Portugal, in Ch. 3 —using only a short wire indoors! Encouraged by this he built a 35ft. high tower of 1in. wood and mounted on top a 55Mc/s 3-element beam to cover Band I. He can rotate this beam from the receiving position, using a 24V motor with gearbox.

When it became clear that Britain was going to adopt 625-line u.h.f. TV, he added a u.h.f. converter and soon received stations in Holland and Germany. An interesting observation by Mr. Blaney is that he considers special multi-element aerials are *not* required; he says, "I get results just as good on an 8ft. dipole 12ft. above ground and a 3-element which I have not yet put outside for Bands IV and V".

During the last few months he has logged Italy, Hungary, Spain and Holland, at around 7.30 p.m. on Band I and Holland and Germany on Band V.

Mr. Blaney also sent in some interesting photos of the screen including two mystery cards which are reproduced on this page and which we are printing for the benefit of other readers who may also be puzzled.

May we hear from other TV DX enthusiasts?

OSCILLOSCOPE TIMEBASES

— continued from page 106

combined output voltages exceeding some two-thirds of the applied h.t. Many oscilloscope c.r.t.'s require very large total deflection voltages for screen coverage, so that a paraphase amplifier of the type of Fig. 15(c) would need inconveniently high h.t. supply voltages. But in the circuits of Fig. 16, each valve alone can supply a deflection output signal having an amplitude some two-thirds or more of the h.t. voltage, so that the total deflection signal can be as high as one-and-a-half the h.t. voltage in amplitude. Apart from this, both arrangements give considerable amplification. If this is not required in full, the drive can be taken from a suitable tapping on the Miller valve anode load.

Both paraphase amplifier arrangements are also reasonably familiar from audio amplifier practice, where they are sometimes used. It should be pointed out that the trimming of the two resistors between the anodes in Fig. 16(b) to values slightly different, in order to achieve true push-pull balance, so important for use in audio amplifiers, is here not strictly necessary as conditions are far less critical.

Fig. 16 shows paraphase amplifiers which are found not only in the timebase output stages of oscilloscopes, but also as signal amplifier output stages for the Y-deflection, as the demands are there the same.

Small or cheap oscilloscopes often operate without paraphase amplifiers. The timebase or signal amplifier outputs are coupled direct to one deflector plate, the other plate of each pair being returned through a leak resistor to the final anode, or to a shift potential control arranged in the form of a single one of the potentiometers shown for this purpose in Fig. 17. When using paraphase amplifiers in good quality oscilloscope designs, shift controls should be symmetrical too, as shown in full in Fig. 17, which also shows the general scheme of connections to the cathode-ray tube of oscilloscope.

Conclusion

This article has now covered the entire range of important circuit bricks available for designing oscilloscope timebases, and it is hoped that the discussions will prove of value to those readers designing their own oscilloscopes. ■

A MONTHLY COMMENTARY

Underneath the Dipole

BY ICONOS

TELEVISION is a compound of vision and sound. For many months I have been grumbling about the reluctant attention paid by many TV set manufacturers to this part of their package. The small, inadequate loudspeakers secreted away in the side, back or top of the sets, sometimes resemble those in office intercoms, and the quality isn't much better. This applies particularly to hired sets for piped television services.

Of course, price is the main factor, and competition between rival manufacturers and hirers tends to reduce quality to the lowest common denominator. "*The most important factor is—whether it harmonises with the furniture, the carpets or the curtains*", say the manufacturers. "*The general public doesn't notice anything else as long as the set works and is easy to switch on!*".

Better Sound

Nevertheless, I have always felt that there is a market for television receivers capable of giving high quality sound as well as high quality picture. The stumbling block always seems to be when a set reaches the department responsible for the cabinet styling, colour and the inevitable brass embellishments.

It is true that the general public appreciates good sound even less than a good picture, and will put up with terrible rattles and distortions. They have become conditioned to it by the tinny noises that emanate from tiny transistor sets with overloaded earphones as loudspeakers. The quality of sound on some of these sets is sometimes inferior to the noise from a 1903 Edison Bell phonograph. I know, because I've got one of these historic talking machines, which play cylindrical records!

Yet important strides have been made in the sound field in the last three or four years, particularly with stereophonic reproduction of gramophone records. The best hi-fi stereo sets I have heard, have been equipped with entirely separate loudspeakers, which can be placed in suitable positions in a room without being tied down to the set itself.

Stereo reproducers with one internal speaker and one separate speaker are also effective. This is the line I would like to see taken with television sound; not for stereophony, but for a set to have a simple external loudspeaker pair of terminals and switch.

Stereophonic Sound

There are countries which broadcast stereophonic sound regularly as a public radio service. The use of a multiplex system for transmitting stereophonic f.m. sound on v.h.f. is an actual fact in a number of radio and television stations in the USA and Japan. The second channel of sound is transmitted on a subcarrier from a single v.h.f. transmitter, and can be heard by listeners and viewers who already possess the usual hi-fi stereophonic amplifiers and loudspeakers.

Of course, the special radio or television receivers have to be added to de-scramble the multiplex sound signal. This is no vague piece of gossip, based on wishful thinking upon the part of a stereo enthusiast! A very solid piece of evidence came into my hands recently, when I bought a heavy American radio receiver of special design which was made in Japan!

It incorporates the following: (a) two separate radio tuners for receiving medium, short and v.h.f. sound, (b) stereo or mono outputs (each 15W) to feed loudspeakers, (c) provision for reproducing sounds from a stereo-tape recorder or from stereo disc transcription pickups (magnetic, ceramic or crystal cartridges), (d) scratch filter, (e) bass and top pre-emphasis switching at low level and, of course, (f) provision for a

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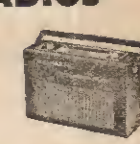

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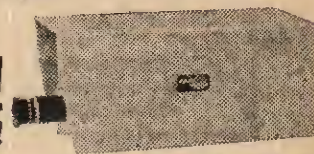

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