Practical TELEVISION

JANUARY 1966

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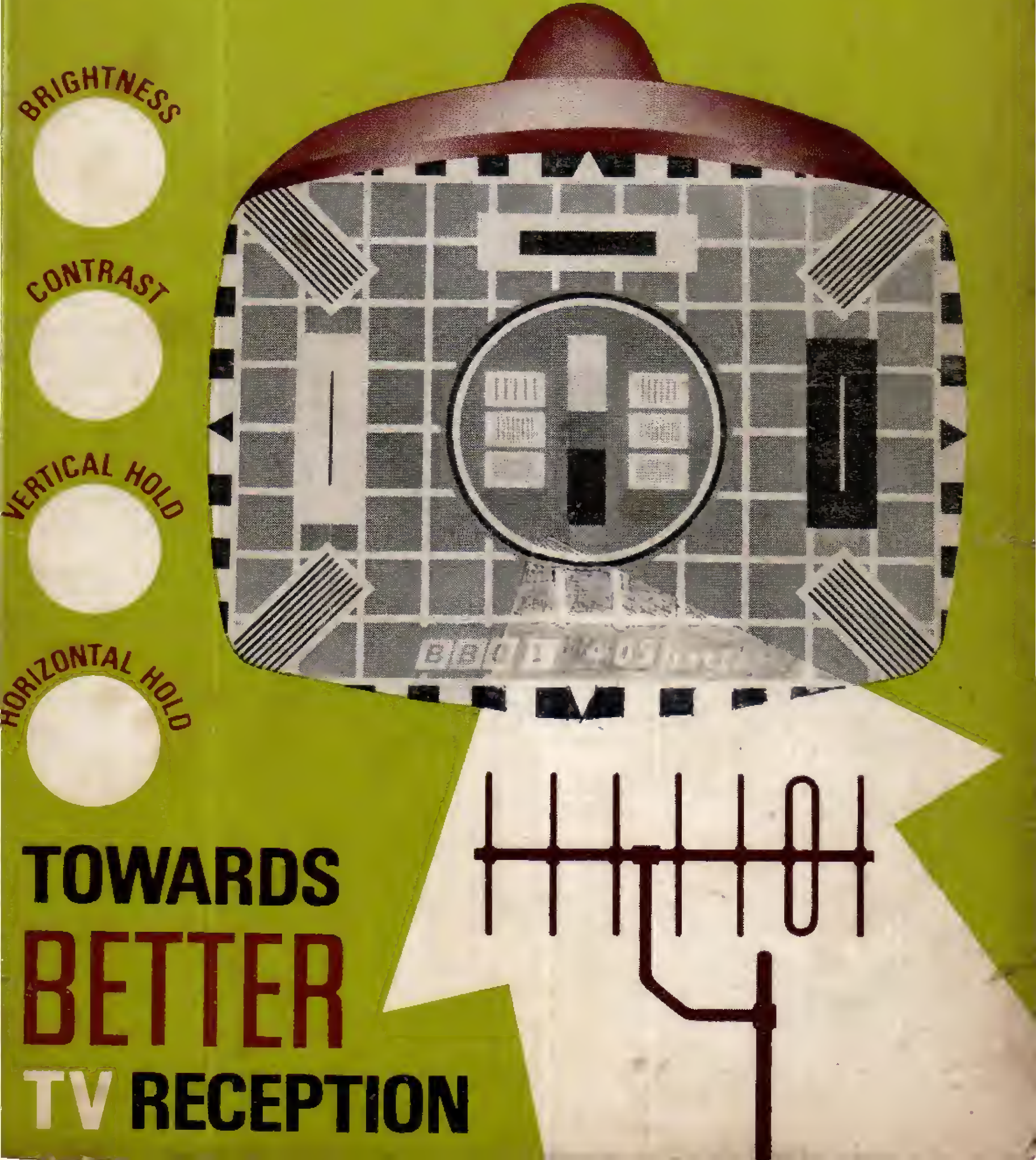


TOWARDS BETTER TV RECEPTION

Practical Television

JANUARY 1966
VOL. 15 184

AN OPEN LETTER TO THE POSTMASTER GENERAL
The Rt. Hon. Anthony Wedgwood Benn, M.P.

Dear Minister, 23/11/65

In the debates on broadcasting in the House of Commons in May 1965, the following problems were discussed: BBC-2's u.h.f. transmissions; a possible increase in BBC licence fees; an alternative source of revenue by a limited amount of advertising on BBC-2; the allocation (or not) of a fourth channel for independent television or some other organisation; choice of a colour TV system.

All of these items were haunted by the estimate that BBC's cumulative deficit by 31st March 1966 would be £25M, rising to about £120M in five years' time.

Many TV engineers now consider that the capital outlay on BBC-2 transmitters on u.h.f. will be over £120M, that anything up to 400 large, medium and small slave transmitters will be required (with corresponding operational costs). At present, viewers' reactions to BBC-2 on the u.h.f. bands has been tepid, and will continue to remain so until a quota of colour transmissions are included.

We hope, Minister, that you will bear in mind viewers' reluctance to pay larger licence fees and the BBC's forebodings on their financial future. May we make these practical suggestions for dealing with these problems?

(a) Allocate the present u.h.f. transmitters jointly to BBC (3 days) and ITV companies (4 days).

(b) As soon as possible, select the colour TV system on the u.h.f. bands and permit colour advertising by ITA companies.

(c) Reserve the Fourth Channel for later use, to enable both BBC and ITV to expand their activities to a full week for each, or to utilise the Fourth Channel for educational or industrial purposes.

(d) Retain the present v.h.f. coverage on BBC-1 and ITV on a permanent basis.

Colour TV on 405 lines is an attractive proposition, but restricted bandwidths are the limiting factor for quality and compatibility on monochrome receivers. The early introduction of colour on 625 lines, with its increased resolution, would provide an incentive to viewers and a boost to industry. In America there are already seven million colour TV sets. Must we drop behind internationally because of BBC's rising deficit?

Yours respectfully,

W. N. STEVENS,
Editor, PRACTICAL TELEVISION.

(Latest colour news on page 157)

THIS MONTH

OUR NEXT ISSUE DATED FEBRUARY WILL BE PUBLISHED ON JAN. 20th

All correspondence intended for the Editor should be addressed to: The Editor, "Practical Television", George Newnes Ltd., Tower House, Southampton Street, London, W.C.2. Phone: TEMple Bar 4363. Telegrams: Newnes Rand London. Subscription rates, including postage: 29s. per year to any part of the world.

TELETOPICS

ELECTRONIC RENTALS ASSOCIATION RECOMMENDATION ON COLOUR TV

THE E.R.A. submits that a decision should be made as soon as possible on the introduction of a public colour television service and that there should be no delay in announcing the decision.

A public service of colour television should be introduced as soon as possible, starting in the London area and progressively extended to give coverage of all major centres of population within two years.

Colour programmes should be transmitted, at peak viewing times, for at least one and a half hours on each weekday and more at week-ends. The proportion of colour transmissions should be increased rapidly—with a target of at least 50% of programme hours within five years.

Colour television programmes should be made available by both BBC and ITA. The service might, initially, be provided by the BBC only, but within one year also by the ITA.

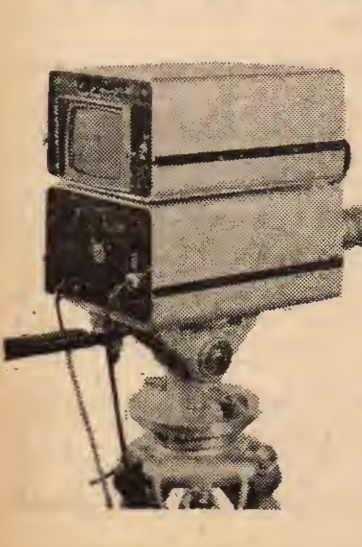
E.R.A. strongly recommend that both BBC and ITA should use the PAL system with 625-line standards in the u.h.f. band.

Regular colour test transmissions should be available daily, except Sundays, as part of the normal test transmission for a period of three months before the opening of a service in any particular area. After the commencement of the colour service half the time occupied by normal test transmissions in the day time should be devoted to colour by alternating colour and black and white test transmissions at fifteen minute intervals.

Adequate training facilities in colour television set servicing must be made available at technical colleges etc., as soon as possible after the decision to introduce a colour service has been made. These training facilities should be available to full-time, day release and evening class students in all parts of the country.

If it is found necessary to increase television licence revenue to meet the cost of colour transmissions, a separate colour television licence should be adopted rather than any increase in the general TV licence fee.

RANK AUDIO VISUAL CCTV CAMERA



PHOTOGRAPH shows the R17 closed circuit television camera with accessory electronic viewfinder. It is marketed by Rank Audio Visual.

It is a low-cost, lightweight and fully transistorised unit specially designed for educational and industrial applications.

With a scanning standard of 625 lines at 50 cycles, the R17 camera is suitable for use from mains supplies of 200—250V a.c. 50 cycles. It provides a fully stabilised, high definition image with good picture geometry.

The camera has provision for remote control operation of electrical focus, beam, and target, for specialist applications. It can be used with an external sync pulse generator when required.

SPECIAL EVENING LECTURES

THERE will be nine lectures on Colour Television commencing on 3rd February, 1966. They will start at 7 p.m. and finish at 9 p.m.

The lecturers will be T. Jacobs, B.Sc., and P. L. Mothersole, A.M.I.E.E., M.I.E.R.E., both of Mullard Limited. The course content will be: Basic principles of colour reproduction; proposed colour television systems; display devices; receiver circuits.

The fee for the course of lectures is £2 15s. and the lectures will be held at the Hendon College of Technology, The Burroughs, Hendon, London, N.W.4.

BBC-2 TEST TRANSMISSIONS FROM ROWRIDGE

THE BBC commenced full BBC-2 programme transmissions from Rowridge, Isle of Wight, on the 18th December.

The Rowridge transmitter will bring BBC-2 to about one million people in South Hampshire, most of the Isle of Wight, parts of East Dorset and South West Sussex, and a small area in southern Wiltshire.

TV STUDIO FOR MEXICO

GREAT BRITAIN is sending a complete television studio centre, made by Pye TVT, to Mexico. The equipment, a gift from the British Government, will be installed in the Politecnico Nacional, in Mexico City for educational purposes.

The gift is the result of an offer made by Prince Philip during his recent visit to Mexico, where he stressed the importance of television as an aid to the teaching of students.

AERIALITE LITERATURE

THE following literature is available on request from: Aerialite Limited, Hargreaves Works, Congleton, Cheshire.

"Aerialite Television and Radio Aerials and Accessories WALL CHART". "Aerialite 'Golden Gain' U.H.F. Aerials Brochure and price list."

EXPERIMENTAL COLOUR TELEVISION TRANSMISSIONS

THE schedule of BBC experimental colour television transmissions from Crystal Palace channel 33 on the PAL system is as follows:

Monday, 1400—1700, test card, colour-slides and colour bars; Tuesday, 1400—1700, test card, colour-slides and colour bars; Wednesday, 1400—1600, test card, colour-slides and colour bars; 1600—1700, live studio pictures and films, 1810—1900, live studio pictures and films; Thursday, 1400—1700, test card, colour slides, and colour bars; Friday, 1400—1600, test card, colour slides, and colour bars, 1600—1700, live studio pictures and films, 1800—1900, live studio pictures and films.

The test card periods consist of 15 minutes of test card in black and white, 10 minutes of colour bars and 35 minutes of colour slides in each hour.

SLADE RADIO SOCIETY TV SHOW

SLADE '65, the second TV show (on closed circuit) to be presented by the Society, took place on Saturday, 2nd October. Three cameras were in use, and most of the equipment was built by amateurs.

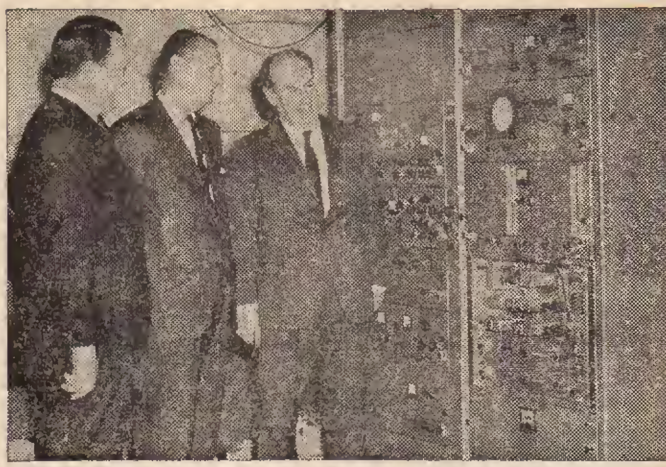
The first part of the show, produced by Slade Radio, consisted of a magazine programme, comic sketches, and an excerpt from "The Importance of being Earnest". The second part, produced by Sutton Operatic Society, was an excerpt from "South Pacific", with a cast of sixty.

All video equipment worked well, but the sound gear gave a little trouble. Despite this, the evening's entertainment went down well, and a great deal of TV experience, both technical and otherwise, was gained by all those involved.

THE FILMSHOW

MAKE a note of the P.W. and P.TV. Filmshow. — See the notice on page 162.

AMERICANS BUY BRITISH



SHOWN here during a recent visit to the Marconi Company is Mr. William P. Kusack, the Chief Engineer of the Field Communications Corporation of Chicago, USA.

He is seen (centre) examining the control and drive units of one of the two 25kW u.h.f. television transmitters that have been ordered by Television Chicago, part of the Field Communications Corporation. With him, on the left, is Mr. T. Mayer, Manager of the Marconi Broadcasting Division and Mr. W. J. Morcom, Chief Engineer of the Company's Telecommunications group.

These transmitters, together with six of the new Marconi Mk V television cameras, were chosen by Television Chicago after an intensive appraisal of all the equipment on the market. It is, in fact, the first time that British television transmitters have ever been sold in the United States of America.

MINI ELECTROLYTICS FROM MULLARD

FROM Mullard comes the C428 series of miniature long-life electrolytic capacitors for industrial applications.

Typical service life figures at 40°C are 200,000 hours' continuous operation at an estimated failure rate of only 0·025% per 1,000 hours at full rated voltage.

The capacity range of the series is from 2·5μF to 320μF. Working voltages are from 4V to 64V.

EUROPE'S COLOUR TV UNIT

A MOBILE colour TV recording unit, the first of its type to become operational in Europe, has been set up by Intertel at a cost of more than £200,000.

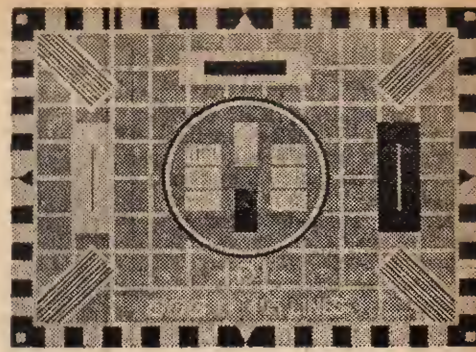
The new colour unit comprises three vehicles including a generator and includes four Marconi B3200 colour cameras, each with three 3in. image orthicons and zoom lens, together with NTSC 525 and 625-line encoders, PAL 625-line encoder, two Marconi 12-channel sound mixers and eight Conrad 17in. colour monitors and ancillary equipment, including vision mixing units. The mobile recorders are two Ampex VR2000 video tape recorders with full colour units and featuring high-band recording.

A Happy Christmas and Successful New Year from the Editor and Staff.

GORDON J. KING

TOWARDS BETTER TV RECEPTION

First of a Series



THE performance of a correctly working television set is determined by (i) the strength and quality of the signal applied to it from the aerial system, (ii) the strength of the voltage applied to it from the mains or power supply and (iii) the accuracy of the setting of its preset and main controls.

The performance, of course, is also determined by the electrical condition of the various parts making up the receiver and by the tuning and adjustments of the various circuits. However, there are many thousands of cases of poor reception which are caused not by a fault in the set itself but by the three external factors given above. First of all let us investigate these in turn.

For any television set to work properly it needs sound and vision signals of specific voltage to overcome noise signal voltages which are generated by the set itself. All sets generate noise voltages. On vision these show up on the picture as " snow " or grain while on sound they are heard as a " hiss " from the loudspeaker.

NOISE SIGNALS

It has been discovered that for the noise signals to have insignificant effect on the reception they must be exceeded in strength about 100 times by the sound signal and 200 times by the vision signal as applied to the set from the aerial. The generated noise signals can be considered as existing at the aerial socket of the set.

Thus, if the aerial is removed from the set, noise signals only are present and by turning up the brightness, contrast and volume controls, they are revealed as a grain or snow effect on the screen and by a " hiss " from the loudspeaker, as already mentioned. There would be no picture or sound under this condition, of course.

Now, if a very strong aerial signal is applied to the set, as obtained by viewers living near a transmitter, the noise signal will be very small in comparison. Indeed, the aerial signal would be more than 200 times as strong as the noise signal. This would mean that the noise signal would be neither heard nor seen and the sound and picture would be as pure as transmitted.

Unfortunately, in many areas the vision signal is not always 200 times stronger than the noise signal, nor the sound signal 100 times stronger than the noise signal. When the vision signal is only about 10 times stronger than the noise signal grain on the picture is very disturbing. When the aerial signal falls below 10 times the picture is virtually impossible to view for any length of time. On sound, however, the " hiss " due to the noise signal may not be so disturbing. The picture is the most critical so far as noise is concerned.

At ratios of signal-to-noise between, say, 10-to-1 and 200-to-1 intermediate amounts of grain appear on the picture. A picture resulting from a signal/noise ratio of about 100-to-1 is very viewable and the grain background is not at all disturbing, but the grain increases to an intolerable amount as the signal/noise ratio drops to about 10-to-1, as mentioned already.

LOW-NOISE DEVICES

At this juncture we should define this "noise signal " a little more. This signal is generated by the normal actions of amplification and frequency conversion within the tuner. As yet, it is impossible to amplify and frequency convert without making noise.

There are very expensive ways of minimising the strength of the noise signal in low-level amplifiers and converters. These are employed in satellite communications systems and take the form of MASER devices. The term stands for " Microwave Amplification by Stimulated Emission of Radiation " and the term for the corresponding oscillator is MOSER.

A device which is slightly less noisy than valves and transistors but considerably more noisy than a MASER is a " Parametric Amplifier ". All these devices, however, are far out of the scope of the commercial TV set and are referred to academically only in this article.

We thus have significant noise signals to contend with. The signal/noise ratio of a TV installation is kept as high as possible by designers creating tuners of the lowest noise factor and by aerial erectors or viewers ensuring that the set is fed with the strongest possible sound and vision signals on all the channels viewed.

It must be understood that the noise signals we are at present considering are not the same as those signals which are picked up by the aerial from some source of external interference, such as car ignition systems, electric switches and household electrical appliances. These we will call " interference signals " to distinguish them from the noise signals actually generated by the set itself.

Noise signals are produced by the random movement of electrons in components and conductors and by thermal effects as electrons are accelerated from the cathode to the anode in a valve.

The noise signal generated by a tuner, for instance, has a value which increases as the tuned frequency is increased. In the case of a v.h.f. tuner (i.e. a tuner covering channels 1 to 5 in Band I and 6 to 13 in Band III) the effective strength of the noise signal on channel 1 may be in the order of 3μV (1μV being equal to one-millionth of a volt) and 5μV on channel 13

To procure the desirable 200-to-1 signal/noise ratio respectively on these two channels, therefore, the aerials would have to supply the set with signals of 600μV and 1,000μV. However, as has been discussed, signals of 300μV and 500μV respectively (100-to-1 signal/noise ratio) would still allow the set to give a good noise-free performance.

NOISE AT U.H.F.

On the 625-line u.h.f. channels noise signals are more of a problem. The effective noise signal strength at the low end of Band IV may be about 8μV, rising to 12μV at the top end of Band V. Thus, our 200-to-1 signal/noise ratio would be attained by aerial signals of 1,600μV and 2,400μV respectively, while the 100-to-1 ratio would be attained by signals of 800μV and 1,200μV.

Clearly, then, to secure a picture on the u.h.f. bands of equivalent noise content as the picture on the v.h.f. bands, the u.h.f. aerial signal needs to be considerably higher, depending upon the actual channels compared. This is, indeed, a major problem so far as reception in the u.h.f. bands is concerned, for u.h.f. signals are much more affected in their propagation from the station to the set than are v.h.f. signals, and they are much more easily weakened.

How are set designers overcoming this problem? Well, there is not a lot that the set designers can do about the propagation aspects, but what they can do (and, indeed, are doing) is to design u.h.f. tuners with lower noise figures.

HOW TRANSISTORS HELP

Recently, they have been helped considerably by the advent of the u.h.f. transistor. A transistor can give almost as much amplification of the u.h.f. signals as a valve, but since it does not rely on thermal effects for its operation, it can amplify without generating as much noise as a valve. U.H.F. tuners employing transistors can work at the same signal/noise ratio as valve tuners with an aerial signal of about two-thirds the strength of that required by valve tuners. This is of great help as will be appreciated.

Many dual-standard receivers are now adopting transistor u.h.f. tuners. Transistors also have noise advantage over valves at the frequencies corresponding to the v.h.f. bands, but transistor tuners are not quite as important here as at u.h.f. because the strength of the signals obtainable on the v.h.f. channels from the aerials is generally greater than that of the u.h.f. signals. Nevertheless, there is also likely to be a trend towards transistor v.h.f. tuners and, indeed, fully transistorised TV sets in the future.

Having now seen what the designer is doing to improve reception, what can the dealer or viewer himself do to help in this respect? Here the major problem is ensuring that the set receives as much aerial signal as possible, especially in poor reception areas where it is normally a bit of a job to secure even a 100-to-1 signal/noise ratio.

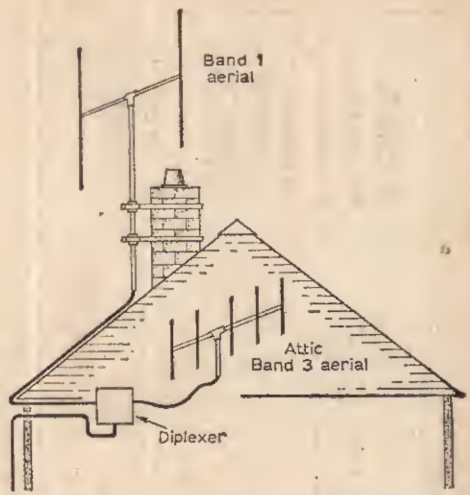


Fig. 1—Here is shown how a Band III aerial mounted in the attic can be diplexed into the common downlead. Great improvement in reception is possible if the BBC aerial alone has previously been for ITV as well as BBC.

So far as reception on Band I and III is concerned, there are very few areas where the signal is so weak that it cannot in some way be processed to secure the minimum signal/noise ratio.

Unfortunately there is a trend to "make do" with any old aerial in areas of moderate and good signal strength. This is all very well provided the "make do" affair gives the set signals of sufficient strength to procure at least a 100-to-1 signal/noise ratio.

This is not always the case, and the author has investigated reception problems where the signal strength is adequate to give a signal/noise ratio even above 200-to-1 and yet the set has been found to be exhibiting a signal/noise ratio performance about 50-to-1 or even less!

IMPROVING ITV RECEPTION

In many cases, the poor reception is on Band III. And, funnily, this is because the signal strength on the Band III channel is so high that reception has been found possible on the Band I aerial. By the use of the very simplest loft Band III aerial diplexed to the downlead a substantial improvement in reception has been achieved with the minimum of cost. Well worth paying for. Fig. 1 shows a Band III aerial diplexed to the Band I aerial downlead.

In areas where the signal is below moderate, separate or composite Band I/III aerials are essential. Reception of the Band I programme is generally good, unless one happens to be unfortunately located where this signal is greatly attenuated or cut off completely by a hill, in which case a hill-mounted aerial or operation from a relay system is about the only solution. There are few areas now where Band III reception at 100-to-1 signal/noise ratio cannot be achieved, unless, again, of course, the signal is cut off by a local hill.

If Band III reception is poor for no apparent reason the aerial should first come under close scrutiny. If reception has always been poor one should try turning the aerial to pull as much signal as possible out of the ether! Band III aerials are far more directional than their BBC counterparts, so can lose signal considerably by being off direction. After a gale it is not uncommon for an aerial to have swung as much as 40 or 50° off direction.

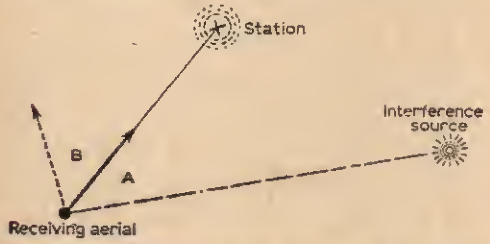


Fig. 2—By reorientating the aerial from the direction of the full-line arrow to that of the broken-line arrow the angle from the interference source is increased from A to A+B, while the off-beam angle relative to the station is B.

Next a check should be made of the downlead and its connections at the aerial and at the set or diplexer. Coaxial downlead which has been in external service for some years can pick up water in its dielectric, resulting in a great rise in its signal attenuation factor.

It pays to replace any dubious cable, especially if one has reason to believe that it may be in some way responsible for the poor ITV reception. In areas of poor ITV reception good quality, low-loss cable should be employed on the main downlead and also for the lead connecting the ITV aerial to the diplexer.

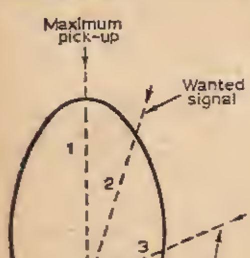


Fig. 3—The response of an aerial. When "on beam", the pick-up is proportional to the length of line 1. Thus, by reorientating so that the wanted signal causes a pick-up proportional to line 2 the interference is pushed down proportional to line 3, much shorter than line 2 (a ratio equal to the length of line 2 to the length of line 3). This is a higher ratio than with the aerial "on beam" which would give a ratio of wanted signal to interference proportional to the length of line 1 to the length of line 2.

DON'T FORGET THE DIPLEXER

An outside diplexer can also fill with water when it rains. Although this may eventually drain away it does not do the works any good, and signal attenuation is greatly increased by leakages brought about by the water. If in doubt, replace the diplexer. They are not costly, and it pays to get a good one.

If reception is still poor after all these things have been examined or attended to, one must consider the possibility of replacing the aerial itself for one of higher gain (i.e., more elements). Unfortunately, the best aerial is not always fitted for reasons of economy and competition relative to the dealer or the rental company.

But remember even if one is renting a set, there is no reason why a better aerial system cannot be installed by the viewers provided the set itself is not tampered with and assuming that the aerial system is the property of the viewer. It is interesting to note that the majority of "poor reception" complaints investigated by the Post Office result from bad or indifferent aerial installations.

One does not like to see the skyline cluttered with chimney-mounted aerials, but in secondary service areas and in screened pockets such aerials are essential for good reception, particularly on the higher frequency channels.

By-laws prohibiting the use of outside aerials are in force in some council residential areas. Such a law often makes it impossible for affected viewers to obtain pictures based on a signal/noise ratio of 100-to-1.

COMMUNAL AERIAL

Some councils, however, understand the technical problems involved and cater for restricted tenants in terms of a communal aerial system. Provided the "master aerial" of such a system is sited high and clear of interference, the associated aerial amplifiers of low-noise specifications and the installation generally well designed, then each viewer is assured of signals equal in strength and quality to those which would be obtained from an elaborate and expensive individual aerial.

Poorly designed communal aerial systems, on the other hand, can cause a great deal of trouble for the viewer and can be responsible for very grainy or poor quality pictures, even though the strength of the signals piped to each subscriber is at least that which would normally give high signal/noise ratios from an ordinary aerial.

The reason for the poor, grainy pictures results from the use of aerial amplifiers which are not specifically low-noise and which may be overdriven to supply a large number of viewers. Viewers as a whole experiencing such reception from a communal system should complain strongly to the council or controller of the system.

It is pointless for designers to create sets with highly efficient low-noise tuners if noise in the amplifiers feeding signals to such sets is going to detract completely from the effort! Many communal systems, however, are highly efficient and noise-free and without them reception in the area would be extremely poor.

Much of what has already been said applies also

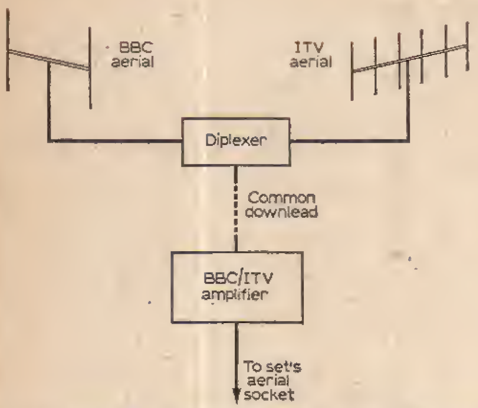


Fig. 4—A BBC/ITV amplifier connected in the downlead.

to Band I reception. In most areas the BBC programme is carried on a Band I channel and the signal is less subject to attenuation both in the ether and in the downlead. Nevertheless electrical and co-channel interference effects are more troublesome on the lower number channels than on the higher number ones of Band III. This then brings us to interference as distinct from noise.

SIGNAL/INTERFERENCE RATIO

Forgetting now the signal/noise ratio in the installation itself we find that we have another ratio—this time the signal/interference ratio. This is the strength of the wanted signal to the unwanted interfering signal. The same magnitude of ratios as for noise apply. That is, the interference is non-existent on the screen when the wanted signal is 200 times stronger than the interfering signal and barely visible when the ratio is 100-to-1.

The exercise this time is either to increase the strength of the wanted signal without increasing the strength of the interfering signal or to reduce the strength of the interfering signal without reducing the strength of the wanted signal unduly.

In practice it is often possible to obtain an improved signal/interference ratio by reorientating the aerial in such a way that the strength of the wanted signal falls only a little while the strength of the interfering signal falls considerably more.

How this can be done is shown in Fig. 2. Here we see the receiving aerial in full line pointing direct to the station. While this gives the strongest signal in the aerial the aerial is only a few degrees off beam relative to a source of interference. A strong interfering signal is also given in the aerial.

Now if we turn the aerial away from the interference as shown by the direction of the broken line we find that we have virtually doubled the angle from the interference and yet put the aerial off beam from the required signal by a smaller angle

Thus we secure an increase in signal/interference ratio. Why this happens is shown in Fig. 3. The squashed heart-shaped pattern is called the "polar diagram" of the aerial and reveals the aerial's directivity.

The relative pick-up efficiency or response of the aerial is given by this pattern. For instance, the response of the aerial when it is pointing to the signal is given by the length of line 1. Now when the aerial is moved round a little so that the wanted signal is off beam the response is relative to line 2 (this is a little shorter than line 1).

However, at this setting the response to the interference is relative to line 3, which is substantially shorter than line 2. The signal/interference ratio given by the aerial is then line 2/line 3. This is far better than if the aerial were pointing to the wanted signal, since we should then have an aerial signal/interference ratio of line 1/line 2.

It will be appreciated, of course, that the degree of interference discrimination provided by the aerial is governed by the polar diagram. The directivity or "beam width" of an aerial is controlled by the number of elements in its make-up and by its design. Generally speaking the directivity is increased with increase in number of elements.

NUMBER OF ELEMENTS

Thus for optimum interference discrimination an aerial with a large number of elements would be required. For this reason a Band III aerial is more directional than a Band I aerial and most u.h.f. aerials are even more directional than a Band III aerial. The greater the directivity of an aerial the more critical becomes the orientation adjustment to secure the best possible signal/interference ratio.

It will be seen that the signal/interference ratio is somewhat related to the signal/noise ratio and vice versa. For example, if we reorientate an aerial to improve the signal/interference ratio we may probably worsen the signal/noise ratio. It then becomes a matter of compromise between ordinary interference effects and noise.

Some viewers are under the impression that an aerial amplifier can improve the *signal/interference* ratio. This is not true because an amplifier boosts both the wanted signal and the unwanted interference by the same amount. The ratio between the two is not altered, of course.

What is really meant is that the *signal/noise* ratio can be improved by the use of an aerial amplifier. But this happens *only* when the amplifier has a noise figure better than that of the

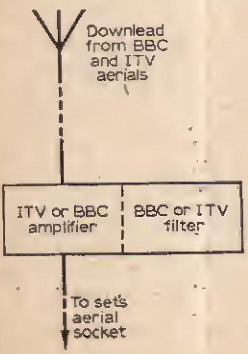


Fig. 5—A BBC-only or ITV-only amplifier may incorporate a filter to bypass the unamplified channel, as shown.

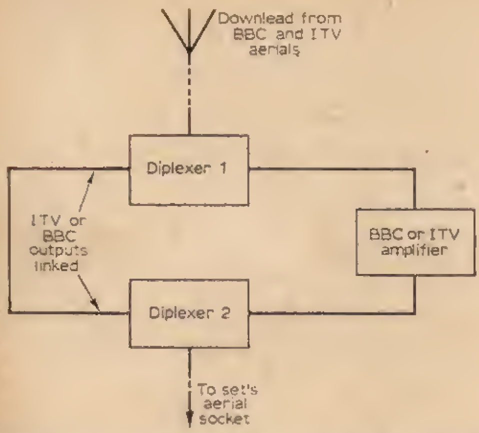


Fig. 6—Two diplexers can be used to allow the amplification of one channel relative to the other. With separate downleads, of course, diplexing would not be required two times.

set's tuner. The recent development of transistor amplifiers has made this possible, sometimes with dramatic results. A picture full of noise (grain) without an amplifier has been seen to pull almost completely out of the noise by a well-designed amplifier.

Some amplifiers of this kind are designed to work on both Band I and III channels. These are handy in that they can be connected simply between the downlead carrying both signals and the set's aerial socket as shown in Fig. 4.

Even if one signal is strong enough without a boost the extra boost given by the amplifier does not matter much since the set's a.g.c. can usually take care of the stronger signal.

It is possible also to obtain amplifiers in which is a BBC or ITV filter. This type of amplifier can also be connected in series with a common downlead so that only the weak channel is boosted, not the other. This arrangement is shown in Fig. 5. An alternative arrangement is to use two diplexers and connect the appropriate amplifier between the corresponding outputs while linking the other outputs as shown in Fig 6.

The methods employing a filter or diplexer can cause instability troubles, however, if the filtering is not too good between the output and the input of the amplifier. The Band I/III arrangement is not troubled in this way.

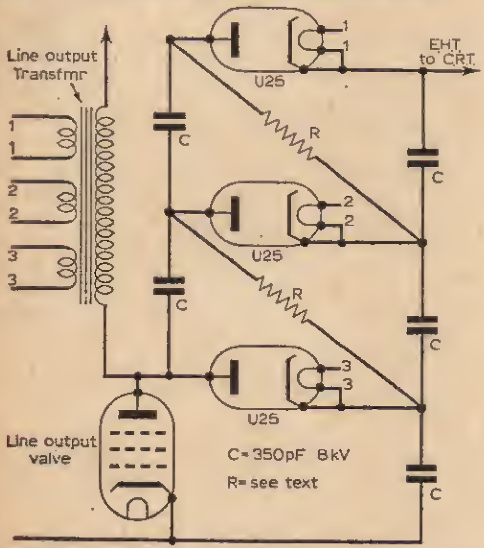
It should be mentioned that by locating an amplifier at the aerial end of a downlead any interference pick-up in the downlead is not amplified as it is with the amplifier located at the set end of the lead.

In practice the downlead picks up insignificant amounts of interference when it is correctly matched, but the aerial mounting of a u.h.f. amplifier can improve the signal/noise ratio.

PART 2 NEXT MONTH

Pulse Voltage Tripler

EHT WITHOUT AN OVERWIND



By D. HINDS, B.Sc.

THIS method of obtaining e.h.t. was tried by the writer when the overwind of a 21in. K-B burnt out, the only alternative being to replace the transformer. This proved impossible to obtain and in any case would have been expensive.

The three heater windings were placed in the space previously occupied by the overwind and the rest of the circuit built on a sheet of perspex mounted over the transformer. The capacitors were Radiospares 8kV pulse ceramics and the charging resistors made by cutting a Metrosil e.h.t. regulator (as used in Ekco T221, etc.). Each resistor was about 3in. long, the connections being made by wrapping copper wire round tightly and soldering.

In the particular set used there was plenty of power available to run the three heaters but if required the heater power can be supplied by simple mains isolation transformer placed in series with the valve heaters. This method of running the e.h.t. rectifier heater has been used for some time by the writer in sets converted for running on both 405 and 625 lines and for obtaining "instant TV".

The transformer is surprisingly easy to make owing to the small number of turns required. The tripler circuit is slightly inferior to the half-wave circuit in regulation, which is determined by the charging resistors, being better the smaller their value is. The circuit may be found useful for increasing e.h.t. as, for example, when using a larger tube to modernise an old set with a good chassis. ■

RADIO AND TV SERVICING AS A PROFESSION

by John D. Benson

FOR more than 35 years, the author has been engaged in the business of radio and television servicing in all its aspects. During that period of almost four decades, many applications by parents have been dealt with concerning the employment of their sons as apprentices. Many applications have been turned down, much to the astonishment of the parents, for it is not generally realised or understood how wide and exacting the scope of training is to become a qualified technician.

In the past, youths were employed in the radio and television trade, in many cases as little better than messenger and odd-job boys. Their training, such as it was, being haphazard and very much a matter of hit and miss methods. These conditions led to a very poor view, by the public, of the chances of a youth becoming a trained technician who could expect a reasonable rate of pay.

Without proper training facilities, trainees became, more or less, handymen and "tinkerers" and in general were responsible for the very poor opinion which the public held of service engineers.

It is largely due to the good work put in by Trade organisations that the future of the apprentice service engineer has been assured and no longer left to hit and miss methods.

The law now demands that trainee apprentices must be released to attend day school at a Technical College, followed by. evening tuition. The training provides for general education and technical instruction up to degree standard, if required.

Wide Range of Subjects

When interviewing parents, who have applied for an apprenticeship for their son, surprise has often been expressed when the wide range of subjects covered by servicing has been explained to them. In the early days of radio, before the advent of television, the battery receiver both home constructed and manufactured, was still popular with the mains operated receiver gaining ground fast. In those days, service work was of necessity, limited in range and likewise the choice of test instruments. With the advent of television in the middle thirties, the tempo of service work quickened, rule of thumb methods were of little use when dealing with the complexities of television circuitry.

During the years of World War II, although the television service was suspended and the commercial development of radio curtailed, vast strides were being made, technically, until shortly after the war, yet another revolutionary device was introduced to add to the burden of the service engineer, the transistor.

The transistor was not only a new device, but required a completely new way of thought when dealing with its circuitry. The would-be apprentice to television and radio servicing is now faced with a complete array of electronic appliances which call for a high degree of know-how when servicing is necessary.

B. of T. Regulations

The trainee is now assured of correct training during his apprenticeship and the employer is bound by Board of Trade regulations to provide suitable workshops and facilities, but what are the qualities required by the trainee to make a successful service engineer?

The Radio and Television trade covers a wide field of appliances which consist of mechanical, electrical and electronic devices, not forgetting woodwork as represented by cabinets etc. It is therefore necessary for the trainee to be dexterous with his hands—this can be checked from his school report or is often demonstrated by models he has made.

A keen interest in reading and an ability to write legibly (this is probably the toughest nut to crack). It will also be necessary to ascertain that the applicant has a fair knowlédge of basic mathematics.

Servicing work and training calls for a great deal of patience, tolerance and good humour, all difficult qualities to excel in, but very necessary for the successful engineer. The service engineer is often called on to deal direct with the public, he may be an excellent technician, but if bad tempered or intolerant, can cause endless trouble.

Remuneration

We have briefly considered the qualities which an applicant for an apprenticeship should have, and which will be looked for by an employer, but we have not mentioned the rate of remuneration which will be received during the six-year period of training. The six-year period applies to trainees who start at the age of 15. Apprenticeships cannot begin until 16, the first year therefore serves as a probationary period, during which both trainee and employer can ascertain the suitability of the overall conditions.

During the probationary period, the rate of pay is, of necessity, low and varies cosiderably, but generally lies in the region of £2. The rate of pay is low because during the first twelve months the trainee's activities are largely non-productive.

At 16 the trainee can be legally signed up as an apprentice and entered at the local Technical College for day school and evening classes. The

—continued on page 162

UNDERNEATH

THE DIPOLE

The onlooker at a rehearsal of the film clips and commentaries for the BBC and ITV television news programmes usually beholds what appears to be chaos, which, a few minutes later is presented to the public in a smooth professional manner with a Fleet Street flavour. The same applies to dramatic and musical productions of the theatre, where the individual influences of a multitude of artistic and technical talents and the restraints of the producers (who hold the purse strings) are in constant conflict right up to the "first night".

This chaos has been noted by the newspaper representatives who attended the rehearsals of the Royal Variety Performance at the London Palladium, where stage producer Robert Nesbitt and a team of television and backstage technicians shaped a magnificent performance in a professional manner. The fact that it was a Royal Occasion necessarily introduced a slightly more formal ingredient for the expensively attired audience who paid large amounts for their seats, for the benefit of the Variety Artistes Benevolent Fund and their Brinsworth Home (to the extent of about £15,000) and by the ITV network (about £25,000), with such little time for rehearsals, a great deal was accomplished.

And if the timing went astray in the public performance by prolonged applause or for other reasons, it could always be adjusted by a number of judicious cuts by the videotape editor. Even until the tape is finally edited for television. the battle goes on. But the artistic battle is not pursued with the horse-drawn armaments of Wellington, Tree or Irving, but with the modern mechanised and electronic facilities of Montgomery, Marconi, Bernard Delfont and Strand Electric. The programme was rather like the curate's egg, good and bad in parts. Pity the untalented and mediocre acts couldn't have been cut out with Wellington's sword across the videotape.

Dates to Remember

The Royal Performance was on November 9th and its transmission was on November 14. Weeks have passed since these important dates in the television calendar and I was unable to collect them in time for the December instalment of my monthly comments. But in the same month another historic event took place which may well influence the trends in television programme making.

Inauspiciously and almost with an atmosphere of secrecy, on November 1st, an elaborate coloured musical production for the cinema was shot, with television aids to multiple motion picture film cameras at Pinewood Studios. The subject was *Stop the World, I want to get off*, a theatrical musical starring Millicent Martin and Tony Tanner, presented by Warner Brothers and produced by Bill Sargent. Please to remember the First of November, that was the D-day of a new phase in the film production industry.

D-Day

Imagine the problem of converting a film studio into what is virtually a colour television studio within four weeks! Film studios as such are virtually much the same as they were twenty or thirty years ago. They had just settled down making talking pictures with sound on film, blimped cameras and ancillary facilities to improve the general quality, sound as well as picture—including coloured picture. The output per day of cut and edited film became less and less in quantity as the directors and technicians became more and more particular in quality.

The annual report of the National Film Finance Corporation stated that the daily output average was 2 minutes 28 seconds per day per stage compared with 30 minutes per day per stage in television studios, using videotape on 405 lines or on the hazardous telerecording method for world release to television stations using other line standards.

The time has now come when the partial application of television techniques will have to be utilised to make film production a viable proposition, not only for the cinemas with black-and-white and colour photography, but also for black-and-white and colour films specifically for television. So at Pinewood, television lighting control, television flooring on the stage (to avoid camera tracks) electronic viewfinders, vision mixing of motion picture cameras, TV monitors and what-have-you were rushed in.

Tempus Fugit

Time flies, especially when you are working *against* time. There were only three weeks in which to obtain all the special equipment and instal it. The Mitchell "System 35" was sent from Hollywood by air freight, and this included three Mitchell film cameras (each with monitors) which was controlled from a vision-mixer type of console in a room adjacent to the studio stage. As each individual camera was run up to film speed, (as and when required), the "line" monitor and tally light indicated the camera in use, much the same as is done with a TV camera.

All this part was in the basic Mitchell camera equipment, which was being checked and tested, and did not arrive in London until a few days before shooting commenced. In the meantime about twenty other monitors of different sizes, with or without sound, were hired in London, in readiness.

TV Floor

This, however, was only part of the equipment necessary. There was the preparation of a smooth floor on top of the existing traditionally nobbly film studio wooden floor which was sanded and covered with three-ply sheets. These were carefully laid down and screwed down to the old floor. This resulted in a surprisingly smooth floor surface.

TV Lighting

The lighting director called for a high intensity of light (white plus coloured by filters on the lamps), to be controlled on a remote control board on which could be switched 58 contactors at the touch of a stop on the Strand Type CD "organ" console, which had 14 "memories". The lighting pattern, white or coloured, could therefore be preset with 16 different arrangements, each reproduced effortlessly and accurately.

The lighting arrangements were far more elaborate than normal television lighting, because it was for colour photography with a complicated lighting plot. About 5,000 amps at 240 volts d.c. was about the maximum load carried, which was recorded on a graph. As there was insufficient time to prepare remote control dimming (a surprise new development—but only used for lamps with colour filters), manually operated variable resistances, had to be introduced. Remote dimmers for normal television were too small for this purpose.

These are but a few of the innovations which had to be set up and working in less than four weeks. This was long before the basic Mitchell equipment arrived in London, within a week of starting the production on Pinewood's D Stage No. 7. D-Day for Pinewood! It was a tremendous step forward, promoted for the first time in the world by Warner Brothers, the American organisation which made the first really progressive step in talking pictures nearly thirty years ago, when Al Jolson's *Jazz Singer* and *The Singing Fool* achieved such a tremendous success.

These vintage films were made with synchronised discs running at 33⅓ revolutions, with turntables coupled to the projectors. Tempus fugit revs on and Warner Brothers have done it again, by starting another revolution in film making techniques.

The privilege of watching the feverish haste of the technicians responsible for integrating such colossal changes in techniques calls for a sedative to tranquilise the Kaleidoscope of colour film and colour television. So let us consider the artistic techniques of the light entertainers who through years have soothed the eyes and ears of spectators with their relaxed performances.

Val Doonican, with good looks and good voice, gives a soothing performance, however "corny" his songs may be. So does Andy Williams, the American, whose telerecorded 16mm films are seen and enjoyed in Britain despite poor quality picture but because of excellent sound quality. Then there is Matt Monro, Dean Martin, Frank Sinatra, Perry Como and — of course — Bing Crosby, who stays the course over many years.

These performers dominate — even seem to sit back and rest—upon the background of first-class orchestrations and enthusiastic applause. These are all instances where the artiste dominates the TV or film scene and the musical director keeps his musicians under control. Elaborate and busy backgrounds are used on many LP records as a "backing" for pop groups and other gimmicky presentations. This is especially useful if the vocalists have no real training and talent.

Good confident performers don't need elaborate orchestral backings, just as good actors don't need busy and elaborate settings in television plays. Backgrounds should be *backgrounds*, not obtrusive interferences upsetting the pictorial balance and "jamming" the lyrics. Techniques should always remain the servants, not the masters in any medium of entertainment, and this especially applies to television.

Idle Talk

There are things you should not believe, even with a large pinch of salt. It is *not* true that the Theatre Management of the Royal Court Theatre, Mr. Kenneth Tynan, the egg-head critic; Mr. Ned Sherrin, specialist in clean humour, are all taking over future BBC programme policy from Sir Hugh Greene. It is just not true that the BBC are going to fight back Granada's *Coronation Street*, with a serial based on Bond's unsavoury play *Saved*, which is notable for its stoning-the-baby-in-a-pram scene. Neither is it true that increased BBC-TV licences will have green shield stamps attached. Nor that BBC-2 U.H.F. aerials will be raised to the height of 2,500 feet. There's no truth in idle talk!

STOP PRESS!

ICONOS' SELECTIONS AND FORM STRAIGHT FROM THE ELECTRONIC PARK RACE COURSE.

COLOUR SYSTEM STAKES (625 LINES)

6 TO 4 ON—"PAL" ("Potential Improvements" out of "Phase Distortion").

EVENS—"SECAM" ("Best Present Results" out of "Computer Parameters").

10 TO 1 AGAINST—"NTSC" ("Face Saver" out of "BBC").

50 TO 1 AGAINST—"QUAM" ("Good Idea" out of "Professional Joke").

100 TO 1 AGAINST—"BLACK AND WHITE" ("Blue Patter" out of "Tynan Delight").

"SECAM" is a good hedge on colour videotape prospects. Postmaster General likely to disqualify all colour runners and award the race to "Black-and-white" colour.

Just as we are going to press, news came through that the P.M.G. had announced in the House that the TAC recommendation to the Government was to adopt the PAL System on 625-lines u.h.f.

In view of this, the odds quoted in the race card above can be taken as Starting Prices (subject to Jockeying-club decision).

FIRST TIME TESTS

PART 5

By H. W. Hellyer

A.G.C. AND INTERFERENCE LIMITERS

FAULTS in the a.g.c. circuits of a television receiver can be baffling to diagnose and tedious to trace. Often, the very act of making tests causes drastic changes of symptoms, perhaps masking the source of the trouble. Some knowledge of the particular circuit under test is necessary; there have been numerous variations on the theme of automatically controlling gain. We must begin this part of the series with a brief discussion of the principles of automatic gain control.

Changes in signal strength cause variations in the overall contrast level of a receiver and a picture whose black and white balance is wrong may be at one moment pale grey monotone and at the next soot and whitewash glare, unless some precaution is taken to guard against the variations. The changes can be caused by an obvious reflection of secondary signals, such as with aircraft flutter, less obvious fading due to refracted signals from upper atmosphere layers in fringe areas, especially noticeable with the longer wavelengths of Band I signals, or the changes in signal level when switching from one channel to another. Fading that is not too frequent or severe can be controlled manually with a sensitivity or contrast control, but some automatic means will be desirable for more frequent or intermittent changes in the level of the incoming signal.

With a radio receiver, the problem is easier to solve because the amplitude of the carrier has a constant average value. A sample of the rectified signal is fed back as a negative bias to early stages so that an increase in signal strength causes an increase in bias and decrease of gain. But the television carrier depends for its amplitude on the brightness content of the picture and the average level of the incoming signal is not then constant when brightness levels change. Some pictures may be peak white while others (too many it sometimes seems in certain programmes!) are nearly down to black-level. It is therefore not possible to sample the d.c. content at the video detector and feed this back as a control voltage to the earlier stages.

The most convenient part of the television signal waveform that will be constant in amplitude for a given signal level, regardless of picture content is the "black-level". There are difficulties about using this as a reference, however, as the only convenient parts of the signal at which the black level occurs are at the "front and back porches", twice per line. This is just prior to the line sync pulse at the end of a line, and just after the sync pulse at the beginning of a line.

A.G.C. Systems

The first and most widely used a.g.c. system, is necessarily something of a compromise. Assuming that the picture modulation does not vary from its average value except for short periods, a sample of this average or mean signal level is used as a control source. This can be done by taking off a control voltage from the grid of the sync separator valve. Sync pulse amplitude is proportional to signal strength. The grid and cathode of the sync separator act as a diode, with the grid leak as diode load. The time constant of this grid circuit is fairly high. Positive-going pulses drive the valve into grid current and the charge capacitor holds the grid negative at a value greater than anode cut-off. The larger the sync pulses, the more the grid current, and thus the greater the negative voltage at the grid. The long time constant of the circuit tends to smooth out the bias, rendering transient changes in signal level ineffective.

The drawback is obvious: bright pictures that last more than a few seconds tend to reduce the a.g.c.

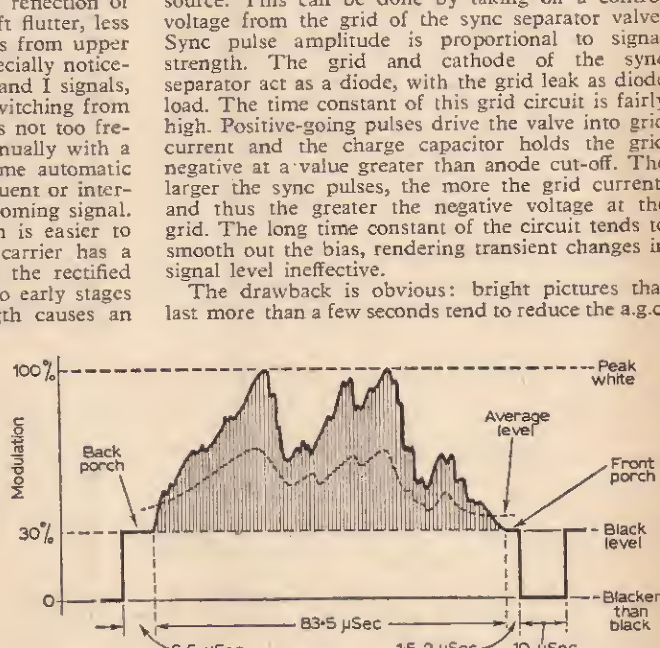


Fig. 14: One line of television waveform, showing relative time values of sync pulses and porches.

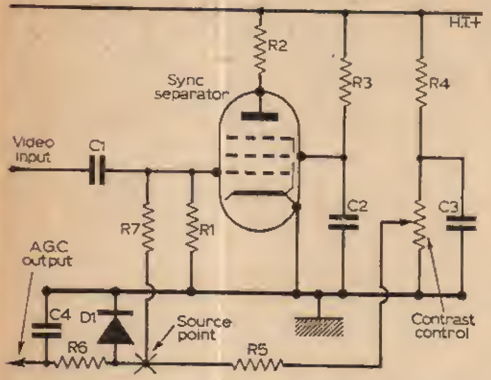


Fig. 15: Simplified circuit of mean-level a.g.c. system.

and dark pictures to increase it because of the mean-level process. The d.c. component of the picture is also removed—leading to some interesting circuits that attempt to restore it.

Control of the amount of feedback voltage is made by a compensating positive voltage being fed to the a.g.c. line. This is conveniently done by arranging the contrast control as part of a potentiometer network across the h.t. line, taking off the required positive voltage at its slider. Fig. 15 shows the rudiments of the system. The interesting points to note are the time constants of the circuit and the relative voltage levels. R5, R6 and R7 will all be resistors of more than 1MΩ and the screen resistor of the pentode, R3, will also be a high value. The anode resistor R2, however, will be much lower in value, and in practice may be part of a network, used to tap off the field and line sync pulses. The capacitors in this circuit would typically be 0·1μF.

The next important point is that the relative voltages depend on the incoming sync pulses. Overloading would occur if the sync pulses were absent and only the positive voltage from the contrast control remained on the a.g.c. line. A clamping diode D1, sometimes a small germanium diode as shown, or part of a valve, is fitted in a sense that causes it to conduct if the a.g.c. line becomes positive, effectively shunting the line to chassis.

The most obvious symptom of a.g.c. failure is thus an ineffective control of contrast. High value resistors of the carbon compound type have a habit of going even higher with age, and this is one possible cause of failure. The easiest way of determining the point of failure is to make voltage tests. Although we have tried, in this series, to keep the required amount of test instruments to the minimum, it should be stressed here the a.g.c. tests will require a meter of at least 20,000Ω/V sensitivity. Anything less efficient than this will tend to affect the circuit impedances, and apart from interpretation of readings being practically impossible, the meter will mask the fault.

Simple Testing

This is not to say that no testing can be done without expensive instruments. An intelligent assessment of the symptoms and a few disturbance tests can help us. First, if the signal is weak and the contrast control has little or no effect, this could be due to an inadequate positive voltage to back off the a.g.c. The result is over-biasing of the controlled stages. Tests for h.t. at the contrast control can be made with a neon tester, as previously described, and a meter of low sensitivity will still be useful here to indicate change in voltage at the slider as the contrast control is turned.

If there is no control of contrast and a temporary short-circuit of the a.g.c. line to chassis increases the gain, the contrast control network should be suspected. This can be a considerably more complicated circuit than that shown in Fig. 15, and again some care must be taken when dealing with high value filter resistors which may have changed in value. An example might be when replacement of D1 or C4 only partially cures the fault. R5 or R6 may have changed in value if the set was operated under fault conditions for any length of time at minimum contrast setting. Temporarily shunting these resistors should not alter the gain drastically if all is in order. If it does, look for a "high" resistor at the point of test.

If the a.g.c. line is suspected, but some small control of contrast can still be made, it is possible to check the effectiveness of bias by removing the

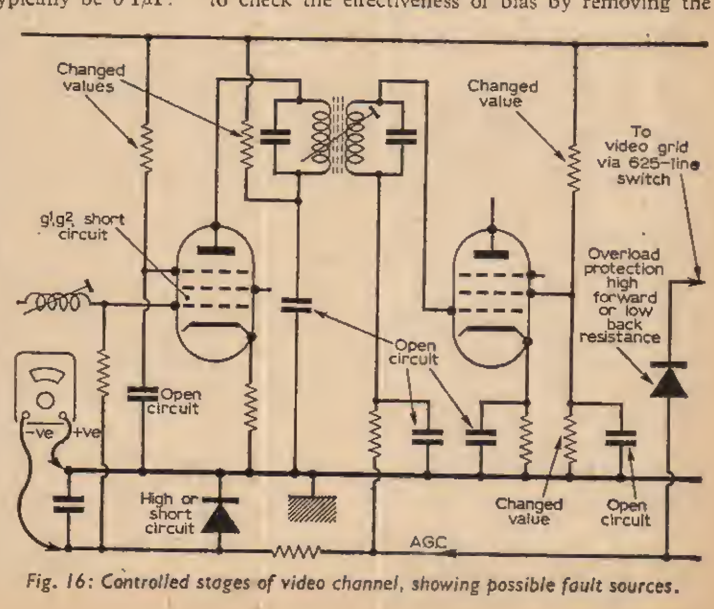


Fig. 16: Controlled stages of video channel, showing possible fault sources.

a.g.c. source, disconnecting at point X (Fig. 15). and inserting a fixed bias voltage in place of the a.g.c. An ordinary ohmeter on the "Ohms" range is suitable, with 1·5 or 3V battery used as d.c. source (not on the high ohms ranges, which often use a battery of higher voltage). The potential on the test leads is opposite to the polarity markings, and the meter can be connected each way round, noting the effect on the picture. With the negative potential applied to the a.g.c. line, the gain should decrease, and vice versa. This test quickly determines whether the trouble is in the controlled stages or in the source stages and contrast network.

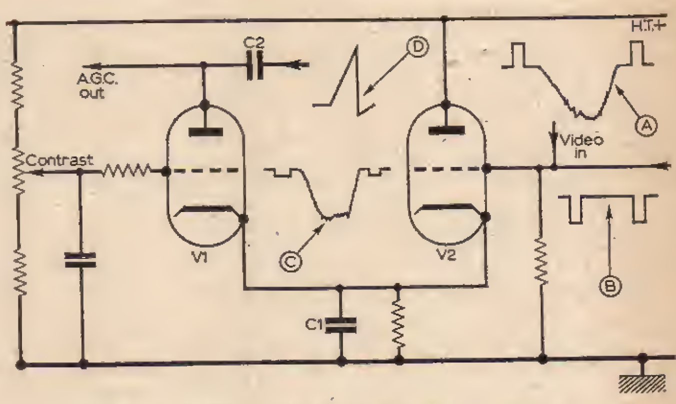


Fig. 17: Principles of one method of gated or keyed a.g.c.

Controlled Stages

A number of faults can occur in the controlled stages to affect the a.g.c. Some possibilities are outlined in Fig. 16, which shows two vision i.f. stages, in skeleton form, indicating the vulnerable points. The meter shown connected across the line should be either a valve-voltmeter or a meter of high sensitivity, as previously explained. A quick test at the appropriate feed points to the controlled circuits while removing and re-applying the signal will give an indication of the presence of negative bias. Alteration of the contrast control should change this bias, (less negative at maximum contrast), and removal of the source should leave no residual positive voltage on the a.g.c. line.

When measuring, use as high a voltage range as is possible to get full advantage of the meter's sensitivity. For example, it is better to read three or four volts at the extreme low end of the 100V range than a mid-scale reading on the 10V range.

Referring again to Fig. 16, we note that a possible G1-G2 valve short-circuit is stipulated. This happened in many older receivers quite often. The result is a positive voltage on the a.g.c. line which can destroy the clamp diode, and has been known in many instances to cause a progressive fault ending in video overload and the burning out of several components—not to mention ruination of sections of printed circuit board! If a very strong signal overloads the receiver and the clamp diode fails to protect, look for this possibility.

Another fault that can have similar results is a self-oscillating i.f. stage. Open-circuited decoupling capacitors are the usual cause. If a strong negative bias is noted, regardless of the contrast setting and sometimes with the signal removed altogether, look for this possibility. In its earlier stages, before the clamp diode fails, or if a valve clamp is used, the symptom can give a peculiar effect of a backward acting contrast control.

An open-circuited screen-grid decoupler, or high resistor may cause the valve to run into grid

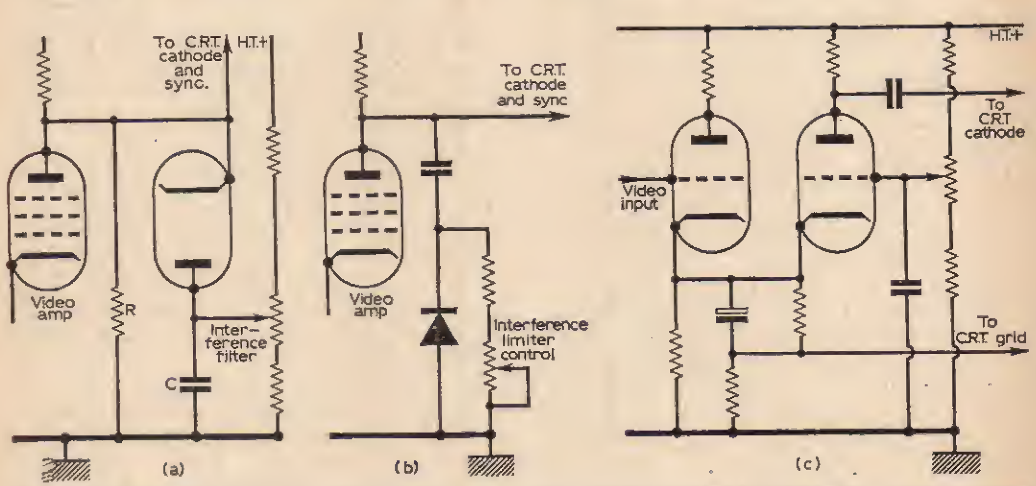


Fig. 18: (a) Interference limiter with bias determined by setting of potentiometer. (b) Self-biasing version of simple limiter. (c) Black-spotter circuit.

current, producing excessive bias as stronger signals are applied. This can give the symptom of a good picture on a fairly weak channel and a noisy signal on strong channels if the delay to the forward stages is thus reduced. This delay is simply the back-biasing condition, and separate networks will sometimes be found for i.f. and r.f. stages, feeding back different bias voltages. These can be isolated to prove the source of the trouble. Separate clamp diodes will often be used on these individual lines.

A further diode that can cause a flattening of the picture when it changes in characteristics is the overload protection diode. This is shown as used in 405-625 line sets, but it should be remembered that overload protection for the video amplifier was just as necessary on older sets when the incoming signal was absent but a carrier was still transmitted. In many receivers, overload protection took the form of a small diode which conducted the vision signal away from the video amplifier until the a.g.c. came into operation, or a bias derived from the sound channel.

Keyed A.G.C.

Keyed a.g.c. systems use these protection circuits in many forms. Although there are far too many different systems to occupy use here* the general principle of keyed a.g.c. needs consideration, and an outline of some faults and tests can be given.

The keyed system samples the black level of the television waveform, and thus obtains a reference voltage from a point always 30 per cent of maximum signal amplitude, even when picture information is absent. Black level increases and decreases in proportion with signal level. The usual procedure is to employ one valve to give a reference voltage from the black level portions—which we have seen are of short duration—and another valve which charges the a.g.c. reservoir capacitor from energy derived from the line flyback pulse. Fig. 17 shows the rudiments of one such system.

The video signal is applied to V2 grid, sync pulses positive-going as shown (A) and to the same point negative-going line sync pulses are applied (B). To obtain correct operation, these pulses will often be amplified before application. The relative levels are such that the signal on the grid of V2 has a peak voltage determined by black level (C). The voltage across C1 will vary in phase with the black level as the signal strength alters. V1 has no h.t. applied to its anode, but the relative grid-cathode voltage is determined by the standing positive voltage applied from the contrast control and the voltage across C1. When a sharp positive pulse from the line output transformer is received at the anode (D), the valve conducts and charges C2 negatively. This negative charge is applied as a.g.c., via the appropriate filters, to the controlled stages.

The factor of interest about this system is that it is not rigidly tied to the "back-porch" period, as earlier systems were. The first system in this country was the now historic Pye Automatic Picture Control. A.P.C. (now used as an alternative abbreviation for practically any system of video a.g.c.), used on the Pye V4 in 1953. It uses a cathode follower with input signal fed to the grid directly from the video amplifier. The output from the cathode is applied to the tube and the sync separator and also to the anode of a pulse sampling diode. The cathode of this valve is coupled to the cathode of a triode a.p.c. amplifier, to which point is also applied a delayed pulse from the line output transformer. A special transformer is used for the coupling, and the pulse from the flyback is delayed so that it occurs during the back porch period just before picture modulation commences for each line. The negative pulse at the anode of the a.p.c. amplifier is passed to another diode cathode. This diode is biased to cut-off, and the pulse therefore causes it to conduct, charging the reservoir capacitor. The resultant negative voltage is applied to the 1st i.f. control grid. A control in the grid circuit of the amplifier stage is used to set the contrast level. Protection for the video stage, during the warming-up period of the boost diode, is provided by a diode between line output valve cathode and video amplifier grid, effectively holding the latter to chassis potential until the line output stage conducts.

Most important factor in tracing faults in keyed systems is a knowledge of the particular circuit. In general, the most common fault is loss of the sampling pulse, for a number of different reasons. The sampling valve then remains cut off and any alteration of contrast control has no effect. Although a high resistance voltmeter can be used to trace the gating or keying pulse (which is, of course, a pulsating d.c.), this does not give information about its synchronism, which is as important as its amplitude. An oscilloscope is the true answer for fault tracing in such circuits—but description of these scope tests defeats the object of this series of articles, and can be found elsewhere.

Awkward Faults

One peculiar symptom that can happen with some types of gated a.g.c. is an apparently normal control of contrast yet a lack of automatic control, so that a change in signal level, most obvious when changing channels, still results in the user having to adjust his contrast control setting. This is caused by a breakdown somewhere between the video amplifier and the sampling circuit, so that a.g.c. is solely derived from the line pulses!

Another teaser was the earlier Ferguson circuit, which used an EF80 as a.g.c. amplifier, but with a circuit arranged so that it passed very little current. "No control of contrast" could be cured by substituting the valve, but the replacement subsequently fails. The reason was a poisoning of the cathode, the result of running a valve with very little anode current. The makers suggested reducing heater power by shunting the heater with a 270Ω resistor as a solution. The poisoned valve can recover, if not damaged too badly, by being used under normal conditions as a sound or vision amplifier, and need not be thrown away.

In keyed systems, as in mean-level systems, failure of the filter components will upset the operation of the controlled stages. An a.g.c. decoupling capacitor which open-circuits will result in a.g.c. pulses reaching the amplifier and a reduced gain picture which tends to tear, especially at the top, can be the result. With a keyed system, in a set using flywheel sync, this may only be detected as a shading at the top of the picture. Worse conditions may give impaired line sync, despite the flywheel action, and shading at the left-hand side of the picture. Many a fruitless hour has been spent chasing faults in flywheel sync circuits which were really the result of faulty a.g.c. decoupling, or filtering. This is where the first-time test, the handy 0·1μF and the 1MΩ resistor, shunted across suspect components, can save much labour.

Interference Limiters

Before plunging too deeply into a.g.c. circuits when the contrast of the picture is lacking, investigate the possibility of a fault in the interference limiter circuits. The usual arrangement is a shunt circuit from the anode of the video amplifier, as in Fig. 18 (a), with its alternative version, (b), or an inverter principle known as a "black-spotter", as in (c).

The simple type of circuit just consists of a charge capacitor C in series with a diode, with a shunt resistor, R. The charge on the capacitor follows the changes in signal level and the diode does not conduct. The relative voltages are determined by the bias network fed from the h.t. line (again, watch the high value resistors). When a peak of interference occurs, the diode momentarily conducts as the capacitor can not follow the voltage change rapidly enough, the video signal is temporarily shunted and the white spot is reduced in intensity.

A faulty diode, charge capacitor, or bias component can result in drastic flattening of highlights. It has even been known (but whisper it please!) for an experienced engineer to replace a cathode ray tube when the fault was simply a short-circuited interference limiter diode.

The second circuit (b) is a self-biasing variation of (a), with C charging up as the video amplifier conducts, the level being determined by the resistor settings.

The spot-inverter circuit of (c) acts in a different way, compensating the whiter-than-white interference pulse at the cathode with a pulse at the grid of the tube, and is thus often known as a "black spotter". Negative-going signals from the video amplifier are applied to the grid of V1, and from its cathode, the negative-going signal is taken to the tube cathode and to the inverter V2 cathode. V2 grid is held by the control and an interference pulse causes it to conduct. The resultant pulse at the anode is applied to the tube grid, neutralising the interference pulse at its cathode. A fault in this kind of circuit can cause the picture to turn inside out. Testing, as before, is quickly carried out by valve substitution and disturbance tests of components, noting the effect on the picture.

*See Part 6 "Stock Faults", Page 33, October 1964, and "Video A.G.C. Systems", Page 159, January 1965, and Page 228, February 1965, et seq.

(To Be Continued)

RADIO AND TV SERVICING AS A PROFESSION

—continued from page 155

rates of pay during the five-year period of training have been laid down by various trade organisations, but vary considerably from district to district. Increases of pay are generally given as each birthday falls and vary, but a fair average would be £1 per week. The conditions are subject to review under the New Industrial Training Act which became law last year, but there is still much work to be done before the benefits of this Act can be put into action, nevertheless it is a step in the right direction and will further strengthen the service engineer apprentice's position in the future.

The apprentice who works hard and obtains his City and Guilds certificate in Radio and Television is in a very strong position and can in most areas expect a salary in excess of £1,000 per annum. A further concession which is becoming common practice throughout the trade, is the five-day week with at least 14 days paid holiday.

The youth who remains at school and takes his GCE and is successful in obtaining the necessary "O" levels can obtain an apprenticeship without the preliminary year's probationary period and at Technical College can generally start his technical training without the course in general education.

Colour TV

In the very near future colour Television will be added to the problems of the service engineer; already many engineers have attended courses in this new medium and as soon as a decision has been reached regarding the system that will be used, there will be more opportunities for the service engineer to qualify and reap the rewards.

In summarising then, and in the light of a long experience, the youth who plans to take up radio and television servicing as a career, provided he is determined to work hard and qualify, the future can hold for him interesting and rewarding prospects. In conclusion, then, and remembering that radio and television have become an important part of the nation's life, the qualified service engineer can fill a very important place in the life of the community, with suitable rewards. ■

THE NEV-ICON CCTV CAMERA

By M. L. Michaelis - Part 2

THE resulting video waveform appearing across R20 and applied to the modulator diode D1 is thus entirely negative with respect to the chassis line, reaching zero (i.e. chassis-line potential) only at the moments of most positive excursions (peak highlights of the scene being televised). At all other times the video waveform consequently represents a correspondingly great cut-off bias for the diode, which must be exceeded on each cycle of the v.h.f. oscillation from L1/C19 before the diode D1 can conduct and pass *the remainder* of the v.h.f. cycle to the output socket.

When the video waveform at a given moment corresponds to a peak highlight, the diode D1 has no cut-off bias, so that the full v.h.f. oscillator amplitude can get through to the output socket, giving maximum carrier amplitude there as required for highlights on a positive-modulation 405-line system. When the momentary video voltage corresponds to a very dark point of the image, the negative cut-off bias at the diode D1 is high and can be exceeded only by the positive tips of the v.h.f. waveform, so that only these tips get through to the output socket (theoretically) and there represent the required low carrier amplitude under these conditions.

Stray Capacitance

The above-described theoretical principle of modulation is seriously modified in practice by the fact that the diode D1 and its wiring inevitably represents a parallel stray capacitor which will feed some v.h.f. signal straight through to the output socket without being modulated. If this effect is not compensated for in a practical circuit there remains a fairly high residual carrier level which it is impossible to reduce however negative the momentary video input voltage to the modulator diode is made. On a positive-modulation 405-line signal this residual carrier level means that sync pulses are clipped or entirely absent, so that the sync separator and timebase lock circuits on the receiver are not able to function correctly.

Two measures have been taken in the circuit of Fig. 2 to combat this residual carrier level. Firstly, the small capacitor C17 has been added to feed a corresponding v.h.f. signal of opposite phase from the emitter of the v.h.f. oscillator to the output socket. This completes the effective network of capacitances to a balanced bridge as commonly employed for such compensations. C17 is here present in the form of a pair of tightly twisted insulated wires which can be made too long initially and then cut progressively until correct neutralisation is obtained, i.e. optimum sync-to-vision ratio on the waveform at the video detector of an ordinary television receiver as displayed on an oscilloscope.

In general, this still leads to somewhat clipped sync pulses on positive modulation, because of other stray couplings in the mutually unscreened circuits. This is corrected by the second measure of applying strong sync pulses to the emitter of the v.h.f. oscillator via R23. The oscillator amplitude itself is therewith reduced sufficiently during sync pulses so as to establish an overall modulated output waveform which is correct to standard in all important respects.

The v.h.f. oscillator TR4 is in every sense conventional, with tuned collector load L1/C19 for setting the TV channel and positive feedback capacitor C18 from collector to emitter to sustain oscillation.

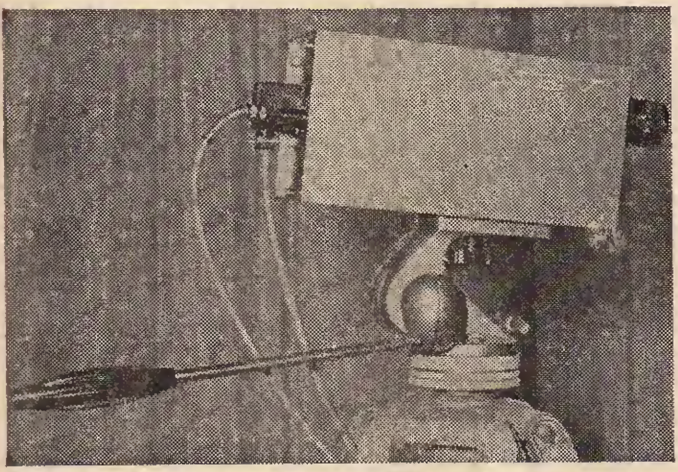
Decoupling

The individual stages of the video and v.h.f. circuits are seen to use no mutual decoupling, presumably to save space and components. The circuit is nevertheless perfectly stable as it stands, but any attempts which were made to increase effective gain by increasing collector load resistors or by interposing a further stage between TR3 collector and TR4 emitter to obtain some additional direct modulation of the oscillator with the vision signal provoked instability.

Considering that the gain and bandwidth were certainly sufficient for very reasonable results with the circuit as it stands, the complications of adding stage-for-stage decoupling on an already fairly crowded circuit board were decided against, in favour of subsequent addition of an emitter follower output stage and video output socket driven from TR1 collector. This permits any external video amplifier and tuner with any desired degree of compensation and bandwidth extension to be connected with a single coaxial cable, and experiments with the existing signal chain of another equipment showed that a very high picture definition is easily achieved under these conditions where required. Since more than sufficient sync for a preliminary waveform has already been injected prior to the point of take-off of the signal for the external amplifier at TR1 collector, no additional connections are required and the ancillary unit need have nothing more than an input socket and an output socket.

Negative Modulation

Careful consideration of the principle of the modulator circuit with D1 as already described in detail for positive modulation shows that negative modulation is immediately obtained if the diode D1 is simply reversed. The action is then quite analogous, but in practice even better because the diode now clamps the fixed sync pulses to the chassis line in its d.c. restorer action, instead of the variable picture highlight level. Although not greatly different on either standard, the performance of the modulator circuit is thus slightly more definite on CCIR negative modulation.



General view of the camera unit.

Any residual carrier signal coupled straight through to the output capacitively is far less serious on negative modulation, since it there merely leads to a slight flattening of picture highlights which is in most cases quite unnoticeable provided that the neutralisation C17 has been adjusted critically whilst observing the video detector output of the receiver on an oscilloscope.

Sync pulses represent full carrier amplitude on negative modulation, where the modulating action of D1 is best. Thus the sync pulse feed line to TR4 emitter via R23 had to be interrupted on negative modulation, and even the remaining sync injection into the video waveform at TR1 emitter was still too great so that a 1kΩ linear preset potentiometer had to be added in parallel with C5 for making the necessary adjustments of final sync level on negative modulation whilst scoping the receiver video waveform.

D1 is a point-contact diode which is very sensitive to soldering heat, thus use a heat shunt in the form of a pair of pliers.

Frame Timebase Circuit

This circuit is not a self-running oscillator, but rather a distorting amplifier to produce a sawtooth waveform from the mains sinewave of the a.c. h.t. winding on the mains transformer. The method adopted is the conventional two-stage procedure of first squaring the sinewave and then employing the differentiated negative flank of the resulting squarewave to gate the flyback of a charging capacitor integrator circuit (ramp generator).

Referring to Fig. 3, the 260V a.c. sinewave from the h.t. winding in the power pack is applied via a phase-shifting network and via the resistor R39 to an 8-volt zener diode ZD1. Whenever the a.c. input voltage is positive to the chassis line, ZD1 conducts in the forward direction and holds the voltage applied to C31 at chassis line potential. Whenever the input voltage is more negative than −8V the anode of ZD1 rests at the zener voltage of −8V with respect to the chassis line. Since the total amplitude of the a.c. input voltage is very high, the transition between these limits on each half-cycle is very rapid, so that a very good symmetrical negative-rectified squarewave of 8V amplitude is applied to C31. The time constant of C31 and R35 is about 0·7mSec which is much shorter than the 10mSec duration of a mains-frequency halfcycle. Thus the flanks of the squarewave applied to C31 are differentiated to give a train of alternate positive and negative pulses about 0·7mSec wide across R35. The positive pulses are without effect at TR6 base, since they drive this transistor further in a cut-off direction. The negative pulses open TR6 for their duration to establish the field flyback.

Field Flyback Action

The phasing of the negative pulses at TR6 base in relation to the high collector supply voltage waveform is such as to produce heavy charging current through C33 and C35 applying heavy negative bias to the base of TR7 so that its emitter-collector path virtually short-circuits C36 and C37 which capacitors are consequently discharged very rapidly.

Field Stroke Action

When the negative pulse at TR6 base has terminated C35 is left with its top plate charged more negative than just prior to the flyback, so that

TR7 remains more strongly cut-on than before the flyback commenced. C36 and C37 are virtually discharged at this time, so that the charge-driving voltage difference via R43 is high and the charging speed would be high, were it not for the moderating action of the parallel discharging resistance of TR7 still conducting quite heavily. As the recharge of C36, C37 progresses, i.e. the field stroke proceeds, the difference voltage still driving charge into C36, C37 via R43 decreases and the rate of field run would decrease. But C35 is at the same time discharging, so that the negative voltage at TR7 base is falling and the parallel discharge conduction of TR7 across C36, C37 is decreasing. This represents an accelerating influence upon the rate of recharge of C36, C37 which can be made to compensate the natural deceleration of the exponential characteristic by suitably adjusting the discharge time constant of C35. Hence VR3 operates as field linearity control.

Ingenious as this circuit is, it represents mathematically the sum of two opposed exponentials which can only be approximately (though quite reasonably) linear. As seen on the receiver there will be slight residual expansion both at the top and at the bottom of the field. The value of C35 may need alteration until this symmetrical expansion is the absolute minimum achievable for an optimum setting of VR3 in each case. There will necessarily be some interdependance with the field amplitude setting of VR4 which again depends upon the line amplitude achievable on 405 or 625-line operation respectively, i.e. the establishment of correct aspect radio. Any adjustments to this circuit are therefore quite tricky, but with some patience a very good performance can be achieved on both standards.

In the unit modified by the author improved field linearity resulted at the correct aspect ratio setting on 625-line operation when C35 was reduced to 65μF, but this is probably not general. It must be remembered that the actual values of high-capacitance low-voltage electrolytics can differ widely from the nominal ones, so that empirical adjustments with actually available components will be necessary in each case where any modification to the field timebase circuit is considered to be necessary.

The effective duration of the field flyback and thus the field sync and blanking pulses is determined by the time constant of C31/R35. If alterations are desired for optimum performance with a particular receiver or for any other reason, the value of C31 may be changed appropriately.

Line Timebase Circuit

The line timebase generator is a free-running multivibrator with the transistors TR8 and TR9. The line deflection coil, being primarily inductive, requires a virtually square voltage waveform for linear deflection current rise, which waveform is correctly provided by a multivibrator.

The type of multivibrator here employed is assymmetrical, i.e. one half-cycle (producing the line stroke) is much longer than the other (representing the line flyback). The line stroke is produced in a quite conventional manner by a recovery exponential of C39 via R45, R46 and VR6 at the base of TR8, holding TR8 cut-off until the right-hand plate of C39 is no longer positive with respect to the chassis line. It becomes positive in the first place by losing electrons to chassis through the base-emitter path of TR8 during the line flyback when the overswing of the damped circuit L2/C10 produces a negative pulse at the collector of TR9 which places the same quantity of electrons onto the left-hand plate of C39 during the line flyback.

The overswing action of L2/C10 produces the other, shorter half-cycle of the multivibrator action which determines the line flyback. The action is roughly as follows. As soon as the right-hand plate of C39 is no longer positive to chassis and TR8 can consequently start to conduct, a positive pulse is developed across R47 which cuts TR9 off. The electron current originally flowing down through L2 to chassis via the collector-emitter path of TR9 must therewith be diverted to the bottom plate of C10 and to the left-hand plate of C39, since the current through an inductor cannot cease abruptly. It must continue to flow until the energy of the magnetic field produced by the current flowing through the inductor has been transferred as charge energy into the associated capacitances. This is the basic principle of any oscillatory circuit involving inductance and capacitance.

When the former magnetic energy has transferred sufficiently as electrostatic energy in the charge developed across C10 and C39, the current through L2, which must have come through R48, has dropped. This amounts to a negative pulse across R48 which is applied to TR9 base, so that TR9 opens again and makes the charge accumulated on C39 felt as a positive cut-off bias at TR8 base because the left-hand plate of C39 is then virtually connected to chassis when TR9 is again open. We are therefore back to the start of a new line run as C39 discharges bringing TR8 base progressively less positive until it can cut-on again and initiate the next flyback.

Production of Sawtooth Line Deflection Current

The build-up of a sawtooth current waveform in the line scan coils is rendered possible because TR9 is prevented from cutting-on to saturation by the fact that R47 is returned to the collector (neglecting L2 for the slower events of the line run). Some definite small negative voltage thus remains with respect to chassis at the collector of TR9 during the line run and this small (negative) voltage can allow the required gradual build-up of current in the line deflection coil on the initial virtually linear part of its natural time constant given by the ratio of its inductance to its self-resistance. This current is of course integrated as charge on C41 during the line run (electrons deficient on the bottom plate and in excess on the top plate) since there is no d.c. connection to the coils.

The high-amplitude positive overswing flyback pulse at TR9 collector during flyback draws these electrons off to C10 and C39.

The much increased voltage amplitude of this flyback pulse relative to the line run drive voltage formerly at TR9 collector permits sufficiently rapid build-up of discharge current through the line scan coil for this purpose, so that in fact the charge on C41 is even slightly reversed by the end of the flyback and the complete effective waveform applied to the line coil is therewith seen to be pure a.c., as it must be with a purely capacitive coupling.

VR5 as series resistor in the d.c. feed to TR9 which supplies the scan power controls the line amplitude resulting from the above-described action.

The use of an overswing coil L2 instead of a second conventional CR-recovery to produce the second (flyback) half-cycle of the multivibrator is seen to store sufficient power in the circuit of TR9 for driving the line deflection coils directly, without needing a separate output stage. Thus this simple and ingenious type of multivibrator (admittedly somewhat involved as far as its detailed action is concerned) is another interesting novelty leading to a useful simplification of the circuit as a whole.

Conversion to 625 lines

In spite of the apparently intricate relationships within the line timebase circuit, a drastic change of speed up to 625 lines is immediately possible just by reducing C39 to 0·01μF, whereupon the correct lock setting for CCIR will be found to lie within the range of VR6 situated on the rear vertical circuit board.

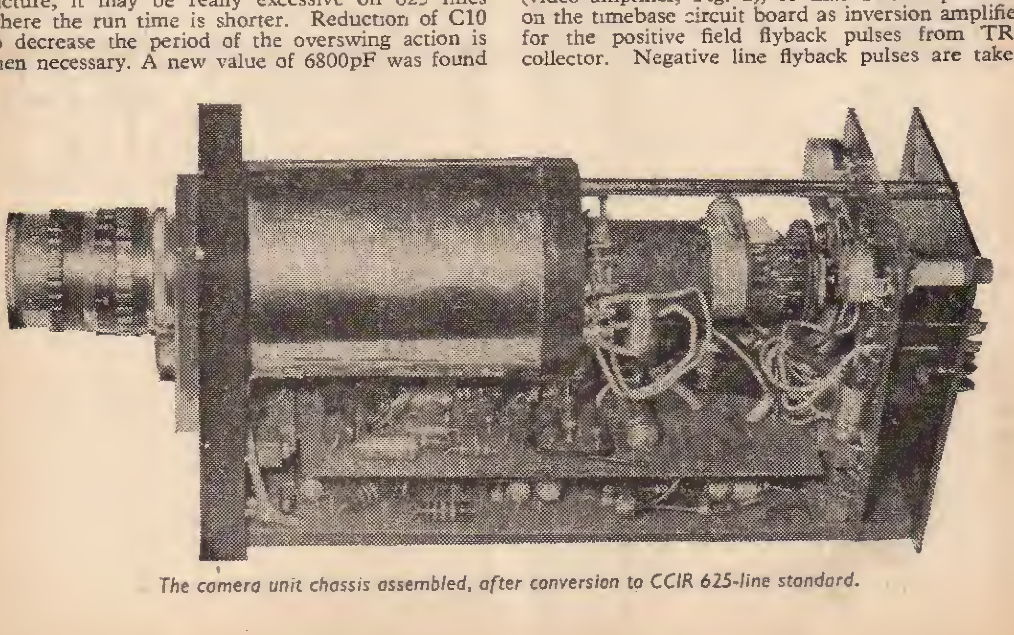
Trouble may be experienced due to an excessively long line flyback pulse. Since this is already rather long at 405 lines, so that the makers even recommend increasing the width on the receiver to avoid black vertical bands at the edges of the picture, it may be really excessive on 625 lines where the run time is shorter. Reduction of C10 to decrease the period of the overswing action is then necessary. A new value of 6800pF was found satisfactory for C10 in the author's equipment on 625 lines. Reduction of C10 leads to an increase of flyback pulse amplitude, because the same magnetic energy then has to transfer into a smaller capacitance. But this is very desirable in such a change, because it means that there is little change of line amplitude. The shorter line period is counteracted by the higher drive square wave amplitude impressed across the line deflection coil, so that the line scan current reaches the same amplitude in both cases.

Sync and Blanking Circuits

Since the waveform across the line scan coil is a good square wave with a negative pulse during flyback, line blanking to cut-off the vidicon during line flyback to prevent interference with accumulating picture charges is achieved simply by applying the line scan waveform to the vidicon grid via C43.

The field scan waveform cannot be used in a similar manner since the field coils are primarily resistive and are thus fed with a sawtooth voltage waveform which is unsuitable for blanking, containing no flyback pulses. However, excellent field flyback pulses are available at the collector of TR6, the flyback gating transistor. Since TR6 is cut-on during all field flybacks by the differentiated pulses developed at C31/R35 as already described, the flyback pulses at the collector are positive and they are consequently applied via a suitable d.c. clamping circuit (C30, D3, R34) to the cathode of the vidicon.

In addition to the blanking functions on the vidicon beam current, the flyback pulses are required for insertion as sync pulses in the composite vision waveform. Negative polarity is here required for the point of insertion at TR1 emitter (video amplifier, Fig. 2), so that TR5 is provided on the timebase circuit board as inversion amplifier for the positive field flyback pulses from TR6 collector. Negative line flyback pulses are taken



The camera unit chassis assembled, after conversion to CCIR 625-line standard.

via C38 from the line deflection coil circuit. The trains of line and field sync insertion pulses are then combined across the clamping circuit D2, C27, R31 which clips them appropriately and prevents changes of sync level during the field returns relative to the line returns.

Vidicon Tube Circuits

The potentials for the respective electrodes of the vidicon tube are obtained from a single h.t. bleeder chain including two miniature neon stabiliser tubes arranged in such a manner that the adjustable wall anode voltage (electrical beam focus) is stabilised against external changes of supply voltage. The less critical beam current control VR2 is not stabilised, nor is the input voltage to the already mentioned automatic target volage regulating circuit. The focus coil current is stabilised with TR10. Thus it is merely the focus which is fully stabilised, since only it could lead to a deterioration of picture quality and definition for moderate changes of vidicon supply voltages with mains fluctuations or temperature changes.

Preset Controls

There are two preset controls on the amplifier circuit board. Looking at the rear of the camera, the control on the right is the beam currrent control VR2 and that immediately adjacent to it is the contrast (video gain) control VR1. The beam current should be increased until the picture highlights just do not wash out, and the video gain should be increased to a level giving satisfactory depth of vision modulation.

There are three preset controls on the timebase circuit board. Again looking at the rear of the camera, the right-hand control is the field amplitude and the left-hand control is the line amplitude. The control running across the panel is for making adjustments to the field linearity.

Line lock control VR6 is available on the rear vertical circuit board, access thereto being through a small hole adjacent to the coaxial output socket. It is essential to use an insulated trimming tool when adjusting this control or the v.h.f. oscillator trimmer (accessible through a hole to the left of the lens looking at the front of the camera), since the respective controls carry collector supply voltage and short-circuits to the casing are inevitable with a metallic screwdriver blade.

The only manual control provided and necessary is the electrical focus adjustment VR7. This is situated at the top left on the rear of the camera, in the form of a miniature white knob which should be finally adjusted after the camera has been allowed to warm-up for 10 minutes prior to each period of operation. On the optical side, the lens stop should be adjusted for optimum picture gradation with sufficient light to give adequate contrast, yet not excessive light reaching the target and causing the highlights to wash-out. Televised scenes should normally be lit to at least 50ft candles, i.e. the normal level of good office lighting. The camera will work reasonably well on scenes with intensities of illumination down to 10ft candles and in some cases even less. ■

UHF "BOWTIE" A

W. GROOME

ONE of the advantages of u.h.f. is that aerial designs too bulky for, say, 45Mc/s can be scaled to small, practical dimensions. The Band V aerial shown in the photograph can be made in an hour or so for a cost of only a few shillings, yet it provides an excellent BBC-2 input in a district where the present (July, 1965) low-power transmission from Sutton Coldfield is generally troublesome. The trifling cost certainly justifies a trial before buying an expensive array of park railings for the chimney. Although the prototype is for Band V the article includes dimensions derived by the same formula for Band IV.

This type of aerial has been known since 1940 as a "corner reflector", a description that is less apt now that it is turned round for horizontal polarisation but unlikely to be changed after all this time. The purpose of the reflector—which in this version is made cheaply of aluminium foil on hardboard—is to cast mirror images of the signal upon the dipole, correctly phased to supplement the direct pick-up. It also provides excellent back-to-front discrimination.

Dipole Impedance

The impedance seen at the centre of the dipole is influenced both by the angle of the reflector and by the dipole-to-apex distance, but the latter can be set to produce the required 75Ω for angles between 60° and 90°. Again, these two factors affect the length of the reflector sides and the decision to adopt 90° was guided by the smaller size this angle permits. The penalty of slightly lower gain than 60° was considered fair trade.

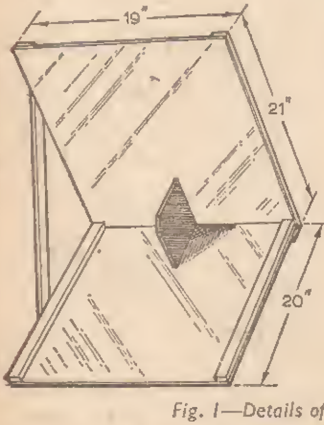
Channel 40 radiates vision and sound on 623·25 and 629·25Mc/s respectively and the aerial was designed for 625Mc/s, for which the wavelength is 48cm. For a 90° reflector and 75Ω impedance the dipole-to-apex distance should be ·35λ, which is 16·8cm or 6·614in. The effective reflector length must be not less than three times this distance, say 20in., and its minimum width is one wavelength, 19in. With allowance for an external batten joint the two pieces of hardboard should be cut 20in. and 21in. long and both 19in. wide. These sizes can be exceeded if you have handy pieces already cut or you can, for economy, make them up from smaller pieces provided the edge joints are backed with adequate strips of the same material.

Reflector Assembly

Assembly of the reflector is shown in Fig. 1 and it will be seen that the dipole mounting strut adds stiffness to the apex. Further support is supplied by wood edge strips of about 1½in. x ⅜in. braced by side stays of the same section. The latter should be screw fitted in case they have to be removed to facilitate shifting the aerial through the loft opening. A small hole in each stay provides the simple means of lashing the aerial to the rafters. Another small hole through the apex of the reflector forms the cable entry. It will be noticed that the edge stiffeners are fitted to the face of one reflector side and to the reverse of the other. This is merely to simplify a nailed and pinned assembly and enables all four strips to have one end firmly nailed through to the rear batten.

The inner surfaces (but not the side support stays) should be covered with aluminium cooking foil, glued on and lapped over the edges. Joints, if the foil is too narrow, need no electrical bonding but should run across the reflector parallel with the dipole and have wide overlaps.

The dipole mounting strut begins as a piece of ½in. wood cut 5¼in. square. One corner is cut away at right-angles to a diagonal line, as in Fig. 2,



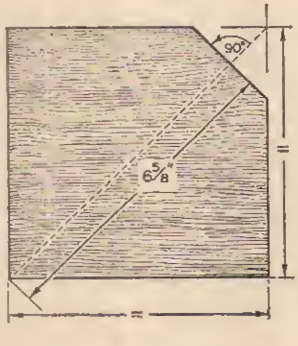


Fig. 1—Details of hardboard reflector.
Fig. 2—The dipole mounting strut.

ERIAL

to establish the dipole-to-apex distance. This works out at 6·614in., but 6⅝in. is near enough in view of the tolerance of the system and the fact that the tapered dipole itself varies the distance. At the point to which the dipole is to be fitted the thickness of the strut should be reduced to $\frac{5}{16}$in. by paring each side equally. This will ensure that the dipole elements will not touch wood.

Dipole Elements

Make the dipole elements of aluminium or copper sheet, cut and scored as in Fig. 3. Drill as shown and fit 6BA screws and nuts temporarily before bending to triangular cross-section. (It would be difficult to fit the screws after bending.) It will be noticed that self-threading screws have been used for the prototype, hence the appearance of heads on the outside instead of nuts and washers. Perspex sheet $\frac{1}{16}$in. or ⅛in. thick is a more suitable material for the dipole mounting plate than the resin laminate types. Details of this simple part, together with the complete bow-tie assembly, are given in Fig. 3. Note the solder tag under each end nut.

Screw the bow-tie to the strut in the reflector and solder the 75Ω coaxial lead to the tags, leading the cable out through the hole in the apex and anchoring it to the external wood batten by clip or staple. The aerial is now ready for use. No mounting arrangements have been included because it is a simple matter to suspend the aerial from the roof timbers by cords attached by holes in the front stays and staples in the rear batten. The normal position is such that the apex and dipole lie on a horizontal line pointing towards the transmitter. Adjustment is best done while the test card is on the air and the assistance of someone who can interpret what he sees on the screen is desirable—someone with sufficient vocal power to have his bellowed observations heard in the loft. I found that my wife was excellent in observation but not altogether effective with the bellow!

The aerial has broad-band characteristics and would probably receive all local frequencies in the band without alteration. However, it has been shown that calculation of dimensions is easy enough for those who would like to tune "spot on" to a frequency other than 625Mc/s. This applies equally to Band IV but the details below are for a 530Mc/s aerial to tune the four London area channels.

λ=56·6cm.

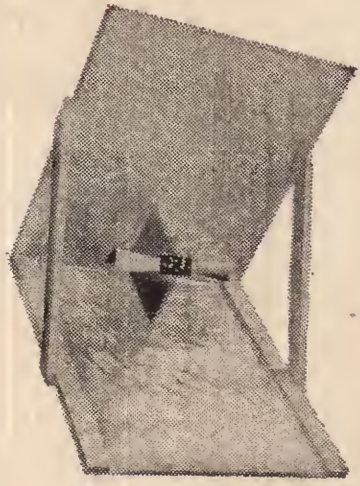
Dipole 10⅝in. overall, elements 5⅛in. long.

Dipole to apex 7¾in.

Reflector 23in. wide, 24in. long minimum.

Although only a few inches larger in each dimension than the Band V aerial the difference may become significant when you attempt to manoeuvre the assembly through the loft hatch. For this reason a screwed assembly is suggested, for this can be partly dismantled after trial fitting and re-erected *in situ* up there among the cobwebs.

—continued on page 172



Photograph of prototype. Note position of "Bowtie" element.

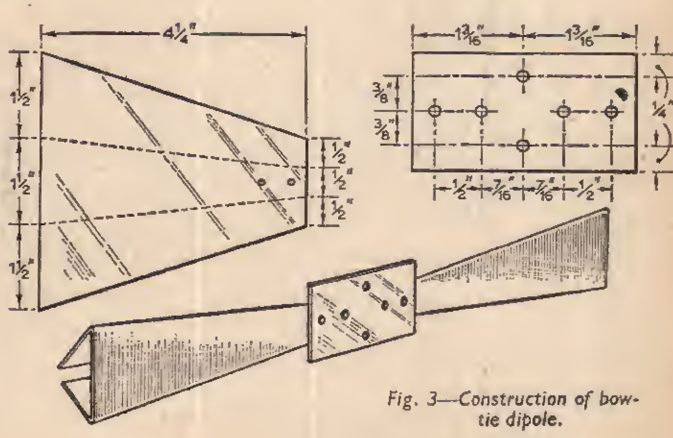


Fig. 3—Construction of bow-tie dipole.

G. K. FAIRFIELD

Checking Performance

OF EXPERIMENTAL RECEIVERS

Part Two

LAST month I described several unusual receiver measurement techniques and in one of these a simple bi-metallic thermocouple was used. As the reader will appreciate this device can be put to several uses in limit performance measurements in the television receiver.

Transformer Measurement

The temperature at which the power transformers run in a television set can have a considerable effect on the life of these components. If the line output transformer, for example, is operated continuously at temperatures far in excess of its rating then the wax impregnation will soften and run off, the interwinding insulation will become brittle and eventually crack, causing breakdown to ultimately occur. Excessive corona from the e.h.t. winding due to the melting of the protective wax coating has caused many a television receiver fire with widespread damage throughout the set.

The most reliable check on this component is a direct check on the running temperature, using the thermocouple described. The "hot" junction can be strapped to the low voltage windings as shown in Fig. 6. (Not to the core since this is usually constructed of ferrite—a good heat insulator, and certainly not to the e.h.t. winding or this will cause a breakdown of the transformer due to corona discharge.) The thermocouple will have been calibrated previously and it will only be necessary to note the microammeter reading after the set has been in operation for at least half an hour. A temperature rise of up to 55°C is permissible with most designs. Anything over this will run the risk of ultimate breakdown.

An alternative way of measuring transformer temperature rise is to make use of the positive temperature coefficient of copper used in the transformer winding. In other words the increase of resistance of the winding as the transformer gets hotter. For this measurement we require a sensitive ohmmeter — preferably a Wheatstone Bridge. Selecting a winding in the centre of the transformer, its resistance is carefully measured after the set has been switched off for at least one hour. This gives a measure of the "cold" resistance, Rc. The set is switched on and runs for an hour inside its cabinet. Immediately after switching off the resistance of this same winding is again measured. This gives a higher resistance figure for the "hot" resistance, Rh. The transformer temperature rise is then given by:—

$$\text{Rise } (°\text{C}) = \frac{\text{Rh} - \text{Rc}}{\text{Rc} \times 0{\cdot}00393}$$

A typical example would be a mains transformer in which the primary resistance could be 22Ω when measured "cold" and 26·1Ω when measured "hot". The temperature rise would then be:—

$$\frac{26{\cdot}1 - 22{\cdot}0}{22 \times 0{\cdot}00393} = 48°\text{C}$$

which is within the 55°C limit mentioned earlier.

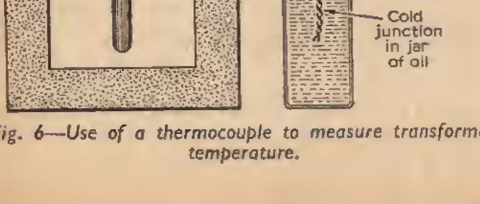


Fig. 6—Use of a thermocouple to measure transformer temperature.

Receiver Alignment

In aligning the r.f. and i.f. stages of the receiver there is unfortunately no cheap substitute for the signal generator. As an indicator, however, we can make use of the detection diodes incorporated in the receiver and use a microammeter in series with the diode, instead of the more usual diode valve-voltmeter (Fig. 7). We are, in fact, constructing our own valve-voltmeter in this way.

If the alignment is commenced from the last vision i.f. stage and proceeding stage by stage towards the aerial circuit then the microammeter can remain permanently in series with the diode for all the vision alignment measurements. For sound alignment it will, of course, be necessary to transfer this to the sound detector diode. A 50μA ammeter will be required for this purpose, shunted by a small capacitor as shown in Fig. 7. Since linearity of movement for this microammeter is not of importance (since we will always adjust the tuned circuits for a maximum), then use could be made of the very cheap "surplus stores" meters which are available. These often originally served to measure air temperature in aircraft and after the interior shunt resistance has been removed a very sensitive instrument often results.

Valve Characteristic Measurement

Finally a new use for that old television receiver! The experimenter often has a collection of power valves of doubtful origin and would like to check their performance under dynamic conditions. This is often the case with line scanning valves for instance where a static valve test would not show up faults occurring at peak currents. The most useful characteristic for such valves is the anode current/anode voltage (Ia/Va), variation since this is directly related to the power that the valve can handle. With very little difficulty this characteristic can be displayed on the screen of a cathode-ray tube and the performance of the valve checked very quickly.

The circuit used is shown in Fig. 8. It is assumed that the e.h.t. and brightness control section of the set is in working order and also the h.t. supply. Other sections not needed for this experimental set-up, such as the sound and vision receiver and time bases, can be disconnected from their connections to the cathode-ray tube and scanning coils. If the e.h.t. is derived from the line time base, as is usually the case, it will be necessary to load the scanning transformer with an inductance of about 10 mH in place of the scanning coils to maintain a supply of accelerating volts for the tube.

The condition of the cathode-ray tube is not very important providing it is capable of showing a single line trace on the screen. Before modifying the set this can be checked simply by disconnecting the field scan coils to collapse the raster to a single line.

The valve to be checked is connected to a source of about 200 volts, as shown, with the field scanning coils of the television receiver in series with the anode. Also in series with the h.t. supply is the secondary winding of a 200 volt a.c. mains transformer. Thus the h.t. supply for the valve will

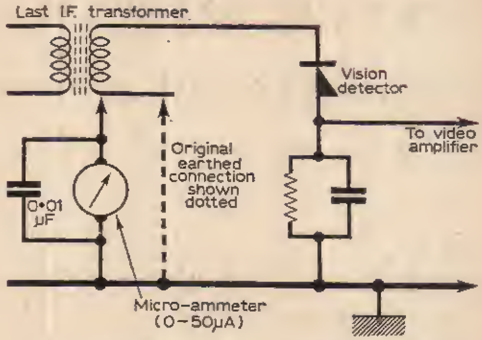


Fig. 7—Insertion of a microammeter for receiver alignment.

be made to vary between 0 volts, when the induced voltage across the secondary winding is of the opposite sign to that of the 200 volt h.t. supply; and +400 volts, when the induced voltage adds to the h.t. supply (see Fig. 9).

With the grid bias set to a value determined by potentiometer P, the variation of the anode supply voltage will cause a change in the anode current of the valve, and, since this current flows through the field coils, it will cause the cathode-ray tube beam to be deflected vertically in accordance with the value of the current, Ia. At the same time a voltage proportional to the anode potential, Va is derived from a 6·3 volt winding on the transformer and caused to deflect the beam in a horizontal direction. Thus the Ia/Va characteristic is displayed over the voltage range determined previously as 0 to 400 volts, for a given grid bias—Vg. Of course the range of Va could be adjusted to suit the valve by altering the value of h.t. supply

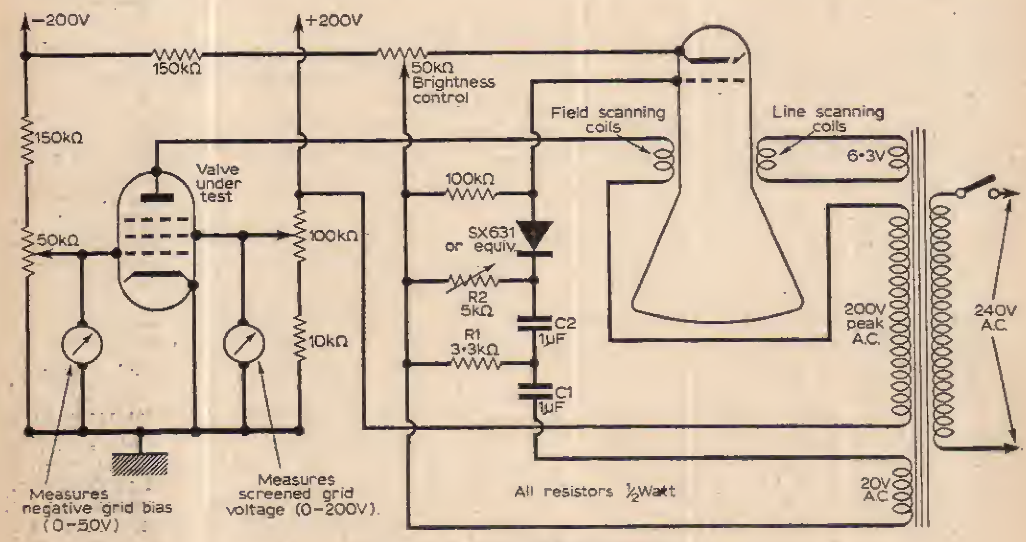


Fig. 8—Valve characteristic display.

and secondary voltage (which I have fixed at 200 volts in the above example). Both must be kept the same or the minimum value of Va will not be 0 volts.

Unfortunately with the simple scheme so far described, the characteristic as the anode voltage *falls* from +400 volts to 0 volts will also be displayed on the screen. This can cause some confusion as the traces will not lie exactly on top of one another. To remove this negative characteristic a beam blanking circuit is used to supply a large negative voltage on the grid of the tube at the correct time period. A 20 volt a.c. secondary winding on the mains transformer supplies a sinusoidal waveform to a phase-shift circuit, C1R1C2R2. With R2 correctly adjusted a sine wave shifted by

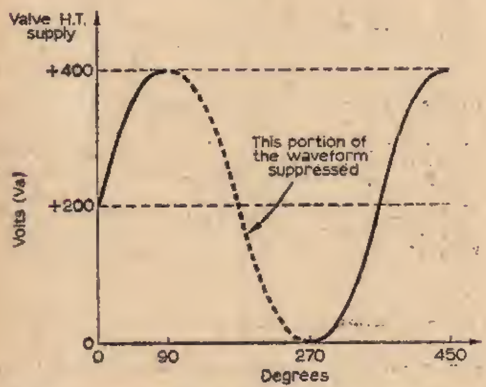


Fig. 9—Variation of valve anode voltage with sinusoidal mains voltage.

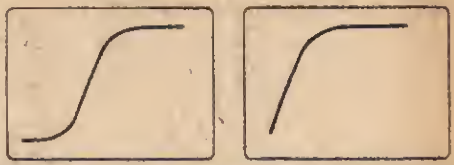


Fig. 10—Left—correct curve showing a flattening at both ends of the Ia/Va characteristic. Right—incorrect portion of the trace blanked out, due to the anode current decaying more slowly when the anode voltage goes from a high value to a low value.

exactly 90° with respect to the input waveform will be applied to rectifier V2 and a negative half-cycle of the wave is developed across the 100kΩ cathode-ray tube series resistor.

Consideration of the diagram of Fig. 9 will show that under these conditions only the rising portion of the anode potential Va will be displayed on the tube. Adjustment of R2 is quite easily achieved by observation of the cathode-ray tube trace when displaying a characteristic. The correct setting is obtained when a complete single trace is obtained with a flattened portion at either extremity of the trace (see Fig. 10). This corresponds to zero anode volts on one hand and valve saturation at the other end of the trace.

Calibration of the waveform displayed can be carried out under static conditions by passing known current measured with a series milliammeter through the field coils from a d.c. supply, and in the horizontal direction by applying a known d.c. voltage across the line scanning coils. This will only need to be carried out once and the calibration points marked on the screen of the tube in ink. ■

UHF "BOWTIE" AERIAL

—continued from page 169

The construction described is adequate for a sheltered existence in the loft but if erected outside it would sail away to the next county with the first light wind. However, the same dimensional details could be interpreted in metal provided the wind resistance of the reflector is drastically reduced. Fortunately it is not necessary to achieve the optical reflection that is provided with foil, which is used mainly because of its low cost. The wavelengths even in the higher megacycle range are very long compared with that of light and an apparently coarse surface can appear to the signal as a highly reflective plane provided its "flaws" are small compared with the wavelength. Hence an open wire mesh can be used and will bring a considerable reduction in the area opposed to the wind.

The strong welded rectangular type of mesh would be suitable and the 90° reflector could be bent up from a single length. A sturdy but light frame would be necessary, welded (with the aid of your local garage workshop perhaps) complete with strong erection arrangements. A plain tubular dipole would be stronger and easier to mount rigidly than the bow-tie. The strut would have to be all plastic and some thought would have to be given to the weatherproofing of cable connections. Clearly the construction of an outdoor aerial is a far more formidable task than an indoor model and should be undertaken only by those experienced in metal work. ■

Servicing TELEVISION Receivers

No. 120: The Decca DM3/C serial No. 50,001 onward

by L. Lawry-Johns

CONTINUED FROM PAGE 112 OF THE DECEMBER ISSUE

Loss of Contrast

Many set owners have blamed the tube, thinking that loss of emission is responsible for a weakly contrasted picture, when in actual fact the video amplifier PCF80 is at fault, and replacement restores a normal contrasted picture. In this connection, it is also prudent to check the capacitor C40 100μF, which is across one of the video amplifier bias resistors. When this component becomes open circuited the effect is not only one of loss of contrast, but also of poor synchronisation, the frame hold being particularly affected because of its low frequency. Low emission in the tube results in not only weak contrast, but the whites appearing silvery before going negative as the brilliance, contrast and/or gain controls are advanced.

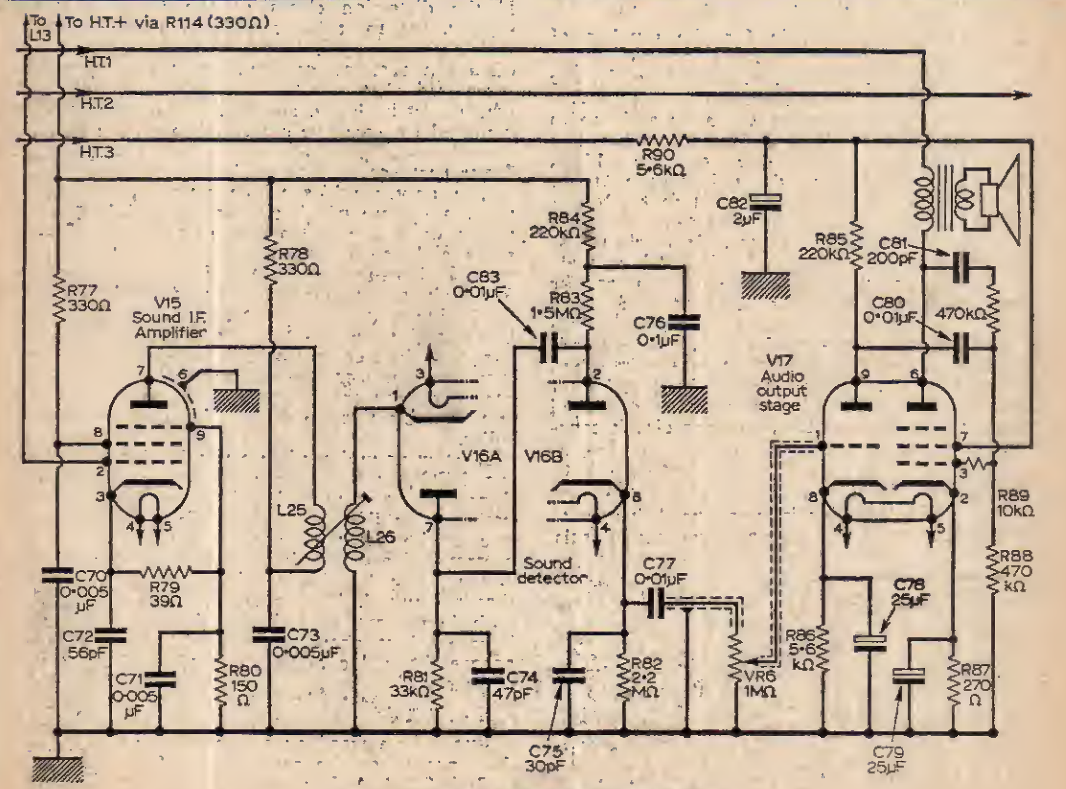


Fig. 4—Sound i.f. amplifier and audio stages.

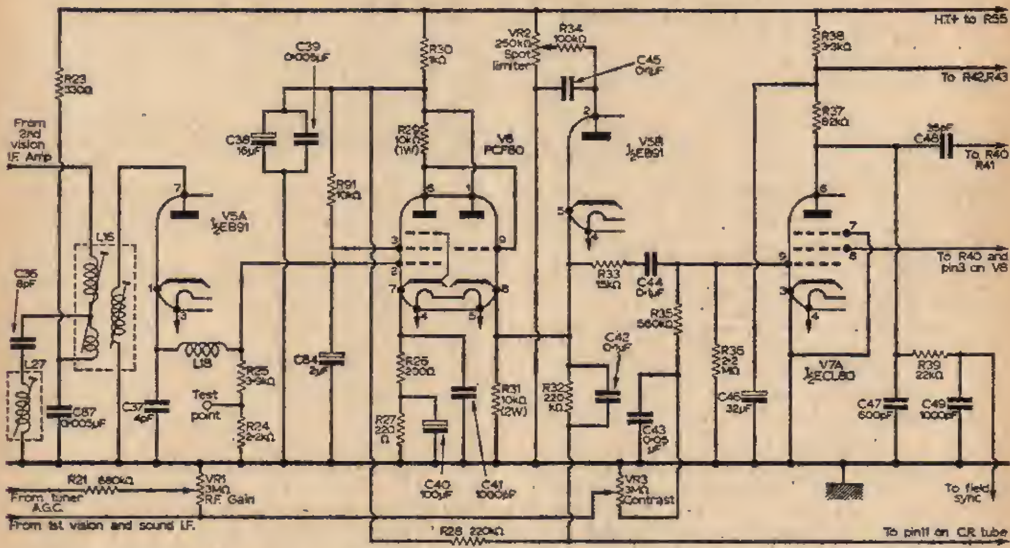


Fig. 5—Video stages—detector V5A, amplifier V6 and limiter V5B. V7A is the sync separator.

Sub H.T. Line Electrolytics

This receiver is notable for the number of electrolytic capacitors used to separately decouple various sections of the circuit. For example, the video amplifier alone uses two h.t. electrolytics C38 16μF and a 2μF decoupling pin 3, in addition to the cathode 100μF. The audio circuit has two 16μF, and one 2μF, one of the 16μF, C68, being used for decoupling the tuner unit and early i.f. stages. In addition a 32μF is used in the h.t. feed to the line oscillator-discriminator-sync separator stages. It is always as well, therefore, to have a test 32μF 350V available with convenient leads or prods so that it can be bridged across any suspect as a quick check. O.C. electrolytics can produce various symptoms, including cross modulation—sound on vision—vision on sound—poor sync—weak contrast, and some other, more odd effects. Many receivers have had their alignment seriously and unnecessarily disturbed when the fault was, in fact, an open circuit capacitor.

Sound Distortion

When audio distortion is experienced, it pays to note the effect of the r.f. gain and contrast controls. If the distortion clears as the signal becomes weaker, the most likely offender is R83 1·5MΩ, which will often be found to be "high." If the distortion remains, or even worsens, as the gain is reduced, check the PCL82 V17, the 0·01μF C80, which may be leaky, and R87 270Ω which can be damaged by excessive current through the PCL82.

Tuner Troubles

The only troubles which normally afflict the tuner are those which can be attributed to faulty valves or improper contact between the biscuit studs and the bank springs. The latter should never be bent in an attempt to improve the contact. The only attention needed here is a clean up of the biscuit studs which do get tarnished. Rub them bright and apply a little grease or oil to provide a surface barrier to further deterioration. If the studs do not locate properly on the springs, the correct adjustment (which is very rarely required) is to the large leaf spring which carries the stop roller.

A noisy or grainy picture usually denotes a failing PCC84 whilst the symptom of no signals directs attention to both valves, more particularly perhaps, the PCF80. A new PCF80 may necessitate readjustment of the oscillator coil core if correct tuning is outside the range of the fine tuner. A fairly long knitting needle, nicely shaped, is all that is required. The fine tuner is set midway and both knobs are pushed off. The trimming tool is inserted at about the one o'clock position to engage the coil core which is adjusted for maximum sound

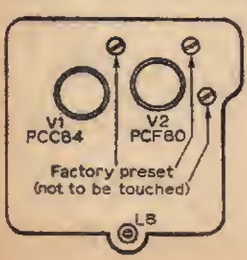


Fig. 6—Location of V1, V2 and L8.

Fuse Failure

Just to be awkard we will mention a short which does *not* cause the set fuses to fail! C61 is a 0·02μF 250V A.C. rated capacitor. It is wired from the neutral side of the mains to the switched

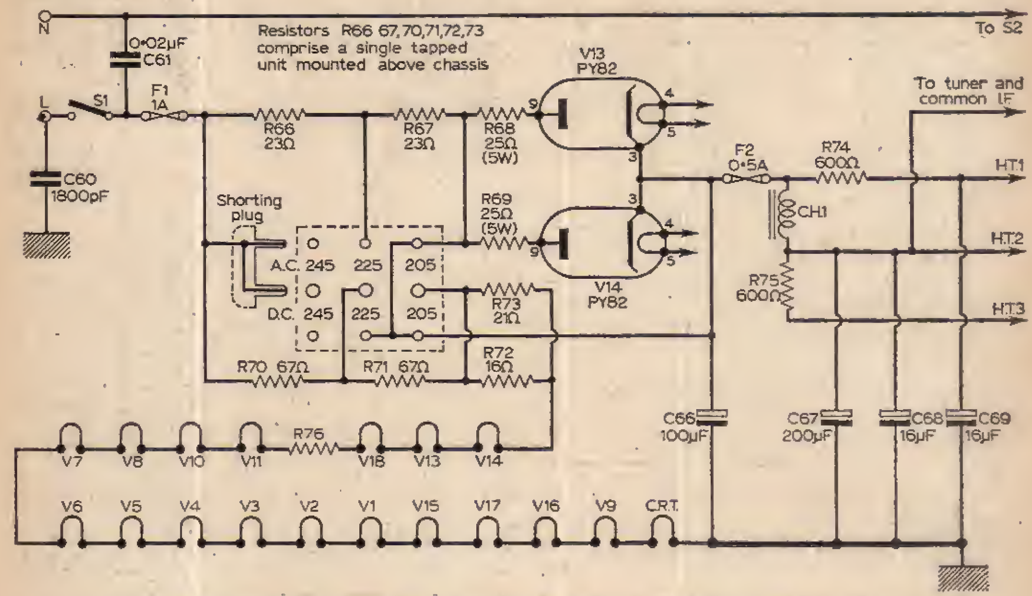


Fig. 7—Mains power supply and heater chain circuitry. Note if C61 is replaced it must be 250V a.c. working.

side of the live mains before the fuse F1, which is perhaps a little unfortunate. When these capacitors go, they go like a pistol shot and either blow the mains supply fuse or shatter the live contacts of the on/off switch.

The 1A fuse usually fails when the PY82 valves internally arc, as they often do. If there is any doubt about their responsibility, light tapping on the valve envelope will often reveal the culprit as particles spark across the electrode assembly.

If and when the PY82 valves light very brightly after switching on, check both and the PY81, which may have a heater-cathode short. Failure of the heaters to glow at all could, of course, mean failure of the 1A fuse, an open circuited section of the mains dropper or a failure of one of the valve heaters. The PY81 is often the valve which is found to be responsible, and it is worth checking this one first if a meter or a neon is not to hand to run along the heater chain. ■

DX-TV

A MONTHLY FEATURE FOR DX ENTHUSIASTS

by Charles Rafarel

THE past month has not been too bad, although conditions could have been better. There were some Sporadic E openings, notably as follows:

October 23—R1, M.T. Budapest.

October 24—E2, E3 and E4, T.V.E. Spain, also E3 Portugal.

October 25—E3, T.V.E. Spain.

Since then Sporadic E reception has been absent in this area, although this is about normal for this time of the year. Tropospheric openings have been reasonably good at times and although we have not had the spectacular conditions reported last month, Band III DX has once again been quite good.

As I am at present re-organising the u.h.f. side of the equipment here, I cannot give a personal assessment of what has been happening, but from correspondents' reports it seems that u.h.f. has been roughly on a par with last month.

NEWS

There have been a number of alterations in the test transmissions of French TV. As before, there is a half hour duration test transmission before the start of programmes, and also an afternoon transmission (1230 G.M.T. onwards) when there is no afternoon programme. This applies to all weekdays except Monday, there is no Monday test transmission in the afternoon as TV retailers are shut on Mondays.

The form of both these test transmissions has changed somewhat and two new features have been introduced into both of them: (1) A caption now appears as below:—

"Emission destinée aux constructeurs.
Transmission de Fréquences Vocales."
40Hz.

*(Transmission intended for constructors.
Transmission of Vocal Frequencies.
40 cycles.)*

While this type of caption is being transmitted a 40c/s note is transmitted, then the frequency indication is changed to 80 cycles, and an 80c/s note is sent out, and in all 10 frequencies appear: 40, 80, 125, 250, 500c/s, 1k, 2k, 4k, 8k, and 15kc/s are transmitted each one for approximately one minute duration.

(2) At other times a new version of the O.R.T.F. test card is used. This does not carry the "statue" in the centre, but in place of this the words:—

"24 heures sur 24	*(24 hours out of 24*
écoutez	*listen to*
France	*France*
Inter."	*Inter.)*

While this type of test card is being transmitted, the associated sound channel relays the long wave sound broadcast from the Allouis transmitter of France Inter. This might well be confusing here for DXers looking for the TV sound channel as they could be under the impression they were receiving a harmonic of the long wave station.

Just a final note on French TV. I heard a TV news item recently about the opening of a new regional station in Burgundy at Nuits St. George, but no mention of the channel. And what has happened to Rouen Gd. Couronne on F10? It has been recently putting a much improved signal into Southern England and has been well received as far north as Northampton. This was not normally a very good signal, so there may have been some modifications at the transmitter.

READERS' REPORTS

Jack Readings of Cowley, nr. Cheltenham, has sent us an excellent O.R.T.F. 2nd Chain test card photo of his reception of Lille Ch 27. He is really quite a distance from Lille, which makes the clarity of his photo quite remarkable. He has also had Caen Ch 25, and the Band III Lille F8 as well.

In addition to French u.h.f., like other DXers, he has had a number of West German u.h.f. transmitters as well, but as there are so many of these in operation, it is not possible to identify them individually, unless the DXer is lucky enough to see the station name transmitted.

D. F. Browne of Hove is a new contributor, and he has come in in a "blaze of glory", on u.h.f. with France Ch 21 Brest, Ch 25 Caen, Ch 27 Lille, Ch 33 Rouen, and probably Ch 45 Rennes as well. He also reports reception on many u.h.f. channels from West Germany, but full identification is not possible from the information received.

May I stress one point re u.h.f. identification? Would correspondents ensure that their u.h.f. tuner calibration for *each* channel is correct; we really do need this before we can even attempt to tackle identification problems for you.

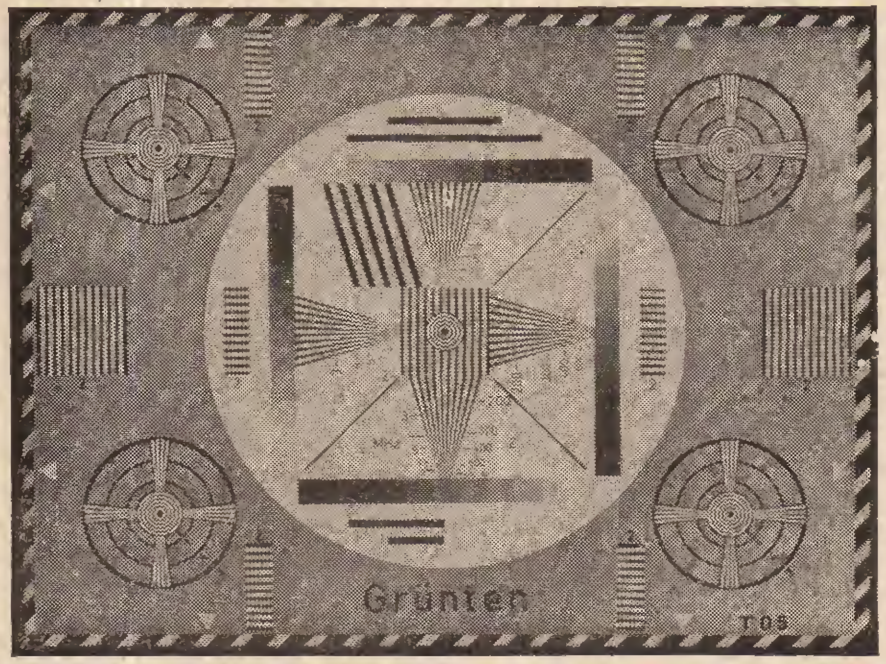
A. G. Challis of Brundall, Norfolk, has turned in a good log with France F8 Lille, Belgium E8 Wavre, and E2 Ruiselede, Denmark E7 Sonderjealland, and (via Sporadic E) U.S.S.R., Poland, Norway, Sweden, and Czechoslovakia. With this success behind him he is now turning to u.h.f., and I feel sure that from his geographical location he will do well.

Our old friend **M. Roper** of Torpoint, Cornwall, is now improving his aerial installation by the introduction of a new "tip-over" mast! He is suffering, it appears, from the absence of Brest Ch 21, his nearest Continental u.h.f. This transmitter does seem to be "patchy" in its propagation area, and it is not easy to receive even when the distance is quite modest.

B. Williamson of Shetland has been receiving Bergen, Norway, on Ch E9, and this on a horizontal array! He is now inspired to erect a Band III aerial, so I feel sure that we shall be hearing of more Scandinavian results from him soon. He has been receiving T.V.E. via Sporadic E as well, although there has not been much activity in his area recently, so I suppose the Shetland domestic viewers have had less to complain about this year.

I am getting many requests for details on the conversion of different makes and models of TV sets for DX work. When asking for details please enclose the service sheet and/or circuit for your set, otherwise it may be impossible to offer any useful advice.

DATA PANEL-5 B.R.GRÜNTEN, WEST GERMANY



Channels: Bayrischer Rundfunk operates on channels E2, E3 and E4. The E2 transmitter at Grünten is the most often received here, but E3 Kreuzberg, and E4 Raichberg are also seen at times. The only difference in the test card is in the station name at the bottom.

Test Card: Monday to Saturday 10.00 to 10.30 G.M.T. card but no sound. Mon., Wed. and Fri. 10.30 to 11.25 card with note or music. Tues., Thurs. and Sat. 10.30 to 12.00 card with note or music. Also Mon. to Sat. inclusive 13.00 until start of programme about 16.35 card with note or music.

Programmes: Normally start about 16.35 daily. At times the E.B.U. electronic test pattern with single white circle is also radiated (see page 497 *Practical Television*, August 1965).

NEW SOLID-STATE CCTV SYSTEM FROM EMI

A NEW solid-state closed circuit television system —Type 9— has been developed by EMI Electronics Ltd.

Three different cameras, including one of the smallest in the world, have been designed for use in the new system. They operate with modular power and control units, which are considerably smaller than any other units with similar functions currently available.

Printed-circuit construction is used throughout and all sub-units and printed circuit cards are easily unplugged from the main frames for servicing. In the case of serious failure a new sub-unit or circuit card may be inserted in a few moments.

Available as standard accessories are attachments for the remote control of focus, lens aperture (iris), zoom and lens changing. Remotely controlled pan and tilt heads are available for the control of camera movement and special camera enclosures are designed for use in wet, dusty or explosive conditions.

The Type 9 equipment is also fully compatible with the low-cost EMI Type 8A self-contained, solid-state closed circuit television camera.

TRADE NEWS • TRADE NEWS • TRADE NEWS TRADE NEWS • TRADE NEWS • TRADE NEWS

SOLID STATE POWER SUPPLY FOR TRAVELLING WAVE TUBES

STANDARD Telephones and Cables Limited has engineered what it believes to be the first example of a completely solid state power and control system for a stabilized e.h.t. supply to a travelling wave tube. The units will be used in u.h.f. television translator units to be supplied to the BBC by the company.

The new STC power units are a closed loop system for voltage output stabilization. Included in the units are sub-assemblies of thyristor control stacks, silicon avalanche e.h.t. rectifiers, which are self-protecting against voltage transients and 3-phase thyristor trigger units.

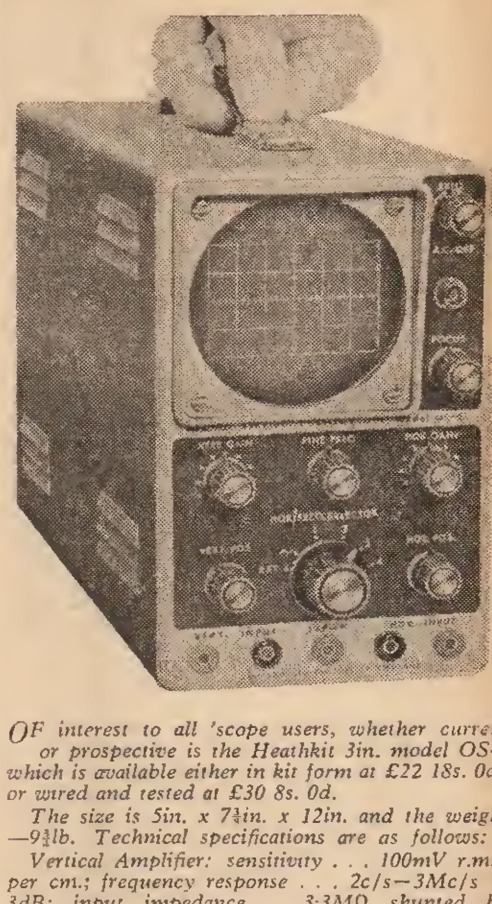
Operating from normal mains supplies to the unattended translater stations, the STC power units will function under fluctuations of a.c. supply voltage to provide 3,200 volts d.c. at 0·75A to the TWT's with a stability of ±0·5%.

Solid state e.h.t. supplies for travelling wave tubes are smaller and cheaper than conventional equipments using transductors. In addition to their adoption for TV transmitters it is expected that the new equipment will find applications in national and international communications systems.

WHAT are they? An object shot from an unusual angle? No they're three microwave tunnel diodes—the first to be manufactured in the UK. Already the diode is being used as a low noise communication link of G.E.C. Telecommunications Ltd., which can handle 960 telephone channels or a colour TV signal. The diode is designed for use in low noise amplifiers at frequencies up to the S-band (2—4Gc/s) and samples are available with minimum cut-off frequencies of 6, 8, and 10Gc/s.

The photograph shows the diodes enlarged some eight times. In real life, their vital statistics are 1·5mm x 1·4mm.

HEATHKIT OS-2



OF interest to all 'scope users, whether current or prospective is the Heathkit 3in. model OS-2 which is available either in kit form at £22 18s. 0d., or wired and tested at £30 8s. 0d.

The size is 5in. x 7¾in. x 12in. and the weight —9¾lb. Technical specifications are as follows:

Vertical Amplifier: sensitivity . . . 100mV r.m.s. per cm.; frequency response . . . 2c/s—3Mc/s ± 3dB; input impedance . . . 3·3MΩ shunted by 20pF.

Horizontal Amplifier: sensitivity . . . 100mV r.m.s. per cm.; frequency response . . . 2c/s — 300kc/s ± 3dB; input impedance . . . 10MΩ shunted by 20pF.

Timebase Generator: recurrent type . . . linear sawtooth produced by multivibrator; range . . . 20c/s — 200k/s in four steps; synchronisation . . . automatic lock-in circuit, using self-limiting synchronising cathode follower; retrace blanking . . . blanking amplifier provided, operates on all ranges.

General: valve complement . . . ECF80(1), 12AU7(4), 12AX7(1), EZ80(1), and c.r.t. 3RP1, medium persistence, green trace.

BEULAH TV CAMERA KIT

FROM Beulah Electronics Ltd., 126 Hamilton Road, West Norwood, S.E.27, comes the "Beukit" CCTV camera kit. The printed circuit board has all the component positions marked on it and a preformed cable harness reduces the wiring time by nearly three hours.

Power consumption is approximately 15W: line frequency 405-625 per sec.; frame frequency 50 per sec.; frame pulse width approximately 4 lines duration and line blanking width approximately 18μSec at 405 lines. Modulated output is provided

The camera kit costs £40, the vidicon £12 and on channels 1—5 in band 1.

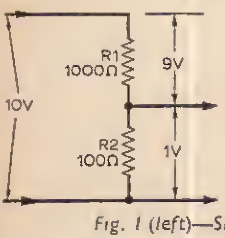
The camera kit costs £40, the vidicon £12 and the lens £13 19s.

ATTENUATORS

—THEIR FUNCTION AND DESIGN

by H. T. Kitchen

An attenuator can be described as a device which reduces the amplitude of an electrical signal. Since a resistor impedes the flow of current one could assume that this is all that would be necessary, and to a certain extent, no more, one would be quite right. Attenuators, however, can be quite complex devices requiring considerably more thought and ingenuity than one would at first suppose, and it is hoped to present to the reader in a simple form some of the factors and formulae that have to be considered when designing an attenuator.



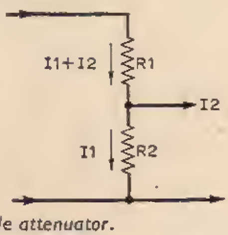


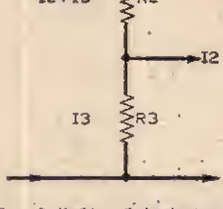
Fig. 1 (left)—Simple attenuator.

Fig. 2 (right)—Method of calculating component values.

The simplest practical attenuator is one consisting of two resistors in series, as in Fig. 1. The signal to be attenuated is fed across the two resistors and the output, duly attenuated, is taken from their junction, the degree of attenuation depending on the relative values of R1 and R2. Thus if $R1 = 1k\Omega$ and $R2 = 100\Omega$ and the input voltage $= 10V$, the output voltage will be 1/10th of the input, the remaining 9/10th being dropped across R1. The total resistance of R1 + R2 will, of course, depend on the source impedance into which the attenuator will be connected. The degree of attenuation afforded by R1 R2 is dependent upon the signal current being zero. In other words it must work into an infinite impedance such as the grid of a valve. Where the flow of signal current is appreciable, it will have to be taken into account when calculating component values. Figs. 2 and 3 show how to do this when calculating component values for fixed value one step and two step attenuators where R1 drops the total current I1 passed, R2 drops I2 + I3 and so on. Obviously this principle can be extended indefinitely and although it is included among attenuators it is probably of more use when supplying the various anode and screen requirements of a number of valves.

Potential Divider Extension

An extension of this simple type of potential divider is shown in Fig. 4 and is commonly met in many types of equipment, being used at the input end of oscilloscopes and valve voltmeters, and at the output end of many audio oscillators and some simple r.f. oscillators. Where the attenuation required is in decimal fractions, nothing more than mental arithmetic, aided perhaps by pencil and paper, is required. For instance, if Fig. 4 was required to have a total resistance RT of $1M\Omega$ and to provide attenuation factors of 10, 100 and 1,000, we would start by assuming that $RT = R1 + R2 + R3 + R4$, and then calculate the value of R4. Since $RT = 1M\Omega$ and the attenuation factor "a" = 1,000, $R4 = \frac{RT}{a} = 1k\Omega$. R3, which is calculated next is equal to $\frac{RT}{100} - R4$ which gives us



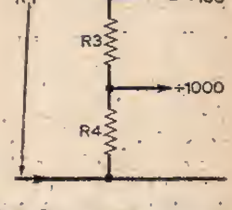


Fig. 3 (left)—Calculating values for two-step attenuator.

Fig. 4 (right)—Commercial step-attenuator.

$$\frac{10^{7}}{10^{6}} = 10k\Omega - 1k\Omega = 9k\Omega.$$

R3 is therefore 9kΩ. Similarly, R2 will be given by $\frac{RT}{10}$ minus R (R3 + R4) or 90kΩ. Finally, Rt, which is equal to RT minus R2 + R3 + R4 or 900kΩ. Added together they all add up to RT, and in fact this is a useful check, for if all the individual resistors calculated are found to be equal to RT the chances are they are correct. Little accuracy would be lost if R2, R3 and R4 were made 9·1kΩ, 91kΩ and 910kΩ, which are the nearest preferred values, whilst 10kΩ, 100kΩ and 1MΩ resistors could be used where absolute accuracy was not of paramount importance.

dB Losses

Although this method works well where decimal fractions or other straight forward ratios are concerned, the chances are that it will become time consuming and more than somewhat tedious if odd ratios have to be calculated, such ratios not being uncommon where the attenuator is desired to provide a number of specific dB losses. In these cases a table giving dB losses below unity can be of the utmost importance since it allows resistance values to be obtained as direct fractions of RT. Let us suppose that an attenuator with RT = 100Ω is required to provide a loss of 2dB. From our table we see that 2dB corresponds to a loss of 0·794, so that R2 would be equal to 79·4Ω, leaving R1 at 20·6Ω: If Fig. 4 was required to provide three steps of 10dB and have RT = 1,000Ω, we would start by finding the value of R4, which would be 31·6Ω. R3 would be 68·4Ω and R2 would be 216Ω, leaving R1 = RT − 316Ω or 684Ω, bearing in mind the remarks previously made about subtracting R4 from the calculated value of R3 and R3 + R4 from R2.

For many applications such as z.f. or low a.f. work this type of attenuator is quite adequate. It has several inherent characteristics which may or may not prove to be a disadvantage for work where higher frequencies are involved. Perhaps the most important of these characteristics is that its attenuation varies with frequency rendering an attenuator calibrated at x c/s useless at y kc/s. Why this should occur is readily explained by studying Fig. 5, which shows the normal components R1 and R2 plus a capacitor Pc in parallel with R1, and the dotted capacitor Sc in parallel with R2. We can for the time being ignore Pc and concentrate on the effect of Sc. At z.f. and low a.f. Sc has no effect upon the attenuation afforded by R1 and R2 alone, but as the frequency is increased the reactance of Sc decreases more and more so that it increasingly bypasses the signal to earth. When we reach the frequency at which the reactance of Sc is equal to R2 the signal will have been attenuated by 6dB compared to z.f. Now let us consider the effect of capacitor Pc, which is deliberately added across R1, unlike Sc which is present in all circuits to some extent, in the form of "strays". If by luck or skilful management we can make Pc a particular value we can counteract the effect of Sc and provide a perfectly level response. This again due to the decrease in Xc brought about by an increase in frequency, so that Pc passes the precise voltage "lost" by Sc. A level response will result when the time constant of R1 × Pc = R2 × Strays, and since the strays are variable Pc is usually a preset trimmer capacitor.

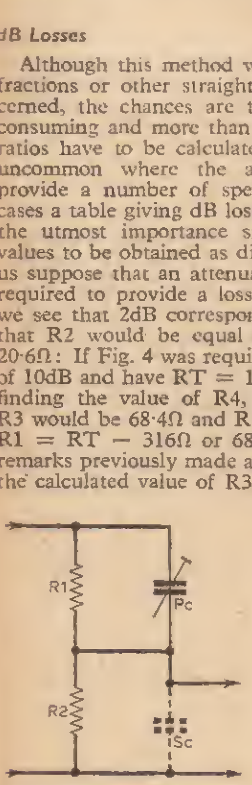


Fig. 5—Note the shunt capacitance across R2.

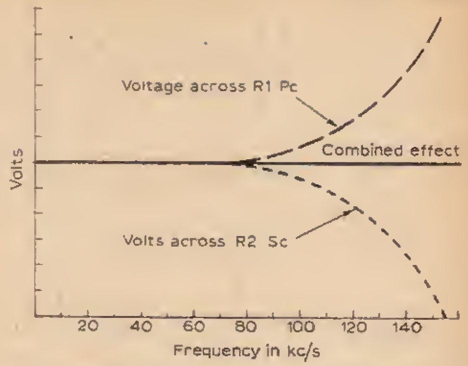


Fig. 6—Graph showing effects of shunt capacitance.

Impedance

The second characteristic to be considered is that of impedance. The output impedance Zo will differ from the input impedance Z1 by a factor equal to the attenuation ratio—but only when the load across Zo is infinite, as explained earlier. In a multislip or infinitely variable attenuator Zo will vary from equal to Z1 at zero loss to $\frac{1}{a}$ which will be the maximum ratio of attenuation.

The last characteristic of any significance concerns balance, or rather, the lack of it. Since one side of this type of attenuator is earthed or at least at chassis potential, it follows that it will be unsuitable for attenuating a signal balanced to earth. Where such a signal has to be attenuated or it is necessary to maintain Z1 = Zo a different form of attenuator will have to be used. This is illustrated in Fig. 7a, from which it will be seen that it comprises three resistors arranged as a "T" and, in fact, this is the name it is commonly known by. It fulfills the requirements of having Z1 = Zo, but is unbalanced. It is, however, easily converted for balanced operation by the addition of two further series resistors, Fig. 7b. When this is done all the series (horizontal) resistors have half the calculated values, the parallel (vertical) resistors being unchanged.

An infinitely variable form of "T" is shown in Fig. 7c, and comprises three ganged variable resistors. As the two series resistors increase in value the parallel one decreases and vice versa, thus maintaining Z1 = Zo, whilst providing infinite attenuation.

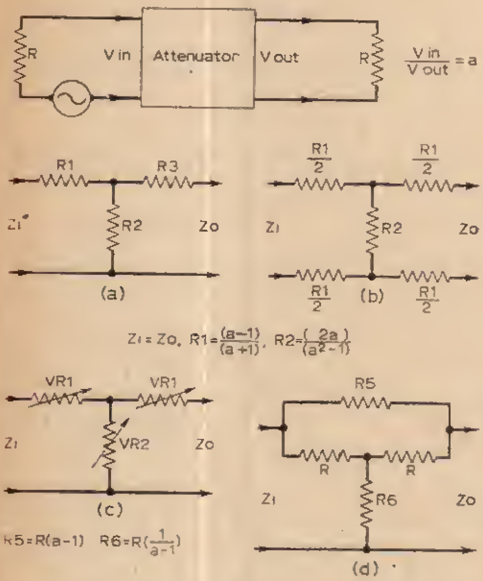


Fig. 7—Different forms of attenuator networks.

A variation of the ordinary T is the bridged T illustrated in Fig. 7d. Its primary advantage is that only R5 and R6 have to be adjusted to vary "a", the other two resistors being made equal to Z1 and Zo. These can therefore be permanently connected into circuit and a simple two pole switch used for selecting the desired attenuation ratios.

The π (pi) type attenuators illustrated in Fig. 8a and 8b balanced and unbalanced, have somewhat similar characteristics to the T types already discussed so that a choice of either type will depend upon personal taste tempered, perhaps, by experience.

Fixed Attenuation Rate

Although both the π and T types so far considered provide a fixed rate of attenuation it is often desirable for this to be variable whilst still maintaining Z1 = Zo. This can be done quite easily by arranging as many π's or T's as may be necessary, "side by side" as in Fig. 9. It is absolutely necessary to know whether π or T sections are to be used, for adjustments have to be made to either the series or parallel resistors, depending on which configuration will be used. Where T sections are to be used there will be two series resistors in series, and with the π type there will be two parallel resistors in parallel. Both legs can therefore consist of a single resistor having half the calculated value. There is a saving of components when this method is used as opposed to the requisite number of individual sections.

Although this form of attenuator is popularly referred to as a constant impedance device it does not, in fact, present a constant impedance, particularly when the switch wiper is at the extreme ends. This impedance change, however, is normally only slight and in point of fact the ladder, as it is often known, is almost certainly the most popular form of attenuator for almost all a.f. and m.f. and many v.h.f. oscillators. For v.h.f. and u.h.f. work specialised forms of ladder are used in which the active elements are screened from one another in cast aluminium boxes, to minimize leakage between adjacent sections.

It is probably safe to say that the majority of constructors build their attenuators around a rotary switch having one or more poles, their number depending on the type of attenuator used. The L type would only need a single pole switch as would the unbalanced T and π types. The balanced forms of T's and π's would, however, require a two pole switch.

Switching Circuits

There are other switching circuits which can sometimes be more useful if not more elegant. Instead of a rotary switch one could use a push button system, or less elegantly, a number of toggle switches having double pole two way contacts. The maximum attenuation would obviously depend on the number of push buttons or toggle switches as well as on the attenuation afforded by each switch. Fig. 10 illustrates an attenuator, designed along these lines, which provides a maximum rate of attenuation of 7dB in 1dB steps. When all the switches are open there is no attenuation. Closing S1 brings in 1dB, S2 brings in 2dB and S3 4dB. S1 + S2 equals 3dB, S1 + S3 equals 5dB, and S2 + S3 equals 6dB, whilst S1 + S2 + S3 equals 7dB. Adding another 8dB section would give a maximum of 15dB in 1dB steps, and additional 16dB would give 31dB in 1dB steps and so on.

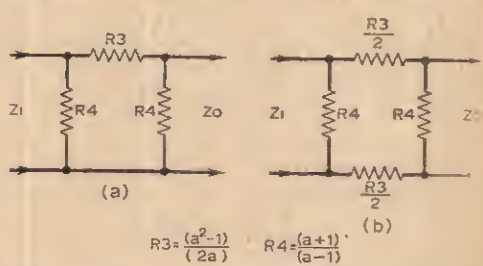


Fig. 8—π type attenuators (a) balanced, (b) unbalanced

This type of switching, particularly the toggle switch, has one advantage over the rotary switch particularly for r.f. work. With the rotary switch leakage across adjacent sections renders precise attenuation factors difficult to obtain, and this problem gets worse as the frequency is increased. Using toggle switches, it is possible to isolate each from its neighbour by means of careful screening and so

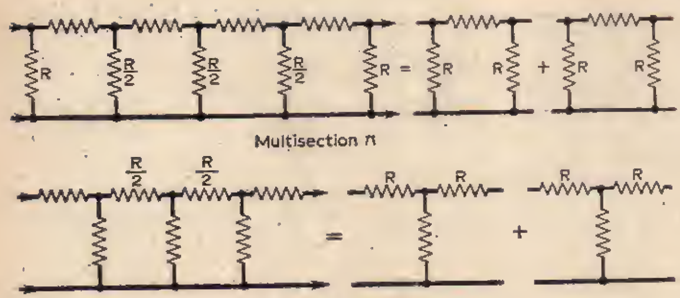
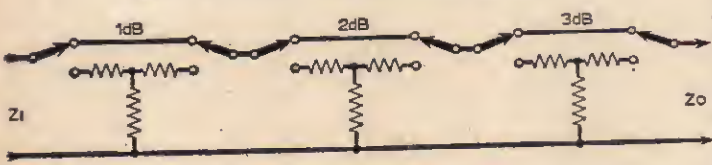


Fig. 9 (above)—Multisection pi and T networks.

Fig. 10 (below)—Switched attenuator (see text).



reduce leakage to a manageable level. The last type of attenuator to be considered is the highly specialised piston or wave guide which is devoted almost entirely to v.h.f. and u.h.f. applications. The principle of these is quite simple. Two concentric tubes are arranged so that one slides in and out of the other, which is fixed. A transmitting element is fixed to the static tube and a pickup element is fixed to the moving tube so that they can be placed very near to each other without actually touching, at which point the maximum signal transfer takes place. As the moving tube is withdrawn the distance between the elements increases and the signal transfer decreases. A rack and pinion is commonly used to drive the moving tube with a scale attached to the knob used to turn the pinion calibrated in dB's attenuator. A Faraday screen soldered to the end of the moving tube which is earthed, is used to prevent electrostatic pick-up whilst allowing the desired magnetic pick-up to take place. Although the principle is simple enough the mechanical construction is often complex, requiring critical machining if the attenuator is to function in the intended manner. A few "thou" more or less can cause mismatching at frequencies whose very wavelength is extremely short, and since few constructors will have the machining facilities necessary it is not intended to dig too deeply into this type of attenuator.

The Decibel

It would not, perhaps, be out of place to conclude this short discourse by a reference to that much used—and abused—unit, the decibel, particularly for the benefit of the newcomer who may only have a sketchy idea of what a dB is and what it does.

It is essential to remember that a dB is a ratio, a ratio of something to something else, more concisely volts, amps and watts, or fractions thereof. We cannot therefore have an amplifier with an output of just x dB, but we can have an amplifier with an output of x dB referred to y dB, which is really the same thing as saying that you put in so much and get so much more out. People who talk about outputs without mentioning the reference level are either hardened pro's who assume everyone within earshot is acquainted with the reference, or else they don't know their dB's. It is definitely safer, if not apparently so erudite, to quote a reference level and so put the issue beyond doubt.

For precise work, and in order to be academically correct, it is essential to know the input and output impedances *and these must be equal*. Why this should be can best be illustrated by considering an audio amplifier capable of delivering 5W across a 15Ω resistive load for an input of 1·5V across 1·5MΩ. The impedance levels have a ratio of no less than $10^5:1$. In order to calculate the voltage gain (if any) we will need to know the voltage developed across the 15Ω load at 5W and this, of course, will be equal to $\sqrt{W \times R}$ or $\sqrt{5 \times 15} = 8{\cdot}65$V. The voltage gain will therefore be equal to 8·65 : 1·5 or 15·5dB, which is not particularly impressive and does not give a true picture. This can be obtained if the impedance levels are allowed for by using the formula

$$20 \log \frac{Eo}{E1} = 10 \log 10 \frac{R1}{R2}$$

where R1 and R2 are the resistive elements of the impedances. If the current gain is being measured it will be equal to

$$20 \log 10 \frac{Io}{I1} + 10 \log 10 \frac{R2}{R1}.$$

Lastly dB are log functions multiplied by addition and divided by subtraction. ■

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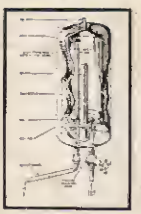

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